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RESEARCH ARTICLE

Cognitive and affective empathy, executive functions, and the key role of personal distress: Why do autistic traits predict mental health symptoms in neurotypical adults?

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Abstract
Individuals with elevated autistic traits often experience internalizing symptoms that affect their quality of life. However, the mechanisms underlying this process in neurotypical populations remain unclear. The present study investigated the mediating roles of executive functions (cognitive flexibility, working memory, inhibitory control) and social cognition (affective empathy, cognitive empathy) in this relationship. The mental health symptoms of 159 neurotypical adult participants (ranging 18–45) were assessed using the Autism Quotient, Depression Anxiety Stress-21, Patient Health Questionnaire-9, and Generalized Anxiety Questionnaire-7. Within the same participants, executive functions were assessed using the Wisconsin Card Sorting Task, N-back Task, and Go/No-Go Task, while social cognition was assessed using the Interpersonal Reactivity Index, the Eyes Test, and the Self-Assessment Manikin. Results indicated that autistic traits were positively associated with mental health symptoms. Among the examined variables, personal distress—a component of affective empathy—was the only factor showing a link between attention-switching difficulties and mental health symptoms. Neither cognitive empathy nor executive functions demonstrated significant associations. These findings suggest that heightened affective empathy may be related to greater emotional vulnerability in individuals with elevated autistic traits. The study contributes to a better understanding of the associations among autistic traits, affective empathy, and mental health, and underscores the importance of considering emotion-regulation processes in future research.

Keywords Autistic traits · Executive functions · Social cognition · Mental health

Introduction

Autistic traits refer to the features of autism spectrum disorder (ASD) that are present in individuals who do not meet the clinical criteria for an ASD diagnosis (Baron-Cohen et al. 2001a). Numerous studies have demonstrated that both individuals with ASD and neurotypical individuals who exhibit elevated autistic traits typically experience a range of internalizing and externalizing symptoms that can significantly impact their overall quality of life. These symptoms can manifest in various ways and can lead to individuals experiencing significant distress, social difficulties, and reduced life satisfaction (Albantakis et al. 2020; Kanne et al. 2009; Mason and Happé 2022; van Steensel et al. 2013).

It is important to note that the link between mental health and autistic traits extends beyond individuals with ASD. Research indicates that individuals in the neurotypical population diagnosed with anxiety or mood disorders

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often exhibit more autistic traits than individuals not diagnosed with these disorders (Albantakis et al. 2020; Towbin et al. 2005; van Steensel et al. 2013). High levels of these traits may predict anxiety, depression, and stress (Fietz et al. 2018), with individuals displaying greater autistic traits being more susceptible to conditions like bipolar disorder and anxiety, resulting in longer hospital stays (Dell'Osso et al. 2018, 2019). Additionally, those with elevated autistic traits often report lower mental well-being (Kanne et al. 2009; Stimpson et al. 2021). Ishizuka et al. (2022) linked persistent depression in newly diagnosed patients to specific traits of autism, such as difficulties in attention switching. Indeed, even mild autism symptoms can increase vulnerability to mental health issues, influenced by genetic and environmental factors (Lundström et al. 2011).

The susceptibility to mental health problems associated with elevated autistic traits in nonautistic individuals is complex and remains to be fully explored. However, the evidence so far suggests that cognitive and social impairments, particularly in executive functions (EFs) and social cognitive skills, are likely to contribute significantly (Zelazo 2020). Difficulties in EFs have also been linked to internalizing behaviors and anxiety (Gardiner and Iarocci 2018; Hollocks et al. 2014; Zimmerman 2016), while challenges in social cognitive skills including empathic skills also correlate with mental health conditions (Colonnesi et al. 2017; Conner et al. 2020).

Social cognition and executive functions as mediators

Social cognitive skills, including cognitive and affective empathy, are essential for social functioning, academic success, and mental health (Allemand et al. 2015; Baron-Cohen 2001a; Blair 2005). While social cognition is indeed a broad construct, in this study, it is operationalized through both cognitive and affective empathy, which reflect emotion perception and understanding. This focus allows us to capture socio-emotional processes closely linked to executive functions (EFs) and mental health, rather than general cognitive abilities. Cognitive empathy involves understanding and predicting the emotions, desires, and beliefs of others (Shamay-Tsoory 2011) and supports higher-order cognitive processes such as Theory of Mind (Perry and Shamay-Tsoory 2013). Affective empathy, also known as emotional empathy, entails recognizing and responding to others' emotions and comprises several subcomponents—such as emotion contagion, shared pain, and empathic concern—that can sometimes elicit personal distress (Perry and Shamay-Tsoory 2013; Zaki 2017). Empirical findings reflect this complexity. For instance, Sönmez and Jordan (2023) found that affective empathy was linked to generalized anxiety disorder and social phobia in adolescents with ASD, while cognitive empathy was negatively associated with separation anxiety. Similarly, Gambin and Sharp (2018) reported that cognitive empathy negatively correlates with social anxiety, while affective empathy positively associates with anxiety disorders. Importantly, Tone and Tully (2014) describe affective empathy as a "risky strength"; while it enhances social skills, it can also lead to personal distress, making emotion regulation crucial in preventing internalizing problems (Gambin and Sharp 2016). This perspective underscores the dual nature of affective empathy, where its benefits must be balanced against the emotional toll it can impose.

Executive functions (EFs) are neurocognitive skills that regulate cognitive, behavioral, and emotional processes, supporting social, psychological, and academic development, as well as overall well-being (Diamond 2013; Zelazo 2020). They facilitate self-regulation, problem-solving, and adaptive learning (Diamond 2013; Zelazo 2015), and the three core EF skills (inhibitory control, working memory, and cognitive flexibility) are distinct but interrelated (Miyake et al. 2000) and are central to various lines of research (Diamond 2013; Zelazo 2020). EFs are also linked to improved social competence and emotional regulation in individuals with ASD (Fong and Iarocci 2020). Emotion regulation difficulties also correlate with internalizing and externalizing symptoms (Cai et al. 2018; Conner et al. 2020; Mazefsky et al. 2013). Hollocks et al. (2014) found EFs are related to anxiety in ASD but not to depression, while Wallace et al. (2016) associated impairments in flexibility and metacognition with both anxiety and depression.

