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ARTICLE

The Influential Mechanisms of Theory of Mind on Prosocial Behavior and the Effect of Mindfulness Intervention

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ABSTRACT

Background: Theory of Mind (ToM) and empathy are crucial cognitive and emotional capacities that influence social interactions. While their role in promoting prosocial behavior has been established, the potential moderating effect of mindfulness on this relationship remains unexplored. Understanding these complex interactions is vital for developing effective interventions to foster prosocial behavior among college students. This study examines the influence of ToM on college students' prosocial behavior and explores the moderating role of mindfulness in this relationship. **Methods:** A mixed-methods approach combining questionnaires and experimental design was employed. Study 1: A survey of 759 college students (mean age 22.03 years; 477 females) was conducted using the ToM Scale, Interpersonal Reactivity Index, Prosocial Behavior Tendency Scale, and Mindfulness Awareness Scale. Data were analyzed using correlation and moderated mediation analyses. Study 2: An 8-week mindfulness attention training program was implemented for the intervention group and compared with a control group. Mindfulness training served as a moderating variable to validate Model 59 from Study 1. **Results:** 1. Study 1 found: (a) ToM was significantly positively correlated with prosocial behavior ($r = 0.31$, $p < 0.01$). (b) Empathy partially mediated the relationship between ToM and prosocial behavior ($\beta = 0.10$, $p < 0.001$, 95% CI [0.06, 0.14]). (c) Mindfulness negatively moderated the direct path between ToM and three dimensions of prosocial behavior, as well as the indirect path between empathy and kin altruism and reciprocal altruism. Specifically, high levels of mindfulness weakened the direct impact of ToM on prosocial behavior. High levels of mindfulness also weakened the indirect influence of ToM on prosocial behavior through empathy. 2. Study 2 results showed: (a) The intervention group had significantly higher levels of trait mindfulness compared to the control group ($t = 2.56$, $p < 0.05$). (b) The validity of the moderated mediation model 59 from Study 1 was verified. **Conclusion:** While ToM and empathy play crucial roles in fostering prosocial behavior, mindfulness exhibits a more complex influence than anticipated, potentially inhibiting prosocial behavior under certain circumstances. These findings offer novel insights into the psychological mechanisms underlying prosocial behavior and underscore the importance of considering multiple interacting factors in its promotion.

KEYWORDS

Prosocial behavior; Theory of Mind; trait mindfulness; empathy; mindfulness intervention

Introduction

Theory of Mind (ToM), defined as the ability to understand and infer others' mental states, plays a crucial role in social interactions [1]. The development of ToM is closely associated with children's prosocial behavior. Qiu et al. conducted a meta-analysis of cross-sectional and longitudinal studies, revealing a significant positive correlation between ToM and prosocial behavior among children and adolescents aged 2–19 years [2]. Furthermore, Shoshani experimentally demonstrated that children with more advanced ToM abilities were better at recognizing the concerns of distressed peers or adults and showed significantly more empathic concern [3]. These findings collectively underscore the crucial role of ToM in facilitating children's social interactions and prosocial behavior development. Numerous research findings indicate a close connection between ToM and prosocial behavior [4–6], promoting the development of various types of prosocial behaviors such as cooperation, helping, sharing, fairness, and emotional support [7–10]. Based on these findings, we propose hypothesis 1: ToM is positively correlated with prosocial behavior.

The social information processing theory posits that individuals interpret new information using existing experiences and concepts [11]. In this process, individuals with better ToM abilities can more accurately encode social cues such as others' mental states, thereby responding more appropriately and exhibiting more prosocial behaviors [12]. Empirical research supports this view [13].

However, the influence of ToM on prosocial behavior is not direct; empathy appears to play a significant mediating role in this process. Empathy is defined as an individual's ability to indirectly understand, feel, and interpret others' emotional states through external observation and verbal communication [14]. Longitudinal studies have shown that empathic concern has a persistent direct association with subsequent prosocial behavior, while perspective-taking ability (an important aspect of ToM) is only indirectly related to prosocial behavior through its influence on empathic concern [14].

Firstly, ToM provides the necessary cognitive foundation for empathy. Conceptually, accurately identifying others' mental states is a prerequisite for perceiving their emotions and responding appropriately. Previous research has demonstrated a positive correlation between ToM abilities and empathy levels [15]. Recent findings in cognitive neuroscience further reveal that ToM and empathy are actually supported by distinct neural networks, distinguishable at both behavioral and neural levels, and interact in complex social contexts [16]. Secondly, when individuals can accurately identify others' emotions and needs, they are more likely to experience emotional resonance and sympathy, thereby eliciting empathic responses. In other words, higher ToM abilities enable individuals to better understand others' mental states, enhance their capacity for empathy, and consequently promote prosocial behavior [17]. This process is crucial for accurately understanding others' states and generating appropriate empathic responses, which may subsequently influence prosocial behavior. In this process, ToM provides the cognitive basis for empathy, while empathy may serve as the key mechanism for translating this cognitive understanding into prosocial behavior. Based on these arguments, we propose hypothesis 2: Empathy mediates the influence of ToM on prosocial behavior.

The interplay between mindfulness, ToM, empathy, and prosocial behavior is complex and multifaceted. Building upon the existing hypotheses, we propose that mindfulness may play a crucial moderating role in the relationships between these constructs.

Mindfulness, characterized by conscious attention to present experiences and non-judgmental acceptance [18], can enhance ToM and empathic concern through brief mindfulness meditation [19]. Individuals with higher levels of mindfulness may better attune to the mental states and emotions of others, potentially enhancing the influence of ToM on empathic responses. The relationship between ToM and empathy may thus be moderated by mindfulness.

Moreover, mindfulness may moderate the direct relationship between theory of mind (ToM) and prosocial behavior. Individuals with higher levels of mindfulness are more likely to act based on their understanding of others' mental states, as they exhibit greater attentiveness and awareness of the current environment and others' needs [20]. Research indicates that both trait mindfulness and mindfulness interventions are positively correlated with prosocial behavior [21], and mindfulness interventions can effectively enhance prosocial behavior [22]. These findings suggest that mindfulness may strengthen the connection between ToM and prosocial behavior.

The relationship between empathy and prosocial behavior may also be moderated by mindfulness. Due to enhanced awareness and present-focused attention, mindful individuals are more likely to translate empathy into prosocial behavior [23]. Furthermore, mindfulness can assist individuals in managing their emotional responses to others' suffering more effectively [24] and enhance empathic concern [25], thereby facilitating more efficacious prosocial responses.

Based on the aforementioned arguments, we propose Hypothesis 3: Mindfulness positively moderates the relationships between (a) ToM and empathy, (b) ToM and prosocial behavior, and (c) empathy and prosocial behavior. In other words, higher levels of mindfulness will strengthen these pathways. The relationships between variables are illustrated in Fig. 1.

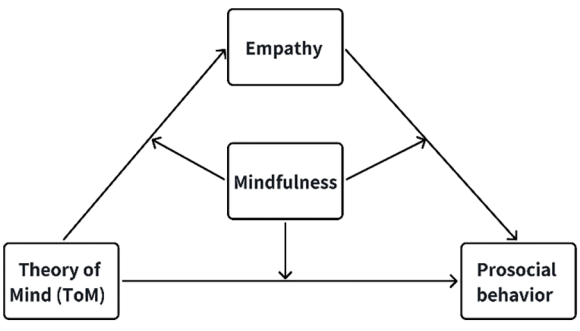

FIGURE 1. Diagram of the Hypothesized model.

