ORIGINAL RESEARCH

The Association Between Autistic Traits and Depression in College Students: The Mediating Roles of Interpersonal Emotion Regulation and Social Self-Efficacy

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Purpose: Higher rates of depression are associated with autistic traits; however, the precise association between autistic traits and depression has yet to be fully elucidated. Good interpersonal emotional regulation and social self-efficacy are crucial for mental health; therefore, in this study, we investigated the relationships between autistic traits, interpersonal emotional regulation, social self-efficacy, and depression.

Patients and Methods: In total, 1024 participants (613 females and 411 males) aged 16 to 23 years old (M = 19.03, SD = 0.95) completed questionnaires that were designed to evaluate their autistic traits, interpersonal emotion regulation, social self-efficacy and depression. Data were analyzed by Spearman correlation and mediation effects analyses.

Results: Autistic traits were significantly and positively correlated with depression (r = 0.39, p < 0.001), and autistic traits were shown to positively predict depression (B = 0.28, p < 0.001). Interpersonal emotion regulation and social self-efficacy were found to play a serial mediating role between autistic traits and depression (indirect effect = 0.020, p = 0.006).

Conclusion: This study is a supplement to the mechanism of the relationship between autistic traits and depression. Interpersonal emotion regulation and social self-efficacy are important predictors of possible depression in individuals with high autistic traits. These findings suggest combining interpersonal emotional regulation training and exploring the clinical value of interpersonal emotional regulation interventions in individuals with high autistic traits and autism spectrum disorder, aiming to build social confidence, reduce negative moods, restore social functioning, and other aspects.

Keywords: autistic traits, depression, interpersonal emotion regulation, social self-efficacy, chain mediation

Introduction

People with autism spectrum disorder (ASD) are a form of neurodiversity, and the main challenges they face are negative attitudes towards them, including discrimination and exclusion, and a lack of supportive environments appropriate for ASD.[1] Based on large-scale epidemic and surveillance studies, approximately 1–2% of the general population is estimated to be autistic.[2–4] Autistic traits are distributed across the general population in a normal distribution pattern.[5,6] Numerous studies have demonstrated that individuals with high autistic traits exhibit similarities with those with ASD in various aspects, including emotions, cognition and behavior. For example, they often exhibit elevated levels

of emotional distress,[7] limited cognitive flexibility,[8] and poor social skills.[9] Based on the high similarity between autistic traits and ASD, studies of autistic traits cannot only help us to understand the mechanisms underlying ASD and develop appropriate intervention strategies, but also help us to improve the mental health and social functionality of groups with high autistic traits.

Approximately 70–80% of individuals with ASD encounter mental health issues.[10–12] Of these psychiatric concerns, anxiety, irritability, and depression are extremely common,[13] and mood disorders often co-occur.[14,15] Individuals with autism co-occurrence with other psychiatric disorders increases the risk of dysfunction, poor life satisfaction, and suicide.[16,17] One study of adults with autism reported higher levels of depression, which in turn affected their loneliness.[18] Similarly, among a non-clinical community or student population, participants with a higher level of autistic traits have been found to report heightened anxiety and depression,[19,20] an increased likelihood of being bullied[21,22] and lower relationship satisfaction.[23,24] Collectively, these findings demonstrate a strong positive association between autistic traits and depression in both clinical and non-clinical samples. Over recent years, several studies have attempted to investigate the mechanisms underlying autistic traits and depression. A longitudinal study focusing on children with high autistic traits demonstrated that cross-neurotype interaction difficulty was a factor that increased the likelihood of depression.[22] A recent study showed that neurodiverse first-semester college students who reported being less satisfied with their social connectedness tended to express more symptoms of depression and anxiety.[25] However, the exact pathway of autism traits and depression has yet to be elucidated. Therefore, it is necessary to further investigate the underlying mechanisms of autistic traits and depression if we are to reduce the risk of depression in individuals with high autistic traits and provide theoretical support to develop interventions to improve depression.