Although these domains have often been studied separately, research increasingly shows that EFs and social cognition are both conceptually and functionally connected. EFs help regulate social attention, emotions, and behavior, while social understanding depends on flexible cognitive processes to interpret others' perspectives (Diamond 2013; Zelazo 2020). Difficulties in either area can reinforce each other and raise the risk of internalizing and externalizing problems (Fong and Iarocci 2020; Mairon et al. 2023; Yetim et al. 2024). However, research has yet to thoroughly explore how social cognition and EFs jointly mediate the relationship between autistic traits and mental health, especially in nonautistic adults. One research approach has focused on EFs as predictors of internalizing symptoms like anxiety and depression, without considering social–emotional variables in autistic samples (e.g., Wallace et al. 2016). Another has examined social-cognitive and empathy processes related to mental health outcomes but has not included EF measures (e.g., Domes et al. 2016). Other studies have investigated the connection between autistic traits and EFs in nonclinical groups, without evaluating social cognition or mental health

outcomes (e.g., Maes et al. 2013). Still, some research has looked at EF and social cognition together, mostly within autistic samples (e.g., Hollocks et al. 2014; Zimmerman et al. 2017), while a few studies in nonclinical adults linked measures of autistic traits, empathy, or theory-of-mind with EF performance but did not include mental health variables (e.g., Gökçen et al. 2016). Because of this, comprehensive models that include both domains and mental health outcomes are still rare in nonclinical groups with autistic traits. Addressing this gap could inform treatment strategies for both individuals with ASD (Fong and Iarocci 2020; Sönmez and Jordan 2023; Wallace et al. 2016) and neurotypical individuals with autistic traits. Studying EFs and social cognitive skills (cognitive empathy and affective empathy) together may offer a clearer picture of how cognitive control and socio-emotional processes jointly relate to mental health in people with higher autistic traits.

Accordingly, in contrast to previous research, the current study adopts an exploratory approach to concurrently identify potential relationships and mediating factors of social cognition (cognitive empathy and affective empathy) and EFs so as enhance understanding of the relationship between autistic traits and mental health symptoms in the neurotypical population. To our knowledge, this is the first published research to investigate social cognition and EFs concurrently in this context. Consequently, we anticipate that our findings will contribute to a deeper understanding of the significance of social cognition and EFs in informing intervention and prevention strategies for mental health symptoms associated with autistic traits in neurotypical individuals.

Method

Participants

The study employed a power analysis using the G*Power 3.1 version to determine the required number of participants (Faul et al. 2009). For multivariate analyses, a sample size of 145 participants was deemed necessary to detect a medium effect size of 0.15 (F^2) with a desirable power of 0.95 at an alpha level of 0.05. The current study's sample comprises 159 neurotypical participants, with 141 identifying as female and 18 as male, falling within the age range of 18 to 45 (M=27.90, SD=6.48). Demographic characteristics and descriptive statistics are provided in Table 1. Convenience sampling methodology was employed, utilizing advertisements distributed through social media, mailing lists, and campus platforms to recruit participants. The inclusion criteria stipulated that participants were neurotypical adults aged 18 or above, proficient in the use of computers, smartphones, or tablets, fluent in reading and speaking Turkish, and without a history of psychiatric disorders (including, ASD), as well as physical or neurological conditions that impeded the use of technological devices. Exclusion criteria were established for individuals below 18 years of age or possessing any history of psychiatric or physical conditions hindering the use of technological devices.

Materials

In this study, both self-report and performance-based tasks were utilized in line with usage in previous research. Variables such as autistic traits, mental health symptoms, and empathy are often evaluated through self-report measures due to their subjective and experiential nature (Baron-Cohen et al. 2001a; Davis 1983). EFs are typically assessed using performance-based tasks, which provide objective measures of cognitive processing, and additionally, empathy performance tasks were incorporated as suggested by previous literature (Baron-Cohen et al. 2001b; Diamond 2013; Grainger et al. 2023; Higgings et al. 2024; Miyake et al. 2000). All self-report measures and performance tasks were presented to all participants but in a different randomized order to minimize order effects.

Self-Report questionnaires

Autism quotient

To measure autistic traits in a neurotypical sample, a version of the Autism Quotient for adults (AQ; Baron-Cohen et al. 2001a) adapted to Turkish culture (Köse et al. 2010) was used. This self-report questionnaire consists of 50 questions, to which they responded using the rating scale "definitely agree," "slightly agree," "slightly disagree," and "definitely disagree." In the Turkish adaptation of the AQ for adults, Cronbach's alpha value for this scale is 0.64, and test-retest reliability is r=.72. Köse et al. (2010) reported Cronbach's alpha coefficients ranging from 0.32 to 0.52 across subscales. The AQ is a widely used instrument that measures five domains (Kocabasoğlu 2015): social skills (confidence and comfort in social situations; α=0.77), communication (the ability to engage in reciprocal communication and understand social cues; α=0.65), attention to detail (heightened focus on details and patterns; α=0.63), attention switching (the ability to shift attention between tasks and adapt to change; α=0.67), and imagination (imaginative thinking; α=0.65).

Table 1 Demographic characteristics and descriptive statistics ($n = 159$)

