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Autistic Traits and Emotion Dysregulation in 5–11-Year-Old Intellectually Able Children With Autism Spectrum Condition: Mediating Role of Emotion Regulation Strategies

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ABSTRACT

Emotion dysregulation (ED) is common among children with an autism spectrum condition (ASC). However, the mechanisms underlying emotion regulation strategies (ERSs) and their impacts on ED in this population remain unclear. The current study examined whether ED is directly related to autistic traits or mediated by deficits in ERSs after comorbidity is accounted for. A cohort of 110 intellectually able children aged 5–11 years with ASC participated in this study. Autistic traits and ED were assessed using the Autism Spectrum Quotient-Children and Child Behavior Checklist, respectively. Intrinsic ERSs, specifically cognitive reappraisal and expressive suppression, were evaluated using the Parent Emotion Regulation Questionnaire, alongside items measuring parental coregulation as an extrinsic ERS. After adjusting for comorbidities (i.e., other neurodevelopmental or neurological disorders), the findings revealed pronounced autistic traits in social skills, attention switching, communication, and imagination correlated with higher ED levels, with parental coregulation mediating this correlation. Notably, the effects of communication and imagination on ED were fully mediated by parental coregulation. Additionally, autistic traits related to imagination were demonstrated to impair the development of cognitive reappraisal, further exacerbating ED. These results provide a deeper understanding of the emotional challenges faced by intellectually able children with ASC. The findings of this study underscore the importance of interventions aimed at enhancing emotion regulation within the parent–child dyad and fostering the development of cognitive reappraisal through imitative tasks. Such ERS-focused interventions hold potential for mitigating the adverse effects of autistic traits on emotional functioning.

1 | Introduction

Autism spectrum condition (ASC) is a common neurodevelopmental disorder characterized by persistent difficulties in social communication and interaction as well as restricted and repetitive patterns of behavior, interests, or activities (Mandy 2017). The global prevalence of ASC is estimated to range from 21.2 to 22.5 per 1000 children across racial groups (Gallin et al. 2024), with the prevalence being markedly higher in boys (43.0 per 1000) than in girls (11.4 per 1000) (Maenner et al. 2023). ASC presents considerable challenges for affected individuals, their families, and broader educational and social support systems (Graham Holmes et al. 2020). Intellectually able children with ASC who do not exhibit intellectual disabilities often experience emotional dysregulation (ED; Shaffer et al. 2023). ED in this population often manifests through behavioral problems such

as yelling, avoidance, hitting objects, aggression, defiance, self-injury, and tantrums (Jahromi et al. 2012).

The mechanisms underlying ED in intellectually able children with ASC remain poorly understood. A review by Keluskar et al. (2021) revealed three key factors to be associated with ED in children with ASC: autistic traits, emotion regulation strategies (ERSs), and comorbid conditions. Additionally, research indicates that as such children transition to elementary school, they face increased academic demands, more complex social interactions, and a need to conform to group rules, all of which can exacerbate ED-related challenges (Heuser-Spura et al. 2021). Given these considerations, the present study investigated the mechanisms of ED in intellectually able children with ASC who are aged 5–11 years, with a focus on the interplay between autistic traits, ERSs, and comorbidities. Specifically, it explored whether ED in intellectually able children with ASC stems directly from their autistic traits or if ERSs mediate the relationship between autistic traits and ED. In doing so, this study also accounted for comorbid conditions. Elucidating these mechanisms can provide findings that can inform the development of targeted interventions for the effective management of ED in this population.

ED and ERSs are two distinct constructs. ED refers to patterns of emotional experiences (e.g., distress, tantrums, and violent anger) or expressions (e.g., internalizing or externalizing behaviors) that disrupt goal-directed activities (Thompson 2019). These emotional disturbances prevent individuals from achieving key objectives, such as improving their emotional state in difficult situations, mobilizing the necessary resources to confront challenges, thinking clearly, strengthening interpersonal relationships, and achieving other personal goals. By contrast, ERSs are strategies individuals use to manage their emotional experiences and expressions, such as cognitive reappraisal, expressive suppression, and coregulation with others. These strategies enable individuals to regulate their emotional responses and prevent ED (Naragon-Gainey et al. 2017).

1.1 | ASC to ED

According to the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* (*DSM-5*) indicates that social communication deficits, restricted and repetitive behaviors (RRB), and sensory sensitivities (SS) are core traits of ASC (American Psychological Association [APA], 2013). These traits are closely linked to ED in children with ASC, including those who are intellectually able (Keluskar et al. 2021). In children with ASC, even those who are intellectually able, social communication deficits are considerable challenges that can lead to difficulties in forming and maintaining relationships and in sharing emotions and thoughts. These difficulties often result in social isolation (Martínez-González et al. 2022). Notably, RRB encompass three primary components: repetitive motor behaviors (e.g., hand mannerisms), insistence on sameness (e.g., resistance to routine changes), and restricted interests (e.g., intense focus on specific topics; Uljarević et al. 2022). Greenlee et al. (2021) demonstrated that the severity of RRB is correlated with increased ED. They proposed two hypotheses to explain this relationship: first, that RRB and ED improve concurrently across development and second, that shared neurobiological mechanisms underlie the connection between RRBs and self-regulation in ASC. Sensory sensitivities, including hypersensitivity and hyposensitivity, further complicate these traits by affecting various sensory modalities such as smell, touch, and balance (Rinaldi et al. 2023). Sensory processing differences may contribute to various higher-order cognitive and social deficits in ASC, and atypical sensory processing can significantly impact emotional regulation (Schauder and Bennetto 2016). According to Dunn's model (Dunn 1997), children with low neurological thresholds for sensory stimuli who avoid sensory-rich activities may appear withdrawn or unwell or be prone to emotional outbursts.