Study 1: Theory of Mind Influences Prosocial Behavior, the Mediating Role of Empathy and the Moderating Role of Trait Mindfulness

Methods

Participants

Participants were undergraduate students from Shandong Normal University in China, recruited through online platforms. The questionnaire survey was conducted from 1 June, 2022, to 20 July, 2022. The study employed a convenience sampling method, with participation on a voluntary basis. Initially, 759 questionnaires were collected. To ensure data quality and validity, we implemented a rigorous screening process. Questionnaires with more than 75% identical responses or missing critical information were excluded from the analysis. This screening resulted in a final sample of 754 valid responses (99.3% retention rate). The participants' mean age was 23.00 years (SD = 0.05). The gender distribution of the sample was 37.3% male (n = 281) and 62.7% female (n = 473). Regarding religious affiliation, 83.0% of participants reported no religious beliefs. In terms of residential background, 61.5% of participants were from rural areas, 22.4% from urban areas, and 16.1% did not specify their place of residence.

Procedures

This study was approved by the Ethics Committee of the School of Teacher Education, Hechi University (IRB No. H2306). All participants signed the informed consent in this study.

Measures

Self-reported prosocial behavior

To evaluate participants' prosocial behavior, we utilized the Self-Report Altruism Scale Distinguished by the Recipient (SRAS-DR), a validated instrument developed by Oda et al. [26]. This comprehensive measure comprises 21 items that assess three distinct dimensions of altruistic behavior: altruism directed towards kin, friends, and strangers. Respondents indicated their level of agreement with each item on a 5-point Likert-type scale, with anchors ranging from 1 (strong disagreement) to 5 (strong agreement). An aggregate score was computed, with higher values denoting greater prosocial tendencies. In our sample, the instrument demonstrated excellent internal consistency, with Cronbach's alpha coefficients of 0.96 for the full scale. The subscales also exhibited robust reliability: kin altruism (α = 0.91), reciprocal altruism (α = 0.93), and pure altruism (α = 0.88).

ToM

In this study, we employed the "Reading the Mind in the Eyes" Test (Eyes test) [27], a revised version developed by Baron-Cohen et al. to assess the ToM in adults. The Eyes test consists of a series of photographs depicting the eye region of individuals, and participants are asked to infer the mental state of the person in each image. Each photograph is presented with four options, such as (a) panic, (b) jealousy, (c) disgust, and (d) arrogance. Participants are required to select the option that best reflects the expression of the person in the photograph. The test comprises 36 items, with each correct answer scored as 1 point and each incorrect answer scored as 0 points, resulting in a total score ranging from 0 to 36. In the current study, the Cronbach's alpha coefficient for the questionnaire was 0.93, indicating high internal consistency reliability.

Empathy

The Chinese version of the Interpersonal Reactivity Index (C-IRI; Davis, 1983) was utilized to evaluate participants' empathy levels [28,29]. The C-IRI is a self-report instrument comprising 22 items that assess four dimensions of empathy: perspective taking, fantasy, empathic concern, and personal distress. Perspective taking evaluates the capacity to comprehend and adopt others' viewpoints, while fantasy measures empathic responses to fictional characters in various media. Empathic concern assesses other-oriented emotions evoked by individuals in need, whereas personal distress measures self-oriented negative emotional reactions to others' distress. Perspective taking and fantasy represent cognitive aspects of empathy, while empathic concern and personal distress reflect emotional sharing capabilities. Although these four components have been demonstrated to differentially predict prosocial behavior [28], only the total score was employed in this study for brevity. The psychometric properties of the C-IRI were found to be satisfactory. The internal consistency of the overall scale was robust, with a Cronbach's alpha of 0.82. The subscales demonstrated varying levels of reliability, with alpha coefficients ranging from 0.59 to 0.78 across the four dimensions.

Trait mindfulness

The measurement of trait mindfulness was conducted using the Mindfulness Attention Perception Scale [20]. This scale includes 15 questions, such as "When I am in a bad mood, I should not avoid it but let it disappear naturally" and "I always pay attention to my physical feelings and psychological state". This scale uses a 6-point scoring system (1 = almost none, 6 = almost always), with higher scores indicating a higher level of trait mindfulness. Previous studies have shown that in this study, the scale's α the coefficient is 0.70.

Statistical analysis

Statistical analyses were conducted using IBM SPSS Statistics 26.0 and the PROCESS macro version 4.2 for SPSS [30]. Analyses included: 1. Descriptive statistics and Pearson correlations for all variables. 2. Mediation analysis (PROCESS Model 4) to test empathy's mediating role between ToM and prosocial behavior (PB). 3. Moderated mediation analysis (PROCESS Model 59) to examine mindfulness's moderating effects on ToM-empathy, ToM-PB, and empathy-PB relationships. For the moderated mediation analysis, all continuous predictor variables were mean-centered prior to analysis. Bootstrap sampling (5000 samples) was used to estimate the 95% confidence intervals for the conditional indirect effects. The significance of the effects was determined by examining whether the

confidence intervals included zero. The statistical significance level was set at $p < 0.05$ for all analyses.

Result

Correlations between ToM, prosocial behavior, empathy, and mindfulness

Table 1 lists the descriptive statistical results and correlation coefficients for each variable. The results show several significant positive correlations. For instance, the correlation coefficient between ToM and Empathy is 0.35 ($p < 0.01$), indicating a significant positive relationship. Similarly, Mindfulness is positively correlated with both Empathy (r = 0.21, $p < 0.01$) and Prosocial Behavior (r = 0.38, $p < 0.01$). This result validates hypothesis 1.

Mediating effect of empathy and the moderating effect of mindfulness

Mediation analysis

The analysis revealed significant relationships between ToM, empathy, and prosocial behavior (see Table 2 and Fig. 2). ToM significantly predicted prosocial behavior (β = 0.30, t = 8.70, $p < 0.001$), and this prediction remained significant even after including empathy as a mediator (β = 0.21, t = 5.83, $p < 0.001$). Furthermore, ToM positively predicted empathy (β = 0.34, t = 10.06, $p < 0.001$), which in turn positively predicted prosocial behavior (β = 0.28, t = 7.72, $p < 0.001$). These results support hypothesis 2, confirming empathy's mediating role in the relationship between ToM and prosocial behavior.

Moreover, as shown in Table 3, the Bootstrap 95% confidence intervals for both the direct effect on prosocial behavior and the mediating effect of empathy do not include zero, indicating that ToM not only directly predicts prosocial behavior but also indirectly predicts it through the mediating effect of empathy. Specifically, the direct effect (0.21) and the mediating effect (0.10) account for 68% and 32% of the total effect (0.31), respectively. These results indicate that empathy plays a partial mediating role in the relationship between ToM and prosocial behavior.

Moderated mediation analysis

The results of the moderated mediation analysis are presented in Table 4. The analysis revealed significant interactions between ToM, empathy, mindfulness, and kin altruism.

