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EMPIRICAL RESEARCH

Why So Lonely? The Direct and Indirect Associations between Developmental Trajectories of Fear of Negative Evaluation, Prosocial Behavior and Loneliness in Adolescence

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Abstract

Fear of negative evaluation and prosocial behavior have been identified as predictive factors influencing the development of loneliness in adolescence, representing typical factors in the cognitive and behavioral processes of re-affiliation. The elucidation of plausible direct and indirect pathways linking these pivotal factors to adolescents' loneliness need further exploration. This study aimed to investigate the direct and indirect relationships between the fear of negative evaluation, prosocial behavior, and adolescents' loneliness through the lens of developmental changes. A total of 533 adolescents (49.0% girls, $M_{age} = 15.18$ years, $SD = 0.71$) participated in this longitudinal study, assessed at three timepoints over a span of two years with 12-month intervals. Latent growth modeling uncovered direct associations between the developmental trajectories of both fear of negative evaluation and prosocial behavior with the developmental trajectory of adolescents' loneliness. The developmental trajectory of fear of negative evaluation exhibited an indirect association with the developmental trajectory of loneliness through the mediating role of prosocial behavior. These findings highlighted the roles of cognitive and behavioral re-affiliation processes, both independently and as mediators, in influencing adolescent loneliness, suggesting that interventions aimed at reducing fear of negative evaluation and promoting prosocial behavior could effectively mitigate adolescents' loneliness.

Keywords Fear of negative evaluation · Prosocial behavior · Loneliness · Adolescence · Latent growth modeling · Re-affiliation process

Introduction

Loneliness is an unpleasant experience characterized by a lack of desired interpersonal relationships (Mahon et al., 2006), and it is associated with detrimental consequences on mental health challenges and suicidal ideation (for a review, see Loades et al., 2020; Tomova et al., 2021). Given the escalating significance of social belonging during adolescence (Tomova et al., 2021), adolescents find themselves susceptible to loneliness, align with their heightened yet unfulfilled need for social connection (Hang et al., 2023). A recent meta-analysis revealed a relatively high prevalence of loneliness among adolescents, ranging from 9.2% (6.8% to 12.4%) in South-East Asia to 14.4% (12.2% to 17.1%) in the Eastern Mediterranean region, which suggested that adolescents' experience of problematic levels of loneliness is a common phenomenon worldwide (Surkalim et al., 2022). Considering the numerous negative impacts and the high prevalence of loneliness during adolescence (Christiansen et al., 2021; Matthews et al., 2022), it is crucial to explore the developmental changes in adolescents' loneliness and the factors that contribute to their feelings for fostering adolescents' healthy development and effective interventions (Qualter et al., 2015). In this context, the Re-affiliation Mechanism Model (RAM) emphasizes the role of behavioral (e.g., prosocial behavior; Lanser and Eisenberger (2022)) and cognitive factors (e.g., fear of negative evaluation; Geukens et al., 2022) in both the emergence and

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persistence of prolonged loneliness over time (Cacioppo et al., 2015; Qualter et al., 2015). However, there remains a need to elucidate how these re-affiliation processes influences an adolescent's experience of loneliness. Specifically, it is unclear whether cognitive and behavioral re-affiliation processes act as distinct parallel pathways or operate as mediational processes in alleviating loneliness (Qualter et al., 2015). It is noteworthy that deviations in the RAM could potentially result in prolonged loneliness (Qualter et al., 2015). Thus, it is important to investigate the associations between the cognitive and behavioral re-affiliation processes of RAM to better comprehend the origins of loneliness, which may help to propose targeted loneliness interventions for adolescents. Within the framework of RAM, this study aims to explore prospective associations between the cognitive (i.e., fear of negative evaluation) and behavioral re-affiliation processes (i.e., prosocial behavior) in adolescents' loneliness through longitudinal designs.

Direct Associations between Fear of Negative Evaluation, Prosocial Behavior and Loneliness

According to the evolutionary theory of loneliness, the experience of loneliness is not inherently problematic at any age; instead, it serves to activate both behavioral and cognitive re-affiliation processes aimed at reconnecting with others (Cacioppo & Cacioppo, 2018; Qualter et al., 2015). As RAM suggests, not all individuals grappling with loneliness successfully reestablish connections, resulting in a state of chronic loneliness (Geukens et al., 2023). Impediments to reconnection may arise from cognitive biases in social information processing and negative social behaviors (Qualter et al., 2015; for a review, see Spithoven et al., 2017). Loneliness is specifically associated with negative interpretations of social information and self-defeating cognitions, such as an increased fear of negative evaluation by others (Qualter et al., 2015; Geukens et al., 2022). Negative social behaviors, such as increased withdrawal and diminished engagement in prosocial behaviors during adolescence, are hypothesized as significant obstacles to successful re-affiliation (Geukens et al., 2021). However, research on the cognitive and behavioral re-affiliation process and its obstacles in adolescent loneliness is limited.