1.2 | ASC to ERSs

Mazefsky et al. (2014) adopted the theoretical framework of Connor-Smith et al. (2000), which categorizes emotional responses along two dimensions: (a) voluntary versus involuntary and (b) engagement (focused on the stressor) versus disengagement (focused away from it). Within this framework, voluntary engagement strategies are further subdivided into primary strategies, the focus of which is to alter the stressor, and secondary strategies, the focus of which is to adapt to the stressor. Effective intrinsic ERSs for school-aged children include cognitive reappraisal and expressive suppression (Charlton et al. 2020). Cognitive reappraisal involves altering one's interpretation of a situation to change its emotional impact (Gross 2008). This adaptive, voluntary engagement ER strategy (Charlton et al. 2020) enables children to reframe potentially negative experiences positively. For instance, a child might reinterpret exam anxiety as an opportunity to demonstrate their knowledge. Research indicates that children as young as 5–10 years old can effectively employ this strategy (Dennis and Hajcak 2009). Conversely, expressive suppression involves concealing emotional responses after they have been activated, such as suppressing anger in response to teasing (Gross 2008). This is considered a maladaptive, involuntary engagement strategy (Charlton et al. 2020). Relative to typically developing (TD) children, intellectually able children with ASC rely less on cognitive reappraisal and more on expressive suppression, with this strategy particularly often applied when they are confronted with negative stimuli and lack adult support (Jahromi et al. 2012; Samson et al. 2015). Although such children can benefit from cognitive reappraisal when they employ it, they often struggle to use it effectively, indicating that they face challenges in emotion regulation (Jahromi et al. 2012).

In addition to intrinsic ERSs, such as cognitive reappraisal and expressive suppression, children with ASC rely on extrinsic ERSs, which involve obtaining external support. Notably, the relationship between self-regulation and external regulation is inherently transactional because the development of a child's self-regulatory abilities is shaped by early caregiver support and guidance (Ting and Weiss 2017). A key extrinsic strategy for children with ASC is parental coregulation, where parents provide emotional scaffolding by encouraging their children, redirecting attention, or rendering tasks more engaging (Gulsrud et al. 2010). This form of support is crucial because ER development relies on a reciprocal dynamic between a child's self-regulatory efforts and parental guidance (Sameroff and Fiese 2000). Starting in a child's infancy, parents employ

various strategies to help their children regulate their emotions. However, as intellectually able children with ASC grow, their social communication deficits can disrupt this reciprocal process of interaction (Hirschler-Guttenberg et al. 2015). Nevertheless, research has indicated that children with ASC often seek parental support during emotionally distressing situations, and such support can improve their ER capabilities (Gulsrud et al. 2010; Hirschler-Guttenberg et al. 2015). However, whether parental guidance translates into effective coregulation, particularly in families with intellectually able children with ASC, remains uncertain. This gap in the understanding of such children raises key questions regarding how the interplay between ASC traits and parental coregulation influences ED.

Regarding the development of ERSs (Cibralic et al. 2019; Samson et al. 2015), parental coregulation, cognitive reappraisal, and expressive suppression are all common ERSs in children aged 5–11 years. In general, early in their development, children rely primarily on extrinsic ER strategies, particularly coregulation with their parents. As children's cognitive abilities, such as working memory, cognitive flexibility, and self-monitoring, mature, they gradually develop intrinsic ERSs, such as cognitive reappraisal and expressive suppression, which enable the children to regulate their emotions independently. Research suggests that intellectually able children with ASC exhibit a pattern of maladaptive ERS use relative to that of TD children (Jahromi et al. 2012).

Autistic traits can significantly influence the development of ERSs, as highlighted by various theories in developmental psychopathology, including social motivation theory, theory of mind, and executive functioning (EF) theory. According to social motivation theory (Kim et al. 2015), children with ASC may react negatively to social stimuli, which can lead to social withdrawal, or may find social interactions to be less rewarding than nonsocial stimuli, which can result in a lower frequency of initiating social interactions. Children with ASC often have theory of mind deficits (Baron-Cohen et al. 1985; Jones et al. 2018) and therefore struggle to understand their own and others' emotions, which impairs their ability to interpret social cues and engage in typical social behaviors. Taken together, these theories explain why intellectually able children with ASC often experience difficulties with social interaction, communication, and emotional coregulation. Additionally, children with ASC often experience challenges with executive functions, such as planning, inhibition, cognitive flexibility, and working memory, which limit their adaptability (Landry and Chouinard 2016). The EF hypothesis (Kenny et al. 2019) suggests that these cognitive challenges, which are managed by the frontal lobes, explain why intellectually able children with ASC struggle to switch attention and maintain focus during emotional distress. Consequently, these children tend to rely less on cognitive reappraisal strategies and more on expressive suppression (Samson et al. 2012, 2015).

1.3 | ERSs to ED

Most individuals employ ERSs, and each strategy can lead to different adaptive or maladaptive emotional experiences and expressions. Aldao et al. (2010) conducted a review of the literature and noted that cognitive reappraisal, which involves reframing an emotional situation in a more benign or positive light, is effective in reducing distress. By contrast, maladaptive appraisal processes, such as hostile attribution or negative internal attribution, are core factors that contribute to the development of depression, anxiety, and aggressive behaviors. Moreover, suppression and avoidance have long been recognized as maladaptive responses to emotional experiences. These strategies are associated with both internalizing behaviors (e.g., depression and anxiety) and externalizing behaviors (e.g., aggression). Although expressive suppression may temporarily reduce outward displays of emotion and potentially alleviate the subjective experience of emotions in the short term, it is less effective at reducing emotional intensity and physiological arousal over the long term (Gross 1998).