	n	Mean (SD)	Minimum	Maximum
Age	159	27.90 (6.48)	18	45
Cisgender (%)				
Female	141 (88.7)	–	–	–
Male	18 (11.3)	–	–	–
Education (%)				
Middle School	3 (1.9)	–	–	–
High School	18 (11.3)	–	–	–
Associate degree	19 (11.9)			
Bachelor's degree	83 (52.2)	–	–	–
Master's degree	28 (17.6)	–	–	–
Doctorate degree	8 (5.0)	–	–	–
AQ	159	19.97 (6.07)	6	38
Social Skills	159	3.84 (1.99)	0	9
Attention Switching	159	5.58 (1.86)	1	10
Attention to Detail	159	4.66 (1.90)	0	8
Communication	159	2.99 (2.21)	0	10
Imagination	159	2.90 (1.94)	0	7
DASS-21	159	26.19 (11.56)	6	57
Depression	159	7.28 (4.39)	0	20
Anxiety	159	9.68 (4.07)	1	19
Stress	159	9.23 (4.07)	0	21
GAD-7	159	9.23 (5.05)	0	21
PHQ-9	159	12.66 (6.79)	0	27
The Eyes	159	24.45 (3.94)	8	32
Self-Assessment Manikin	159	124.28 (18.09)	72	182
IRI	159	70.11 (11.72)	40	95
Perspective Taking	159	17.62 (4.26)	7	28
Fantasy	159	17.76 (4.76)	4	28
Empathic Concern	159	16.48 (3.20)	9	25
Personal Distress	159	18.25 (4.18)	8	28
WM Accuracy	159	131.51 (51.15)	31	398
WM Errors	159	41.04 (26.18)	1	128
IN Accuracy	159	329.68 (82.97)	119	400
IN Errors	159	11.87 (20.36)	0	150
CF Accuracy	159	188.18 (26.89)	87	230
CF Errors	159	36.06 (21.62)	20	70

Note. AQ = Autism Quotient; DASS-21 = Depression Anxiety Stress Subscale-21; IRI = Interpersonal Reactivity Index; WM = Working Memory; IN; Inhibitory Control; CF = Cognitive Flexibility

Depression anxiety stress scale 21

The Depression, Anxiety, and Stress Scale (DASS-21; Lovibond and Lovibond 1995) is a widely used self-report measure to assess levels of depression, anxiety, and stress in adults. Sarıçam (2018) conducted the Turkish adaptation study for the DASS-21. This scale comprises three subscales, each dedicated to measuring depression, anxiety, and stress, with a total of 21 items. The Turkish adaptation of the DASS-21 demonstrates acceptable internal consistency, with Cronbach's Alpha coefficients of 0.87 for the depression subscale, 0.85 for anxiety, and 0.81 for stress. In the current research, the total score derived from the DASS-21 was utilized to assess mental health symptoms comprehensively, providing an evaluation of participants' mental health symptoms across depression, anxiety, and stress domains.

Patient health questionnaire—9

The Patient Health Questionnaire 9 (PHQ-9; Kroenke et al. 2001) is a widely utilized self-report instrument designed to assess depression symptoms in both clinical and non-clinical populations. It comprises nine questions targeting various aspects of depression symptomatology, with scores ranging from 0 to 27. Additionally, one question assessing daily functioning is included, resulting in a total of 10 items, each answered from 0 (not at all) to 3 (nearly every day) in the Turkish version of the PHQ-9, and their findings indicate acceptable psychometric properties, with a total Cronbach's Alpha coefficient of 0.84, reflecting robust internal consistency (Sari et al. 2016).

Generalized anxiety disorder questionnaire—7

Generalized Anxiety Disorder Questionnaire 7 (GAD-7; Newman et al. 2002) is a 4-point Likert scale to examine the anxiety scores of the participants. It is a checklist of the main six symptoms of generalized anxiety disorder. It consists of 7 questions, each answered from 0 (not at all) to 3 (nearly every day). The adaptation to Turkish culture was conducted (Konkan et al. 2013), and the total Cronbach's Alpha was reported as 0.85.

Interpersonal reactivity index

The Interpersonal Reactivity Index (IRI; Davis 1983) serves as a tool used widely for assessing cognitive and affective empathy. The IRI comprises 28 self-report items, and the scale is organized into four subscales: perspective-taking, empathic concern, fantasy, and personal distress. Components of affective empathy are personal distress and empathic concern, while cognitive empathy includes perspective-taking and fantasy (Sindermann et al. 2019). Through the Turkish adaptation of the IRI, the internal consistency of the four subscales has been reported, ranging from 0.60 to 0.76 (Engeler and Yargic 2007).

Performance tasks

Wisconsin card sorting task

The Wisconsin Card Sorting Task (WCST; Berg 1948) serves as a performance-based assessment to measure cognitive flexibility. During the task, participants are presented with a series of 200 cards (two blocks of 100 cards each), each card containing one trial. The key feature of the WCST is the changing sorting rule, and participants are tasked with matching the color, number, and shape of the cards to the corresponding rule and response. Throughout the task, the number of perseverative error scores (errors made by persisting with the same sorting strategy despite feedback indicating it is incorrect) and the number of correct responses are recorded. Higher accuracy scores and lower perseverative errors indicate better cognitive flexibility.

N-Back task

Working memory was assessed using the N-Back Task (Kirchner 1958). Participants are presented with a sequence of stimuli one by one and must determine if the current stimulus matches the one presented N trials ago. In this study, the $n=2$ rule was employed, requiring participants to indicate if the letter was presented two trials ago. The task includes eight blocks of 50 trials, each utilizing the letters A, B, C, D, E, H, I, K, L, M, O, P, R, S, and T. Accuracy and false alarms were recorded. Higher accuracy scores and lower false alarms indicate better working memory.

Go / No-Go task

The Go/No-Go Task was utilized to assess inhibitory control (Donders 1969). During the task, participants were required to respond promptly and accurately to each target stimulus ("go" trials) while refraining from responding to non-target stimuli ("no go" trials). The stimuli consisted solely of the text "go" or "no-go." The task consisted of 12 blocks, each containing 50 trials. Commission errors, which denote incorrect responses to "no-go" trials, and accuracy were recorded to analyze the data. Higher accuracy and lower commission error rates indicate greater inhibitory control.

The eyes test

The Eyes Test, recognized as a performance task for emotion recognition and an indicator of cognitive empathy, involves participants viewing a series of 37 black-and-white images depicting human eyes. For each image, participants select from four words the one that best describes what the person in the image is feeling or thinking. The Turkish version used in this study was adapted by Girli (2014), exhibiting acceptable internal consistency with a Cronbach alpha coefficient exceeding 0.70. Higher scores on this test indicate higher cognitive empathy scores.