In the context of cognitive the re-affiliation process within the RAM, fear of negative evaluation may hinder the re-affiliation process as typical self-defeating cognition (Geukens et al., 2022; Qualter et al., 2015). Fear of negative evaluation involves an individual's apprehension regarding potential negative judgments from others in a social context (Weeks et al., 2005). It encompasses beliefs that others have high-performance standards and doubts about living up to these standards, leading to dissatisfaction with perceived social relationships (Lipton et al., 2016). Throughout adolescence, fear of negative evaluation is commonly experienced by youth (Aune et al., 2022). When adolescents fear negative evaluation by others, they may be unwilling to make efforts to reconnect, resulting in prolonged loneliness over time (Geukens et al., 2022). A recent longitudinal study employed latent growth curve modeling (LGCM), successfully identifying the anticipated developmental trajectories of fear of negative evaluation and loneliness (Geukens et al., 2022). However, this study omitted an examination of whether changes in fear of negative evaluation could predict changes in loneliness, neglecting an essential facet of investigating the direct influence of fear of negative evaluation on loneliness from a developmental perspective (Geukens et al., 2022). Thus, the direct relationship between fear of negative evaluation and adolescents' loneliness needs further explored.

Regarding the behavioral re-affiliation process, the RAM posits that engagement in prosocial behavior can ameliorate individuals' experiences of loneliness due to its inherent capacity to actively foster connections with others (Lanser and Eisenberger (2022)). That is, engaging in positive social behavior might mitigate individuals' loneliness by fulfilling their needs to reconnect with others (Luhmann & Hawkley, 2016). This fundamental need for social interaction is intrinsic from birth, and unmet social needs can lead to profound feelings of loneliness (Luhmann & Hawkley, 2016). Several cross-sectional studies consistently underscore a negative association between prosocial behavior and adolescents' experiences of loneliness (Griese & Buhs, 2014; Woodhouse et al., 2012). A longitudinal study substantiates these findings by demonstrating that prosocial behavior negatively predicts children's loneliness over a two-year period (Chen et al., 2022). Thus, prosocial behavior may function as a protective factor in mitigating adolescents' loneliness by meeting their needs for social connection.

Despite existing research demonstrating the interconnectedness between the fear of negative evaluation, prosocial behavior and loneliness, most studies have predominantly treated these variables in isolation, rather than exploring their collective impact (Liu et al., 2020; Woodhouse et al., 2012). As the RAM posits, cognitive and behavioral re-affiliation processes may reciprocally influence each other, ultimately alleviating feelings of loneliness (Qualter et al., 2015). Given the intertwined nature of cognitive and behavioral re-affiliation processes, it is imperative to simultaneously examine both domains to elucidate the distinctive relationships between the fear of negative evaluation, prosocial behaviors, and adolescents' loneliness. Adolescence is a critical period characterized by substantial shifts in cognition, behavior, and emotional adjustment (Hagan et al., 2019; Sharp et al., 2018). Previous studies have also documented meaningful changes in

adolescents' fear of negative evaluation, prosocial behavior, and loneliness (e.g., Danneel et al., 2018; Nelemans et al., 2019; Van der Graaff et al., 2018). Such changes necessitate a better understanding of the relations among fear of negative evaluation, prosocial behavior and loneliness from a developmental change perspective. Consequently, it is necessary to incorporate developmental changes as measurable variables to reveal whether and how changes in fear of negative evaluation, prosocial behavior and loneliness are related.

Indirect Associations between Fear of Negative Evaluation, Prosocial Behavior and Loneliness

The distressing nature of loneliness can serve as a catalyst for the cognitive and behavioral re-affiliation process, aimed at mitigating prolonged loneliness according to the RAM (Qualter et al., 2015). However, it remains unclear whether the cognitive and behavioral re-affiliation process operates independently or functions as a mediating mechanism influencing adolescents' experiences of loneliness.

Fear of negative evaluation, representing chronic concerns about eliciting negative reactions from others, may hinder individuals' attempts to engage in social interactions (Geukens et al., 2022). Aligned with the evolutionary theory of loneliness, negative cognition leads individuals to become excessively attentive to negative social information (Geukens et al., 2022; Goossens, 2018). These cognitive biases can compel individuals to withdraw further from social engagements (Qualter et al., 2015), including prosocial behaviors, thereby increasing their susceptibility to loneliness and prolonged periods of isolation (Geukens et al., 2022). Specifically, individuals with heightened levels of fear of negative evaluation exhibit a reduced inclination to offer assistance to others (Karakashian et al., 2006), potentially intensifying subsequent experiences of loneliness (Bennett et al., 2014). Existing research provides substantial evidence supporting the proposition that negative cognitions could trigger negative behaviors, subsequently reinforcing those negative cognitions (Gong & Nikitin, 2021; Qualter et al., 2015), culminating in heightened loneliness.

