A Within-Person Analysis of Developmental Cascades Among Prosocial Behavioral Tendency, Internalizing Problems, and Externalizing Problems in Early Adolescence

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Abstract

Understanding the developmental cascades among prosocial behavior tendencies, internalizing problems, and externalizing problems holds important value for promoting adolescent mental health. Using within-person analysis methods, we analyzed three-year longitudinal data from 894 junior high school students and compared them with traditional cross-lagged panel models. The results revealed: (1) At the within-person level, prosocial behavior tendencies exhibited moderate or weak co-development relationships with internalizing and externalizing problems; T1 prosocial behavior tendencies negatively predicted T2 internalizing problems, and T2 prosocial behavior tendencies negatively predicted T3 externalizing problems, demonstrating weak predictive effects; (2) In the female group, T2 internalizing problems positively predicted T3 externalizing problems, whereas in the male group, internalizing and externalizing problems showed no mutual predictive effects; (3) The four factors of prosocial behavior tendencies (public, compliant, emotional, and altruistic) negatively predicted internalizing problems, and they only negatively predicted externalizing problems at T2, with weak predictive effects; (4) The research findings obtained through within-person analysis methods differed from those of traditional cross-lagged analysis methods, and different within-person analysis models also yielded different results. Conclusion: The development of prosocial behavior tendencies in early adolescence can reduce internalizing and externalizing problems, and this effect shows gender differences; within-person analysis methods hold important applied value in research on adolescent psychopathological development.

Full Text

Preamble

Intraindividual Analysis of Developmental Cascades Among Prosocial Behavior Tendency, Internalizing Problems, and Externalizing Problems in Early Adolescence

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Abstract

Understanding the developmental cascades among prosocial behavior tendency, internalizing problems, and externalizing problems holds significant value for promoting adolescent mental health. Using intraindividual analysis methods, this study examined three-year longitudinal data from 894 junior high school students and compared the results with traditional cross-lagged panel models. Findings revealed: (1) At the intraindividual level, prosocial behavior tendency showed moderate to weak co-movement relationships with internalizing and externalizing problems. T1 prosocial behavior tendency negatively predicted T2 internalizing problems, and T2 prosocial behavior tendency negatively predicted T3 externalizing problems, demonstrating weak predictive effects. (2) Among girls, T2 internalizing problems positively predicted T3 externalizing problems, whereas no reciprocal predictive relationships between internalizing and externalizing problems were found among boys. (3) Four factors of prosocial behavior tendency (public, compliant, emotional, and altruistic) negatively predicted internalizing problems, and they only negatively predicted externalizing problems at T2, showing weak predictive effects. (4) Results from intraindividual analysis methods differed from those obtained through traditional cross-lagged analysis, and different intraindividual analysis models also yielded divergent findings.

Conclusion: The development of prosocial behavior tendency in early adolescence can reduce internalizing and externalizing problems, with gender differences in these effects. Intraindividual analysis methods hold important applied value in research on adolescent psychopathological development.

Keywords: prosocial behavior tendency, internalizing and externalizing problems, Random-Intercept Cross-Lagged Panel Model, General Cross-Lagged Panel Model, developmental cascades

Prosocial behaviors (such as helping, comforting, cooperating, sharing, and donating) constitute an essential component of adolescent social development.

Prosocial behavior reflects positive tendencies and healthy traits in an individual' s personality structure related to the external world, encompassing both prosocial behavioral habits and prosocial behavior tendencies (Kou & Zhang, 2006). Against the backdrop of contemporary social changes, mental health problems among Chinese children and adolescents have become particularly prominent (Gao et al., 2013). However, identifying effective pathways for promoting adolescent mental health from a preventive perspective presents enormous challenges both theoretically and methodologically (Kazdin, 1993). Conceptually, increased prosocial behavior should reduce externalizing problems (e.g., aggression) while also decreasing internalizing problems (e.g., depression) because engaging in prosocial behavior requires better emotion regulation capabilities and promotes positive emotions (e.g., the joy of helping others). Therefore, cultivating prosocial behavior tendencies in adolescents holds promise as an effective approach to mental health promotion.

The developmental cascades model describes this process, wherein functioning in one domain (level or system) influences functioning in another domain (level or system). For instance, cognitive development and social development represent different domains, behavioral development and physiological development represent different levels, and parent-child relationships and peer relationships represent different systems. These domains (levels or systems) involve complex interactions that, over time, produce cumulative effects leading to spillover effects across levels, domains, and systems (Masten & Cicchetti, 2010).

Researchers typically employ longitudinal designs to test developmental cascade models. However, past studies have often based their conclusions on Cross-Lagged Panel Models (CLPM) (Kenny, 1975). Because CLPM confounds within-person effects (within-group effects) and between-person effects (between-group effects), it cannot adequately address the reciprocal relationships described by cascade models. Moreover, previous models have typically assumed continuity in developmental cascades while paying insufficient attention to their discontinuity (Cohen et al., 2018). For example, externalizing problems may positively predict subsequent internalizing problems, but their developmental cascade may also be discontinuous—at certain developmental stages, externalizing problems might fail to predict internalizing problems or even predict them in the opposite direction. Within-person analysis methods that use the individual as their own control reflect within-person changes in variables and their temporal relationships, aligning more closely with the theoretical assumptions of developmental cascade models. Furthermore, certain within-person analysis models do not require the assumption of continuity in psychopathological developmental cascades, thereby providing more accurate estimates (Zyphur et al., 2020).

Given the potential value of deepening our understanding of developmental cascades among prosocial behavior tendency, internalizing problems, and externalizing problems for adolescent mental health promotion, it is necessary to conduct within-person analyses of the interactions among these three constructs

in Chinese adolescent populations. This study attempts to examine the developmental cascades among prosocial behavior tendency, internalizing problems, and externalizing problems in Chinese adolescents and to illustrate how within-person analysis and traditional CLPM analysis affect research conclusions.