Self-assessment manikin

The Self-Assessment Manikin (SAM; Bradley and Lang 1994) was employed to measure participants' self-reported emotional responses to facial expression images, assessing affective empathy. The facial expressions are depicted using the Karolinska Directed Emotional Faces database (KDEF; Conley et al. 2018; Lundqvist et al. 1998), consisting of 30 images (15 male, 15 female) displaying six emotional expressions: neutral, sadness, happiness, anger, fear, and disgust. Participants rate each facial expression on a valence scale ranging from more negative (1) to more positive (9). This adaptation of the task is based on the work of Wai and Tiliopoulos (2012), with valence scores for each emotion obtained by summing responses across all images.

Procedure

Approval for this study was granted by the Ethical Committee (details are given in the Acknowledgments section). Participation in the study was voluntary, and each participant provided informed consent before taking part. Data

collection was conducted through an online platform created specifically for the research, with participants accessing the platform via a link distributed through email or various social media platforms through advertisements. Upon accessing the platform, participants completed self-report questionnaires and performance tasks. The entire process, including all tasks, lasted approximately 30 min. All collected data were stored securely and confidentially, ensuring participant privacy and anonymity.

Statistical analysis

The data analysis was conducted using SPSS version 25.0 and the PROCESS Macro 4.2 for SPSS (Hayes 2022). Given the lack of prior research on the interplay among these variables, this study employed an exploratory approach to uncover potential relationships. Initially, preliminary analyses, including descriptive statistics, were performed to examine the demographic characteristics of the participants, as presented in Table 1. The skewness and kurtosis of the data were within an acceptable range (-1.5 to +1.5), allowing for the use of parametric tests, as recommended by Tabachnick and Fidell (2013). Before proceeding to the mediation analysis, Pearson correlations were used to explore the relationships between variables as an initial step while controlling for age and cisgender due to their potential effects on mental health, social cognition, and executive functions (Conner et al. 2020; Mason and Happé 2022). To address concerns regarding multiple comparisons, we report both adjusted and unadjusted *p*-values in the results. The False Discovery Rate (FDR) correction was applied to control for Type I error, with an adjusted significance threshold of 0.012 for correlations. This dual reporting of *p*-values allows readers to evaluate the robustness of our findings while maintaining transparency about the exploratory nature of the analyses (Benjamini and Hochberg 1995; McDonald 2014).

Mediation analyses were conducted using the PROCESS Macro (Model 4; Hayes 2022), with bootstrapped estimation (5000 samples) to assess indirect effects. These analyses were conducted to explore the potential mediating effects of EFs and empathy subscales on the relationship between autistic traits and mental health symptoms. Although the DASS-21, PHQ-9, and GAD-7 are conceptually related and showed high intercorrelations (e.g., PHQ-9 with DASS-21 depression: $r = .76$; GAD-7 with DASS-21 anxiety: $r = .71$), each was analyzed in a separate mediation model to prevent redundancy and avoid multicollinearity. This design enabled us to examine the consistency of indirect effects across three operational definitions of internalizing symptoms—general distress, depression, and anxiety—thereby enhancing the validity and robustness of the findings while at the same time providing important converging evidence across these instruments. While most mediators, such as perspective-taking, fantasy, and working memory errors, did not yield significant indirect effects, personal distress emerged as a significant mediator. Consequently, only the mediation findings involving personal distress are reported in the Results section. This highlights the distinct role of personal distress in influencing the relationship between attention-switching and mental health symptoms. The mediation models assessed both direct effects, indirect effects, and total effects, all of which are reported in the Results section.

Results

Correlation analyses among autistic Traits, social Cognition, executive functions and mental health

To explore the connections between autistic traits, social cognition, executive functions, and mental health symptoms, Pearson correlation analysis was performed while controlling for age and cisgender. The results revealed the total AQ score exhibited a positive correlation with the DASS-21 score, as well as GAD-7. And PHQ-9 ($p < .01$). Among the AQ subscales, attention switching and communication demonstrated a positive significant correlation with the DASS-21, GAD-7, and PHQ-9, see Table 2. In terms of EFs, results indicated a positive correlation between WM errors and the attention to detail subscale of AQ ($p < .01$). Additionally, WM errors marginally positively correlated with the total DASS-21 and GAD-7 ($p < .05$). Inhibitory control errors were positively correlated with total DASS-21 ($p < .01$). Detailed information on these analyses is presented in Table 3.

Mediation analyses

The first mediation analysis was conducted to examine the mediating effect of self-report affective empathy on attention switching and DASS-21, with age and cisgender included as covariates. The total effect of the model was found to be significant, F (3, 155) = 5.01, $b = 1.36$, $SE = 0.48$, CI [0.41, 2.30], $R^2 = 0.08$, $p < .01$. There was also a significant direct effect, F (4, 154) = 6.75, b = 1.05, $SE = 0.47$, CI [0.11, 1.99], $R^2 = 0.15$, $p < .001$. Notably, age and cisgender did not reach significance once personal distress was introduced into the model ($p > .05$). A significant indirect effect was also found, $b = 0.31$, $SE = 0.15$, BCa CI [0.07, 0.66], as determined through bootstrapped estimation with 5000 samples (Hayes 2022). These results suggest that personal distress partially mediated the relationship between attention switching and