Concerning the behavioral re-affiliation process, it has been suggested that the experience of loneliness motivates people to withdraw from social encounters (Qualter et al., 2015). Such negative social behavior might result in prolonged loneliness, whereas the positive social behavior might decrease the feeling of loneliness. However, social withdrawing allows the next link in the mechanism-the cognitive re-affiliation process-to work effectively and lead to mitigating the experience of loneliness (Qualter et al., 2015). In other words, individuals will be able to assess the level of threat and determine whether they need to find other ways of behaving to reaffiliate with others by withdrawing from the immediate social encounters (Qualter et al., 2015). It is proposed that the behavioral re-affiliation process not only directly impacts individuals' loneliness but also indirectly influences individuals' loneliness across the cognitive re-affiliation process (Qualter et al., 2015). Regarding prosocial behavior, it is likely to reduce adolescents' loneliness by counteracting the fear of negative evaluation that engenders and maintains loneliness (Lanser and Eisenberger (2022)). A longitudinal study has substantiated that early engagement in prosocial behavior can bolster subsequent positive self-perception (Fu et al., 2017), thus serving as a protective factor against loneliness.

Although prior studies employed longitudinal designs to independently investigated the impacts of prosocial behavior and fear of negative evaluation on adolescents' loneliness, there has been limited exploration of indirect associations between these variables within a developmental framework. It remains unclear how the cognitive process (i.e., fear of negative evaluation) and the behavioral process (i.e., prosocial behavior) interplay and jointly influence the experience of loneliness via distinct mediating pathways. Notably, studies suggested that fear of negative evaluation, prosocial behavior, and loneliness are dynamic and change over time in adolescence (e.g., Geukens et al., 2022; Mund et al., 2020a, 2020b; Nelemans et al., 2019; Van der Graaff et al., 2018). Therefore, the present study aims to investigate the indirect linkages among the fear of negative evaluation, prosocial behavior, and loneliness within a developmental framework.

Current Study

Loneliness manifests most prominently during adolescence due to shifts in interpersonal relationship dynamics. According to RAM, the cognitive and behavioral re-affiliation process are hypothesized to influence adolescents' loneliness. The questions remain unclear whether cognitive and behavioral re-affiliation processes act as distinct parallel pathways or operate as mediational processes in alleviating loneliness. To address these questions, the present study employed a longitudinal design coupled with Latent Growth Curve Models (LGCM) to investigate the direct and indirect relations among developmental trajectories in fear of negative evaluation, prosocial behavior and loneliness. First, this study sought to determine whether the developmental trajectories of one domain (either fear of negative evaluation or prosocial behavior) were directly linked to the developmental trajectories of loneliness, while accounting for the influence of the other domain. Secondly, the present study aimed to examine whether the developmental trajectories of one domain (fear of negative evaluation or prosocial behavior) were indirectly associated

with the developmental trajectories of loneliness through the mediation of the other domain. The hypotheses of this study are outlined as follows. Prosocial behavior exhibits a negative association with loneliness in adolescents, encompassing both the initial levels and changes (Hypothesis 1); fear of negative evaluation demonstrates a positive association with loneliness in adolescents, encompassing both the initial levels and changes (Hypothesis 2). One domain (either fear of negative evaluation or prosocial behavior) is indirectly associated with loneliness through the mediation of the other domain among adolescents, encompassing both initial levels and changes as suggested by the RAM (Hypothesis 3).

Methods

Participants

Participants were drawn from an urban high school in northwestern China via nonrandom convenience sampling. Students were invited to participate in assessments at 3 time points across 2 years, with 1-year interval. All students were invited to our survey and completed a set of self-report questionnaires at senior one. At the baseline assessment (T1; November 2018), 824 first year high school students participated (376 females; 13–18 years, $M = 15.21$, $SD = 0.74$). After one year (T2; November 2019), 87.62% of the T1 participants took part in this assessment. The T3 data collection took place in November 2020 (amid the COVID-19 pandemic), and it leads to participants attrition across three wave measurements. Consequently, 64.8% of the T1 participants engaged in three waves of the assessments (T3; November 2020) and were included into the final model, leaving 533 adolescents with three timepoint data (49.0% girls; 14–18 years, $M_{age} = 16.22$, $SD = 0.698$).

Procedure

This study was approved by the University Committee on Human Research Protection of East China Normal University. Informed consent was obtained from parents and adolescents before data collection. Adolescents who volunteered to participated completed questionnaires independently during regular class time with a trained graduate assistant. Participants were informed that their participation was voluntary, and they could withdraw at any time during data collection.

Attrition

Attrition analyses were conducted to examine whether the 533 retained adolescents differed from those who dropped out at T3. Results indicated that those missing at T3 were more likely to be girls ($p = 0.002$). However, no significant differences were found for fear of negative evaluation ($p = 0.895$), prosocial behavior ($p = 0.069$) and loneliness ($p = 0.816$).

Measures

Fear of negative evaluation

Fear of negative evaluation was assessed with the subscale of the Social Anxiety Scale (SAS; La Greca & Lopez, 1998), comprising 8 items (e.g., "I worry about what other kids think of me"). Participants responded on a 5-point Likert scale ranging from 1 (*totally disagree*) to 7 (*totally agree*). The fear of negative evaluation subscale of the SAS has shown adequate reliability and validity among Chinese adolescents (Liu et al., 2020). In this study, the Cronbach's coefficients α were 0.895, 0.905 and 0.901 for T1 to T3, respectively.