Additionally, parental active and passive coregulation, along with general scaffolding, is closely related to the development of externalizing problems in children. Interventions focused on emotion regulation for children with ASC should encourage parents to use scaffolding techniques, particularly when their child exhibits anger or heightened emotional arousal (Ting and Weiss 2017). Research has highlighted the critical role of parent–child interactions in understanding child mental health, and studies have demonstrated that parents exert a key influence on their children's emotional development not only during toddlerhood but also throughout the school-age years (McKee et al. 2023; Ting and Weiss 2017).

1.4 | The Current Study

The current study investigated whether ERSs mediate the relationship between autistic-like traits (e.g., social skill deficits, communication difficulties, imagination, attention switching, and heightened attention to detail) and ED in school-aged intellectually able children with ASC. We hypothesized that ERSs, specifically cognitive appraisal, expressive suppression, and parental coregulation, mediate the relationship between autistic-like traits and ED. Additionally, comorbid conditions may exacerbate the effects of autism traits and hinder the development of effective ER abilities (Keluskar et al. 2021). Moreover, a child's age and sex can significantly influence the expression of autistic traits and the development of ER abilities. The effects of these factors can vary across developmental stages and between sexes (Baker et al. 2019; Wieckowski et al. 2021). Therefore, we hypothesized that the ED of intellectually able children with ASC would be influenced by their age, sex, and comorbidities. Consequently, these variables were adjusted in our models.

2 | Methods

2.1 | Participants

A total of 135 children aged 5–11 years with ASC and their parents were recruited from parenting websites and local clinics across northern, central, and southern Taiwan. Child participants under the age of seven involved in this study are required to provide an early intervention evaluation report, while participants aged seven and above must provide a diagnostic certificate. Information on ASC diagnosis and comorbid

diagnoses was obtained from these chart review documents. All child participants had received a confirmed diagnosis of ASC from a child psychiatrist based on the criteria outlined in the *DSM-5* (APA, 2013). Furthermore, children with an FSIQ < 70, categorized as within the delay range as assessed by clinical psychologists or trained master's students in clinical psychology using the Wechsler Preschool and Primary Scale of Intelligence, Fourth Edition (WPPSI-IV) or the Wechsler Intelligence Scale for Children, Fifth Edition (WISC-V), were excluded from the study. The final sample comprised 110 participants with ASC (mean age = 6.40 years, standard deviation [SD] = 1.60; 96 boys) and their parents. Of these children, 39 had comorbidities, including 18 with another neurodevelopmental disorder (15 with ADHD alone and 2 with both ADHD and developmental coordination disorder), 14 with neurological problems (i.e., preterm birth, epilepsy, or Tourette syndrome), and 7 with both a neurodevelopmental disorder and neurological problems (6 of whom had an ADHD diagnosis). These other comorbid neurodevelopmental diagnoses are provided by child psychiatry based on the *DSM-5* (APA, 2013), and diagnoses of neurological problems are provided by a pediatric neurologist. The mean age of the children's fathers and mothers was 42.19 (SD = 4.95) and 40.00 (SD = 4.41) years, respectively. Among the fathers, 19 (17.27%) had less than a college degree, whereas 89 (80.91%) had a college degree or higher. Two fathers' educational levels were not recorded. For the mothers, 12 (10.91%) held less than a college degree, and 98 (89.10%) held a college degree or higher. Regarding family income, 34 participants (30.91%) reported a monthly household income of < NT$60,000, 48 (43.64%) reported an income between NT$60,000 and NT$100,000, and 26 (23.64%) reported an income > NT$100,000. None of the participating parents reported receiving a low-income household subsidy.

2.2 | Measures

2.2.1 | Demographic and Diagnostic Information

Demographic data, including the child's age and sex, were reported by parents. Diagnostic data, including information regarding comorbidities and cognitive abilities, were provided by board-certified child psychiatrists and clinical psychologists.

2.2.2 | Autistic Traits

The Autism Spectrum Quotient—Children's Version (Auyeung et al. 2008) (AQ-C), a parent-reported questionnaire designed for children aged 4–11 years, was employed to assess autistic traits. The AQ-C comprises 50 items that evaluate 5 domains: social skills, attention switching, attention to detail, communication, and imagination. Each subscale contains 10 items, and responses to each item are rated on a 4-point Likert scale with endpoints ranging from 0 (*definitely agree*) to 3 (*definitely disagree*), with some items being reverse-scored. The total score and domain scores (derived from the sum of 10 items in each domain) demonstrated internal consistency in this study, with the following Cronbach's alpha values: total ($\alpha = 0.86$), social skills ($\alpha = 0.81$), attention switching ($\alpha = 0.76$), attention to detail ($\alpha = 0.46$), communication ($\alpha = 0.67$), and imagination ($\alpha = 0.70$). For the attention to detail subscale, the limited sample size precluded the use of factor analysis or item selection. Additionally, scores were calculated by summing all 10 items, following prior research in Taiwan (Tsai et al. 2017) and other countries where factor analysis was not feasible (Francés et al. 2023; Melling et al. 2017). However, to improve internal consistency, we adopted the 7-item version of the subscale (excluding items 29, 30, and 49) from Auyeung et al. (2008), which increased Cronbach's alpha from 0.46 to 0.67. Therefore, the 7-item version was used for subsequent analyses in this study. Higher scores indicated stronger autistic-like traits.