1.1 The Relationship Between Internalizing and Externalizing Problems

Internalizing problems typically refer to internal (e.g., cognitive, emotional) difficulties associated with excessive self-regulation, including symptoms such as depression, (low) self-esteem, and self-harm/suicidal ideation. Externalizing problems generally refer to negative behaviors resulting from deficient self-regulation, such as aggression, deviant peer associations, ADHD, and risky behaviors (Graber & Sontag, 2009; Memmott-Elison et al., 2020). Initial externalizing problems may lead to subsequent internalizing problems because externalizing problems are often associated with frustration intolerance, poor self-regulation, and impulsivity, which can cause problems in parent-child and peer relationships, making children and adolescents feel more anxious and less worthy (Burke et al., 2005), and more prone to depression (Reitz et al., 2005). Conversely, initial internalizing problems may also lead to subsequent externalizing problems because children and adolescents may "mask" internal depression by exhibiting externalizing problems (Carlson & Cantwell, 1980). Empirically, most studies indicate that externalizing problems predict internalizing problems, whereas internalizing problems do not predict externalizing problems (Memmott-Elison et al., 2020), though some research suggests bidirectional relationships (Lee & Stone, 2012; Weeks et al., 2016).

In terms of temporal relationships, beyond their mutual influence, internalizing and externalizing problems also exhibit co-developmental correlations because they share common influencing factors, including genetic factors and gene-environment interactions (Chen et al., 2015), adverse social circumstances (Flouri & Sarmadi, 2016), adolescent characteristics (Xie et al., 2016), risk factors (e.g., excessively harsh parenting), and protective factors (e.g., developmentally appropriate parenting) (Pinquart, 2017).

1.2 The Relationship Between Prosocial Behavior and Internalizing/Externalizing Problems

Three theoretical perspectives generally explain the relationship between prosocial behavior and internalizing/externalizing problems. First, children and adolescents who engage in prosocial behavior typically possess better self-regulation capabilities, making them less likely to develop internalizing problems from excessive self-regulation and less likely to develop externalizing problems from self-regulation deficits (Graber & Sontag, 2009; Memmott-Elison et al., 2020). Second, from a social information processing perspective, researchers suggest that children and adolescents who engage in prosocial behavior tend to have benevolent attribution biases and social competence. Moreover, engaging in prosocial

behavior elicits positive responses from others, thereby reinforcing adolescents' positive internal working models. Adolescents with positive internal working models can process socio-emotional information (including negative emotional information) more fully and accurately, thereby reducing internalizing or externalizing problems (Cassidy & Shaver, 2016; Flouri & Sarmadi, 2016). Third, from a motivational process perspective, different types of prosocial behavior and different targets of prosocial behavior may involve different motivational processes (Davidov et al., 2016; Paulus, 2018). For example, excessive "concern for others' needs" may imply excessive self-regulation, leading to internalizing problems. The motivational processes underlying prosocial behavior toward strangers versus parents may also differ.

Considerable evidence indicates that prosocial behavior serves as a protective factor against externalizing and internalizing problems. A recent meta-analysis incorporating 55 studies and 742 effect sizes found that prosocial behavior showed a moderate negative correlation with externalizing problems (r = -0.20) and a smaller negative correlation with internalizing problems (r = -0.08) (Memmott-Elison et al., 2020). Longitudinal studies have also accumulated substantial evidence that prosocial behavior can reduce externalizing problems (Mesurado et al., 2019).

Some research suggests that internalizing and externalizing problems in children and adolescents may also influence the development of prosocial behavior. For example, children and adolescents exhibiting more externalizing problems may show less prosocial behavior due to deficient self-regulation (Padilla-Walker et al., 2017). Children and adolescents experiencing internalizing problems may show more empathy toward peers experiencing similar problems, thereby exhibiting prosocial behavior toward peers but less prosocial behavior toward parents (Padilla-Walker et al., 2015). Overall, however, research on the reciprocal influences among prosocial behavior, internalizing problems, and externalizing problems remains insufficient.

1.3 Moderating Factors in the Relationship Between Prosocial Behavior and Internalizing/Externalizing Problems

Prosocial behavior is a complex process with multiple components, and different components have different mechanisms of association with externalizing and internalizing problems (Carlo & Randall, 2002; Paulus, 2018). Numerous important moderating factors may exist in the prosocial behavior process, including age, gender, family income, ethnicity, parental education, and family structure (Memmott-Elison et al., 2020). Memmott-Elison et al.' s (2020) meta-analysis found that, aside from age and gender, other variables did not moderate the relationship between prosocial behavior and externalizing/internalizing problems. Regarding age, the correlation between prosocial behavior and internalizing problems was strongest in early adolescence, followed by middle and late adolescence, with no significant association found in emerging adulthood samples. Regarding gender, research consistently shows that girls tend to re-

port higher levels of prosocial behavior and internalizing problems than boys (Zimmer-Gembeck et al., 2005), while boys exhibit more externalizing behavior than girls (Leadbeater et al., 1999). Additionally, some studies have found that high "concern" tendencies are associated with internalizing problems (e.g., depression, anxiety) in girls but not in boys (Flynn et al., 2015; Nantel-Vivier et al., 2014).

1.4 Continuity and Discontinuity in Psychopathological Developmental Cascades

Although the aforementioned literature has advanced our understanding of developmental cascades among prosocial behavior tendency, internalizing problems, and externalizing problems in early adolescence, a major limitation of these studies is their assumption of continuity in developmental cascades, with insufficient attention to the phenomenon of continuity and discontinuity in these cascades. The continuity discussed here differs from the traditional concepts of "continuity" and "stage," which refer to developmental processes from quantitative to qualitative change. Similar to other psychopathological developments (e.g., pathological personality development), certain "pathological organizational structures" formed during development (Cicchetti & Toth, 1998) only manifest observable pathological symptoms under specific conditions. For example, externalizing problems typically show continuous positive prediction of externalizing or internalizing problems (i.e., continuity), but due to changes in internal and external conditions during development, externalizing problems may fail to continuously predict internalizing problems or may even predict them in the opposite direction (i.e., discontinuity).

