Journal of Autism and Developmental Disorders
https://doi.org/10.1007/s10803-023-06190-5

ORIGINAL PAPER

The Relationship Between Social Skills and Sensory Profile, Emotion Regulation, and Empathizing/Systemizing in Adolescents on the Autism Spectrum

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Accepted: 9 November 2023

Abstract

This study aims to evaluate the relationship between social skills and sensory features, emotion regulation, and empathy in adolescents on the autism spectrum. One hundred and twenty-three adolescents were included in the study (50 autistic, 73 typically developing-TD adolescents). The participants filled out the Adolescent/Adult Sensory Profile (AASP) and Emotion Regulation Questionnaire. Parents of the participants completed the Child Empathy and Systemizing Quotient (EQ-C/SQ-C) and Autism-Social Skills Profile (ASSP) scales. Social reciprocity, social participation/avoidance, ASSP total scores, empathy and systemizing scores were lower, and detrimental social behaviors, low registration sensory profile scores were higher in the autism spectrum group. While a difference between genders was observed in sensory sensitivity, sensation avoiding, low registration quadrants and empathy scores, no gender and group interaction was found in any domain. Social skill total scores were correlated to sensation seeking and low registration sensory features, empathy, systemizing, and reappraisal emotion regulation scores. A hierarchical multiple linear regression analysis was conducted controlling for group and gender, sensation seeking ($p = .032$, $\beta = 0.138$), low registration ($p = .012$, $\beta = -0.215$) of the AASP, and empathy ($p < .001$, $\beta = 0.555$) and systemizing ($p = .033$, $\beta = 0.138$) scores of the EQ/SQ-C was found to significantly predict social skill total scores. Although emotional regulation strategies may play a role, sensory processing features and empathy and systemizing skills seem to be the more significant contributors to social skills during adolescence. Interventions targeting sensory processing and especially improving empathy and systematization skills may positively affect social skills in adolescents on the autism spectrum.

Keywords Autism spectrum disorder · Social skills · Emotion regulation · Sensory processing · Empathy · Systemizing

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Introduction

Difficulties in social interaction and communication skills on the autism spectrum are evident from an early age. These difficulties can lead to challenges in the long term despite an intellectual level in the average range. Adolescence is the period when social relations with peers hold significant importance. During this period, adolescents highly value their friendships and seek trust, solidarity, and social support from their peers (Goel et al., 2018). Unfortunately, the ability to decipher social cues and subtleties of social communication is often challenging for autistic adolescents; particularly for those with poorer functional independence and greater impairment in social skills (Laugeson et al., 2012; Orsmond et al., 2004). Social responsiveness difficulties and poor social skills also affect mental health and are associated

Published online: 20 December 2023

with emotional symptoms, peer problems, conduct problems, and hyperactivity in autistic children (Ratcliffe et al., 2015). Social difficulties are important to predict employment as well as mental health and social interaction in autistic individuals (Chen et al., 2015). In a study conducted with high school leavers with autism, higher social skills were found to be significantly associated with increases in employment (Chiang et al., 2013).

In addition to challenges in social communication and social interaction, differences in sensory features (hyper- or hypo-reactivity to sensory inputs or unusual interest in sensory aspects of the environment) are also present in many individuals on the spectrum (Schaaf et al., 2023). As much as 95% of the children and adults on the autism spectrum have been reported to have atypical sensory processing in samples from the United States and the United Kingdom. (Lane et al., 2012). In a recent editorial (Schaaf et al., 2023) it was stated that most (over 70%) of children on the autism spectrum have sensory features that span a broad range of types, sensory modalities, and patterns (Kirby et al., 2022; Lane et al., 2022; Schaaf et al., 2023). Lane et al. (2022) reported that 6–12-year-olds and females displayed the most sensory over-responding symptoms.