Interpersonal emotion regulation (IER) refers to the process by which individuals change their own or others' emotional states through interactions between individuals.[26] Numerous studies have shown that individuals with high autistic traits tend to exhibit a weaker ability to regulate their emotions,[27–29] thus making these individuals more susceptible to depression.[30,31] However, emotions are social responses.[32] Thus, we focus here on emotion regulation that relies on external resources. Unlike the vast majority of individuals who only focus on the emotional regulation of their own emotional states,[33,34] IER emphasizes the fact that individuals can change their own emotional state, or that of others, via interpersonal interactions.[35,36] IER involves four distinct factors: soothing, enhancing positive affect, perspective taking, and social modeling.[37] Good IER is crucial for the improvement and maintenance of mental health.[38]

The interpersonal relationship theory of depression[39] suggests that individuals who experience more rejection, conflict, and other negative social interactions, tend to develop more negative cognitive patterns and self-evaluations. Moreover, these negative social experiences can lead to the deterioration of self-awareness, ultimately increasing the risk of depression. Autistic people may feel more comfortable with less social engagement due to negative past experiences such as bullying or social exclusion.[18] This may increase their risk of social withdrawal, isolation, and interpersonal relationship problems. When the mindset and social relationships are severely disrupted, individuals with high autistic traits may be unwilling to exploit others to regulate their own emotions due to social difficulties and fewer social connections.[40] In other words, individuals with high autistic traits may engage in less IER processes to regulate their negative emotions and this difficulty in regulating emotion may further contribute to depressive symptoms in individuals with high autistic traits. Empirical studies have also shown that IER was an important factor for predicting depression and that the enhancement of positive affect was inversely related to the severity of depression.[41,42] By applying IER, individuals can reduce their own negative emotions and lower their level of depression while helping others to improve their emotions.[43,44] Therefore, it is important to study and manipulate the process of IER in individuals with autistic traits, and further investigate whether IER mediates the relationship between autistic traits and depression. Furthermore, we are interested in which aspects of depression with high autistic traits can be prevented through effective interpersonal emotion regulation, and clarify the specific mechanisms of action involved; this research could yield suggestions for developing effective interventions.

According to the "double empathy problem" theory, autistic people face the challenge of the cross-neurotype interaction difficulty.[45] In reference to a discrepancy in reciprocity between autistic individuals and neurotypical individuals, this is likely to lead to interpersonal relationship issues and reduce confidence in social interactions for autistic individuals. Social self-efficacy refers to an individual's cognitive belief in their ability to initiate social

interactions and maintain interpersonal relationships, thus representing a form of social confidence.[46,47] The temporal need-threat model suggests that social exclusion can threaten an individual's needs for efficacy.[48] Ren et al[49] also found that introverted individuals are more likely to exhibit withdrawal behaviors after experiencing rejection, and negative social interactions may lead to a reduction in an individual's social self-efficacy. Furthermore, those with high autistic traits are more likely to experience negative social interactions in their daily life, and also more likely to exhibit social avoidance behaviors, resulting in a series of negative emotions, including social anxiety.[50] Individuals with social anxiety tend to increasingly doubt their social skills;[51] this leads to decreased levels of self-confidence and a further reduction in social self-efficacy. However, on the one hand, individuals with low social self-efficacy, despite having lower confidence in their social abilities, still have strong social needs and may be more eager to improve their social skills and expand their social circle. On the other hand, they may find it difficult to overcome challenges in real life. This conflict between interpersonal needs and practical difficulties is likely to lead to interpersonal stress and even depression in individuals with high autism traits.[52] A strong body of evidence has demonstrated that social self-efficacy can positively predict depression.[53,54] Therefore, we hypothesized that social self-efficacy may also act as a mediating factor between autistic traits and depression.

In addition, the regulation of interpersonal emotion is closely related to self-efficacy; Hofmann et al[37] explained individuals' impaired interpersonal emotion regulation, due to lower levels of self-efficacy, can lead to psychological distress. Social self-efficacy is a specific concept of self-efficacy within the interpersonal domain. Based on this, we hypothesized that individuals with high autistic traits may have difficulties in IER, which resulting in low social self-efficacy and subsequently, depressive symptoms. In summary, in the present study, we aimed to investigate the relationship and underlying mechanisms that linked autistic traits and depression, and formulated two hypotheses based on existing literature. First, we hypothesized that autistic traits were positively correlated with depression; second, and we hypothesized that IER and social self-efficacy acted as sequential mediators between autistic traits and depression.

Materials and Methods

Participants

Using convenience sampling, the study conducted a cross-sectional survey in Anhui Province, China, from September to November 2023. Through an online questionnaire platform, the reasons for the study were explained and confidentiality was guaranteed, and college students who were not diagnosed with autism, major depressive disorder, and other psychiatric disorders were surveyed. 1050 questionnaires were collected, of which 26 participants were excluded from the final sample for reasons such as not answering the questionnaire carefully (all items selected the same response), and the unusually short time to complete the survey. The validity of the final questionnaire was 97.52%.