Table 2 Correlations among autistic Traits, social Cognition, and mental health symptoms ($n = 159$)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. AQ	-																		
2. Social Skills	0.75***	-																	
3. Attention Switching	0.58***	0.27***	-																
4. Attention to Detail	0.30***	0.10	0.04	-															
5. Communication	0.73***	0.47***	0.22**	−0.11	-														
6. Imagination	0.66***	0.37***	0.18*	0.03	0.45***	-													
7. DASS-21	0.31***	0.14	0.21**	0.13	0.19*	0.09	-												
8. Stress	0.30***	0.17*	0.22**	0.14	0.20*	0.09	0.93***	-											
9. Anxiety	0.33***	0.12	0.25**	0.14	0.17*	0.11	0.94***	0.82***	-										
10. Depression	0.23**	0.08	0.12	0.11	.16[a]	0.04	0.92***	0.77***	0.80***	-									
11. GAD-7	0.22**	0.09	0.20*	0.11	0.22**	0.04	0.75***	0.69***	0.71***	0.69***	-								
12. PHQ-9	0.22**	0.07	0.20*	0.12	0.21**	0.07	0.76***	0.67***	0.68***	0.76***	0.72***	-							
13. IRI	−0.08	−0.08	0.06	0.12	−0.10	−0.22**	0.17*	0.16*	0.15	.15[b]	0.29***	0.18*	-						
14. Perspective Taking	−0.13	−0.15 [a]	−0.02	0.16*	−0.21**	−0.15	0.03	0.01	0.05	0.03	0.08	0.06	0.73***	-					
15. Fantasy	−0.14	−0.11	0.00	0.08	−0.17*	−0.24**	0.06	0.06	0.11	0.05	0.16*	0.10	0.80***	0.49***	-				
16. Empathic Concern	0.03	0.02	−0.03	0.05	0.07	−0.02	0.10	0.10	0.09	0.11	0.21**	0.14	0.60***	0.23**	0.33***	-			
17. Personal Distress	0.06	0.04	0.20*	0.04	0.08	−0.18*	0.29***	0.30***	0.25***	0.26***	0.40***	0.24**	0.69***	0.29***	0.36***	0.32***	-		
18. Self-Assessment Manikin	−0.02	−0.03	−0.01	−0.01	−0.02	−0.02	−0.06	−0.03	−0.08	−0.04	0.01	−0.06	−0.06	−0.01	−0.10	−0.06	−0.00	-	
19. The Eyes Accuracy	−0.07	0.01	0.10	−0.14	0.01	−0.20*	−0.22**	−0.17*	−0.24**	−0.20*	−0.20*	−0.13	−0.09	−0.03	−0.07	−0.16*	−0.01	−0.07	-

Note. AQ = Autism Quotient Total Score; DASS-21 = Depression Anxiety Stress Scale – 21 Total Score; IRI = Interpersonal Reactivity Index Total Score. *** $p < .001$ ** $p < .01$; * $p < .05$; a = 0.053; b = 0.055

total DASS-21. See Fig. 1. Mediation Model 1. (* = $p < .05$, ** = $p < .01$, *** = $p < .001$).

The second mediation analysis focused on examining the mediating effect of personal distress on attention switching and GAD-7 score, with age and cisgender included as covariates. The total effect of the model was significant, F (3, 155) = 5.12, $b = 0.52$, $SE = 0.21$, CI [0.11, 0.93], $R^2 = 0.09$, $p < .01$. However, there was a non-significant direct effect, (F (4, 154) = 10.60, b = 0.32, $SE = 0.20$, CI [-0.07, 0.72], $R^2 = 0.22$, $p > .05$) once age and cisgender were introduced into the model. Both age and cisgender were non-significant ($p > .05$). A significant indirect effect was also found, $b = 0.20$, $SE = 0.08$, BCa CI [0.05, 0.38], through bootstrapped estimation with 5000 samples (Hayes 2022). These findings indicate that personal distress fully mediated the relationship between attention switching and GAD-7 score. See Fig. 2. Mediation Model 2. (* = $p < .05$, ** = $p < .01$, *** = $p < .001$)..

In the third mediation analysis, the focus was on examining the mediating effect of personal distress on attention switching and depression (PHQ-9) score, with age and cisgender included as covariates. The total effect of the model was found to be significant, F (3, 155) = 4.10, $b = 0.71$, $SE = 0.28$, CI [0.15, 1.27], $R^2 = 0.07$, $p < .01$. However, there was a non-significant direct effect (F (4, 154) = 4.99, $b = 0.56$, $SE = 0.28$, CI [-0.01, 1.12], $R^2 = 0.12$, $p > .05$) once age and cisgender were introduced into the model, and both age and cisgender were non-significant ($p > .05$). Furthermore, a significant indirect effect was identified ($b = 0.15$, $SE = 0.08$, BCa CI [0.02, 0.34]) through bootstrapped estimation with 5000 samples (Hayes 2022). These findings suggest that personal distress fully mediated the relationship between attention switching and depression (PHQ-9) score. See Fig. 3. Mediation Model 3. (* = $p < .05$, ** = $p < .01$, *** = $p < .001$)..

Discussion

The primary objective of this study was to explore whether executive functions (cognitive flexibility, working memory, and inhibitory control) and social cognition (cognitive empathy and affective empathy) mediate the relationship between autistic traits and mental health symptoms (anxiety, depression, and stress) in nonautistic individuals.

This study found that personal distress was associated with the link between attention switching and mental health symptoms, though the cross-sectional design precludes causal inference. These results support Happé et al.'s (2006) argument that autism should be studied as separate dimensions rather than a single category due to distinct profiles and associations. Different dimensions can vary based on the questionnaire used; AQ includes five subscales, while others suggest a three-factor model (e.g., BAPQ; Hurley et al. 2007; Köse et al. 2010). Consistent with this study, Ishizuka et al. (2022) identified attention to detail and attention switching as key indicators of depression in nonautistic individuals, while Hoekstra et al. (2008) proposed a dual-factor model distinguishing social skills (communication, imagination, attention switching) from attention to detail. This suggests that different facets of autistic traits—particularly attentional and social dimensions—may differentially relate to emotional functioning, underscoring the importance of examining trait-level variation rather than categorical diagnosis.

The findings partially supported the study hypotheses. Self-reported personal distress—an aspect of affective empathy—was positively correlated with attention switching and negatively correlated with imagination, and was also associated with higher anxiety, depression, and stress. This suggests that individuals who experience higher emotional reactivity may find it more difficult to flexibly shift attention, which may contribute to greater emotional reactivity and internalizing symptoms. This aligns with previous research on affective empathy, autistic traits, and mental health (Gambin and Sharp 2018; Sönmez and Jordan 2023; Tone and Tully 2014). Tone and Tully (2014) describe affective empathy as a "risky strength"—while beneficial, it may lead to internalizing problems if emotion regulation is lacking. Our results support this view, emphasizing the need for adaptive regulation strategies to mitigate distress and enhance affective empathy in nonautistic individuals. Additionally, the pattern of associations observed among imagination, the Eyes Test, and personal distress may suggest that imaginative ability serves as a shared underpinning of both social understanding and emotional responsiveness. In this study, higher AQ imagination scores (reflecting weaker imaginative ability and higher autistic traits) were negatively associated with both Eyes Test performance and personal distress. Although the Eyes Test and personal distress were not directly related, their shared negative link with imagination might indicate that reduced imaginative capacity limits both cognitive and affective components of empathy, diminishing the ability to infer the mental states of others and to emotionally respond to the experiences of others. This interpretation is in line with Nahal et al. (2021), who found that imagination supports social attention and empathic accuracy, and with Gregory et al. (2024), who reported that engaging in imagination enhances empathic concern and prosocial motivation. Taken together, these findings position imagination as a cognitive–affective resource rather than a direct mediator, indicating that variability in imaginative ability is associated with both