Some evidence suggests that continuity assumptions cannot fully describe adolescent psychopathological development. For instance, in adolescent pathological personality development, developments related to self-identity and intimacy show more discontinuity, whereas developments related to personality traits (e.g., introversion-extroversion, response sensitivity) show more continuity (Sharp, 2020). A recent nine-year longitudinal study of depression and anxiety in children and adolescents aged 7 to 15 found that childhood depression and anxiety predicted adolescent depression and anxiety with both continuity and discontinuity (Cohen et al., 2018). Additionally, children and adolescents may exhibit both helpfulness and aggression simultaneously to achieve certain social goals (i.e., a positive correlation between prosociality and aggression), but by middle and late adolescence, the compatibility between helpfulness and aggression decreases (i.e., a negative correlation between prosociality and aggression), demonstrating discontinuity (Hawley, 2003; Kokko et al., 2006). By extension, developmental cascades among social behavior tendencies, internalizing problems, and externalizing problems may exhibit both continuity and discontinuity.

1.5 Research Hypotheses

In summary, this study aims to examine developmental cascades among prosocial behavior tendency, externalizing problems, and internalizing problems in early adolescents. Specific hypotheses are: (1) At the intraindividual level, externalizing problems significantly predict internalizing problems; (2) At the intraindividual level, prosocial behavior tendency significantly predicts externalizing and internalizing problems; (3) Internalizing and externalizing problems show strong co-developmental relationships; (4) Developmental cascades among prosocial behavior tendency, externalizing problems, and internalizing problems show gender differences. Additionally, because traditional CLPM confounds within- and between-person effects, this study compares Random-Intercept Cross-Lagged Panel Model (RI-CLPM; Hamaker et al., 2015) and General Cross-Lagged Panel Model (GCLM; Zyphur et al., 2020)—both within-person analysis methods (with GCLM not assuming continuity in developmental cascades)—with CLPM to demonstrate how different analytical models affect research conclusions.

2.1 Participants

Using cluster sampling, junior high school students from two ordinary middle schools in Tianmen and Jingzhou, Hubei Province were selected as participants for a three-year longitudinal survey (2014-2016) beginning one month after their junior high school enrollment. Based on a standardized regression coefficient $\beta = 0.15$ for prosocial behavior predicting internalizing and externalizing problems, three covariates, and 95% statistical power, the minimum required sample size was calculated as 750. The first survey (T1) was conducted in October 2014, with 974 participants. Follow-up surveys were administered annually (T2 and T3). Two items were included to assess careless responding: "I am 20 years old this year" (yes/no options) and a request to circle both "1" and "5" simultaneously. Responses of "yes" or failure to circle both options were deemed invalid. After excluding invalid questionnaires and accounting for student absences and transfers, 894 participants provided complete data without missing values. The questionnaire invalidity rate was 9.2%, yielding an analytical sample of 894 that met the planned sample size requirement.

The 894 participants ranged in age from 11 to 15 years (M = 12.7, SD = 0.60), including 517 boys (57.8%). Regarding parental education, 94.6% of fathers and 91.5% of mothers had completed nine-year compulsory education, with 56.9% of fathers and 52.2% of mothers having completed high school or above. For family monthly income, 33.9% of fathers earned less than 3,000 RMB, 47.3% earned 3,000-7,000 RMB, 12.2% earned more than 7,000 RMB, and 39 did not report or know their father' s income. For mothers, 48.8% earned less than 3,000 RMB, 36.4% earned 3,000-7,000 RMB, 7.2% earned more than 7,000 RMB, and 44 did not report or know their mother' s income. Regarding perceived family living standards, 0.7% rated their family as low, 7.6% as lower-middle, 57.2% as middle, 29.9% as upper-middle, and 2.7% as high. For housing, 6.2% rented,

90.7% owned or built their homes, 0.8% lived with relatives, and 2.3% lived in employer-provided housing; 84.3% had their own room.

2.2 Measures

Prosocial Tendencies Measure (PTM). The PTM was originally developed by Carlo and Randall (2002) and revised into Chinese by Kou et al. (2007). The scale comprises 26 items measuring six factors: public, anonymous, altruistic, compliant, emotional, and emergency prosocial tendencies. Participants rated items on a 5-point Likert scale (1 = not at all like me, 2 = somewhat like me, 3 = somewhat true of me, 4 = very much like me, 5 = almost exactly like me). Internal consistency reliability for the six factors across the three waves ranged from 0.70 to 0.87. Factor scores were used in analyses.

Depression-Anxiety-Stress Scale (DASS-21). The Chinese version of the DASS-21 was used to assess internalizing problems. The scale includes three factors (stress, anxiety, depression) with 21 items total and demonstrates good psychometric properties in Chinese adolescent samples (Wang et al., 2016). Participants rated items based on their experiences over the past week on a 0-4 Likert scale (0 = did not apply to me at all, 1 = applied to me to some degree, 2 = applied to me to a considerable degree, 3 = applied to me very much, 4 = applied to me very much, most of the time). Internal consistency reliability for the three factors across three waves ranged from 0.75 to 0.87. Factor scores were used in analyses.

Buss-Warren Aggression Questionnaire (BWAQ). The Chinese revised version of the BWAQ (Maxwell, 2008) was used to assess externalizing problems. The questionnaire includes five factors (physical aggression, verbal aggression, anger, hostility, indirect aggression) with 34 items total. Participants rated items on a 5-point Likert scale (1 = not at all like me, 2 = somewhat like me, 3 = somewhat true of me, 4 = very much like me, 5 = almost exactly like me). Internal consistency reliability for the five factors across three waves ranged from 0.62 to 0.82. Factor scores were used in analyses.

2.3 Procedure

After obtaining informed consent from schools and students, three group administrations were conducted at the class level. The content and procedures were essentially identical across the three waves. Demographic variables were only collected at the first wave. Each class was staffed with 1-2 trained graduate students in psychology who served as administrators. Administrators explained instructions, including informed consent, survey purposes, and precautions; answered questions; addressed issues during administration; and monitored quality. In addition to the three questionnaires used in this study, other measures were administered, with total completion time approximately 40 minutes. Participants received small gifts worth about 1 RMB after each wave as appreciation.