Participants were aged between 16 and 23 years (M = 19.03, SD = 0.95). Among them, 411 were males and 613 were females. According to grade, 166 were freshmen, 689 were sophomores, and 169 were juniors. Detailed demographic information is shown in Table 1.

Table 1 Demographic Characteristics of the Participants (N = 1024)

Characteristics		Autistic Traits M±SD	Interpersonal Emotion Regulation M±SD	Social Self-efficacy M±SD	Depression M±SD
Sex	Female(n=613)	117.11±10.06	62.38±16.06	57.88±13.31	13.73±10.28
	Male(n=411)	118.66±9.96	63.58±17.20	59.02±14.99	16.52±11.23
Grade	Freshman(n=166)	114.78±9.73	61.84±15.13	60.13±13.43	14.90±9.78
	Sophomore(n=689)	118.21±10.33	63.08±17.36	58.23±14.78	14.86±10.87
	Junior(n=169)	118.67±8.62	62.96±14.27	57.05±12.45	14.73±11.24

Demographic Questionnaire

All participants were asked to fill out basic personal information, including sex, age, and grade. They were also asked for their contact information in preparation for future behavioral experiments.

Autism-Spectrum Quotient (AQ)

The AQ scale was originally developed by Baron-Cohen.[5] It has five dimensions: social skill, attention switching, attention to detail, communication, and imagination. The AQ includes 50 four-point items (1 = completely disagree to 4 = completely agree). The higher the scores are on this scale, the higher levels of autistic traits.[5] This scale has demonstrated good reliability and validity in a previous cohort of Chinese students.[55] The Cronbach's alpha coefficient was 0.720.

Interpersonal Emotion Regulation Questionnaire (IERQ)

The IERQ scale[37] was used to assess how individuals take advantage of others to regulate their own emotions. The IERQ features 20 five-point items (1 = not true for me at all to 5 = extremely true for me). The higher the scores are on this scale, the more an individual applies IER strategies.[37] The Chinese adaptation of this scale has demonstrated good reliability and validity.[56] The Cronbach's alpha coefficient was 0.958.

Social Self-Efficacy (SSE)

The SSE scale[47] was used to assess perceived self-confidence in social interactions. The SSE consists of a single-factor structure. The Chinese version of the SSE has demonstrated good reliability and validity[57] and consists of 18 five-point items (1 = no confidence at all to 5 = complete confidence). The higher the score are on this scale, the higher an individual's level of perceived social self-efficacy.[47] The Cronbach's alpha coefficient was 0.962.

Center for Epidemiologic Studies Depression Scale (CES-D)

The CES-D scale[58] was used to assess current depressive symptoms. The CES-D comprises four factors: depressed affect, positive affect, somatic and retarded activity, and interpersonal problems. The CES-D is a 20 four-point item instrument (0 = seldom or none of the time to 3 = most or all of the time). The higher score on the scale indicates more severe depressive symptoms.[58] The Chinese version of this scale has demonstrated good reliability and validity in college students.[59] The Cronbach's alpha coefficient was 0.927.

Statistical Analyses

A Microsoft Excel database was generated by exporting data from the completed questionnaires. After data processing, statistical analysis was conducted utilizing SPSS version 23.0 software and Mplus version 8.3. In SPSS, Harman's single factor test was used to examine whether there were significant common method biases in this study. Pearson's correlations analysis was performed on the variables in order to detect initial bivariate relationship between the variables. In Mplus, two sets of main analyses were used to examine the key hypotheses. The first set of analyses addressed the hypothesized chain mediation model, controlling for the initial levels of demographic covariates (ie, gender). Autistic traits represented the independent variable (X), depression was the dependent variable (Y), IER was the first order mediator (M1), and social self-efficacy was the second order mediator (M2). Drawing on the results of the first set of analyses, our second set of analyses investigated which dimension of depression was influenced by the variables encompassing the entire model. Specifically, four dimensions of depression (depressed affect, positive affect, somatic and retarded activity, and interpersonal problems) were added into the model as dependent variables. A 95% confidence interval (CI) that excluded zero indicates that the parameter estimates are significant.

Results
Common Method Bias

The results of Harman's single factor test indicated that the variance interpretation rate of the first component was 20.52%, which is less than the critical standard requirement of 40%.[60] Consequently, there is no significant method bias in this study.