Prosocial behavior

Prosocial behavior was assessed with the Prosocial Behavior Scale for Adolescents (PBSA; Yang et al., 2021), consisting of 16-items, including altruistic behavior, trait pro-sociality, relational behavior and behavior benefiting public welfare (e.g., "I like participating in social activities for public good"). Participants responded on a 7-point Likert scale ranging from 1 (*definitely does not apply to me*) to 7 (*definitely applies to me*). The Cronbach's coefficients α for the total scale were 0.860, 0.883 and 0.902 for T1 to T3, respectively.

Loneliness

The 16-items Loneliness Scale (Asher & Wheeler, 1985) measured adolescents' loneliness on a five-point Likert scale ranging from 1 (very strongly disagree) to 5 (totally agree) (e.g., "I feel lonely"). The Chinese version exhibited good reliabilities in previous studies (e.g., Liu et al., 2020). In this study, Cronbach's coefficients α were 0.912, 0.913, and 0.895 for T1 to T3, respectively.

Statistical Analyses

Descriptive statistics and correlation analyses were conducted using SPSS 22.0, while all other analyses were performed via M*plus* 7.1. In evaluating the models in this study, the criteria employed included the comparative fit index (CFI), root mean square error of approximation (RMSEA), and standard root mean square residual

(SRMR). Model fit was deemed adequate when CFI > 0.90, RMSEA < 0.08, and SRMR < 0.10 (Marsh et al., 2004).

Latent Growth Curve Models (LGCM) has been advocated as a better method for answering questions about individual changes over time and individual differences in change (Rogosa, 1988; Rogosa et al., 1982; Willett & Sayer, 1994). Parallel process LGCM accommodates longitudinal data for situations in which both the mediator and outcome change over time (Selig & Preacher, 2009). Thus, LGCM were employed to investigate the direct and indirect associations among developmental trajectories of fear of negative evaluation, prosocial behavior and loneliness. Initially, a series of univariate LGCM were employed to determine the trajectories of fear of negative evaluation, prosocial behavior and loneliness respectively. Two latent factors were estimated, representing initial levels (i.e., the intercepts) and changes (i.e., the slopes) of each variable. Subsequently, after controlling for the adolescents' gender and age, parallel process LGCMs (see Fig. 1) were tested to examine the direct and unique associations between trajectories of one relationship domain (fear of negative evaluation or prosocial behavior) and trajectories of loneliness when the other relationship domain was controlled. The direct associations for initial levels and changes were both estimated. As shown in Fig. 1, there were two main predictive effects: (1) The direct effect of the intercepts of one re-affiliation domain (e.g., fear of negative evaluation) on the intercepts of loneliness (e.g., Path A) when the effect of the intercepts of the other re-affiliation s domain was controlled (e.g., Path B); and (2) The direct effect of the slopes of one re-affiliation domain (e.g., fear of negative evaluation) on the slopes of loneliness symptoms (e.g., Path C) when the effect of the slopes of the other re-affiliation domain was controlled (e.g., Path D). Finally,

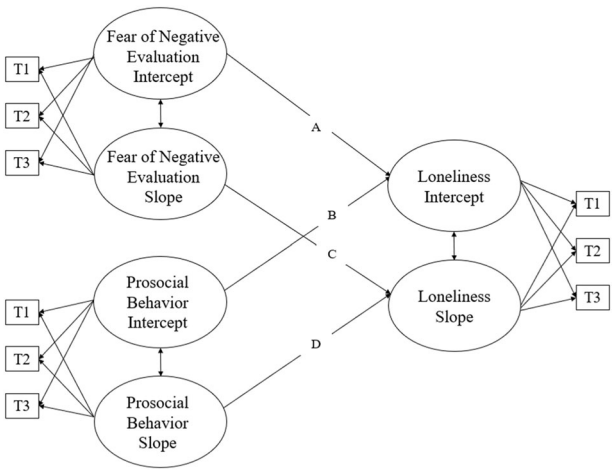

Fig. 1 Parallel-process latent growth curve model for the direct and unique associations between fear of negative evaluation or prosocial behavior and loneliness

parallel process mediation LGCMs were tested to examine the indirect associations among trajectories of fear of negative evaluation, prosocial behavior and loneliness. Two mediation models were examined separately, one indicating the mediating roles of prosocial behavior in the association between fear of negative evaluation and loneliness (see Fig. 2), and the other indicating the mediating roles of fear of negative evaluation in the association between prosocial behavior and loneliness. The indirect associations for initial levels and changes were both estimated. As shown in Fig. 2, there were two main predictive effects: (1) The indirect effect of the intercepts of fear of negative evaluation on the intercepts of loneliness through the intercepts of prosocial behavior (Path A × Path B), and the corresponding direct effect (Path C); and (2) The indirect effect of the slopes of fear of negative evaluation on the slopes of loneliness through the slopes of prosocial behavior (Path D × Path E), and the corresponding direct effect (Path F). The indirect effects in each model were tested through examining confidence intervals based on 5000 bootstrapped samples. Adolescents' gender and age was also controlled in the bootstrapping analyses.