2.2.3 | Emotion Regulation Strategies

ERSs were assessed using the Parent-Rating Version of the Emotion Regulation Questionnaire (P-ERQ), a tool recommended for use with children aged ≥ 5 years (Gunzenhauser et al. 2017). The P-ERQ aligns with Gross's process model of emotion regulation (Gross 1998) and comprises 10 items. It was translated into traditional Chinese with the author's permission by following the International Test Commission guidelines (van de Vijver and Hambleton 1996). The questionnaire evaluates cognitive reappraisal (six items) and expressive suppression (four items). On the basis of previous research (de Orobio Castro et al. 2005), four items that assess parental coregulation were added. In response to feedback from parents during a pilot study, the original 1–7 Likert scale ranging from *strongly disagree* to *strongly agree* was adapted to a 1–7 scale ranging from *never* to *always* for improved clarity. Confirmatory factor analyses revealed a three-factor structure. The internal consistency in this study was as follows: $\alpha = 0.88$, 0.72, and 0.80 for cognitive reappraisal, expressive suppression, and coregulation, respectively.

2.2.4 | Emotion Dysregulation

ED was assessed using the Emotional Dysregulation Index (EDI) from the Mandarin Chinese version of the Child Behavior Checklist (CBCL), designed for children aged 1.5–5 years (CBCL 1.5–5) and 6–18 years (CBCL 6–18), which was developed by Samson et al. (2014). The parents rated each item on a 3-point scale: 0 (not true), 1 (somewhat or sometimes true), or 2 (very true or often true). The 14 items this study selected from the CBCL 1.5–5 version were 10, 13, 17, 18, 35, 47, 53, 66, 81, 82, 85, 87, 90, and 99. The items included from the CBCL 6–18 version were 11, 14, 20, 21, 37, 45, 50, 57, 68, 86, 87, 95, 103, and 112. The EDI demonstrated strong internal consistency, with a Cronbach's α of 0.85, consistent with findings from Samson et al. (2014).

2.3 | Procedure

The participating parents were given the option to participate in the study either by visiting the research laboratory or through online participation. Thirty-four parents provided their child's WPPSI-IV or WISC-V FSIQ results, which were valid at the time of this study and did not require reassessment and opted for online participation. The remaining children ($n = 76$) were required to visit the research laboratory for testing to confirm their eligibility on the basis of intelligence. After receiving a detailed explanation of the research procedures, the parents

TABLE 1 | Descriptive statistics for study variables ($N = 110$).

Variables	Min	Max	Mean	SD	Skewness	Kurtosis
Autistic-like traits						
Social skills	5.00	30.00	19.16	5.00	−0.08	−0.32
Attention switching	11.00	30.00	19.70	3.43	0.22	0.26
Attention to detail	5.00	21.00	12.95	3.75	−0.15	−0.80
Communication	11.00	30.00	22.40	3.91	−0.20	−0.40
Imagination	3.00	30.00	16.95	4.96	0.10	0.10
Emotion regulation strategies						
Cognitive reappraisal	1.00	6.33	2.78	1.01	0.57	0.54
Expressive suppression	1.00	6.00	2.23	1.19	1.10	0.75
Parental coregulation	1.00	7.00	4.21	1.17	−0.12	0.02
Emotion dysregulation						
ED index	0.07	2.00	0.71	0.41	0.54	−0.20
Control (Child)						
Age	5.06	11.84	6.40	1.60	2.29	4.33
	n		%			
Sex (boy/girl)	96/14		87.27/12.73			
Comorbidities (N/Y)	71/39		64.55/35.45			

provided informed consent and subsequently filled out the four scales and questionnaires that were used to collect data.

2.4 | Data Analysis

Data correlations were calculated to assess relationships between the variables. Subsequently, the direct and indirect pathways linking autistic traits to ED that were mediated by ERSs were examined. A parallel multiple mediator model, implemented using the SPSS macro PROCESS version 4.2 with 5000 bootstrapping cycles, was employed. This model assumes that mediator variables are interrelated but do not directly influence each other (Hayes 2022). In the PROCESS macro, a regression-based approach is employed to estimate the direct and indirect effect coefficients between the independent variable (autistic traits) and the dependent variable (child's EDI) through the mediators (ERSs). The child's age, sex, and comorbidity diagnoses were included as covariates in the model. All statistical analyses were conducted using IBM SPSS Statistics 27 (IBM, Armonk, NY, USA).

3 | Results

3.1 | Correlations Between Autistic Traits, ERSs, and EDI

Table 1 presents the descriptive statistics for autistic traits (i.e., AQ-C subscores), ERSs, and ED. The results of the correlation analysis are presented in Table 2. Greater difficulties with social skills ($r = 0.33$, $p = 0.001$), attention switching ($r = 0.53$, $p < 0.001$), and communication ($r = 0.24$, $p = 0.013$) were significantly associated with higher EDI scores, indicating greater ED. Regarding the associations between autistic traits and ERSs, cognitive reappraisal demonstrated significant negative correlations with the social skills, attention switching, communication, and imagination subscores of autistic traits (all $p < 0.001$). Expressive suppression was also significantly negatively correlated with social skills ($r = 0.24$, $p = 0.013$), attention switching ($r = 0.20$, $p = 0.040$), and communication ($r = 0.20$, $p = 0.036$). Parental coregulation was significantly negatively associated with social skills and attention switching, communication, and imagination (all $p < 0.001$). Regarding ERS–EDI associations, both cognitive reappraisal and coregulation were significantly negatively correlated with EDI (both $p < 0.001$).

3.2 | ERSs as a Mediator in the Relationship Between Autistic Traits and EDI

Mediation analyses (Models 1–5) were conducted to investigate the indirect pathways through which autistic traits influence ED in children with ASC, with mediation by the three ERSs. Child age, sex, and comorbidity diagnoses were included as covariates in all models. A summary of the results is presented in Table 3.

The results revealed that parental coregulation significantly mediated the relationship between social skills and ED (Figure 1a). Additionally, a significant association was observed between social skills and parental coregulation (path a: $B = -0.078$, 95% CI: [−0.123, −0.032], $p = 0.001$) and between

TABLE 2 | Correlation matrix for study variables ($N = 110$).