2.4.1 Model Selection and Comparison

This study employed CLPM, RI-CLPM, and GCLM to analyze the data. Figure 1 presents schematic diagrams of the models. For simplicity and clarity, Figure 1 only shows relationships between two variables; developmental cascade models with three variables follow similar patterns. In CLPM (Figure 1a), $\beta_{xt}(x)$ and $\beta_{yt}(y)$ represent autoregressive effects, $\beta_{xt}(y)$ represents the cross-lagged effect of x on y, $\beta_{yt}(x)$ represents the cross-lagged effect of y on x, μ represents residuals, and Ψ represents residual correlations indicating co-variation effects between x and y. In RI-CLPM (Figure 1b), $\eta(x)$ and $\eta(y)$ are added to represent individual differences across the three measurements. These can be understood as individuals' average scores across three waves, with $\mu_t(x)$ and $\mu_t(y)$ representing fluctuations around these means at each time point. Similarly, $\Psi_t(xy)$ represents correlations between fluctuation residuals, indicating co-variation effects between x and y.

GCLM (Figure 1c) differs from RI-CLPM in that each wave' s fluctuation values can only predict observed values, not other fluctuation values. For example, in Figure 1c, $\mu_{t-2}(x)$ can predict x_{t-2}, representing how x's fluctuation at t-2 affects its autoregressive effect. Meanwhile, $\mu_{t-2}(x)$ predicting x_{t-2} and subsequently x_{t-1} and y_t represents how x' s fluctuation at t-2 indirectly affects y' s cross-lagged effect through x_{t-1}. If $\mu_{t-2}(x)$ directly predicts y_{t-1}, this represents a direct cross-lagged effect of x' s fluctuation at t-2 on y_{t-1}. Note that in Figure 1c, a model including all paths from μ to x and y would be over-parameterized and thus unfittable.

In RI-CLPM and GCLM, although some parameters share the same symbols, their meanings differ (e.g., $\eta(x)$ and $\eta(y)$) (Usami, 2020). Therefore, it is necessary to clarify key differences between these models. GCLM is a complex form of Allison' s model (Allison et al., 2017), which derives from the fixed-effects model common in economics. For time-series data, a simple fixed-effects model can be written as:

$$Y_{i,t} = \mu + \beta X_{i,t-1} + \alpha_i + \varepsilon_{i,t} \quad (1)$$

where μ is the intercept, β is the regression coefficient, α_i represents stable between-individual differences, and $\varepsilon_{i,t}$ is measurement error independent of right-side terms. The α_i term captures all stable between-individual differences, allowing within-person examination of variable relationships using the individual as their own control. Notably, α_i affects y, and while the model assumes error terms are independent of other right-side terms, it does not assume α_i is independent of other terms (addressing endogeneity concerns). Similarly, in GCLM, the η term can "influence" or "adjust" autoregressive and cross-lagged effects.

RI-CLPM interprets $\eta(x)$ and $\eta(y)$ as time-invariant variables, sometimes trait-like variables, to separate stable between-individual differences. RI-CLPM as-

sumes that after separating the η terms, they become independent of autoregressive and cross-lagged effects. Additionally, RI-CLPM assumes the tracked system is stable (e.g., autoregressive coefficients are less than 1). RI-CLPM' s advantages include simplicity, clarity, ease of interpretation, and acceptance among trait-oriented researchers, but it imposes more constraints than GCLM.

If we assume the "system" studied with three-variable longitudinal data is stable and that within-person relationships are unaffected by between-person time-invariant variables, RI-CLPM is appropriate. However, RI-CLPM struggles to explain dramatic changes in cross-time predictive relationships (e.g., shifting from positive to negative prediction) because it emphasizes continuous development and system stability. GCLM lacks this constraint; autoregressive and cross-lagged effects are simply adjusted by between-person variables (the η term, analogous to α_i in equation 1) while remaining within-person effects. For our research questions, although RI-CLPM and GCLM differ in their interpretation of the η term, this does not affect our primary focus on within-person relationships, as using the individual as their own control makes causal inference more plausible. Additionally, given the continuity and discontinuity of early adolescent psychopathological development, RI-CLPM emphasizes continuity, whereas GCLM can accommodate both aspects. Table 1 presents longitudinal measurement invariance tests for prosocial behavior tendency, internalizing problems, and externalizing problems.

Table 1 Longitudinal Measurement Invariance Tests for Prosocial Behavior Tendency, Internalizing Problems, and Externalizing Problems

Model	RMSEA	ΔRMSEA
Prosocial Behavior Tendency		
M1: Configural invariance		
M2: Weak invariance		
M3: Strong invariance		
M4: Strict invariance		
Internalizing Problems		
M1: Configural invariance		
M2: Weak invariance		
M3: Strong invariance		
M3.1: Strong invariance a		
Externalizing Problems		
M1: Configural invariance		
M2: Weak invariance		
M3: Strong invariance		
M4: Strict invariance		

Note: a T1 and T2 equivalent, not equivalent with T3.

2.4.2 Common Method Bias Test

Harman' s single-factor test was used to statistically examine common method bias across the three waves (Zhou & Long, 2004). Results showed 14, 20, and 14 factors with eigenvalues greater than 1 at T1-T3, respectively, with the first factor explaining 19.16%, 20.66%, and 21.91% of variance—each below the 40% critical threshold. Thus, no significant common method bias was detected.