Results

Measurement Invariance

A series of sequentially more constrained models were estimated and compared to test the measurement invariance. In the first model (M1: configural invariance), all parameters were freely estimated across time points. In the second model (M2: metric invariance), we then constrained the factor loadings at all time points to be equal. In the third model (M3: scalar invariance), we then further constrained the intercepts to equality at all three time points. Configural invariance was estimated by the model fits of unconstrained M1; metric invariance was tested by comparing M2 with M1; scalar invariance was evaluated by comparing M3 with M2. Given that chi-square values are sensitive to large samples, we considered a decrease in CFI ≤ 0.01 and an increase in RMSEA ≤ 0.015 as indicators of non-invariance (Cheung & Rensvold, 2002). As reported in Table 1, the results suggest that measurement equivalence was reached at a strong level (scalar invariance). Therefore, we used M3 in subsequent cross-lagged model analysis.

Descriptive Statistics

Means, standard deviations, and correlations for study variables are presented in Table 2. Across 3 time points, the correlations among study variables were statistically significant.

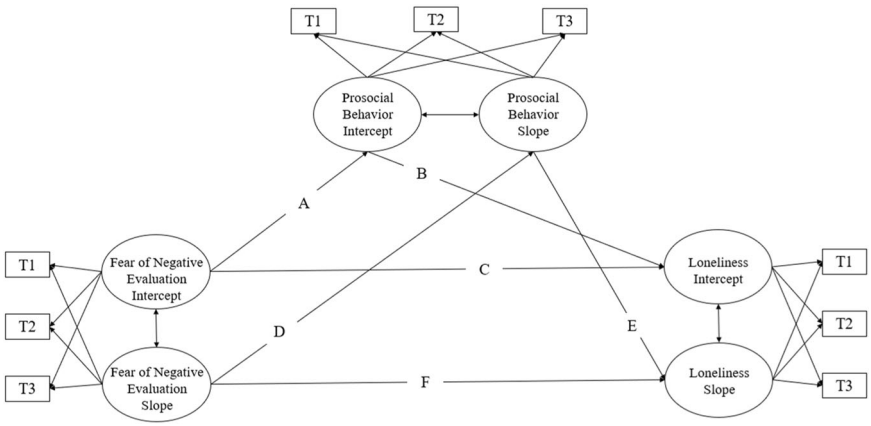

Fig. 2 An example of parallel-process latent growth curve mediation model for the indirect associations among fear of negative evaluation, prosocial behavior and loneliness, displayed by the mediating roles of prosocial behavior. A: the direct effect of the intercepts of fear of negative evaluation on the intercepts of prosocial behavior. B: the direct effect of the intercepts of prosocial behavior on the intercepts of loneliness. C: the direct effect of the intercepts of fear of negative evaluation on the intercepts of loneliness. D: the slopes of fear of negative evaluation on the slopes of prosocial behavior. E: the slopes of prosocial behavior on the slopes of loneliness. F: the direct effect of the slope of fear of negative evaluation on the slope of loneliness

Table 1 Fit statistics for measurement model and tests of measurement invariance

Variable	Model	χ^2	df	CFI	RMSEA	ΔCFI	ΔRMSEA
	M1: configural invariance	898.950	225	0.914	0.055	-	-
FNE	M2: metric invariance	905.844	239	0.915	0.052	+0.001	−0.003
	M3: scalar invariance	960.907	253	0.910	0.052	−0.005	0
	M1: configural invariance	3351.095	1029	0.921	0.055	-	-
PB	M2: metric invariance	3633.368	1059	0.911	0.058	−0.010	+0.003
	M3: scalar invariance	3781.542	1089	0.902	0.058	−0.009	0
	M1: configural invariance	2104.986	834	0.957	0.045	-	-
Loneliness	M2: metric invariance	2141.063	856	0.956	0.043	−0.001	−0.002
	M3: scalar invariance	2284.775	878	0.949	0.047	−0.007	0.004

FNE Fear of Negative Evaluation, *PB* Prosocial Behavior

Table 2 Means, standard deviations, and correlations for study variables

Variables	M	*SD*	1	2	3	4	5	6	7	8	9
1.T1FNE	3.09	0.88	-	0.534**	0.419**	−0.104*	−0.120**	0.390**	0.297**	0.121**	0.143**
2.T2FNE	3.02	0.89		-	0.546**	−0.100*	−0.124**	−0.116*	0.233**	0.287**	0.148**
3.T3FNE	2.98	0.85			-	−0.123**	−0.096*	−0.113*	0.256**	0.220**	0.307**
4. T1PB	4.84	0.80				-	0.511**	0.394**	−0.415**	−0.258**	−0.240**
5. T2PB	4.91	0.84					-	0.528**	−0.298**	−0.377**	−0.317**
6. T3PB	4.92	0.84						-	−0.238**	−0.211**	−0.439**
7. T1AL	2.34	0.64							-	0.581**	0.437**
8. T2AL	2.41	0.67								-	0.532**
9. T3AL	2.43	0.64									-

T1 Time 1, *T2* Time 2, *T3* Time 3, *FNE* Fear of negative evaluation, *PB* Prosocial behavior, *AL* Loneliness

*$p < 0.05$; **$p < 0.01$

Univariate Growth Models

The results for the univariate latent growth curve models are shown in Table 3. The univariate model estimates for all growth trajectories provided adequate fit to the data. According to the intercept factor, the adolescents exhibited significant individual differences in the initial level of fear of negative evaluation, loneliness and prosocial behavior.