	1	2	3	4	5	6	7	8	9	10	11
1. Sex[ref=boy,a]	—										
2. Age	−0.11	—									
3. CMB ref=none,[a]	0.00	0.07	—								
4. SS	−0.17	0.25**	−0.05	—							
5. AS	0.03	0.15	−0.07	0.60***	—						
6. AD	−0.07	0.04	−0.04	0.23*	0.23*	—					
7. CoM	−0.18	0.13	−0.05	0.69***	0.46***	0.31*	—				
8. IMG	−0.17	0.11	−0.16	0.61***	0.32**	0.12	0.55***	—			
9. CR	−0.05	−0.06	0.02	−0.34***	−0.39***	0.00	−0.34***	−0.42***	—		
10. ES	−0.05	0.19	−0.10	0.24*	0.20*	−0.02	0.20*	0.17	0.18	—	
11. CoR	−0.08	−0.02	−0.01	−0.29*	−0.42***	−0.02	−0.23*	−0.25**	0.50***	−0.08	—
12. ED	0.03	−0.01	0.17	0.33**	0.53***	0.00	0.24*	0.04	−0.36***	0.05	−0.44***

Abbreviations: AD = attention to detail; AS = attention switching; CMB = comorbidities; CoM = communication; CoR = parental co-regulation; CR = cognitive reappraisal; ED = emotion dysregulation; ES = expressive suppression; IMG = imagination; SS = social skills.
[a]Spearman rank correlation.
*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

TABLE 3 | Summary of mediation analysis effects with emotion dysregulation as the dependent variable: Models 1–5 ($N = 110$).

			Indirect effect		
Autistic-like traits (IV)	**Total effect**	**Direct effect**	**CR (M1)**	**ES (M2)**	**CoR (M3)**
Model 1					
SS	0.399**	0.243*	0.052	0.008	0.097**
Model 2					
AS	0.585**	0.462**	0.033	0.001	0.088**
Model 3					
AD	0.011	0.006	< 0.001	−0.003	0.008
Model 4					
CoM	0.280**	0.124	0.063	0.011	0.082**
Model 5					
IMG	0.093	−0.139	0.125**	0.017	0.092**

Note: Total effect = Autistic-like traits (IV) → ED (DV) and Autistic-like traits (IV) → M1, M2, M3 → ED (DV). Direct effect = Autistic-like traits (IV) → ED (DV). Indirect effect = Autistic-like traits (IV) → M1, M2, M3 → ED (DV).
Abbreviations: AD = attention to detail; AS = attention switching; CoM = communication; CoR = parental coregulation; CR = cognitive reappraisal; ES = expressive suppression; IMG = imagination; IV = independent variable; M = mediator; SS = social skills.
*$p < 0.05$.
**$p < 0.01$.

parental coregulation and ED (path b: $B = -0.103$, 95% CI: [−0.170, −0.035], $p = 0.003$), with a significant indirect path ($ab = 0.008$, 95% CI [0.001, 0.018]). Moreover, social skills exerted a significant direct effect on ED (path c′: $B = 0.020$, 95% CI: [0.004, 0.036], $p = 0.013$).

Parental coregulation significantly mediated the relationship between attention switching and ED, as illustrated in Figure 1b. Significant associations were noted between attention switching and parental coregulation (path a: $B = -0.149$, 95% CI: [−0.210, −0.089], $p < 0.001$) and between parental