TABLE 1

Descriptive statistics and correlation analysis (N = 759)

Variable	M	SD	1	2	3	4	5	6	7	8	9	10	11
1. ToM	21.14	5.43	1										
2. Empathy	72.64	11.42	0.35**	1									
3. Mindfulness	56.88	7.63	0.29**	0.21**	1								
4. PB	82.59	15.96	0.31**	0.35**	0.38**	1							
5. KA	28.23	5.76	0.29**	0.32**	0.40**	0.94**	1						
6. RA	29.09	5.78	0.39**	0.37**	0.40**	0.92**	0.85**	1					
7. PA	25.27	5.96	0.16**	0.27**	0.23**	0.88**	0.74**	0.66**	1				
8. PT	16.3	3.94	0.19**	0.72**	0.30**	0.26**	0.24**	0.24**	0.23**	1			
9. Fantasy	20.32	4.06	0.34**	0.79**	0.25**	0.28**	0.26**	0.33**	0.18**	0.42**	1		
10. EC	20.78	4.2	0.45**	0.69**	0.30**	0.43**	0.40**	0.43**	0.35**	0.33**	0.52**	1	
11. PD	15.24	4.29	−0.01	0.58**	−0.26**	0.01	0	0.034	0	0.27**	0.25**	0.08*	1

Note: PB = Prosocial Behavior; KA = Kin altruism; RA = Reciprocal altruism; PA = Pure altruism; PT = Perspective taking; EC = Empathy concern; PD = Personal distress. *$p < 0.05$, **$p < 0.01$.

TABLE 2

Mediation analysis of empathy in the relationship between theory of mind and prosocial behavior

Predictors	Prosocial behavior			Empathy			Prosocial behavior		
	Equation 1			Equation 2			Equation 3		
	β	*SE*	*t*	*β*	*SE*	*t*	*β*	*SE*	*t*
ToM	0.30	0.04	8.70***	0.34	0.03	10.06***	0.21	0.04	5.83***
Empathy							0.28	0.03	7.72***
R	0.41			0.35			0.4		
R^2	0.17			0.12			0.16		

Note: ***$p < 0.001$.

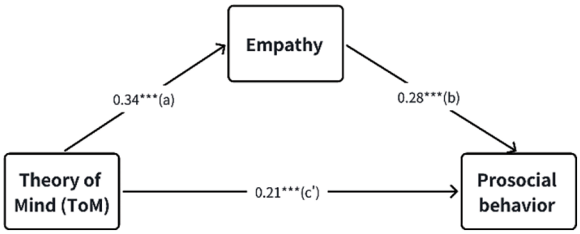

FIGURE 2. The mediating role of empathy in the influence of theory of mind on prosocial behavior (Study 1).
Note: ***$p < 0.001$; The indirect effect of ToM on prosocial behavior through empathy is represented by a*b. The direct effect of ToM on prosocial behavior is represented by c′.

ToM significantly positively predicted empathy. However, the interaction between ToM and mindfulness negatively predicted empathy (β = −0.16, $p < 0.001$), indicating that mindfulness negatively moderated the relationship between ToM and empathy.

The interaction between ToM and mindfulness also negatively predicted kin altruism (β = −0.15, $p < 0.001$), suggesting that mindfulness negatively moderated the direct relationship between ToM and kin altruism.

Empathy significantly positively predicted kin altruism. The interaction between empathy and mindfulness negatively predicted kin altruism (β = −0.07, $p < 0.05$), indicating that mindfulness negatively moderated the relationship between empathy and kin altruism.

These findings collectively support Hypothesis 3, confirming the moderating role of mindfulness in the relationships between ToM, empathy, and kin altruism.

To elucidate the essence of the moderated mediation model, we stratified mindfulness into high and low groups by adding or subtracting one standard deviation from the mean, respectively. Subsequently, we conducted simple slope tests and generated simple effect plots for three different dimensions of prosocial behavior.

Firstly, regarding kin altruism, the simple slope test results reveal that on the direct path (Fig. 3), when mindfulness is low (M − SD), ToM significantly and positively predicts kin altruism ($\beta_{Simple} = 0.2$, $p < 0.001$). Conversely, when mindfulness is high (M + SD), ToM exhibits no significant predictive effect on kin altruism ($\beta_{Simple} = -1.0$, $p > 0.05$).

In the first half of the mediating pathway (Fig. 4), at low levels of mindfulness (M − SD), ToM significantly and positively predicts empathy ($\beta_{Simple} = 0.41$, $p < 0.001$). However, at high levels of mindfulness (M + SD), ToM shows no significant predictive effect on empathy ($\beta_{Simple} = 0.09$, $p > 0.05$).

In the latter half of the mediating pathway (Fig. 5), when mindfulness is low (M − SD), empathy significantly and positively predicts kin altruism ($\beta_{Simple} = 0.23$, $p < 0.001$). When mindfulness is high (M + SD), empathy significantly and positively predicts kin altruism ($\beta_{Simple} = 0.10$, $p < 0.05$). These results further corroborate that mindfulness

TABLE 3

Bootstrap analysis of mediation effects

Effect type	Effect	Bootstrap SE	% of total effect	Bootstrap 95% CI	
				Lower limit	upper limit
Direct effects	0.21	0.04	68%	0.14	0.29
Indirect effects	0.1	0.02	32%	0.06	0.14
Total effect	0.31	0.04	100%	0.24	0.38

TABLE 4

The influence of mindfulness regulation theory of mind on kin altruism through empathy

Variable	Empathy			Kin altruism		
	Equation 1			Equation 2		
	β	*SE*	*t*	*β*	*SE*	*t*
ToM	0.25	0.04	6.77***	0.05	0.04	1.38*
Mindfulness	0.11	0.03	3.19**	0.33	0.03	10.14***
ToM × Mindfulness	−0.16	0.03	−5.42***	−0.15	0.03	−4.61***
Empathy × Mindfulness				−0.07	0.03	−2.16*
Empathy				0.08	0.02	4.87***
R^2		0.17			0.29	
F		37.13			50.22	

Note: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

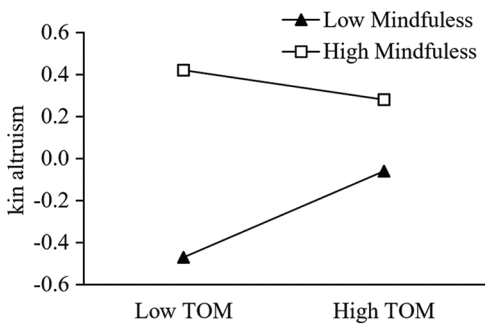

FIGURE 3. The moderating role of mindfulness in the influence of theory of mind on kin altruism.

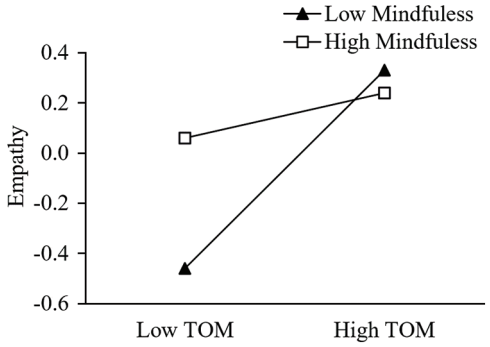

FIGURE 4. The moderating role of mindfulness in the influence of theory of mind on empathy.

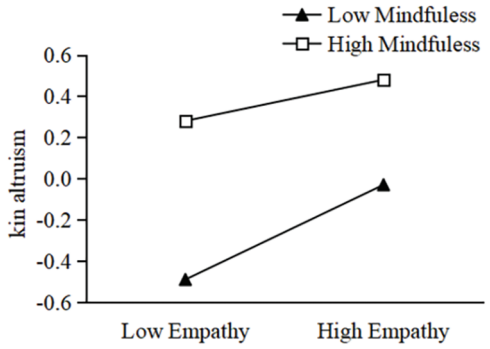

FIGURE 5. The moderating role of mindfulness in the influence of empathy on kin altruism.

significantly moderates the relationships between ToM and empathy, empathy and kin altruism, and ToM and kin altruism, thus supporting our research hypothesis.