Table 3 Model fit, intercept and slope for fear of negative evaluation, loneliness, and prosocial behavior

Variable	Model fit			Growth factors	
	CFI	RMSEA	SRMR	Intercept	Slope
Fear of negative evaluation	1.000	0.000	0.007	3.089**	−0.056*
Loneliness	1.000	0.000	0.006	2.347**	0.047**
Prosocial behavior	0.999	0.024	0.012	4.851**	0.036

CFI comparative fit index, *RMSEA* root mean square error of approximation, *SRMR* standard root mean-square residual

*$p < 0.01$; **$p < 0.001$

As for the slope factor, loneliness showed an increased trend over time, whereas fear of negative evaluation showed a decreased trend over time.

Parallel Process Models

A parallel process model tested the direct and unique associations, both for initial levels and changes. This model showed good fit indices (CFI = 0.946, RMSEA = 0.072 and SRMR = 0.044).

Direct association between fear of negative evaluation and loneliness

The intercept of fear of negative evaluation was positively associated with the intercept of loneliness ($b = 0.335$, 95% CI [0.230, 0.414]), indicating that adolescents with higher initial levels of fear of negative evaluation tended to have higher initial levels of loneliness. Similarly, the slope of fear of negative evaluation was positively associated with the slope of loneliness ($b = 0.502$, 95% CI [0.308, 0.909]), indicating that adolescents who reported an increase over time in fear of negative evaluation tended to report an increase in loneliness.

Direct association between prosocial behavior and loneliness

The intercept of prosocial behavior was negatively associated with the intercept of loneliness ($b = -0.516$, 95% CI [−0.626, −0.416]), indicting those adolescents with higher initial levels of prosocial behavior tended to have lower initial levels of loneliness. Similarly, the slope of prosocial behavior was negatively associated with the slope of loneliness ($b = -0.572$, 95% CI [−0.801, −0.411]), indicating that adolescents who reported an increase over time in prosocial behavior tended to report a decrease in loneliness.

Parallel Process Mediation Models

Two parallel process mediation models were estimated separately. The effect estimates for two mediation models are displayed in Table 4.

Mediation roles of the developmental trajectories of prosocial behavior

Model 1 examined the mediating roles of prosocial behavior in the association between fear of negative evaluation and loneliness. This model provided good fit indices (CFI = 0.950, RMSEA = 0.072, and SRMR = 0.033). As shown in Table 4, the intercept of fear of evaluation was negatively associated with the intercept of prosocial behavior, which in turn was negatively with the intercept of loneliness. The indirect effect of the intercept was significant, indicating that the initial levels of prosocial behavior mediated the association between fear of negative evaluation and loneliness at baseline. The slope of fear of negative evaluation was negatively associated with the slope of loneliness, whereas the association from fear of negative evaluation to the slope of prosocial behavior was not significant. The indirect effect of slope was significant, indicating that changes in prosocial behavior mediated the association between changes in fear of negative evaluation and changes in loneliness.

Mediation roles of the developmental trajectories of fear of negative evaluation

Model 2 examined the mediating roles of fear of negative evaluation in the association between prosocial behavior and loneliness. This model provided good fit indices (CFI = 0.951, RMSEA = 0.071, and SRMR = 0.032). As shown in Table 4, the intercept of prosocial behavior was negatively associated with the intercept of fear of negative evaluation, which in turn was positively with the intercept of loneliness. The indirect effect of the intercept was significant, indicating that the initial levels of fear of negative evaluation mediated the association between prosocial

Table 4 The effect estimates for the two parallel process mediation models

Models	Pathways	Growth factor associations	
		Intercept → Intercept [95% CI]	Slope → Slope [95% CI]
Model 1	Fear of negative evaluation → Prosocial behavior	−0.119 [−0.236, −0.008]	−0.192 [−0.484, 0.007]
	Prosocial behavior→ Loneliness	−0.500 [−0.610, −0.397]	−0.521 [−0.794, −0.305]
	Fear of negative evaluation → Loneliness	0.323 [0.217, 0.421]	0.470 [0.248, 0.857]
	Fear of negative evaluation → Prosocial behavior → Loneliness (Indirect effect)	0.059 [0.006, 0.124]	0.100 [0.005, 0.276]
Model 2	Prosocial behavior → Fear of negative evaluation	−0.149 [−0.256, −0.044]	−0.009 [−0.216, 0.172]
	Fear of negative evaluation → Loneliness	0.313 [0.209, 0.409]	0.0479 [0.290, 0.822]
	Prosocial behavior → Loneliness	−0.501 [−0.606, −0.402]	−0.571 [−0.822. −0.382]
	Prosocial behavior → Fear of negative evaluation → Loneliness (Indirect effect)	−0.047 [−0.083, −0.015]	−0.004 [−0.140, 0.104]

behavior and loneliness at baseline. The slope of prosocial behavior was negatively associated with the slope of loneliness, whereas the association from prosocial behavior to the slope of fear of negative evaluation was not significant. The indirect effect of slope was not significant, indicating that changes in fear of negative evaluation did not mediate the association between changes in prosocial behavior and changes in loneliness.