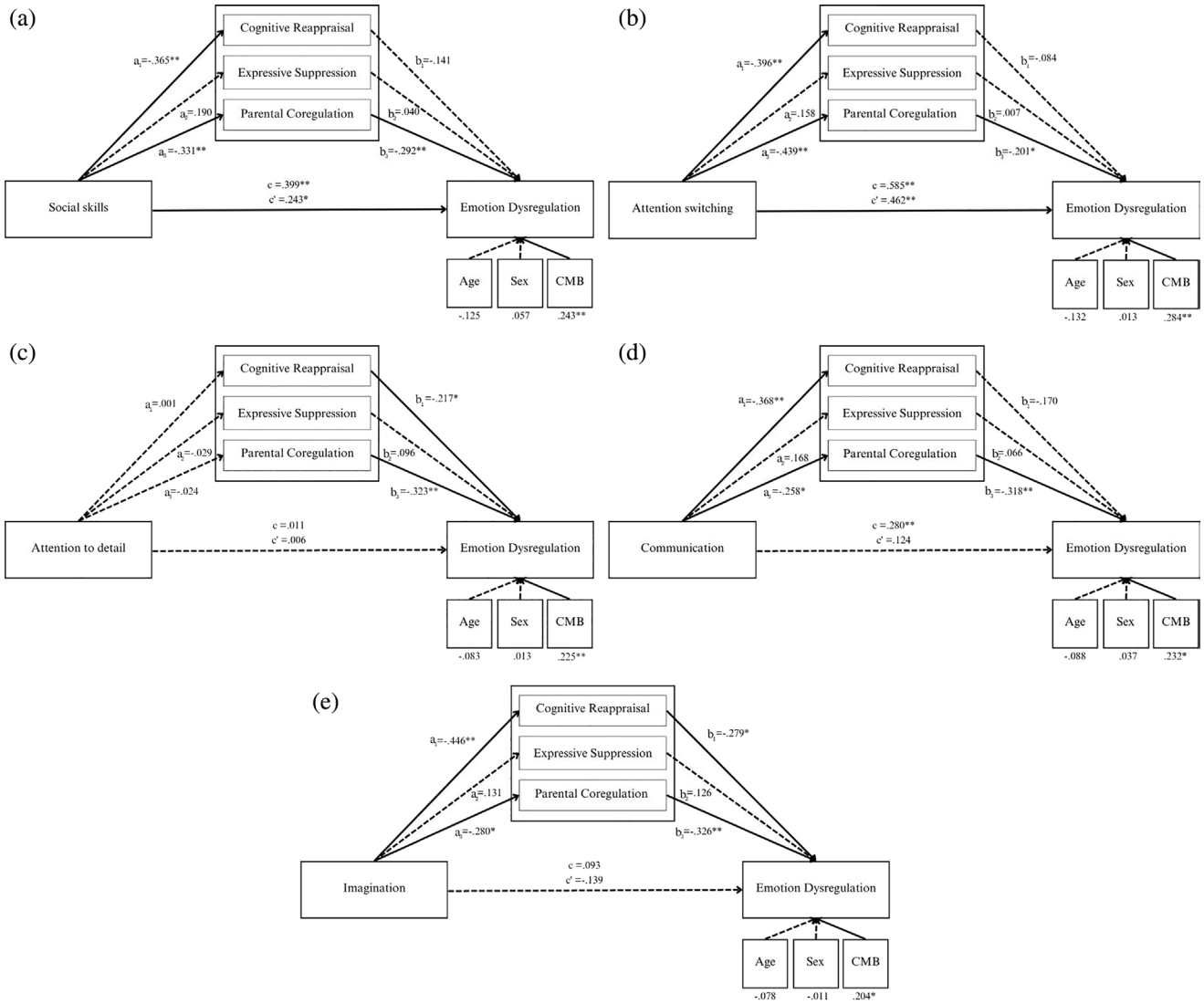

FIGURE 1 | Mediation analysis for Models 1–5 ($N = 110$). (a) Model 1. (b) Model 2. (c) Model 3. (d) Model 4. (e) Model 5. *$p < 0.05$; **$p < 0.01$.

coregulation and ED (path b: $B = -0.070$, 95% CI: [−0.134, −0.007], $p = 0.031$), with a significant indirect path ($ab = 0.011$, 95% CI: [0.001, 0.024]). Furthermore, attention switching exerted a significant direct effect on ED (path c: $B = 0.055$, 95% CI: [0.034, 0.076], $p < 0.001$).

Parental coregulation significantly mediated the relationship between communication and ED, as indicated in Figure 1d. A significant association was observed between communication and parental coregulation (path a: $B = -0.077$, 95% CI: [−0.135, −0.019], $p = 0.009$) and between parental coregulation and ED (path b: $B = -0.112$, 95% CI: [−0.181, −0.043], $p = 0.002$), with a significant indirect path ($ab = 0.009$, 95% CI: [0.001, 0.019]). However, communication had no significant direct effect on ED ($p > 0.05$).

Both cognitive reappraisal and parental coregulation significantly mediated the relationship between imagination and ED, as presented in Figure 1e. A significant association was observed between imagination and cognitive reappraisal (path a: $B = -0.091$, 95% CI: [−0.127, −0.054], $p < 0.001$) and between cognitive reappraisal and ED (path b: B = −0.114, 95% CI: [−0.202, −0.025], $p = 0.012$), with a significant indirect path ($ab = 0.010$, 95% CI [0.002, 0.021]). Additionally, a significant association was noted between imagination and parental coregulation (path a: $B = -0.066$, 95% CI: [−0.112, −0.021], $p = 0.005$) and between parental coregulation and ED (path b: $B = -0.115$, 95% CI: [−0.183, −0.046], $p = 0.001$), with a significant indirect path ($ab = 0.008$, 95% CI: [0.001, 0.017]). However, imagination had no significant direct effect on ED ($p > 0.05$). This lack of a significant direct effect in Models 4 and 5 ($p > 0.05$) underscores the importance of the mediating roles of cognitive reappraisal and parental coregulation. Finally, attention to detail did not exert a significant indirect or direct effect on ED (Table 3).

None of the ERSs significantly mediated the relationship between attention to detail and ED, as illustrated in Figure 1c. Furthermore, attention to detail exhibited no significant direct effect on ED ($p > 0.05$). Additionally, in Models 1–5, of the three covariates considered—child's age, sex, and comorbidities—only comorbidities consistently exerted a significant positive effect on ED, as indicated in Figure 1a–e, whereas age and sex were not significantly related to ED ($p > 0.05$).

4 | Discussion

To the best of our knowledge, this study is the first to investigate the mediating role of ERSs in the relationship between autistic traits and ED in school-aged, intellectually able children with ASC. Our findings reveal that ERSs significantly mediated the relationship between specific autistic traits and ED across Models 1–5. By accounting for potential confounding variables such as child age, sex, and comorbid diagnoses, the study isolated the unique contribution of ERSs to ED. These findings have practical implications for designing targeted interventions aimed at strengthening specific ERSs to mitigate ED in intellectually able children with ASC while considering their distinct autistic profiles.