As illustrated in Table 5, the interaction between ToM and mindfulness demonstrates a significant negative predictive effect on reciprocal altruism ($\beta = -0.16$, $p < 0.05$). This indicates that mindfulness negatively moderates the direct pathway from ToM to reciprocal altruism. Furthermore, empathy exhibits a significant negative predictive effect on reciprocal altruism. Notably, the interaction between empathy and mindfulness significantly positively predicts reciprocal altruism ($\beta = 0.07$, $p < 0.05$). This suggests that mindfulness positively moderates the indirect pathway from empathy to reciprocal altruism. Collectively, these findings provide support for Hypothesis 3. Further insights are gained through simple slope analyses.

Secondly, for reciprocal altruism, the simple slope test results indicate that on the direct path (Fig. 6), when mindfulness is low (M − SD), ToM positively predicts reciprocal altruism tendency ($\beta_{Simple} = 0.32$, $p < 0.001$). However, when mindfulness is high (M + SD), ToM shows no significant predictive effect on reciprocal altruism ($\beta_{Simple} = -0.00$, $p > 0.05$).

The results of the simple slope analysis for the first half of the mediating pathway remain consistent with the previous findings. In the second half of the mediating pathway (Fig. 7), when mindfulness is low (M − SD), empathy significantly and positively predicts reciprocal altruism ($\beta_{Simple} = 0.27$, $p < 0.001$). When mindfulness is high (M + SD), the positive predictive effect of empathy on reciprocal altruism remains significant but diminishes ($\beta_{Simple} = 0.11$, $p < 0.05$), indicating that as mindfulness levels increase, the predictive effect of empathy on reciprocal altruism decreases.

As evidenced in Table 6, the interaction between ToM and mindfulness exhibits a significant negative predictive effect on pure altruism ($\beta = -0.11$, $p < 0.05$). This finding partially corroborates Hypothesis 3. Further elucidation is provided through the simple slope analysis.

Finally, the simple slope test results for pure altruism are illustrated in Fig. 8. When mindfulness is low (M − SD), ToM positively predicts pure altruistic tendencies ($\beta = 0.11$, $p < 0.05$). Conversely, when mindfulness is high (M + SD), the negative predictive effect of ToM on pure altruism is enhanced ($\beta = -0.13$, $p < 0.05$).

Discussion

This study aims to explore the relationship between ToM and prosocial behavior, as well as the potential mediating role of empathy. More importantly, we introduce mindfulness as a regulator to explore how mindfulness interacts with ToM to inject prosocial emotions and behaviors.

ToM is a predictive factor for prosocial behavior

This study found a significant positive correlation between ToM and prosocial behavior, and further regression analysis showed that ToM can also significantly predict prosocial behavior positively, consistent with hypothesis 1. The research results support the views of some researchers. Individuals with higher levels of ToM are more likely to think from the perspective of others, understand their thoughts, and even resonate with them to a certain extent. This empathy ability will affect the motivation of others to cooperate and participate, making them more willing to help others and stimulating more prosocial behavior [31]. Research has shown that ToM is a necessary prerequisite for children to share behavior with strangers. As they develop the ability to monitor and understand each other's intentions, thoughts, beliefs, emotions, and other psychological states, they better consider the thoughts of others and maintain consistency with their behavior to regulate their actions and make more helpful behaviors [32]. Therefore, a person may become increasingly concerned about the happiness of others, and a higher level of ToM understanding is associated with fairer choices in ultimatum games [3]. In the Ultimatum game, there are two types of characters, namely the allocator and receiver. ToM plays an important role in an individual's prosocial behavior. One

TABLE 5

The influence of mindfulness regulation theory of mind on reciprocal altruism through empathy

Variable	Empathy (Equation 1)			Reciprocal altruism (Equation 2)		
	β	*SE*	*t*	*β*	*SE*	*t*
Birthplace	0.01	0.03	0.18	0.03	0.03	0.87
ToM	0.25	0.04	6.77***	0.16	0.03	4.52***
Mindfulness	0.11	0.03	3.19***	0.28	0.03	9.05***
ToM × Mindfulness	−0.16	0.03	−5.42***	−0.16	0.03	−5.09***
Empathy × Mindfulness				0.07	0.03	−2.67**
Empathy				0.19	0.03	5.73***
R^2		0.17				
F		37.13			65.38	

Note: $^{**}p < 0.01$, $^{***}p < 0.001$.

study found that five-year-old children who passed a ToM task were more likely to make a fair decision than those who did not pass the ToM task when the distributor was asked to decide how to divide a donation between themselves and the recipient [3]. This suggests that individuals with higher levels of ToM may have higher levels of social cognitive insight, enabling them to be aware of the needs of others and to make judgements and act accordingly, thereby promoting prosocial behavior [33,34]. To further explore the relationship between ToM and other factors, the researchers designed a multifactorial mixed experiment and analysed the data using logistic regression. The results showed that individuals' sharing behaviors were mainly influenced by ToM and linguistic cognitive abilities. Based on this finding, the researcher suggested that future studies should focus on how to improve participants' ToM and emotional comprehension in order to promote prosocial behavior [6].

Empathy plays a mediating role between ToM and prosocial behavior

The results of this study indicate that empathy plays a mediating role between ToM and prosocial behavior, possibly due to the following reasons: Firstly, argue that ToM can explain the psychology of others and speculate on their next behavioral direction [35]. Overall, ToM refers to an individual's cognitive ability to perceive their own or others' internal state and external behavior, that is, cognitive empathy. Previous experimental studies have found that adopting a cognitive empathy approach when dealing with external groups can better induce emotional empathy in participants, leading to more positive attitudes and more prosocial behaviors [35]. In other words, ToM can improve overall empathy levels by promoting emotional empathy, and cognitive empathy and emotional empathy have a more positive promoting effect on prosocial behavior [36].

Secondly, Dicker found that emotional empathy and ToM, namely cognitive empathy response, are two important factors in the motivation to help others [37]. And explore the roles of emotional information processing and cognitive information processing in providing economic assistance to those in need. And examine whether the information processing mode affects the donation, emotional response, and the relationship between the two, all of which are considered indicators of their donation motivation. Both cognitive empathy and emotional empathy can predict the donation amount, but when the recipient needs help, cognitive information processing is first needed, followed by emotional information processing, which further stimulates the enhancement of prosocial behavior [38].

Finally, Eisenberg argue that the process of prosocial behavior can be divided into three stages: paying attention to the needs of others, determining the intention to help

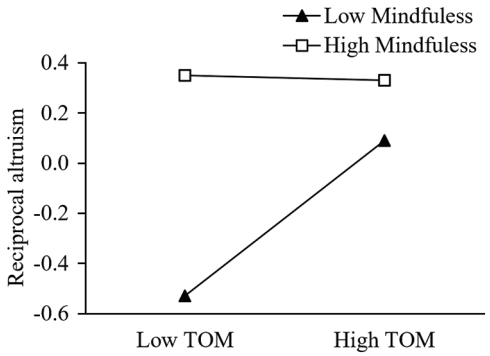

FIGURE 6. The moderating role of mindfulness in the theory of mind on the effects of reciprocity and altruism.

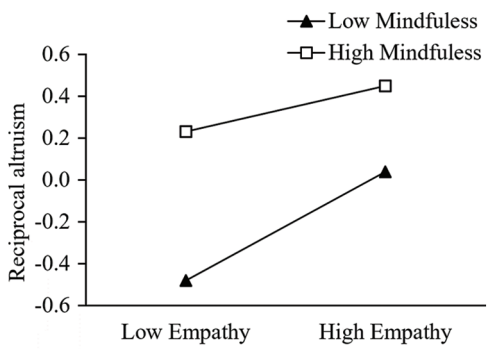

FIGURE 7. The moderating role of mindfulness in the impact of empathy on reciprocity and altruism.