Table 2 Descriptive Statistics of Study Variables and Bivariate Correlations Between Variables (N=1024)

	1	2	3	4	5
1.Sex	1				
2.Autistic traits	0.076*	1			
3.Interpersonal emotion regulation	0.036	−0.357***	1		
4.Social self-efficacy	0.040	−0.525***	0.504***	1	
5.Depression	0.127***	0.394***	−0.247***	−0.398***	1
M	0.40	117.73	62.86	58.34	14.85
SD	0.49	10.04	16.53	14.01	10.75

Notes: Sex: 0 = female, 1 = male. *p < 0.05, ***p < 0.001.

Descriptive Analyses

The descriptive statistical results of each variable and the detailed results of correlation analysis are presented in Table 2. Autistic traits were significantly and positively correlated with depression (r = 0.39, p < 0.001), but were significantly and negatively correlated with IER (r = −0.36, p < 0.001) and social self-efficacy (r = −0.53, p < 0.001). IER (r = −0.25, p < 0.001) and social self-efficacy (r = −0.40, p < 0.001) were significantly and negatively correlated with depression. Furthermore, IER was significantly and positively correlated with social self-efficacy (r = 0.50, p < 0.001). As sex was significantly associated with autistic traits and depression, we controlled for sex in subsequent testing of the model.

The Chain-Mediated Role of Interpersonal Emotion Regulation and Social Self-Efficacy

First, we tested the hypothesized chain mediation model. The model presented an adequate fit to the data: χ2 (126) = 900.479, p < 0.001; χ2/df = 7.147; CFI = 0.928; TLI = 0.914; RMSEA = 0.077 (90% CI = 0.073–0.082); SRMR = 0.076. In Figure 1, the model's path coefficients are illustrated. Autistic traits negatively predicted IER (B = −0.46, p < 0.001) and social self-efficacy (B = −0.59, p < 0.001), but positively predicted depression (B = 0.28, p < 0.001). Although IER
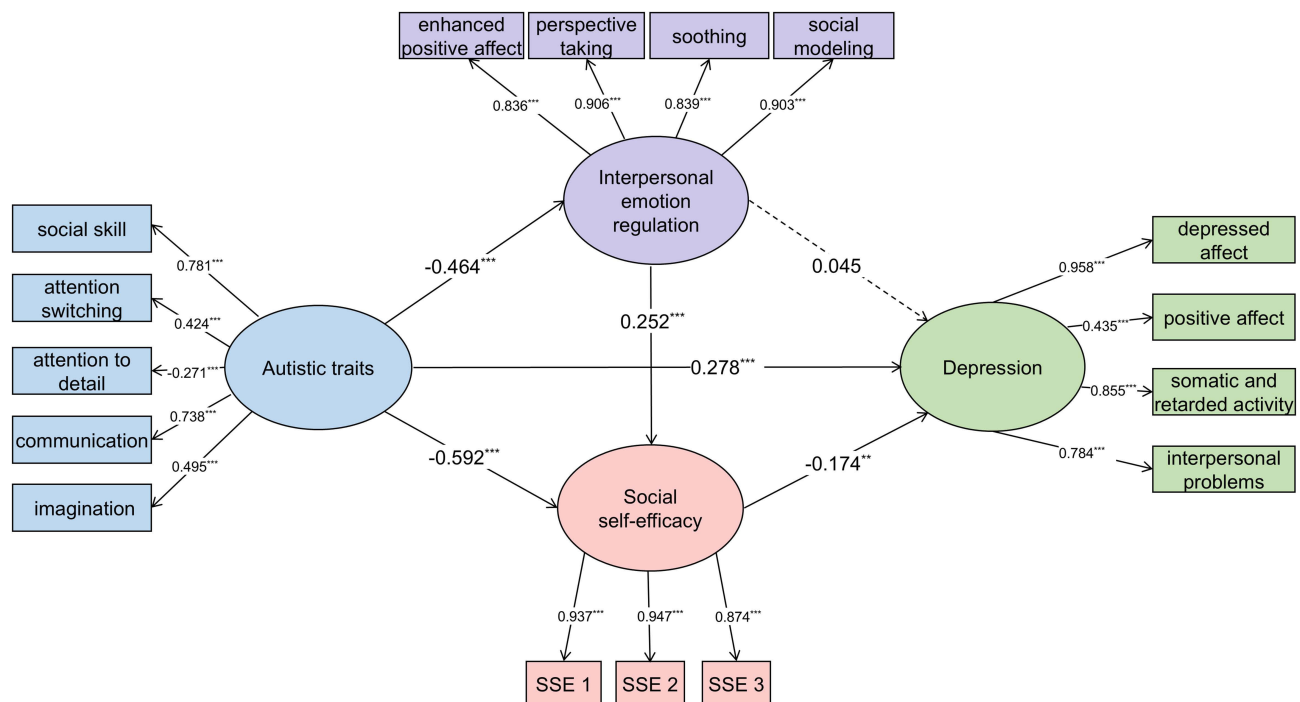