Discussion

Loneliness surges in adolescence (Hang et al., 2023). It is crucial to recognize individual differences in the developmental trajectories of loneliness (Hutten et al., 2021; Qualter et al., 2013). Examining factors influencing loneliness at the individual level offers valuable insights into these disparities. In this context, the RAM underscores the role of behavioral and cognitive factors in both the emergence and persistence of prolonged loneliness over time (Cacioppo et al., 2015; Qualter et al., 2015). However, the potential mechanism of cognitive and behavioral re-affiliation processes on adolescents' loneliness remains ambiguous. The present study investigated the direct and indirect associations among the developmental trajectories of prosocial behavior, fear of negative evaluation and loneliness in Chinese adolescents using longitudinal designs. The results revealed direct links between both the initial levels and changes in fear of negative evaluation and prosocial behavior with the initial levels and changes in loneliness. Furthermore, fear of negative evaluation was indirectly associated with loneliness through the mediating role of prosocial behavior, both for initial levels and changes, whereas prosocial behavior showed an indirect association with loneliness through the mediating role of fear of negative evaluation only for initial levels.

Direct Associations between Developmental Trajectories of Fear of Negative Evaluation, Prosocial Behavior and Adolescents' Loneliness

A significant finding was the associations between the initial levels of fear of negative evaluation, prosocial behavior, and loneliness. Specifically, initial level of fear of negative evaluation was positively related to initial level of loneliness, while the initial level of prosocial behavior was negatively related to initial level of loneliness. These findings align with prior research establishing a positive correlation between fear of negative evaluation and adolescents' loneliness (Liu et al., 2020), and a negative association between prosocial behavior and adolescents' loneliness (Griese & Buhs, 2014; Woodhouse et al., 2012). Adolescents displaying fear of negative evaluation may encounter interference in their daily interactions with others, heightening their sense of loneliness (Gill et al., 2018). Conversely, adolescents engaging in more prosocial behaviors tend to experience reduced feelings of loneliness by actively fostering connections with peers (Lanser and Eisenberger (2022)). The present study suggested that fear of negative evaluation contributes to adolescents' loneliness as a self-defeating perception (Geukens et al., 2022), whereas prosocial behavior can alleviate feelings of loneliness by satisfying their need for social interaction.

Simultaneously, the results underscored the distinct roles played by the fear of negative evaluation and prosocial behavior within the RAM. In contrast to previous research, which primarily focused on independently investigating associations among fear of negative evaluation, prosocial behavior and loneliness, this study extends these associations by integrating additional facets of the cognitive and behavioral re-affiliation process, grounded in the RAM framework. Our findings highlighted the pivotal roles that fear of negative evaluation and prosocial behavior play as significant resources during adolescence, exerting critical and distinct impacts on adolescents' experiences of loneliness. The results revealed significant associations between changes in fear of negative evaluation and prosocial behavior and corresponding changes in adolescents' loneliness. Specifically, an increase in fear of negative evaluation corresponds to an increase in adolescents' loneliness, whereas a heightened level of prosocial behavior correlates with a reduction in loneliness. These findings suggested that fear of negative evaluation operates as a risk factor, while prosocial behavior serves as a protective factor consistently throughout adolescence, rather than only at a single time. These findings further support the notion that adolescents' experiences of loneliness may stem from cognitive biases, specifically the fear of negative evaluation, and could be alleviated by engaging in prosocial behaviors to fulfill their social needs.

Indirect Associations between Developmental Trajectories of Fear of Negative Evaluation, Prosocial Behavior and Adolescents' Loneliness

The present study further investigated the indirect associations between developmental trajectories, specifically the initial levels and changes, of fear of negative evaluation, prosocial behavior and loneliness in adolescence. The findings indicated that the initial level of fear of negative evaluation mediated the relationship between initial levels of prosocial behavior and loneliness. It is suggested that adolescents' engagement in prosocial behavior may alleviate feelings of loneliness by mitigating their fear of negative evaluation. Regarding the mediation role of slope, the present study found that the changes in fear of negative evaluation did not mediate the association between prosocial behavior and loneliness. It suggested the longitudinal impact of dynamic changes in prosocial behavior on developmental changes in loneliness primarily operates directly, without heavy reliance on the cognitive re-affiliation process as the RAM posited. It implied that the process of behavioral re-affiliation may independently influence adolescents' loneliness, functioning as a separate parallel model compared to the cognitive re-affiliation process.

As for prosocial behavior, the present study revealed that initial levels of prosocial behavior indirectly influenced initial level of loneliness through level of fear of negative evaluation. This finding suggested that adolescents with elevated levels of fear of negative evaluation are less inclined to engage in prosocial behavior, resulting in heightened feelings of loneliness attributed to unmet social needs (Luhmann & Hawkley, 2016). Importantly, this study documented the role of changes in prosocial behavior over a two-year period in elucidating the link between fear of negative evaluation and adolescents' loneliness. Specifically, changes in prosocial behavior mediated the association between fear of negative evaluation and loneliness, indicating that variations in fear of negative evaluation indirectly impacted changes in loneliness by influencing shifts in adolescents' prosocial behavior. These findings underscored the importance of the cognitive re-affiliation process, specifically through behavioral re-affiliation process, in shaping adolescents' experience of loneliness, aligning with the RAM (Qualter et al., 2015).