TABLE 6

The influence of mindfulness regulation theory of mind on pure altruism through empathy

Variable	Empathy (Equation 1)			Pure altruism (Equation 2)		
	β	*SE*	*t*	*β*	*SE*	*t*
Birthplace	0.01	0.03	0.18	0.09	0.03	2.54*
ToM	0.25	0.04	6.77***	−0.13	0.04	−0.31
Mindfulness	0.11	0.03	3.19**	0.18	0.04	5.28***
ToM × Mindfulness	−0.16	0.03	−5.42***	−0.11	0.04	−3.14**
Empathy × Mindfulness				−0.01	0.03	−0.29
Empathy				0.19	0.04	5.08***
R^2		0.17				
F		37.13			19.44	

Note: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

others, and engaging in prosocial behavior [39]. In the stage of paying attention to the needs of others, it is necessary to use cognitive empathy. Individuals need to judge the psychological state of others in need, think from the perspective of others, and then balance their own views [40]. Through emotional and emotional empathy, they can stimulate and determine their intention to help others, and then decide whether to engage in prosocial behavior.

The negative regulatory effect of mindfulness

Considering the unique influence of mindfulness, this study constructed a mediation model with a moderating variable. The study hypothesized that mindfulness would positively moderate both the direct and indirect paths in the proposed mediation model. However, the results were inconsistent with the hypotheses. First, for the direct effects, mindfulness negatively moderated the path between ToM and prosocial behavior, but the direction was opposite to hypothesis 3c. Mindfulness negatively moderated the direct effects between ToM and kin altruism, reciprocal altruism, and pure altruism. Overall, mindfulness can promote individuals' prosocial behavior, and the effect is more significant for individuals with lower levels of ToM. However, when the level of mindfulness is higher, individuals with higher levels of ToM tend to exhibit less prosocial behavior than those with lower levels of ToM. Contemporary research suggests that mindfulness training does not universally enhance prosocial behavior. Empirical studies have shown that for individuals with an independent self-construal, mindfulness induced through experience can indeed enhance prosocial tendencies. However, for those with an interdependent self-construal, mindfulness practice may actually inhibit the expression of prosocial behavior [41]. In addition, there may be other reasons. First, mindfulness guides individuals to focus on present experiences rather than future expectations, which may reduce the excitement and motivation for action, thereby decreasing the occurrence of prosocial behavior [42]. Second, mindfulness emphasizes maintaining a non-judgmental awareness of internal and external experiences, an attitude that may lead individuals to respond to others' needs in a neutral and detached manner [43]. Furthermore, the emotion regulation ability cultivated by mindfulness may interfere with prosocial engagement in specific situations [42]. It is noteworthy that certain negative emotions (such as guilt) are key factors in promoting prosocial behavior, and research suggests that mindful breathing practices may reduce future-oriented thinking, leading to a lower state of arousal and thus hindering the development of prosocial emotional responses [44].

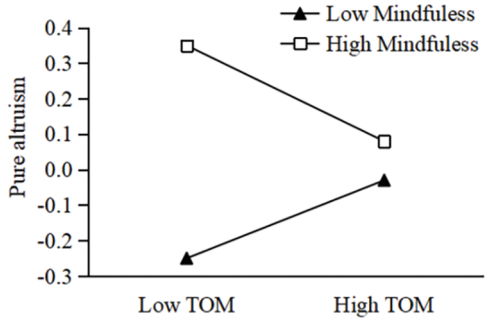

FIGURE 8. The moderating role of mindfulness in the theory of mind on the influence of pure altruism.

Many altruistic behaviors stem from an individual's need to alleviate their own uncomfortable emotions (such as personal distress or guilt) [45]. Although mindfulness may enhance sensitivity to moral issues, this effect does not universally apply to all situations or individuals [46–48]. These findings provide new perspectives for understanding the complex relationship between mindfulness and prosocial behavior while emphasizing the necessity of examining this relationship in specific contexts. For the indirect paths, mindfulness negatively moderates the two paths through which ToM influences prosocial behavior (kin altruism and reciprocal altruism) via empathy, but for pure altruism, mindfulness only negatively moderates the path between ToM and empathy. For the first half of the indirect path, mindfulness negatively moderates the effect of ToM on empathy. When the level of mindfulness is higher, the impact of ToM on empathy is actually weakened. Based on the meta-analysis by Yan et al., executive function is significantly positively correlated with ToM (reflected

through empathy), and the subcomponents of executive function, particularly inhibitory control, working memory, and cognitive flexibility, exhibit stronger relationships with cognitive empathy [49].

Researchers have also examined the relationship between the ToM system and inhibitory control, planning, working memory, language, etc., and the results support that ToM requires cognitive resource consumption [50–53], while attentional resources are limited [54]. In an environment with massive information, individuals need to simultaneously face and process information from various aspects of life, and their attentional resources are always limited, which may inhibit their filtering and control functions [55]. When individuals with high ToM undergo mindfulness intervention, their cognitive resources and energy have already been consumed. However, when cognitive load is too high, our attention is easily distracted. Therefore, during mindfulness intervention, individuals are unable to focus on mindfulness meditation. Due to limited cognitive resources and less attention allocation, their perception of others' mental states (such as beliefs, feelings, emotional resonance, etc.) is weakened. Consequently, for individuals with high levels of mindfulness, the predictive effect of ToM on empathy is actually weaker. For individuals with low levels of ToM, high levels of mindfulness can help them better perceive the needs of others without requiring more resources for deeper judgments, leading to inconsistent results.

Regarding the latter part of the indirect path, the negative moderation of mindfulness on the impact of empathy on prosocial behavior is inconsistent with research hypothesis 3c. We found that under low mindfulness, the influence of empathy on prosocial behavior was enhanced, while under high mindfulness, the impact of empathy on prosocial behavior was weakened. For the latter part of the indirect path, empathy had a significant impact on kin altruism and reciprocal altruism. For pure altruism, mindfulness only negatively moderated the path from ToM to empathy. Empirical research has shown that mindfulness significantly weakened the association between empathy and prosocial behavior. As the level of mindfulness increased, the strength of this association decreased significantly. This finding is consistent with previous research results, which suggest that mindfulness reduces behavioral responses to external cues [56]. This phenomenon can be explained from multiple perspectives: First, mindfulness may reduce the motivation to change the status quo, as new actions may disrupt the calm and relaxed state induced by mindfulness. Second, mindfulness cultivates present-moment focus and acceptance, which may hinder individuals from taking action to achieve an ideal state [57]. In social situations, when witnessing the suffering of others, bystanders typically generate automatic empathic responses (such as sympathy or personal distress). The ideal outcome is for the victim to escape the predicament; otherwise, the bystander may experience negative emotions such as guilt, self-blame, and distress [58]. Based on this reasoning, certain characteristics of mindfulness (such as reduced focus on the future and acceptance of the present) may alleviate negative emotions to some extent, leading empathetic individuals to exhibit fewer reciprocal and kin altruistic behaviors [57]. For highly empathetic individuals who are already able to perceive the negative emotions of others, prosocial behavior actually decreases through the influence of mindfulness. Among the types of prosocial behavior, pure altruism refers to altruistic behavior in which individuals subjectively do not seek any reward and have no blood relationship. Empathy had no effect on pure altruism when mindfulness levels were high or low. This may be due to the development of modern society, where people have a sense of caution when helping strangers.