Figure 1 The chain mediating model of interpersonal emotion regulation and social self-efficacy on the relationship between autistic traits and depression.
Notes: Standardized coefficients are reported. Sex was included as a covariate in the examination but not explicitly displayed in the figure. **p < 0.01, ***p < 0.001.

Table 3 Results Arising from Chain Mediation Analysis of Autistic Traits and Depression (N=1024)

Effect	Path	B	SE	95% CI	p
Direct effect		0.278	0.065	[0.200,0.556]	0.000
Indirect effect	Total indirect effect	0.102	0.044	[0.017,0.192]	0.021
	AT→IER→D	−0.022	0.021	[−0.064,0.016]	0.289
	AT→SSE→D	0.103	0.035	[0.039,0.178]	0.003
	AT→IER→SSE→D	0.020	0.007	[0.008,0.038]	0.006
Total		0.380	0.038	[0.303,0.450]	0.000

Notes: Bootstrap sample size = 5000.
Abbreviations: B, standardized beta (effect); SE, standard error; CI, confidence interval; AT, autistic traits; IER, interpersonal emotion regulation; SSE, social self-efficacy; D, depression.

did not directly predicted depression (B = 0.05, p = 0.28), IER positively predicted social self-efficacy (B = 0.25, p < 0.001). In addition, social self-efficacy negatively predicted depression (B = −0.17, p = 0.002).

Table 3 presents the indirect effects. Analysis indicated that the total indirect effect was significant [B = 0.102, SE = 0.044, 95% CI (0.017, 0.192), p = 0.021], thus accounting for 26.84% of the total effect of autistic traits on depression. The indirect effect of autistic traits through IER and social self-efficacy was also significant [B = 0.020, SE = 0.007, 95% CI (0.008, 0.038), p = 0.006], thus accounting for 5.26% of the total effect of autistic traits on depression. Furthermore, two specific indirect effects were identified in the model. While IER did not mediate association between autistic traits and depression alone, it did explain the variance of depression via social self-efficacy.

Second, the suggested SEM where depressed affect, positive affect, somatic and retarded activity, and interpersonal problems were used as dependent variables. The model exhibited a good fit to the data: χ2 (120) = 703.585, p < 0.001; χ2/df = 5.863; CFI = 0.946; TLI = 0.931; RMSEA = 0.069 (90% CI = 0.064–0.074); SRMR = 0.050. In Figure 2, the model's path coefficients are illustrated. Table 4 shows the results from the four mediation analyses. The serial indirect
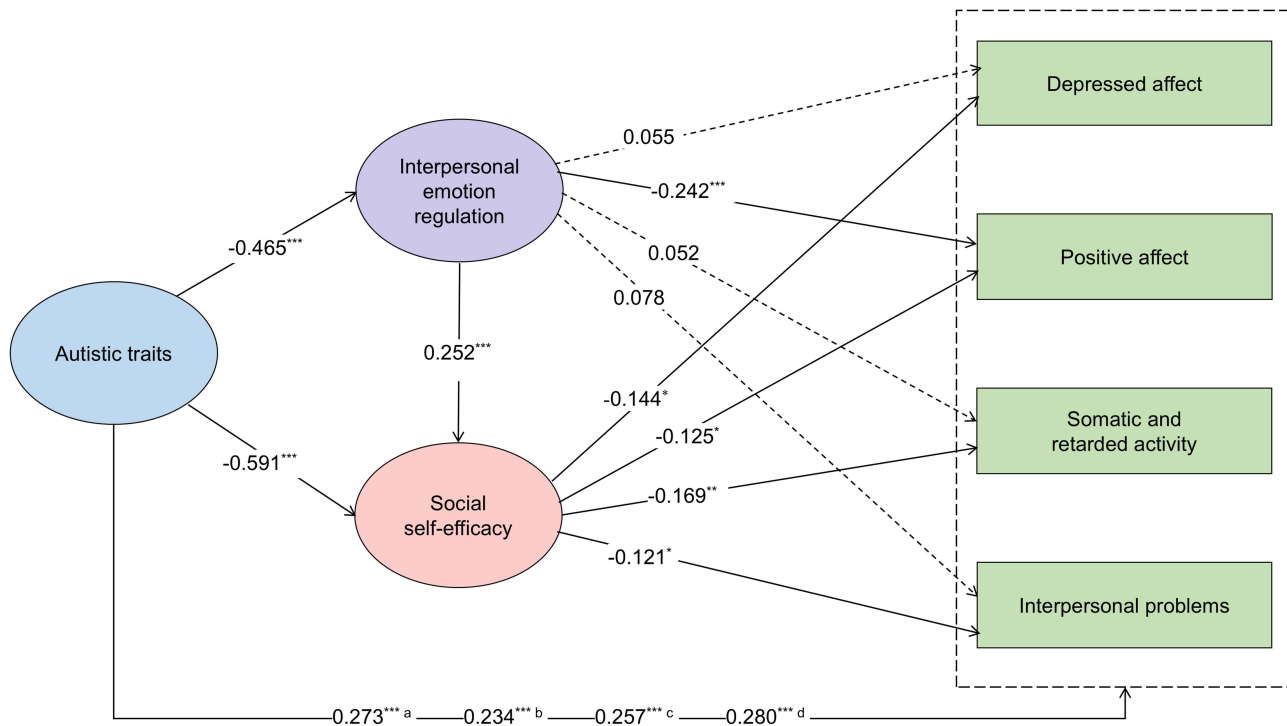