Our findings indicate that school-aged, intellectually able children with ASC who exhibit pronounced autistic traits in the social skills, attention switching, communication, and imagination domains are less likely to manage their emotions through parental coregulation (Models 1, 2, 4, and 5). This suggests that as children with ASC transition to elementary school, their persistent autistic traits may hinder their ability to seek and effectively engage with parental support during heightened emotional states. This difficulty may in turn hinder the parents' ability to be sensitive and responsive to their children's emotional needs. Consequently, the limited use of parental coregulation prevents these children from adjusting their emotional experiences and expressions, contributing to elevated ED levels. Previous studies on this topic have primarily focused on preschool-aged children with ASC and examined their struggles with coregulation (Hirschler-Guttenberg et al. 2015) and the development of intervention models (Gulsrud et al. 2010). The findings of the present study align with Ting and Weiss's (2017) assertion that autistic traits in school-aged children with ASC negatively affect the efficacy of parental coregulation in supporting the emotional management of children with ASC. This process provides scaffolding for the development of independent ERSs, which are essential for fostering a child's socioemotional health. These findings are consistent with those for Sameroff's (2009) transactional model of child development, which emphasizes the reciprocal influences among children, parents, and other social agents. Furthermore, Cibralic et al. (2019) reviewed evidence suggesting that parents of children with ASC often rely on simpler strategies, such as offering physical comfort, rather than employing more complex strategies, such as verbal explanations, to assist their children with emotion regulation. The reliance on simpler strategies may delay ER development in children with ASC (Nuske et al. 2017). However, whether these delays stem from the parents' use of simpler ERSs during coregulation or from the children's autistic traits limiting their engagement with coregulation strategies remains unclear. Overall, our findings highlight the importance of parental coregulation as an ERS for school-aged children with ASC and emphasize the need for further research into how this mechanism interacts with the heterogeneity of autistic traits.

Deficits in social skills—such as limited social comfort, difficulties in forming and maintaining relationships, and reduced engagement in social activities—can hinder a child's ability to navigate social interactions, appropriately respond to social cues, and sustain relationships (Baron-Cohen 1988). These challenges increase the difficulty of effectively expressing emotions, regulating emotional states, and seeking support when required for children (Martínez-González et al. 2022). Furthermore, attention-switching difficulties—manifesting as poor flexibility in shifting focus, managing interruptions, and transitioning between activities—negatively influence coregulation. Limited attentional flexibility can hinder a child's ability to identify their emotions and adjust their emotional state in response to external stimuli (de Vries and Geurts 2012). Communication difficulties, both verbal and nonverbal, such as stereotyped speech patterns, further complicate emotion regulation for intellectually able children with ASC. These challenges can manifest as difficulties initiating and maintaining conversations, understanding figurative language, and interpreting nonverbal cues (Tsai et al. 2020). Such limitations impede the ability of parents to accurately interpret their child's emotional needs and effectively engage in emotion coregulation with them (Nevill et al. 2018).

Notably, our findings suggest that autistic-like imagination does not directly contribute to ED in intellectually able children with ASC. Rather, deficits in imagination appear to indirectly influence ED by impeding the development of ERSs. Children with ASC have been demonstrated to struggle with creative play, hypothetical thinking, pretend play, imagining possibilities, and creating stories (Weisberg 2016). These limitations in imaginative thinking hinder their ability to reinterpret situations and manage emotional responses through imagination (Crespi et al. 2016). Consequently, parents may encounter difficulties in discussing imagined emotional experiences, engaging in coregulation within the relationship, and helping the child adjust their emotional responses during interactions (Altman et al. 2024). Additionally, school-aged, intellectually able children with ASC who struggle with imaginative thinking may face challenges in using cognitive reappraisal to manage their emotions. Hoffman et al. (2023) highlighted that cognitive reappraisal involves reinterpreting situations to alter their emotional impact, with this often completed using imagination and play, which provides a safe situation for children to explore and regulate their feelings. Therapies such as Child-Centered Play Therapy, Mentalization-Based Therapy for Children, Regulation-Focused Therapy for Children, and Dialectical Behavior Therapy for Children incorporate both explicit and implicit reappraisal strategies (Hoffman et al. 2023), which have been linked to improvements in perspective-taking, executive functioning, and cognitive-linguistic abilities (Samson et al. 2015).

In the current study, expressive suppression did not mediate the relationship between autistic traits and ED. Moreover, correlation analysis revealed a weak association between expressive suppression and autistic-like social skills, with no significant relationship between expressive suppression and ED in school-aged, intellectually able children with ASC. These findings suggest that expressive suppression may not constitute a central factor in the developmental trajectory of ED for this population. Consistent with these results, Goldsmith and Kelley (2018) reported that suppression might serve as the most accessible ERS for intellectually able individuals with ASC. These individuals may develop relatively effective suppression techniques to mitigate the immediate or short-term impact of negative emotions. However, the long-term implications of reliance on expressive suppression for mental health warrant further investigation.

Notably, we identified a direct effect of social skills on ED, even after the mediating effects of ERSs were accounted for. For intellectually able children with ASC, challenging social interactions can be emotionally burdensome, leading to feelings of isolation, frustration, anxiety, and distress, which culminate in ED (Wang and Spillane 2009). Conversely, children with stronger social skills tend to exhibit greater emotional stability (Martínez-González et al. 2022). Additionally, in the current study, after the mediating effects of ERSs were accounted for, attention-switching difficulties directly contributed to ED. This finding underscores how struggles with adjusting attentional focus can exacerbate emotional distress in intellectually able children with ASC. Previous studies have revealed that children with ASC experience more difficulty in switching attention during emotional tasks than during nonemotional tasks (de Vries and Geurts 2012; Zhou et al. 2024). By contrast, communication and imagination deficits did not exert direct effects on ED when ERSs were considered as a mediator. This finding indicates that these traits indirectly influenced ED by impeding the development of effective ERSs, which in turn led to ED.

Finally, the attention-to-detail scores exhibited no significant correlation with other variables and did not influence ERSs or ED. However, the AQ-C has limitations in assessing RRBs and SS (Auyeung et al. 2008). Thus, the lack of observed associations between attention to detail and ERSs or ED should not be interpreted as evidence that RRBs and SS are unrelated to these outcomes. Instead, the results should be considered as indicating that these traits were not adequately measured in the present study. Future research should consider employing more targeted instruments, such as the Repetitive Behavior Scale-Revised (RBS-R; Bodfish et al. 2000) for RRBs and the Sensory Profile (SP; Dunn 1999) for SS, to further explore these associations. In summary, the impact of autistic-like traits on ED may be attributable to various mechanisms, and measurement methods for capturing these traits require further refinement to improve their accuracy. Both areas warrant additional investigation to deepen the understanding of the complex interplay between autistic traits, ERSs, and ED.