2.4.3 Measurement Invariance Test

For model simplicity, this study used item parceling (Little et al., 2002), employing scale factor scores as indicators at each wave to test measurement invariance of prosocial behavior tendency, internalizing problems, and externalizing problems across three waves. Following Chen' s (2007) recommendations, invariance was considered achieved if CFI and RMSEA changes were less than 0.01. If CFI and RMSEA changes yielded inconsistent conclusions, RMSEA changes were used for determination. Results are presented in Table 1, which also includes chi-square tests for reference rather than as primary criteria, as chi-square tests have been criticized for being overly sensitive to sample size (Asparouhov et al., 2006). Results indicated strict invariance for prosocial behavior tendency and externalizing problems, but internalizing problems failed strong invariance. Further analysis revealed that internalizing problems were equivalent between T1 and T2 but not with T3. This means T1 and T2 internalizing problem scores cannot be compared between individuals with T3 scores (as scales differ across individuals, rendering comparisons meaningless), but this does not affect within-person analysis.

All models were analyzed using Mplus 8.1 (Muthén & Muthén, 2017). The following fit indices (and criteria for good/acceptable fit) were used: Comparative Fit Index (CFI; $ $0.90 acceptable, $ $0.95 good), Root Mean Square Error of Approximation (RMSEA; $ $0.06 good, $ $0.10 acceptable), and Standardized Root Mean Square Residual (SRMR; $ $0.08 good) (Hu & Bentler, 1999). Other analyses used Stata 15 (StataCorp, 2017).

3.1 Descriptive Statistics and Preliminary Analyses

Descriptive statistics and correlations for prosocial behavior tendency, internalizing problems, and externalizing problems are presented in Table 2. Little' s MCAR test (Little, 1988) using parental education and income as variables indicated that missing data were completely random (^{2} = 50.54, p = 0.54, df = 52, N = 950). Intraclass correlation coefficients (ICC) were 0.48 (SE = 0.02, 95% CI = 0.43-0.51) for internalizing problems, indicating 48% between-person and 52% within-person variance; 0.49 (SE = 0.02, 95% CI = 0.45-0.52) for externalizing problems, indicating 49% between-person and 51% within-person variance; and 0.37 (SE = 0.02, 95% CI = 0.34-0.41) for prosocial behavior tendency, indicating 37% between-person and 63% within-person variance.

Table 2 Means, Standard Deviations, and Pearson Correlations for Prosocial Behavior Tendency, Internalizing Problems, and Externalizing Problems

3.2 Within-Person Analysis of Developmental Cascades Among Prosocial Behavior Tendency, Internalizing Problems, and Externalizing Problems

CLPM, RI-CLPM, and GCLM were used to analyze predictive paths including: reciprocal predictions between internalizing and externalizing problems, prosocial behavior tendency predicting internalizing and externalizing problems, and internalizing and externalizing problems predicting prosocial behavior tendency. All three models showed acceptable fit: CLPM (^{2} = 68.16, df = 9, CFI = 0.96, RMSEA = 0.087, SRMR = 0.037, AIC = 12368.75, BIC = 12583.12); RI-CLPM (^{2} = 36.72, df = 9, CFI = 0.99, RMSEA = 0.060, SRMR = 0.020, AIC = 12325.38, BIC = 12539.76); GCLM (^{2} = 10.69, df = 9, CFI = 0.99, RMSEA = 0.015, SRMR = 0.018, AIC = 12296.86, BIC = 12511.24).

As shown in Table 3, although all three models demonstrated acceptable fit, they yielded markedly different results. For cross-lagged effects, CLPM results indicated that T1 externalizing problems positively predicted T2 internalizing problems (EXT1→INT2), while T2 internalizing problems positively predicted T3 internalizing problems (INT2→EXT3). However, after separating between-person differences, RI-CLPM results showed only that T2 internalizing problems positively predicted T3 externalizing problems (INT2→EXT3).

All three models showed consistency in co-variation effects. At the within-person level, internalizing and externalizing problems measured at all three waves showed substantial correlations, indicating strong co-development between internalizing and externalizing problems from grades 7 to 9 (ages 12-15). This result supports Hypothesis 3. For co-variation between prosocial behavior tendency and internalizing/externalizing problems, CLPM and GCLM results were relatively consistent, showing small to moderate correlations (Table 3).

Table 3 Main Parameters from CLPM, RI-CLPM, and GCLM

Effect	CLPM	RI-CLPM	GCLM
Autoregressive Effects (Within-Person)			
PSO1→PSO2	<0.001	<0.001	<0.001
PSO2→PSO3	<0.001	<0.001	<0.001
EXT1→EXT2	<0.001	<0.001	<0.001
EXT2→EXT3	<0.001	<0.001	<0.001
INT1→INT2	<0.001	<0.001	<0.001
INT2→INT3	<0.001	<0.001	<0.001
Cross-Lagged Effects			
INT1→EXT2			
PSO1→EXT2			

Effect	CLPM	RI-CLPM	GCLM
INT2→EXT3	<0.001	<0.001	
PSO2→EXT3			<0.001
EXT1→INT2	<0.001		
PSO1→INT2			<0.001
EXT2→INT3			
PSO2→INT3			
EXT1→PSO2			
EXT2→PSO3			
INT1→PSO2			
INT2→PSO3			
Co-Variation Effects			
INT1 EXT1	<0.001	<0.001	<0.001
INT1 PSO1	<0.001	<0.001	<0.001
EXT1 PSO1	<0.001	<0.001	<0.001
INT2 EXT2	<0.001	<0.001	<0.001
INT2 PSO2	<0.001	<0.001	<0.001
EXT2 PSO2	<0.001	<0.001	<0.001
INT3 EXT3	<0.001	<0.001	<0.001
INT3 PSO3	<0.001	<0.001	<0.001
EXT3 PSO3	<0.001	<0.001	<0.001
Between-Person Level			
INT EXT	<0.001		
INT PSO	<0.001		
EXT PSO	<0.001		

Note: PSO1 = prosocial behavior tendency at T1, EXT1 = externalizing problems at T1, INT1 = internalizing problems at T1. Bolded values indicate significant path coefficients. In RI-CLPM and GCLM, λ in Figure 1 was fixed to 1, making their degrees of freedom identical to CLPM.