Figure 2 The chain mediating model of interpersonal emotion regulation and social self-efficacy on the relationship between autistic traits and depression across four dimensions.
Notes: Standardized coefficients are reported. Sex was included as a covariate in the examination but not explicitly displayed in the figure. [a]autistic traits → depressed affect, [b]autistic traits → positive affect, [c]autistic traits → somatic and retarded activity, [d]autistic traits → interpersonal problems. *p < 0.05, **p < 0.01, ***p < 0.001.

Table 4 Results Arising from Chain Mediation Analysis of Autistic Traits and Depression Across Four Dimensions (N=1024)

Model		Path	B	95% CI	p
Depressed affect as the dependent variable	Direct		0.273	[0.210,0.579]	0.000
	Indirect	Total indirect	0.076	[−0.006,0.228]	0.071
		AT→IER→DA	−0.026	[−0.100,0.017]	0.211
		AT→SSE→DA	0.085	[0.032,0.224]	0.012
		AT→IER→SSE→DA	0.017	[0.006,0.047]	0.018
	Total		0.349	[0.384,0.619]	0.000
Positive affect as the dependent variable	Direct		0.234	[0.115,0.342]	0.000
	Indirect	Total indirect	0.201	[0.118,0.273]	0.000
		AT→IER→PA	0.113	[0.073,0.151]	0.000
		AT→SSE→PA	0.074	[0.009,0.136]	0.026
		AT→IER→SSE→PA	0.015	[0.002,0.029]	0.033
	Total		0.435	[0.347,0.504]	0.000
Somatic and retarded activity as the dependent variable	Direct		0.257	[0.138,0.418]	0.000
	Indirect	Total indirect	0.096	[0.013,0.193]	0.026
		AT→IER→SRA	−0.024	[−0.072,0.014]	0.227
		AT→SSE→SRA	0.100	[0.041,0.181]	0.003
		AT→IER→SSE→SRA	0.020	[0.008,0.040]	0.006
	Total		0.353	[0.298,0.472]	0.000
Interpersonal problems as the dependent variable	Direct		0.280	[0.051,0.163]	0.288
	Indirect	Total indirect	0.049	[−0.015,0.057]	0.046
		AT→IER→IP	−0.036	[−0.030,0.000]	0.062
		AT→SSE→IP	0.071	[0.001,0.057]	0.046
		AT→IER→SSE→IP	0.014	[0.000,0.012]	0.058
	total		0.330	[0.096,0.164]	0.000

Note: Bootstrap sample size = 5000.
Abbreviations: B, standardized beta (effect); CI, confidence interval; AT, autistic traits; IER, interpersonal emotion regulation; SSE, social self-efficacy; DA, depressed affect; PA, positive affect; SRA, somatic and retarded activity; IP, interpersonal problems.

effects and the indirect effects mediated by social self-efficacy were significant across all models. Specifically, in the model that used positive affect as the dependent variable, the indirect effect of IER as the mediating variable was significant [B = 0.113, SE = 0.020, 95% CI (0.073, 0.151), p < 0.001]; this effect was not significant in other models.