In summary, the results of this study provide a new perspective for understanding the complex relationship between mindfulness and prosocial behavior. The findings suggest that mindfulness can promote prosocial behavior in individuals, but its effects vary depending on the individual's level of ToM. For individuals with lower levels of ToM, the promoting effect of mindfulness is greater; while for individuals with higher levels of ToM, high levels of mindfulness actually weaken prosocial behavior. Furthermore, mindfulness negatively moderated the role of empathy in the indirect path of ToM influencing prosocial behavior. High levels of mindfulness weakened the impact of ToM on empathy, thereby reducing the occurrence of prosocial behavior. These findings indicate that the influence of mindfulness on prosocial behavior is complex and multifaceted, depending on individual characteristics and specific contexts. To further verify whether mindfulness induced through intervention methods plays the same role in the model obtained in Study 1, we designed Study 2.

Study 2: Theory of Mind Influences Prosocial Behavior through Empathy: A Comparison before and after Mindfulness Intervention

Research Hypothesis

Hypothesis 2a: Mindfulness training can significantly enhance an individual's level of trait mindfulness.

Hypothesis 2b: Empathy mediates the relationship between ToM and prosocial behavior.

Hypothesis 2c: Mindfulness moderates both the direct and indirect pathways through which ToM influences prosocial behavior (model diagram identical to study 1).

Purpose of the Study

Study 1 focused on the influence of trait mindfulness on prosocial behavior, and study 2 conducted intervention research through mindfulness intervention training, and reverified the relationship between college students' ToM and prosocial behavior by manipulating mindfulness, and the internal mechanism of the mediating role of empathy and the moderating effect of mindfulness.

Methods

Study design

This study employed a 2 × 2 completely randomized experimental design. It included two levels: an intervention group and a control group, with participants randomly

assigned to these two groups. Participants were randomly allocated to either the intervention group (receiving an eight-week mindfulness training program) or the control group (receiving no training). ToM served as the independent variable, empathy as the mediating variable, and prosocial behavior as the dependent variable. ToM and trait mindfulness were measured in the pre-test, while ToM, trait mindfulness, empathy, and prosocial behavior were assessed in the post-test.

Participants

Using G*power 3.1 to calculate the sample size, with $\eta^2 = 0.5$ and $\alpha = 0.05$, the estimated total sample size should be at least 128 to achieve an 80% statistical power level. This study recruited 302 university students from Nanning, Guilin, Liuzhou, and other places to participate in the research, with 285 valid samples (female N = 34, male N = 251: average age 19.93 years old, SD = 0.88). Among them, 66% of the participants were Han, 28.4% were Zhuang, and 86.3% had no religious beliefs. 56.8% of the families had a per capita monthly income below 3000 yuan, 35.8% had a monthly income between 3000–6000 yuan, and 7.4% had a monthly income above 6000 yuan. The intervention group and the control group each consisted of three classes, forming a total of six classes. Maintaining this division was done to minimize disruption to the regular operation of the school and to facilitate the practical implementation of mindfulness interventions within the existing educational framework. The intervention measures were consistently applied in the three classes of the intervention group, while the three classes in the control group continued their regular activities. All participants had not previously participated in any form of mindfulness training, had normal or corrected-to-normal vision, no cognitive impairments or color blindness, and could receive credits and small gifts upon completion of the experiment.

Material

(1) ToM Measurement—"Eye Reading Mind Test" (same as Study 1)
(2) Prosocial behavior measurements

This study employed the Dictator Game to measure participants' prosocial behavior. The Dictator Game is a classic economic experimental paradigm commonly used to assess individuals' prosocial behavioral tendencies [59]. In this game, participants are randomly assigned to two roles: the dictator and the recipient. The dictator is given a certain amount of money and is told to allocate it between themselves and the recipient. The dictator can give the recipient any amount from zero to the total sum, while the recipient can only passively accept the allocation. As the dictator's decision is not influenced by the recipient, the amount of money given by the dictator reflects their prosocial behavioral tendency; the more money given, the stronger the prosocial tendency [60,61].

In the present study, participants were randomly assigned to the roles of dictator and recipient. The dictator initially received 100 yuan and was required to allocate this money between themselves and an anonymous recipient. The amount of money (0–100 yuan) given by the dictator served as the indicator of their prosocial behavior, with higher scores indicating stronger prosocial tendencies.

(3) Interpersonal Response Index-Chinese Version (IRI-C) scale was used for empathy (same as study 1);
(4) Trait Mindfulness Uses the Mindfulness Attention Awareness Scale (same as Study 1)
(5) Mindfulness training uses mindfulness training audio

The study is based on Kabat-Zinn's Mindfulness-Based Stress Reduction Research Summary, which is described as a hybrid of meditation, body awareness, and yoga by reviewing the literature and translating it into Chinese [62]. Based on the references, the following eight-week training course was formed. The training program is divided into 8 lessons, each lasting 30–35 min, through the main test guidance and audio assistance, to guide the participants to practice carefully and apply the content of the practice course to daily life.

Study procedures

Time Arrangement:

The project ran from 19 September, 2022, to 30 December, 2022, consisting of an 8-week mindfulness training program.

Participant introduction:

Before the study, participants were informed about the process and significance of the mindfulness training and were made aware of the policy allowing them to withdraw, without disclosing the specific purpose of the research.

Grouping:

Participants were divided into an intervention group and a control group. The Chinese version of the Interpersonal Reactivity Index (IRI-C) was utilized.

Pre-test:

Both groups underwent measurements of trait mindfulness and ToM levels before the training.

Intervention measures:

The intervention group participated in eight sessions of Mindfulness-Based Stress Reduction (MBSR) exercises, lasting 30–35 min each.

Control group:

The control group did not receive any specific training during this period.

Post-test:

After the training, both groups were assessed for prosocial behavior using the Dictator Game paradigm. ToM was measured using the "Reading the Mind in the Eyes Test," empathy was assessed with the Chinese version of the Interpersonal Reactivity Index (IRI-C) scale, and trait mindfulness was evaluated using the Mindful Attention Awareness Scale.

Statistical analysis

This study utilized Microsoft Excel and R software for data processing and analysis. Initial data visualization and preprocessing were conducted in Excel, followed by data integration of pre-and post-test datasets in R. Analyses

included descriptive statistics, independent sample *t*-tests for trait mindfulness differences, and correlation analyses among variables. For inferential statistics, the PROCESS macro [30] was employed for mediation analysis (Model 4) and moderated mediation analysis (Model 59) to examine the mediating role of empathy between ToM and Prosocial Behavior (PB), and the moderating effect of mindfulness training on ToM-empathy, ToM-PB, and empathy-PB relationships, respectively. In the moderated mediation analysis, continuous predictor variables were mean-centered, and bootstrap resampling with 5000 samples was used to estimate 95% confidence intervals for conditional indirect effects. The significance level for all analyses was set at $p < 0.05$.

Result

Differential analysis of mindfulness interventions

The results of the intervention group and the control group were analyzed by independent samples *t* test, as shown in Table 7. The comparison between the pretest scores of trait mindfulness showed no statistically significant difference between the groups before the intervention ($t = 1.11$, $p > 0.05$). However, in the post-test, there was a statistically significant difference between the groups ($t = 2.56$, $p < 0.05$), with the intervention group showing higher trait mindfulness scores compared to the control group.

It's worth noting that both groups showed an increase in trait mindfulness scores from pre-test to post-test. The control group's increase (from 39.61 ± 10.03 to 44.63 ± 7.31) was not statistically significant when analyzed with a paired sample *t*-test ($p > 0.05$). This slight increase in the control group might be attributed to factors such as practice effects from repeated measurements, increased awareness of mindfulness concepts due to study participation, or other uncontrolled external influences.