At the within-person level, regarding predictive relationships between prosocial behavior tendency and internalizing/externalizing problems, RI-CLPM and GCLM yielded inconsistent results. GCLM results indicated that prosocial behavior tendency negatively predicted internalizing and externalizing problems (PSO2→EXT3 and PSO1→INT2), partially supporting Hypothesis 2. For reciprocal relationships between internalizing and externalizing problems, GCLM results showed no significant mutual predictions. Additionally, GCLM results indicated that T1 externalizing problems negatively predicted T2 prosocial behavior tendency (EXT1→PSO2: β = -0.21, SE = 0.05, $p < 0.001$), while internalizing problems did not predict prosocial behavior tendency.

3.3 The Role of Prosocial Behavior Tendency in the Developmental Cascade Between Internalizing and Externalizing Problems

To examine how including prosocial behavior tendency affected reciprocal predictions between internalizing and externalizing problems, a GCLM including only internalizing and externalizing problems was tested. Results showed good model fit (^{2} = 17.89, df = 5, CFI = 0.99, RMSEA = 0.055, SRMR = 0.035, AIC = 7361.37, BIC = 7466.17), with externalizing problems significantly negatively predicting internalizing problems (EXT1→INT2: β = -0.06, SE = 0.03, p = 0.04; EXT2→INT3: β = -0.12, SE = 0.03, p < 0.001), but internalizing problems did not significantly predict externalizing problems. This result supports Hypothesis 1.

3.4 Gender Differences in Developmental Cascades Among Prosocial Behavior Tendency, Internalizing Problems, and Externalizing Problems

Given potential gender differences, GCLM was applied separately to boys (n = 517) and girls (n = 349). Both groups showed acceptable fit: boys (^{2} = 16.14, df = 9, CFI = 0.99, RMSEA = 0.039, SRMR = 0.024, AIC = 7784.08, BIC = 7975.24) and girls (^{2} = 5.04, df = 9, CFI = 1.00, RMSEA = 0.000, SRMR = 0.017, AIC = 4480.55, BIC = 4654.03). Unlike the total sample results, the positive prediction of T3 externalizing problems by T2 internalizing problems (INT2→EXT3) was significant only for girls (β = 0.23, SE = 0.08, p = 0.002), while prosocial behavior tendency did not predict internalizing or externalizing problems. For boys, results resembled the total sample: prosocial behavior tendency significantly negatively predicted internalizing and externalizing problems (PSO2→EXT3: β = -0.08, SE = 0.03, p = 0.02; PSO1→INT2: β = -0.08, SE = 0.03, p = 0.02), and T1 externalizing problems negatively predicted T2 prosocial behavior tendency (EXT1→POS2: β = -0.21, SE = 0.05, p < 0.001). These findings indicate heterogeneity between boys and girls in early adolescence regarding how prosocial behavior tendency predicts internalizing problems, how externalizing problems predict prosocial behavior tendency, and how internalizing and externalizing problems interact. This partially supports Hypothesis 4. For girls, internalizing problems predicted externalizing problems.

3.5 Developmental Cascades Between Different Factors of Prosocial Behavior Tendency and Internalizing/Externalizing Problems

Given that different factors of prosocial behavior tendency may have distinct effects, GCLM was applied separately to each of the six factors. All six factor models showed good fit: public (^{2} = 12.64, df = 9, CFI = 0.99, RMSEA = 0.021, SRMR = 0.021, AIC = 14380.18, BIC = 14595.89), anonymous (^{2} = 11.88, df

= 9, CFI = 0.99, RMSEA = 0.019, SRMR = 0.019, AIC = 14089.13, BIC = 14304.84), compliant (^{2} = 6.50, df = 9, CFI = 1.00, RMSEA = 0.001, SRMR = 0.015, AIC = 13231.66, BIC = 13447.37), emotional (^{2} = 9.43, df = 9, CFI = 1.00, RMSEA = 0.007, SRMR = 0.016, AIC = 13668.27, BIC = 13883.97), emergency (^{2} = 10.23, df = 9, CFI = 0.99, RMSEA = 0.012, SRMR = 0.017, AIC = 13748.76, BIC = 3964.47), and altruistic (^{2} = 12.29, df = 9, CFI = 0.99, RMSEA = 0.020, SRMR = 0.018, AIC = 13680.89, BIC = 13896.60). Since our focus was on cross-lagged effects from prosocial behavior tendency to internalizing and externalizing problems, Table 4 only reports these predictive path coefficients. Consistent with Table 3, T1 prosocial behavior tendency factors did not significantly predict T2 externalizing problems. Unlike Table 3, four factors (excluding anonymous and emergency) showed consistent results, significantly negatively predicting internalizing and externalizing problems with small effect sizes.

Table 4 Within-Person Cross-Lagged Effects of Six Prosocial Behavior Tendency Factors from GCLM

Cross-Lagged Effect	Public	Compliant	Emotional	Altruistic
PSO1→EXT2 PSO2→EXT3 PSO1→INT2 PSO2→INT3	< .001	< .001	< .001	< .001

Note: PSO1 = prosocial behavior tendency at T1, EXT1 = externalizing problems at T1, INT1 = internalizing problems at T1. Bolded values indicate significant path coefficients.

Using three-year panel data, this study found strong co-developmental relationships between internalizing and externalizing problems at the within-person level, suggesting common "third variables." In the full cascade model including prosocial behavior, internalizing and externalizing problems showed no reciprocal predictive relationships. Further analysis revealed that when only internalizing and externalizing problems were included, externalizing problems significantly negatively predicted internalizing problems. Regarding the full cascade model, only among girls did T2 internalizing problems positively predict T3 externalizing problems. At the within-person level, prosocial behavior tendency showed moderate to weak co-movement with internalizing and externalizing problems, with T1 prosocial behavior tendency negatively predicting T2 internalizing problems and T2 prosocial behavior tendency negatively predicting T3 externalizing problems, demonstrating weak predictive effects. Meanwhile, T1 externalizing problems negatively predicted T2 prosocial behavior tendency with moderate effect size, but internalizing problems did not predict prosocial behavior tendency.