Among the control variables analyzed, only comorbidities significantly influenced ED in intellectually able children with ASC. Comorbid conditions, which are prevalent in this population (Ivanović 2021; Mutluer et al. 2022), can exacerbate ED more than the effects of autistic traits alone can. However, the present study grouped comorbidities broadly, and further investigation is required to parse out the effects of specific conditions. Analyzing comorbidities separately (e.g., ADHD, developmental coordination disorder, Tourette syndrome, and epilepsy) would provide more precise insights into how these disorders intensify the relationship between autistic traits and ED. The small sample sizes (i.e., 18 with another neurodevelopmental disorder, 14 with neurological issues [i.e., preterm birth, epilepsy, or Tourette syndrome], and 7 with both another neurodevelopmental disorder and neurological issues) for each comorbidity group in this study limited the ability to detect statistically significant differences. These small group sizes underscore the need for larger samples in future research. Furthermore, these findings highlight the importance of tailoring interventions to address specific comorbidities. The efficacy of ERSs may vary depending on the type and presence of these conditions. By contrast, sex, which was included as a covariate in the models, did not significantly influence ED. This lack of significance suggests that ED does not differ between intellectually able boys and girls with ASC. However, the potential moderating role of sex on ERSs remains unclear. Examining whether the mediating relationships between autistic traits and ED differ by sex could offer valuable insights. This study, however, included only 14 girls, which rendered subgroup analysis unfeasible. Future studies should recruit more female participants to further examine potential sex differences in the direct effects of autistic traits on ED and the mediating role of ERSs between intellectually able boys and girls with ASC.

This study used the WPPSI-IV or WISC-V to assess FSIQ as a screening criterion. Participants scoring <70 on the FSIQ were excluded from the study, which ensured that the sample comprised only intellectually able children without cognitive delays. However, some participants did not undergo WPPSI-IV or WISC-V testing in our laboratory and instead provided medical reports containing only categorical FSIQ data (e.g., delay, borderline, and normal). This reliance on categorical data precluded the quantification of individual cognitive ability differences and hindered the inclusion of cognitive ability as a covariate in the analyses. The inability to account for cognitive ability as a covariate could have implications for the findings because it restricted the study's capacity to control for this ability's potential influence on ED. Although this limitation does not directly undermine the study's core findings, it may have reduced precision in the examination of the effects of maturation on ED, its relationship with autistic-like traits, and the mediating role of ERSs. Although previous research has not established a link between cognitive ability and ED in children with ASC (Samson et al. 2014), the role of cognitive ability warrants further exploration. Future research should consider including cognitive ability as a covariate to control for its effect on ED, thereby reducing the impact of cognitive ability on ED and, consequently, on autistic-like behaviors and the mediating role of ERSs.

The current study has some limitations that should be considered. First, it employed a cross-sectional design, which inherently limits the ability to draw causal inferences among variables. Although this design restricts the study's ability to draw definitive conclusions about causal relationships, the findings suggest that interventions aimed at enhancing ERSs may reduce autism-associated ED in school-aged, intellectually able children with ASC. Longitudinal studies are warranted to gain a deeper understanding of the impact of these interventions and their potential to mitigate the long-term effects of autistic traits on ED. Researchers can further examine the causal relationships among autistic traits, ERSs, and ED. Another limitation of the study lies in its reliance on parent reports for data collection, which, although an efficient and cost-effective method, introduces the potential risk of common method bias (CMB). This systematic error can inflate the observed associations between constructs (Madigan et al. 2020). Podsakoff et al. (2003) identified multiple sources of CMB, including biases when data are collected from the same rater (e.g., the same parent reporting multiple behaviors). They noted that factors such as consistency

motives and implicit theories may lead parents to report stronger correlations than would be observed with independent data sources. Podsakoff et al. (2003) recommends using multiple data sources or temporally separating the measurement of predictors and outcomes to confirm the true specificity of ERSs and ED in models. Employing these strategies can help clarify whether observed associations are due to genuine construct differences or method bias. Therefore, future research should incorporate additional methodologies to strengthen the validity of observed ERS–ED associations in intellectually able children with ASC by, for example, collecting reports from teachers, employing laboratory observations, or using experimental tasks such as the Go/NoGo emotion task.

5 | Conclusion

This study reveals that ED in school-aged, intellectually able children with ASC is not only directly associated with their autistic traits but is also significantly mediated by the limitations these traits impose on the development of ERSs, resulting in ED. Specifically, parental coregulation was identified as playing a vital role in the relationship between autistic traits and ED, with deficits in imagination notably hindering the development of cognitive reappraisal.

These findings highlight the importance of designing interventions aimed at improving the ability of children with ASC to seek parental support during heightened emotional states. Such interventions should also focus on enhancing parents' sensitivity to their children's emotional needs, particularly when children face challenges with social skills, attention, communication, and imagination. Fostering parental responsiveness and parental ability to support a child's emotional development can lead to the establishment of a more stable and supportive emotional environment, which can lead to more effective emotion regulation in children. Furthermore, targeted efforts to enhance cognitive reappraisal in children who struggle with imaginative tasks may yield notable benefits in reducing ED. Overall, our study underscores the critical role of ERSs, particularly parental co-regulation, in either reducing or intensifying the effects of autism traits on ED.

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Ethics Statement

The Research Ethics Committee of Chung Shan Medical University Hospital, Taiwan, approved this study. Informed consent was obtained from all individual participants.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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