The significant difference between groups in the post-test, coupled with the larger increase in the intervention group's scores, supports the effectiveness of our intervention in enhancing trait mindfulness. These findings verify hypothesis 2a.

Descriptive statistics and correlation analysis

Table 8 lists the statistics for the description of the pretest variables, Table 8 presents the correlation between the descriptive statistics of each variable in the post-test and the variables.

Mediation analysis

The analysis indicates that there is a significant relationship between ToM, empathy, and prosocial behavior (see Table 9 and Fig. 9). ToM has a clear predictive effect on prosocial behavior ($\beta = 0.99$, $t = 2.65$, $p < 0.01$). The psychological theory has a significant positive predictive effect on empathy ($\beta = 0.30$, $t = 2.01$, $p < 0.05$). After including empathy in the regression equation, ToM can significantly predict prosocial behavior ($\beta = 0.9$, $t = 2.40$, $p < 0.05$). Empathy can significantly predict prosocial behavior ($\beta = 0.3$, $t = 1.98$, $p < 0.001$). And the results verify hypothesis 2b.

In addition, the upper and lower limits of the Bootstrap 95% confidence interval for the direct effect of prosocial behavior and the mediating effect of empathy did not contain 0 (see Table 10), indicating that ToM can not only directly predict prosocial behavior, but also predict prosocial behavior through the mediating role of empathy. The direct effect (0.9) and the mediating effect (0.09) accounted for

TABLE 7

Comparison of trait mindfulness scores between intervention and control groups

Index	Pre-test			Post-test		
	Intervention group *M* ± *SD*	Control group *M* ± *SD*	*t*	Intervention group *M* ± *SD*	Control group *M* ± *SD*	*t*
Trait mindfulness	40.82 ± 7.65	39.61 ± 10.03	1.11	46.78 ± 6.86	44.63 ± 7.31	2.56*

Note: *$p < 0.05$.

TABLE 8

Descriptive statistics and correlations of study variables

Variables	Pre-test *M* ± *SD*	Post-test *M* ± *SD*	1	2	3	4
1. ToM	19.03 ± 3.80	23.54 ± 3.68	1			
2. TM	45.82 ± 7.13	45.83 ± 7.13	0.1	1		
3. IM	0.56 ± 0.50	0.56 ± 0.50	0.22***	0.15*	1	
4. Empathy	–	66.44 ± 9.28	0.12*	0.24***	0.09	1
5. PB	–	45.69 ± 23.51	0.16**	0.13*	0.43***	0.13*

Note: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$; Intervention mindfulness (0 in the control group and 1 in the intervention group); TM = Trait mindfulness; IM = Intervention mindfulness; PB = Prosocial behavior.

TABLE 9

Mediation analysis of empathy in the relationship between theory of mind and prosocial behavior after mindfulness training

Variables	Prosocial behavior (Equation 1)			Empathy (Equation 2)			Prosocial behavior (Equation 3)		
	β	*SE*	*t*	*β*	*SE*	*t*	*β*	*SE*	*t*
ToM (Post-test)	0.99	0.38	2.65**	0.3	0.15	2.01*	0.9	0.38	2.40*
Empathy							0.3	0.15	1.98*
R		0.16			0.12			0.19	
R^2		0.02			0.01			0.04	
F (df)		7.02 (1,283)			4.04 (1,283)			5.51 (2,282)	

Note: *$p < 0.05$.

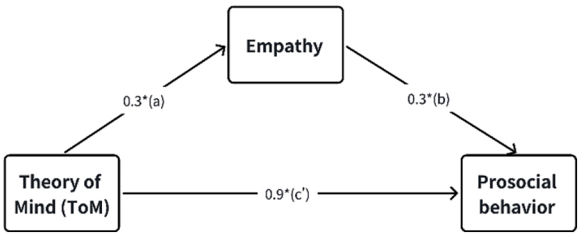

FIGURE 9. The mediating role of empathy in the influence of theory of mind on prosocial behavior (Study 2).
Note: *$p < 0.05$. The indirect effect of ToM on prosocial behavior through empathy is represented by a*b. The direct effect of ToM on prosocial behavior is represented by c′.

80% and 20% of the total (0.99), respectively. This suggests that empathy plays a mediating role in the influence of ToM on prosocial behavior. Thus, hypothesis 2a: empathy plays a partial mediating role in the influence of ToM on prosocial behavior.

Moderated mediation analysis: ToM, mindfulness training, and prosocial behavior

Table 11 presents the results of the moderated mediation analysis, revealing significant interactions among ToM, empathy, mindfulness, and prosocial behavior. Notably, the interaction between ToM and mindfulness positively predicted prosocial behavior ($\beta = 2$, $p < 0.05$). This finding indicates that mindfulness positively moderates the direct relationship between ToM and prosocial behavior. These results partially support Hypothesis 3c, confirming the positive moderating effect of mindfulness on the direct relationship between ToM and prosocial behavior. This suggests that the influence of ToM on prosocial behavior is enhanced when individuals have higher levels of mindfulness.

In order to understand the essence of the moderated mediation model, mindfulness was divided into high and low groups according to the mean plus or minus one standard deviation, and a simple slope test was performed, and a simple effect diagram was drawn, as shown in Fig. 10. Based on the above results, mindfulness training moderated the effect of ToM on prosocial behavior.

In the control group (M − SD), the ToM had no significant predictive effect on prosocial behavior ($\beta_{simple} = -0.48$, $p > 0.05$), and in the mindfulness intervention group (M + SD), the ToM had a significant predictive effect on prosocial behavior ($\beta_{simple} = 2.0$, $p < 0.05$).

Discussion

This study aims to investigate the relationship between ToM and prosocial behavior, as well as the potential mediating role of empathy. More importantly, we introduce mindfulness as a moderating variable to examine the impact of the interaction between ToM and mindfulness on empathy, the impact of the interaction between ToM and empathy on prosocial behavior, and the impact of the interaction between ToM and mindfulness on prosocial behavior.

The results of Study 2 provide further support for Study 1, indicating that ToM, empathy, and mindfulness indeed play crucial roles in promoting prosocial behavior. Study 2 demonstrates that an 8-week mindfulness meditation

TABLE 10

Bootstrap analysis of mediation effects

Effect type	Effect	Bootstrap SE	% of total effect	Bootstrap 95% CI	
				Lower limit	upper limit
Direct effects	0.9	0.07	91%	0.18	1.67
Indirect effects	0.09	0.38	9%	0.00	0.25
Total effect	0.99	0.38	100%	0.27	1.76

TABLE 11

Mindfulness training moderates the influence of theory of mind on prosocial behavior through empathy

	Empathy (Equation 1)			Prosocial behavior (Equation 2)		
	β	*SE*	*t*	*β*	*SE*	*t*
ToM	26	0.15	1.72	0.28	0.35	0.79
Mindfulness training	1.21	1.13	1.06	19.63	2.6	7.57***
ToM × MT	−0.02	0.31	−0.07	2	0.72	2.22*
Empathy				0.23	0.13	1.74
Empathy × MT				0.37	0.27	1.36
R^2		0.01			0.21	
F		1.73			15.22	

Note: *$p < 0.05$, ***$p < 0.001$; Mindfulness training (coded 0 for the control group and 1 for the intervention group); MT = Mindfulness training.

training enhances individuals' trait mindfulness levels, supporting hypothesis 2a. This finding is consistent with previous research results, which suggest that mindfulness practice can increase individuals' trait mindfulness levels [18,20]. Similar to Study 1, Study 2 also finds that empathy mediates the effect of ToM on prosocial behavior, validating hypothesis 2b. This result supports previous research perspectives on the relationship between ToM, empathy, and prosocial behavior [14,17]. Finally, through the 8-week mindfulness training, we separately explore the three-path model of ToM on prosocial behavior. The results partially support hypothesis 3c, indicating that mindfulness training can positively moderate the path from ToM to prosocial behavior.