The present study demonstrated that both the cognitive (i.e., fear of negative evaluation) and behavioral re-affiliation (i.e., prosocial behavior) process have direct and indirect impacts on adolescents' loneliness. These indirect effects revealed the interconnectedness between cognitive and behavioral re-affiliation process. These findings, especially the concurrent influence of indirect adolescents' fear of negative evaluation, prosocial behavior and loneliness, supported by the RAM (Qualter et al., 2015), provided evidence for the potential mechanism from adolescents' cognitive re-affiliation process to loneliness through their behavioral re-affiliation process.

Limitations and Implications

The current study has several limitations. The primary constraint is that all data were based on self-reported questionnaires by adolescents, which might generate the response bias. Future studies could enhance the present study by adopting multiple methods (e.g., experimental design) to offer a more comprehensive understanding of the relationship between the re-affiliation process and adolescents' loneliness. Additionally, the data collection for T3 occurred in November 2020, during the COVID-19 pandemic, which might have influenced adolescents' reports of loneliness and overall results. Furthermore, the present study focused on two typical factors of the re-affiliation process, and future research should consider additional specific factors (e.g., social withdraw) to better comprehend the mechanisms and effects of the re-affiliation process in mitigating adolescents' loneliness. Lastly, the generalizability of these findings may be limited as all participants

were adolescents recruited from China. Given that the behavioral and cognitive re-affiliation processes vary across life stages (Qualter et al., 2015), future studies in diverse regions and age groups are essential to examines the replicability of these findings and explore the extent to which cultural context and age influence these effects.

Despite these limitations, the present study elucidated the protective impact of prosocial behavior and the detrimental influence of fear of negative evaluation on adolescents' loneliness over the course of two years. This potential protective resource against adolescents' loneliness contributed valuable evidence for the formulation of preventive measures and target interventions. Drawing on these findings, the encouragement of prosocial behavior and the reduction of fear of negative evaluation emerge as potential avenues for inducing positive changes in adolescent loneliness. Existing research supports the efficacy of psychological interventions, such as Cognitive Behavioral Therapy (CBT) (Cacioppo et al., 2015; Käll et al., 2020), as well as social and emotional skills training (Eccles and Qualter (2021); Hickin et al., 2021), in mitigating loneliness levels. Educators should contemplate implementing targeted intervention programs aimed at fostering adolescents' prosocial behavior or diminishing their fear of negative evaluation to alleviate the experience of loneliness (e.g., Coelho and Sousa (2017)). Furthermore, the present study explored the connection between the cognitive and behavioral re-affiliation processes of RAM on loneliness, indicating that the cognitive re-affiliation process may impact adolescents' loneliness through behavioral process, not vice-versa. This finding underscored the relatively independent role of the behavioral re-affiliation process (i.e., prosocial behavior), contributing to a deeper understanding of the RAM mechanism in adolescence. In summary, the present study enhanced our comprehension of the longitudinal associations among fear of negative evaluation, prosocial behavior and adolescents' loneliness from a developmental perspective.

Conclusion

Despite the importance of mitigating loneliness for positive development during adolescence, there is a dearth of longitudinal studies exploring how the cognitive and behavioral re-affiliation process may contribute to reducing experience of loneliness in youth based on the RAM. The mechanism of the cognitive and behavioral re-affiliation processes in relation to adolescents' loneliness, specifically whether these processes function as distinct parallel pathways or operate as mediational processes in mitigating loneliness remains unclear. This study utilized a three-wave dataset to examine the direct and indirect associations among fear of negative evaluation, prosocial behavior, and adolescents' loneliness through latent growth modeling. Firstly, the results indicated a direct and unique association between fear of negative evaluation/prosocial behavior and adolescents' loneliness, both for initial levels and changes. It underscored the simultaneous development of loneliness and the constructs of interest, highlighting their central role in the cognitive and behavioral re-affiliation process accounts for feelings of loneliness. Secondly, the mediating effect of prosocial behavior in the association between fear of negative evaluation and loneliness existed for both initial levels and changes. This finding emphasized the mediational path in mitigating adolescents' loneliness, suggesting that the cognitive re-affiliation process indirectly influences loneliness indirectly through the behavioral re-affiliation process. It implied the existence of a relatively independent and mediating mechanism involving the cognitive and behavioral re-affiliation processes in affecting adolescents' loneliness. Lastly, the mediating effect of fear of negative evaluation in the association between prosocial behavior and loneliness was found only at initial levels, not for changes. This finding suggested that the positive behavioral factor may directly impact adolescents' loneliness over a two-year period. Overall, the present study emphasized the critical role of improving adolescents' social cognitive bias and fostering positive social behaviors to reduce loneliness effectively.

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Data Sharing and Declaration The datasets utilized in this study can be approved through reasonable requesting for correspondence author.

Compliance with Ethical Standards

Conflict of interest The authors declare no competing interests.

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Informed consent Informed consent was obtained from parents and adolescents before data collection.

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