Table 3 Correlations among autistic Traits, executive Functions, and mental health symptoms ($n = 159$)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. AQ	-																	
2. Social Skills	0.75***	-																
3. Attention Switching	0.58***	0.27***	-															
4. Attention to Detail	0.30***	0.10	0.04	-														
5. Communication	0.73***	0.47***	0.22**	−0.11	-													
6. Imagination	0.66***	0.37***	0.18*	0.03	0.45***	-												
7. DASS-21	0.31***	0.14	0.21**	0.13	0.19*	0.09	-											
8. Stress	0.30***	0.17*	0.22**	0.14	0.20*	0.09	0.93***	-										
9. Anxiety	0.33***	0.12	0.25**	0.14	0.17*	0.11	0.94***	0.82***	-									
10. Depression	0.23**	0.08	0.12	0.11	.16[a]	0.04	0.92***	0.77***	0.80***	-								
11. GAD-7	0.22**	0.09	0.20*	0.11	0.22**	0.04	0.75***	0.69***	0.71***	0.69***	-							
12. PHQ-9	0.22**	0.07	0.20*	0.12	0.21**	0.07	0.76***	0.67***	0.68***	0.76***	0.72***	-						
13. WM Accuracy	0.04	0.03	−0.06	.15[a]	−0.06	0.09	−0.13	−0.10	−0.13	−0.12	−0.13	−0.14	-					
14. WM Errors	0.07	0.01	−0.05	0.17*	0.05	0.03	0.17*	.16[b]	0.18*	0.13	0.19*	0.08	0.15	-				
15. IN Accuracy	0.04	−0.01	0.02	0.12	−0.01	0.00	−0.01	0.01	0.00	−0.02	0.02	−0.01	0.65***	0.54***	-			
16. IN Errors	0.10	0.07	−0.06	0.08	0.05	0.14	0.21**	0.14	0.24**	0.20*	0.15	0.04	−0.03	0.49***	−0.06	-		
17. CF Accuracy	0.12	0.05	0.06	0.09	0.03	0.11	0.03	0.02	0.05	0.00	0.01	0.01	0.52***	0.36***	0.80***	−0.04	-	
18. CF Errors	−0.10	−0.03	−0.09	−0.05	−0.03	−0.10	−0.03	−0.03	−0.06	−0.00	−0.02	0.01	−0.51**	−0.51***	−0.85***	−0.17*	−0.87***	-

Note. AQ = Autism Quotient Total Score; DASS-21 = Depression Anxiety Stress Scale – 21 Total Score; WM Accuracy = Working Memory Accuracy; IN Accuracy = Inhibitory Control Accuracy; CF Accuracy = Cognitive Flexibility Accuracy; *** $p < .001$ ** $p < .01$; * $p < .05$; a = 0.053; b = 0.052