CLPM has been the "workhorse" of traditional developmental psychopathology

research (Berry & Willoughby, 2017; Hamaker et al., 2015). With only two waves, CLPM remains valuable for generating research leads. However, with increasing availability of multi-wave data, within-person analysis methods can separate between- and within-person effects, using the individual as their own control to examine reciprocal influences. This study compared CLPM, RI-CLPM, and GCLM results, showing that separating between-person effects yields different and sometimes opposite conclusions. For instance, relying on CLPM results would suggest that internalizing and externalizing problems mutually positively predict each other, implying that externalizing problems "transform" into internalizing problems and vice versa (EXT1→INT2→EXT3). However, GCLM results indicated no reciprocal predictions between externalizing and internalizing problems in the total sample, demonstrating that confounding within- and between-person effects seriously impacts conclusions.

Comparing RI-CLPM and GCLM—both within-person models—RI-CLPM showed only that T2 internalizing problems positively predicted T3 externalizing problems, with no other significant paths. GCLM identified more significant paths, including prosocial behavior tendency negatively predicting internalizing and externalizing problems, and externalizing problems negatively predicting prosocial behavior tendency. Relying on RI-CLPM would suggest prosocial behavior tendency does not predict internalizing/externalizing problems and that externalizing problems do not predict prosocial behavior tendency, whereas GCLM suggests the opposite. Thus, different within-person models also yield substantially different conclusions.

RI-CLPM and GCLM have different assumptions and suit different research questions. GCLM better fits theoretical assumptions when considering discontinuity in psychopathological developmental cascades. Our results showed that within-person variance exceeded 50% for all three variables across three years, and autoregressive effects were generally weak—consistent with traditional views of early adolescence as a period of sudden, dramatic changes. RI-CLPM' s interpretation of random intercepts as stable, trait-like variables overlooks this discontinuity, potentially introducing bias. Moreover, all fit indices favored GCLM over CLPM and RI-CLPM, supporting GCLM results. Presenting all three models allows more confident interpretation of consistent findings while prompting careful consideration of model appropriateness for divergent results.

Further GCLM analysis revealed that among girls, T2 internalizing problems positively predicted T3 externalizing problems (INT2→EXT3) with moderate effect size. This aligns with some previous research (Lee & Stone, 2012; Weeks et al., 2016) but contradicts most literature showing only externalizing-to-internalizing predictions (e.g., Moilanen et al., 2010; Murray et al., 2020; van Lier et al., 2012). This discrepancy may relate to analytical methods, as CLPM-based cascade models typically test all possible predictive paths (e.g., T1 predicting T3) and retain only significant paths, confounding within- and between-person effects. Within-person analysis typically assumes that change at one time point affects the next time point through autoregressive and

cross-lagged effects, thus only using T to predict T+1. Simulation studies show CLPM-based modeling can unpredictably affect statistical results, making non-significant effects significant, significant effects non-significant, or even reversing effect directions (Hamaker et al., 2015). Within-person methods have only been applied to cascade research in the past five to six years (Berry & Willoughby, 2017; Hamaker et al., 2015).

Additionally, prosocial behavior tendency did not predict internalizing or externalizing problems among girls. These results suggest that for early adolescent girls, externalizing problems (aggression in this study) may represent a transformation or masking of internalizing problems (depression, anxiety, and stress in this study) associated with negative self-concept and low self-esteem (Lee & Stone, 2012), essentially remaining internalizing problems related to excessive self-regulation (Flynn et al., 2015; Nantel-Vivier et al., 2014). The lack of prediction from prosocial behavior tendency to internalizing/externalizing problems among girls may reflect Chinese cultural realities where families and schools hold different social expectations and parenting practices for adolescent boys and girls, creating gender differences in how prosocial behavior tendency predicts mental health outcomes. These possibilities require further investigation in Chinese youth.

Notably, among boys in our sample, internalizing and externalizing problems showed no reciprocal relationships, contradicting previous findings. For example, research in Korean children found that internalizing problems at ages 8-9 negatively predicted externalizing problems at ages 12-13 (Lee & Stone, 2012), and a recent Swiss study using within-person analysis found that externalizing problems at age 13 negatively predicted internalizing problems at age 15 (Murray et al., 2020). Both studies also found reciprocal positive predictions between internalizing and externalizing problems. Beyond methodological influences, we propose that prosocial behavior tendency may be a key factor. In early adolescent boys, prosocial behavior tendency and related self-regulation and social-cognitive processing preferences may be common influences on the relationship between internalizing and externalizing problems. Results showed that including prosocial behavior tendency eliminated reciprocal predictions, while excluding it revealed significant negative predictions from externalizing to internalizing problems. This suggests possible discontinuity: in childhood, internalizing and externalizing problems may show co-development and mutual influence (Memmott-Elison et al., 2020), but by early adolescence, relationships become more complex, potentially diverging into separate psychopathological pathways or returning to normal developmental trajectories alongside prosocial behavior development (Crittenden & Landini, 2011). Though requiring further verification, these results suggest prosocial behavior development is an important protective factor and potential intervention target for internalizing and externalizing problems, and that gender-differentiated mental health promotion programs are needed for early adolescents.

Further GCLM analysis of the six prosocial behavior tendency factors revealed

that four factors showed weak negative predictions of subsequent internalizing and externalizing problems, consistent with previous research (Memmott-Elison et al., 2020). However, anonymous and emergency prosocial behavior tendency factors did not predict externalizing problems, and only T1 anonymous prosocial behavior tendency negatively predicted T2 internalizing problems. These two factors were added in the Chinese version of the PTM (Kou et al., 2007). This may relate to different types of prosocial behavior having different self-regulation and motivational processes (Davidov et al., 2016; Paulus, 2018). For example, prosocial behavior motivated by reducing others' distress may differ in self-regulation and motivational processes from that motivated by emotional arousal. Research shows that personal abilities and traits do not predict Chinese adolescents' prosocial behavior, whereas social influence factors do (Lai et al., 2015). Additionally, prosocial behavior toward different targets (strangers, acquaintances, peers) has different adaptive significance (Padilla-Walker et al., 2015). Chinese school environments emphasizing collective order and parental social perspective-taking may mean cultural and social factors better explain context-specific prosocial behavior tendencies (Chen et al., 2021; Lai et al., 2015). Future research should consider Chinese cultural traditions and social realities to identify which types of prosocial behavior and which components of the prosocial process have more substantive effects on internalizing and externalizing problems.