Discussion

The study investigated the relationship between autistic traits and depression, as well as the potential mechanisms that mediate this relationship. The findings indicated that IER and social self-efficacy played a serial mediating role between autistic traits and depression. This finding showed that individuals with high autistic traits may have difficulty in social interaction, thus resulting in the reduced use of IER strategies based on interpersonal interaction to cope with negative social interaction experiences. In contrast, more negative experiences will lead to a reduction in their confidence in social situations, and may even lead to more severe depressive symptoms.

First, we identified a significant positive correlation between autistic traits and depressive mood; this was consistent with previous research findings.[7,61] On the one hand, individuals with high autistic traits had a strong need for social adaptation but had difficulty interacting with others and missed out on many opportunities to socialize, thus making it difficult for these individuals to build and maintain social relationships and support networks;[62] this may lead to a depressive mood. On the other hand, individuals with autistic traits immersed themselves in their own world and had difficulty with attention switching.[63] This could explain why individuals with higher autistic traits are more likely to develop mental disorders. For example, a study investigating the relationship between autistic traits and obsessive-

compulsive disorder (OCD) showed that autistic traits in people with OCD were higher than those in healthy people and it was associated with attentional impulsivity.[64] Besides, their limited imagination and poor cognitive flexibility also affected their ability to cope effectively with life challenges; this may further exacerbate depressive mood.[65]

The regulation of emotion is closely related to an individual's social competence and mental health,[66,67] and is of great significance for social and environmental adaptation. Previous research showed that individuals with higher autistic traits tended to have a poorer ability to regulate emotion.[27] However, contemporary emotion regulation research emphasizes intrapersonal processes such as cognitive reappraisal and expressive suppression, but people experiencing affect commonly choose not to go it alone. An emerging literature highlighted the importance of IER,[36] which utilized social cues to facilitate the regulation of emotional states. Few studies have explored the relationship between autistic traits and IER. Our present findings revealed a distinct relationship between autistic traits and IER; specifically, autistic traits were negatively correlated with IER. This may be because individuals with high autistic traits are difficult to understand by others and therefore less likely to participate in interpersonal interactions.[18] Previous research has shown that individuals with high autistic traits have difficulties in emotion recognition and also exhibit lower levels of empathy.[68,69] The introspection-centric simulation theory posits that the reduced cognitive empathy associated with autistic traits may stem from difficulties in alexithymia, specifically the challenge individuals face in understanding their own emotions, which subsequently leads to difficulties in understanding the emotions of others.[70] This could also explain the difficulties in IER experienced by individuals with high autistic traits.

Although most studies demonstrated that IER was correlated with depression,[71,72] the path from IER to depression was not significant when social self-efficacy was added to the chain mediation model of the impact of autistic traits on depression. IER can affect a regulated individual's feelings of hope, calmness, and happiness,[38,73] while the regulator may also experience less happiness[74] and more negative emotions[75] due to the inability to achieve regulatory goals or in response to the suffering of others. However, when we incorporated the four dimensions of depression into our model, we found that autistic traits only influenced positive emotions related to depression through IER. Previous research showed that IER was associated with a reduction in feelings of happiness.[76,77] Furthermore, research has also shown that increasing positive emotions in individuals with depression could promote their recovery of social functionality and lead to a greater sense of happiness.[78] Similarly, previous research on IER training has shown that participants who helped others regulated their emotions to a greater extent during a three-week training reported a more significant increase in subjective well-being.[79] This highlights the importance of manipulating IER to increase positive emotions in order to prevent depression in individuals with high autistic traits.