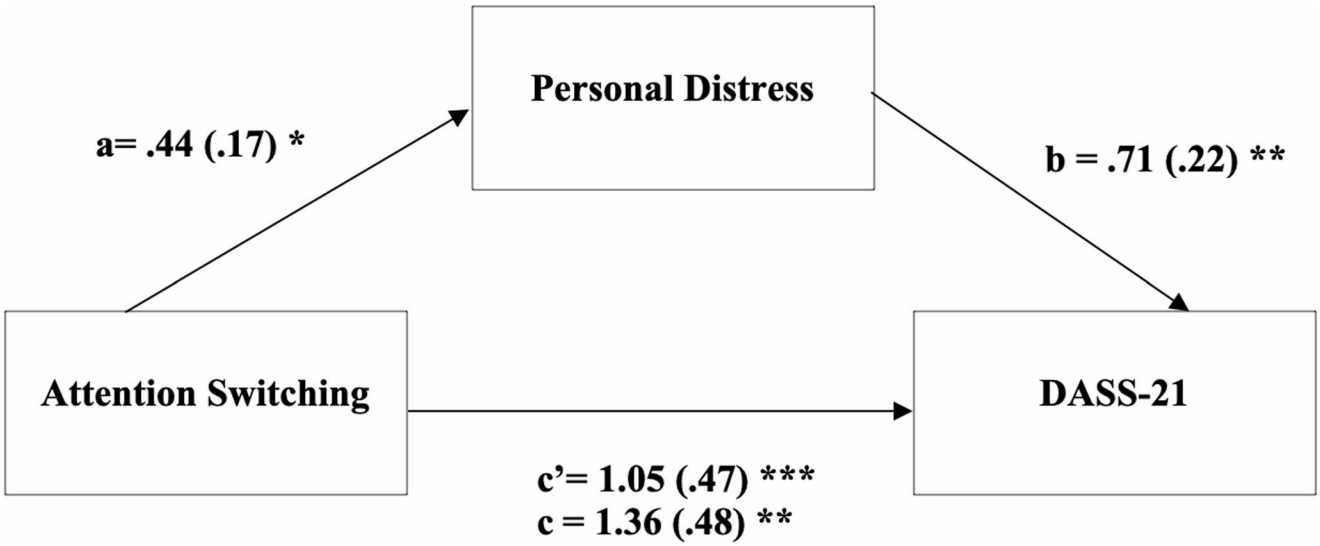

Fig. 1 Mediation Model 1

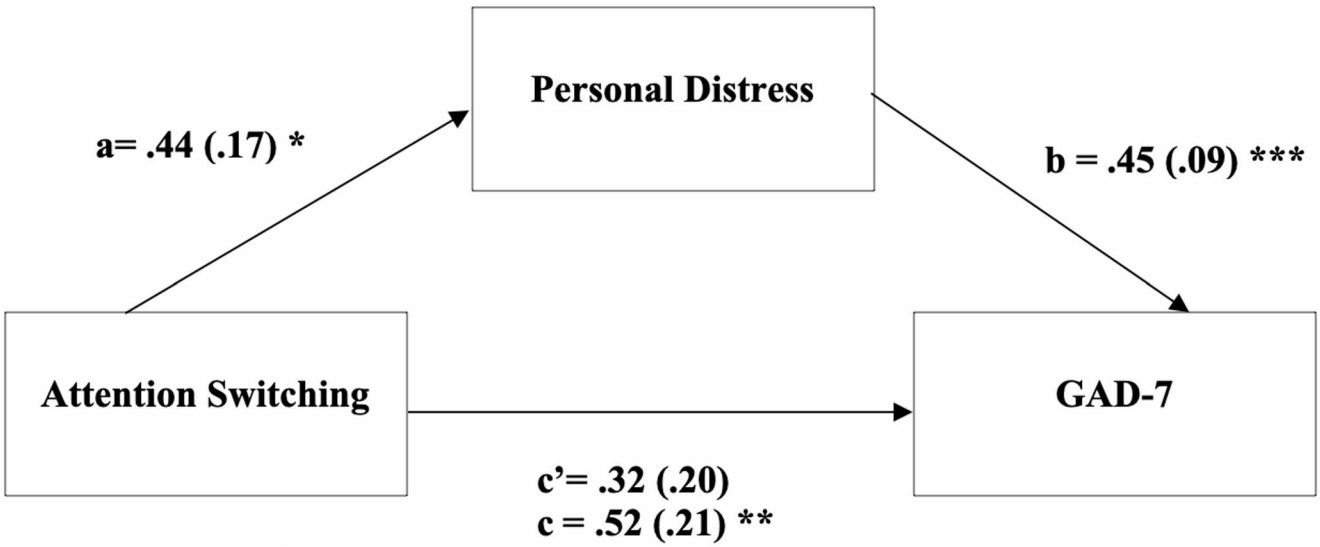

Fig. 2 Mediation Model 2

understanding and emotional engagement with others (Tone and Tully 2014; Zaki 2017).

This study found that higher perspective-taking scores are negatively associated with autistic traits, consistent with previous research (Bos and Stokes 2018; Mazza et al. 2014). Interestingly, other empathy subscales, such as empathic concern and perspective-taking, were not significantly related to internalizing symptoms. This pattern suggests that while affective empathy can heighten vulnerability to distress, cognitive components of empathy may exert protective or neutral effects, consistent with prior work (Gambin and Sharp 2016; Hua et al. 2021). Although both empathic concern and personal distress reflect affective empathy, they differ in orientation and regulation: empathic concern represents other-focused compassion moderated by cognitive control, whereas personal distress indicates self-focused overarousal and poor regulation (Decety and Jackson 2004; Tone and Tully 2014). In Decety and Jackson's (2004) functional model, empathy involves affective sharing, self–other awareness, and regulatory control; when regulation fails, emotional sharing may turn into distress rather than compassion. This distinction may explain why only personal distress mediated the link between attention switching and internalizing symptoms—empathic concern may involve emotional sharing that is better regulated and thus less likely to translate into internalizing vulnerability. Given that empathy might tend to be higher and less variable among females (Baron-Cohen 2002; Christov-Moore et al. 2014), the predominantly female composition of the sample may have resulted in restricted variability on some

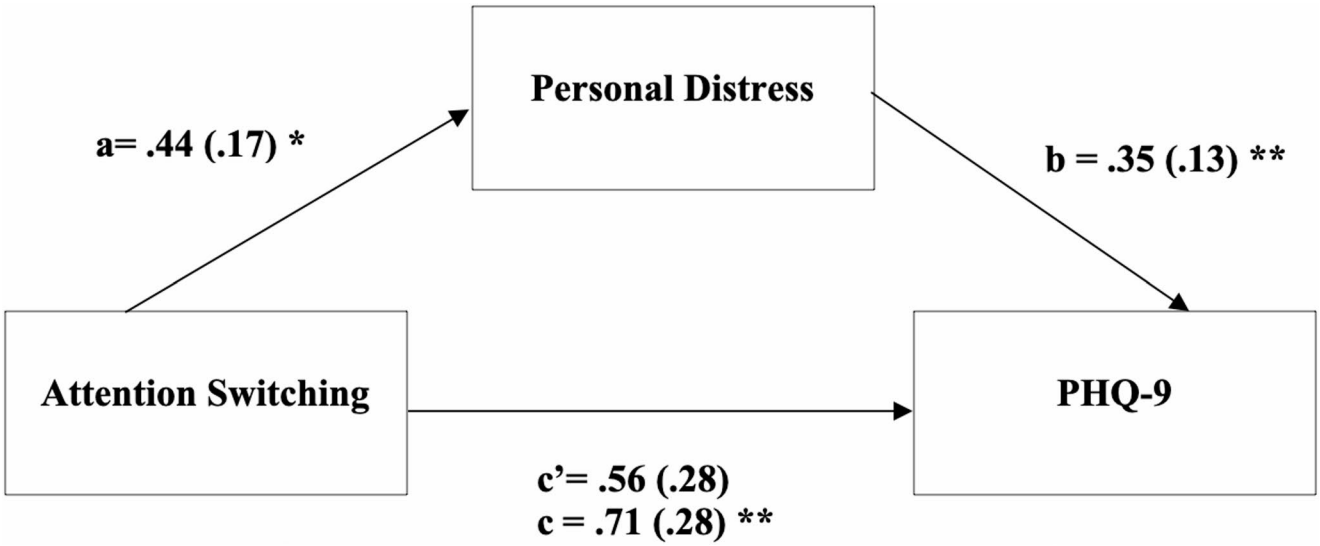

Fig. 3 Mediation Model 3

empathy-related constructs, such as empathic concern or perspective taking. This reduced variability could partly explain why these components did not emerge as significant mediators, whereas personal distress—which captures more self-focus and dysregulated affective responses—showed stronger associations with internalizing symptoms. Moreover, while the Eyes test (a cognitive empathy measure) is negatively associated with mental health symptoms, there was no significant correlation between performance-based tasks and self-reported social cognition. Prior studies report mixed findings on these measures (Grainger et al. 2023; Melchers et al. 2015; Sunahara et al. 2022), likely due to differences in 'state' empathy (measured through tasks) vs. 'trait' and 'perceived skills' empathy (self-reports). While self-report questionnaires are validated in clinical research (Melchers et al. 2015), performance tasks yield variable results (Higgings et al. 2024; Hollocks et al. 2014; Johnston et al. 2008). The present study highlights the importance of combining self-report and performance measures to account for these differences.