This study' s strengths include using within-person analysis to overcome CLPM limitations, yielding results more likely to reflect causal relationships by using the individual as their own control, thereby excluding stable between-person variables (including unmeasured ones like genes, environment, gene-environment interactions, and traits). Another strength is comparing RI-CLPM and GCLM and discussing model construction rationale and applicability from theoretical perspectives.

Two challenges warrant attention. First, handling time-varying variables: theoretically and empirically, developmental cascades among prosocial behavior, internalizing problems, and externalizing problems may involve reciprocal within-person influences, but GCLM may weaken these relationships. With relatively small within-person path coefficients (Memmott-Elison et al., 2020), there is risk of rejecting true effects. Second, handling common "third variables" and their complex interactions with within-person variables. Our results showed substantial within-person co-variation between internalizing and externalizing problems, indicating important shared third variables. Future research requires greater theoretical modeling effort regarding developmental cascades among prosocial behavior tendency, internalizing problems, and externalizing problems—a limitation of this study.

Another limitation is the exclusive use of self-report measures for prosocial behavior, internalizing problems, and externalizing problems without behavioral or informant-report measures, resulting in single-source, single-method data that may affect conclusions. Additionally, this study only examined grades 7-9 (ap-

proximately ages 12-15), limiting generalization beyond this age range. Finally, the sample lacked representativeness. While stable between-person differences reduce representativeness concerns, dynamic developmental characteristics of between-person differences and complex third-variable influences mean sample characteristics could still affect results.

In conclusion: (1) Prosocial behavior tendency development in early adolescence can reduce internalizing and externalizing problems, with different prosocial behavior factors showing different predictive effects. (2) Developmental cascades among prosocial behavior tendency, internalizing problems, and externalizing problems show gender differences. (3) GCLM better fits developmental cascade theory, accommodating both continuity and discontinuity in early adolescent development, making it suitable for analyzing developmental cascades in this period.

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The developmental cascades of prosocial behavior tendency, internalizing and externalizing problems for early adolescence in China: A within-person analysis

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Abstract

Conceptually, prosocial behavior reduces externalizing problems (e.g., aggression) and internalized problems (e.g., depression) because prosocial behavior promotes positive emotions (e.g., to find delight in helping others). Therefore, understanding the development cascades of prosocial behavior tendency, internalizing and externalizing problems is of great value to the promotion of adolescent mental health.

Developmental cascades model describes the above-mentioned process, that is, the function of one domain (level or system) will affect the function of another domain (level or system); as time goes on, multiple interactions in different domains (levels or systems) will produce cumulative effects that can spill over and affect the functions of other domain (level or system) (Masten & Cicchetti, 2010). Researchers usually use longitudinal data to test a developmental cascade model. However, previous studies tend to base their conclusions on Cross-Lagged Panel Models (Kenny, 1975), which cannot sufficiently answer the causally reciprocal relationship the developmental cascade model described because CLPM mixed the between- and within-person effects (Berry & Willoughby, 2017; Hamaker et al., 2015). The results of the within-person analysis, which takes the person himself as the control, is more likely indicating the within-person changes

of studied variables and their temporal relationships, and thus are consistent with the theoretical hypothesis of the developmental cascades model (Zyphur et al., 2020). The current study attempts to test the developmental cascades of prosocial behavior tendency, internalizing and externalizing problems in a sample of Chinese adolescents, and to show how the within-person analysis and the analysis based on traditional CLPM influence the conclusions.

The demographic questionnaire together with Prosocial Behavior Tendency (Carlo & Randall, 2002), Depression-Anxiety-Stress Scale (Wang et al., 2016) and Buss Warren Aggression Questionnaire (Maxwell, 2008) were administered in two junior schools for three years. Totally 894 students completed the three-wave investigation. Among them, the age ranged from 11 to 15 years old (12.7 ± 0.60), including 517 boys (57.8%) at the beginning of the investigation. In terms of parents' education level, 94.6% of fathers completed nine-year compulsory education, and 56.9% of them completed high school or above level education; 91.5% of mothers completed nine-year compulsory education, and 52.2% of them completed high school or above level education.

Two models of within-person analysis (RI-CLPM and GCLM) (Hamaker et al., 2015; Zyphur et al., 2020) were used to analyze the data, compared with the traditional CLPM. The data fitting indexes of the three models are all acceptable, but the results are different leading to very different conclusions. Particularly, GCLM can separate within- and between-person effects; (2) GCLM do not assume continuous development in comparison with RI-CLPM. These advantages of GCLM make GCLM have accurate estimates than other two models. Based on the results of GCLM, the research showed that: (1) at the within-person level, prosocial behavior tendency has a moderate or weak co-movements with internalizing and externalizing problems. The prosocial behavior tendency measured at T1 can predict the internalizing problems measured at T2, and the prosocial behavior tendency measured at T2 can predict the externalizing problems measured at T3; (2) For the girl group, the internalizing problems measured at T2 can predict the externalizing problems measured at T3, while in the boy group, the results did not support the reciprocal relationship between internalizing and externalizing problems; (3) The public, submissive, emotional and altruistic factors of prosocial behavior tendency can negatively predict the next-year internalizing problems, and these four factors can negatively predict the externalizing problems measured at T2. These results suggest the value of prosocial behavior as the potential way to promote adolescent' s mental health, within-person analysis in the developmental cascades research, and also indicate that mental health promotion programs should take the gender difference into account.

Keywords: Prosocial behavior tendency, internalizing and externalizing problems, Random-intercept Cross-lagged Panel Model, General Cross-lagged Panel Model, developmental cascades

Note: Figure translations are in progress. See original paper for figures.