The model described herein demonstrated that social self-efficacy mediated both IER and depression. We found that IER was a positive predictor of social self-efficacy, and that social self-efficacy was a negative predictor of depression. This could be because successful communication experiences between family members and their peers could enhance an individual's evaluation of their social abilities, while individuals with high social self-efficacy could effectively use interpersonal skills to establish relationships with others to derive positive emotional experiences.[80,81] IER is an important method by which we can maintain and develop social relationships.[38] Previous research demonstrated that the daily frequency of IER strategies can positively predict the quality of interpersonal relationships.[82]

Furthermore, the ability of college students to perform IER can predict the establishment and development of their social relationships during their time in school.[83] The interpersonal relationship theory of depression posits that individuals who experience negative interpersonal experiences often develop more negative self-evaluations, and that the deterioration of self-awareness due to negative interpersonal experiences continues to intensify, ultimately increasing the likelihood of depression.[39] Our present findings suggested that successful experiences of individuals with high autistic traits in regulating negative emotions through interpersonal interactions were likely to enhance an individual's social confidence, thus protecting them depression.

Finally, our analyses indicated that social self-efficacy mediated the relationship between autistic traits and depression. This finding concurred with the results of Camus,[54] who detected a negative correlation between social self-efficacy and depressive symptoms in individuals with autism. Individuals with high autistic traits are associated with lower levels of satisfaction with interpersonal relationships;[24] this is likely to result in social problems, including social anxiety and low levels of social self-efficacy. Social self-efficacy is universally important for an individual's mental health, and social self-

efficacy is closely associated with internalizing behaviors such as depression,[84,85] loneliness[86,87] and social anxiety.[51] In general, individuals with high autistic traits are not understood and ostracized in social interactions; this may lead to long-term interpersonal problems and poor social adaptation, thus resulting in low self-esteem. The contradiction between high social adaptation needs and social exclusion makes individuals with autistic traits more prone to depression. This suggests that we should pay close attention to the social self-efficacy of individuals with high autistic traits, prompt society toward reciprocity, help them build confidence in social interactions, and actively participate in social activities.

Limitations and Implications

This study has several limitations. First, we only recruited college students in Anhui Province, China, which could result in a generalizability issue; future research should be designed using a representative national sample. Secondly, the data utilized in this study were cross-sectional, implying that our findings may suggest predictive trends rather than definitive causal linkages. To uncover actual causal relationships among these variables, future research could adopt a longitudinal design or experimental approaches. Finally, this study focused on individuals with high levels of autistic traits; future research should consider whether these results can be generalized to the ASD population. Given the genetic, cognitive, and behavioral similarities between autistic traits and ASD, the results of this study could advance our understanding of the mechanisms underlying the impact of ASD on depression and the development of appropriate interventional strategies. However, high levels of autistic traits do not equate to ASD.[88] Future research should further validate the relationships between ASD symptoms, IER, social self-efficacy, and depression within the ASD population.

Despite these limitations, this study has important implications for the prevention and intervention of depression in individuals with high autistic traits. The mediating effect of IER between autistic traits and positive affect suggests that IER may provide mental health benefits for individuals with high autistic traits. It's interesting that this benefit refers to influencing the positive mood of depression without affecting other aspects of depression. Many studies have highlighted the importance of paying attention to positive emotions in people with mental illness.[89,90] Therefore, focusing on interpersonal emotion regulation training may be beneficial for enhancing positive emotions in individuals with higher autistic traits. Additionally, this is the first study assessing the pathway between autistic traits and depression via IER and social self-efficacy. The results of this study suggest that people with higher autistic traits are in with a higher chance of depression, which is mediated by a pathway from IER to social self-efficacy, and ultimately to depression. This study has identified potential factors for preventing depression in people with high autistic traits. Interventions targeting IER may enhance social self-efficacy and thereby reduce depressive symptoms. IER is malleable and a recent study showed that IER may be a promising avenue for effective emotion regulation in current major depressive disorder.[91] One possible avenue for future research would be to develop IER training and examine whether they provide mental health benefits for autistic persons.

Conclusion

This study shows relationships between autistic traits, interpersonal emotion regulation, social self-efficacy and depression. Interpersonal emotion regulation and social self-efficacy play a mediating role between autistic traits and depression. These findings expand the underlying mechanisms between autistic traits and depression, which could promote the recovery of positive emotions in individuals with depression. In addition, these results suggest that when preventing the risk of depression in individuals with high autistic traits, appropriate interventions could focus on improving IER, enhancing social self-efficacy, and promoting positive emotions.

Data Sharing Statement

Due to reasons of data protection, the preprocessed data is available only upon reasonable request to the corresponding author (Chunyan Zhu).

Ethics Approval and Informed Consent

All the methods were performed in accordance with the Declaration of Helsinki. The study was approved by the Ethical Committee of Anhui Medical University. All the participants provided written informed consent, and for minors, consent was obtained from their legal guardian(s).

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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