Our research found a significant link between WM and attention to detail, consistent with earlier studies highlighting WM challenges in autistic and nonautistic individuals with elevated autistic traits (Demetriou et al. 2018 Gökçen et al. 2016; Hyseni et al. 2019). Autistic traits can be both strengths and challenges; for example, attention to detail may enhance visual WM tasks but not tasks like letter-based n-back or digit span without visual aids (Muth et al. 2014; Nicholls and Stewart 2023; Richmond et al. 2013; Uddin 2022). We also observed a negative relationship between attention to detail and WM performance, alongside positive relationships between mental health symptoms and both attention to detail and WM errors. This pattern aligns with the Attentional Control Theory (Eysenck et al. 2007), which suggests that anxiety may be associated with reduced cognitive control. Although intervention studies have shown that WM training can reduce anxiety and depression (Beloe and Derakshan 2020; Sari et al. 2016), the current findings are correlational and do not imply directionality. Indeed, recent research on attention training also presents promising results for mental health symptoms (Knowles et al. 2016), offering clinical implications for those with autistic traits. These associations may inform future intervention research targeting attentional control and working memory processes in individuals with elevated autistic traits.

Contrary to our expectations, the fewer non-significant relationships observed across autistic traits, EFs, and mental health symptoms contrast with previous studies that suggested individuals with ASD and ADHD exhibit deficits in EFs (Demetriou et al. 2018; Zelazo 2020). One possible explanation could be that our sample included only neurotypical participants, while previous studies focused on neurodiverse samples, such as individuals with ASD and ADHD. Similar findings have been observed in previous studies that found no significant relationship between autistic traits in neurotypical samples and EFs tasks (Kunihira et al. 2006; Landry and Al-Taei 2016; Maes et al. 2013). Therefore, it is possible that although elevated autistic traits may be observed in neurotypical participants, it is not sufficient to conclude that there is a deficiency in EF tasks in general.

An alternative explanation for the lack of significant correlations across autistic traits, mental health symptoms, and EF tasks could be the absence of emotional involvement in EF tasks. We observed the significant relationship between attention switching and attention to detail and EFs, which

involve more cognitive aspects of ASD. Previous research suggests that EF tasks mainly focus on cognitive aspects and do not consider real-world tasks involving emotional contexts (Petersen and Welsh 2014; Zelazo and Carlson 2012). Many studies indicate that "hot" EFs involve processes related to reward, emotion, and motivation, while "cool" EFs include cognitive functions in non-affective contexts (Salehijenad et al. 2021; Zelazo and Carlson 2012). Additionally, "hot" EFs are closely associated with social skills, emotion regulation, and mood disorders (Bernabei et al. 2018; Tsermenstseli and Poland 2016). For example, De Vries and Geurts (2012) found that children with ASD struggle more with emotional tasks than with ecologically valid set-shifting tasks. Thus, autistic traits and mental health symptoms are more closely linked to emotional regulation skills and socio-communication deficits. It is also important to note that the executive function tasks used in this study primarily assessed 'cool' cognitive processes, which involve abstract, non-affective reasoning. These findings now provide the basis for future research to incorporate 'hot' EF tasks—those engaging affective and motivational components—which may reveal stronger associations with internalizing symptoms, given the emotional nature of the outcomes examined here.

Limitations and future studies

The study may have some potential limitations that should be considered. First, it may be beneficial to include self-report measures of EFs, such as the Behavior Rating Inventory of Executive Function (BRIEF; Giola et al. 2002), in addition to performance tasks. This approach may provide a more comprehensive understanding of EF skills in daily life situations because recent studies have suggested that integrating self-report EF measures alongside performance tasks could enhance the translation of EF skills into real-world scenarios (Snyder et al. 2021; van Aken et al. 2023). Unfortunately, no Turkish version of BRIEF is currently available. Future studies may also focus on adapting self-report measures of EFs. Furthermore, it would be valuable to explore the roles of both 'cool' (cognitive) and 'hot' (affective) EFs in relation to mental health, as the literature on these variables is currently limited (Petersen and Welsh 2014; Zelazo and Carlson 2012). In addition, it should be acknowledged that single-session performance-based EF tasks often show modest internal consistency and limited temporal stability (Hedge et al. 2018), which may have reduced the significance of some observed EF effects. Employing multiple-session or latent-variable approaches in future studies could strengthen reliability and construct validity. This comprehensive approach could contribute to a deeper understanding of the impact of EFs and mental health outcomes. Moreover, given that gender differences are well-documented in empathy and emotion regulation (Baron-Cohen 2002; Christov-Moore et al. 2014), as expected, the sample was predominantly female (88.7%), which may limit the generalizability of the findings. Future studies may recruit more gender-balanced samples or include gender as a moderator to examine potential interaction effects. Finally, while our investigation focused on autistic traits in neurotypical participants, it should be acknowledged that the findings may not be directly applicable to neurodiverse samples, such as individuals diagnosed with ASD. Thus, future research could replicate findings across both neurodiverse and neurotypical samples to enhance the generalizability and robustness of the results.

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Author contributions Conceptualization: DS; Methodology: DS and TRJ; Formal analysis and investigation: DS; Writing - original draft preparation: DS; Writing - review and editing: DS and TRJ; Supervision: TRJ.

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Data availability The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Declarations

Conflict of Interest The authors have no competing interests to declare that are relevant to the content of this article.

Ethics approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Approval for this study was granted by the Ethical Committee of Ibn Haldun University (No. E-71395021-050.06.04-34359).

Informed consent and Consent to Participate was obtained from all individual participants included in the study. All participants confirmed they participated voluntarily.

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