Effects of mindfulness intervention

The results of Study 2 indicate that mindfulness training enhances trait mindfulness levels. Compared to the control group, participants who received mindfulness training exhibited higher levels of trait mindfulness. This finding is consistent with previous research results, which suggest that mindfulness practice can improve individuals' attentional and awareness capacities [63]. During the mindfulness practice process, participants are required to focus their attention on the present moment and be aware of changes in thoughts, emotions, and bodily sensations. This practice may enhance participants' metacognitive abilities [64]. It is noteworthy that the present study also observed an increase in mindfulness levels in the control group. This phenomenon may reflect the practice effect of repeated measurements or the influence of other unknown factors. Future research can further explore the potential mechanisms that lead to this change.

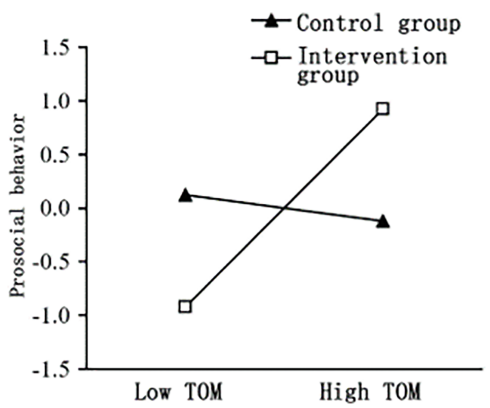

FIGURE 10. The moderating role of mindfulness in the influence of theory of mind on prosocial behavior.

The mediating role of empathy in theory of mind and prosocial behavior

The results of Study 2 validate hypothesis 2b, indicating that empathy plays a partial mediating role in the relationship between ToM and prosocial behavior, which is consistent with our hypothesis. This finding aligns with the research results of Völlm et al., who found that ToM ability is positively correlated with empathy levels [15]. Individuals with high ToM ability can effectively utilize cognitive resources to infer others' help-seeking signals. When signals appear, individuals make decisions through emotional empathy and then use ToM to mobilize cognitive resources to engage in more helping behaviors [65,66]. This result further supports the mediating role of empathy in ToM and prosocial behavior [67]. Decety and Jackson proposed that empathy is a multidimensional construct that includes components such as emotional sharing, self-other awareness, and mental flexibility [17]. ToM may promote the development of empathy by enhancing these components. For example, better ToM ability can help individuals more accurately identify others' emotional states, thereby enhancing emotional sharing [68]. Batson's empathy-altruism hypothesis is consistent with the results of this study [69]. This hypothesis suggests that empathic responses to others' suffering evoke altruistic motivation, thereby promoting prosocial behavior. The present study indicates that ToM ability may be an important prerequisite for this process, indirectly promoting prosocial behavior by enhancing empathy. Empathy only partially mediates the relationship between ToM and prosocial behavior, implying that there are other potential mediating mechanisms. For

example, executive function may be a potential mediating mechanism [6]. Future research can further explore these potential mediating mechanisms to more comprehensively understand the relationship between ToM, empathy, and prosocial behavior.

In summary, the results of this study emphasize the importance of cultivating ToM ability in promoting empathy and prosocial behavior. This has potential implications for education and social policy formulation. For example, incorporating content that cultivates ToM ability into school curricula may help improve students' empathy levels and prosocial behavior [70]. Future research can further explore specific methods and strategies for cultivating ToM ability in educational and social practices, with the aim of maximizing the positive role of ToM in promoting individuals' social adaptation and social harmony.

The moderating role of mindfulness

Based on the unique role of mindfulness, this study constructed a moderated mediation model. The results verified the direct path from ToM to prosocial behavior, indicating that mindfulness training positively moderated the impact of ToM on prosocial behavior, which is consistent with hypothesis 2c. This finding supports Donald's research, which found that trait mindfulness and mindfulness interventions were positively correlated with prosocial behavior [21]. However, the results of the other two paths showed that mindfulness training did not moderate the impact of empathy on prosocial behavior, nor did it moderate the impact of ToM on empathy, which is inconsistent with hypothesis 2c. This may be due to the following reasons:

First, attrition rates in mindfulness intervention studies can be problematic [71]. Participants may experience fatigue from long-term mindfulness practice, leading to dropout. Second, the measurement tools we used may have limitations. Although the "Reading the Mind in the Eyes" Test is widely used to assess ToM, it only captures one aspect of this complex construct [27]. Similarly, the Mindful Attention Awareness Scale (MAAS), used to assess mindfulness, also faces some controversy regarding its construct validity [72].

Furthermore, Van Dam et al. highlight that reverse-scoring mindlessness items (as done in the MAAS) may be inadequate to represent intentional attention or awareness-key components of mindfulness [72]. This raises questions about whether the scale fully captures the intended construct, which may affect our ability to detect moderation effects. Future research could employ multiple ToM and mindfulness measures to provide a more comprehensive assessment of these constructs.

Finally, the intervention effects of mindfulness training may not moderate the relationship between ToM and empathy, as well as empathy and prosocial behavior, in the short term. Mindfulness training may require a longer duration to manifest its effects.

In addition to the factors mentioned above, the impact of mindfulness training on the relationship between ToM and empathy, as well as empathy and prosocial behavior, may be moderated by other factors.

Limitations and future directions

When interpreting the results, it should be considered that this study has several limitations. First, the sample size in Study 2 was relatively small, which may limit the generalizability of the findings. Future research should replicate these results using larger and more diverse samples. Moreover, in Study 2, there was an inconsistency in the measurement methods between the pre-test and post-test in the research design. Only trait mindfulness and ToM were assessed in the pre-test. Second, the mindfulness intervention in this study was relatively short (8 weeks), and the long-term effects of mindfulness training on ToM, empathy, and prosocial behavior remain unclear. Future research could extend the intervention period or include follow-up assessments to examine the sustainability of the intervention effects [23]. Third, the measurement tools used in this study, such as the "Reading the Mind in the Eyes" Test and the Mindful Attention Awareness Scale (MAAS), have limitations in capturing the complex constructs of ToM and mindfulness [27,72]. Future research should employ multiple measurement methods to assess these constructs more comprehensively. Finally, this study did not explore other potential moderating variables, such as personality traits or cultural background, which may influence the effectiveness of mindfulness training [73,74]. Future research should investigate these factors to gain a more nuanced understanding of the underlying mechanisms in the relationship between ToM, empathy, mindfulness, and prosocial behavior.

Conclusion

While ToM and empathy play crucial roles in fostering prosocial behavior, mindfulness exhibits a more complex influence than anticipated, potentially inhibiting prosocial behavior under certain circumstances. These findings offer novel insights into the psychological mechanisms underlying prosocial behavior and underscore the importance of considering multiple interacting factors in its promotion.

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manuscript preparation: Sisi Li and Nailiang Zhong. All authors reviewed the results and approved the final version of the manuscript.

Availability of Data and Materials: The datasets analyzed during the current study are available from the corresponding author on reasonable request.

Ethics Approval: This study was approved by the Ethics Committee of the School of Teacher Education, Hechi University (IRB No. H2306). All participants signed the informed consent in this study.

Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.

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