Sensory processing differences in autistic children have been associated with limited adaptive performance, routine daily activities, nutrition, and sleep (Dellapiazza et al., 2018; Dunn et al., 2016; Mazurek et al., 2013; Mazurek & Petroski, 2015). These sensory features are also linked to restrictive and repetitive behaviors and decreased social functionality (Ben-Sasson et al., 2019). As such, difficulty in processing or integrating sensory information, can also potentially affect many domains of physical and mental health across the lifespan (Leader et al., 2021; Schaaf et al., 2023; Verhulst et al., 2022) These atypical patterns of sensory responsiveness have been reported for stimuli presented in several sensory modalities such as vision, hearing, and touch (Feldman et al., 2019; Robertson & Baron-Cohen, 2017). In addition to the sensory processing features, sensory modalities and multisensory processing is likely to be altered in autism spectrum, given that many of the multisensory differences observed in autism go beyond what would be predicted by the individual sensory performance (Baum et al., 2015; Robertson & Baron-Cohen, 2017). Basic sensory stimuli processing and integration of multisensory stimuli are essential for perceiving complex social information (Thye et al., 2018). Alterations in basic sensory integration have been reported in autism (Waterhouse et al., 1996), with evidence of abnormal integration of auditory and visual stimuli (Foss-Feig et al., 2010; Stevenson et al., 2014). Autistic individuals benefit less from adding auditory information to a visual search task (Collignon et al., 2013), showing decreased multisensory facilitation to audiovisual inputs (Brandwein et al., 2013). There is evidence that sensory dysregulation arises early in the progression of autism spectrum conditions (ASC) and impacts social functioning (Thye et al., 2018). In a study involving autistic children without intellectual disability, ages 6 to 10, atypical multisensory responsiveness and proximal senses of oral sensory, olfactory, and touch modalities were reported to be the strongest predictors of social impairments (Hilton et al., 2010).

Another area of interest in understanding social challenges encountered on the autism spectrum is emotion regulation. The capacity to monitor, evaluate and change (increase or decrease) a person's emotional state to achieve a goal defines emotion regulation, and includes both internal and external processes. Intrinsic emotion regulation refers to an individual's ability to regulate emotions (e.g., using strategies such as self-soothing and self-talk). In contrast, extrinsic emotion regulation relates to situations in which an individual attempts to regulate the emotions of others (Gross, 2013). Autistic children and youth are reported to have difficulties in labeling, understanding, expressing, and controlling their emotions (Mazefsky et al., 2013). Although the link between emotion dysregulation and behavioral problems is intuitively understood, there is little research providing empirical evidence on this subject with better emotion regulation predicting better social skills in autistic children (Berkovits et al., 2017; Reyes et al., 2020).

Another concept that may underlie difficulties in social interactions is the empathizing and systemizing theory put forward by Baron-Cohen to explain the cognitive preferences/diversities in autism (Baron-Cohen, 2009, 2010). This theory attempts to explain neurobiological differences brought on by sex in an empathizing and systemizing spectrum, also building a bridge between this theory and the extreme male brain (EMB) theory. The empathizing-systemizing theory posits that females are more prone to empathizing, which could be defined as attributing mental states to others and responding accordingly, while males are more inclined to systemize, thinking in a more systematic way to organize the world around them. According to the E–S theory, communication and social difficulties observed in autistic individuals without intellectual disability (ID) could be explained by their inclination to systemize rather than empathize. Empathy skills are associated with social-communicative functioning both in autistic individuals and the general population. (Baron-Cohen, 2009; Baron-Cohen et al., 2003; Baron-Cohen & Wheelwright, 2004) However, there are also studies reporting null associations between empathizing and social-communicative functioning difficulties in autistic children without ID (Wang et al., 2019). On the other hand, contrary to EMB theory, Åkerlund et al. (2022) discussed the extreme female brain theory associated with female advantage in social communication in a typically developing population, especially focusing on the role of audio-visual temporal processing for effective

communication. In literature, TD females have shown an auditory acuity/processing advantage (Thornton et al., 2019), and auditory acuity has been associated with speech comprehension as well as the development of language and social communication (Ayasse et al., 2019; Lee et al., 2018). Lai et al. (2017) found that a better signal-detection ability was seen in autistic adults without ID using camouflaging strategies. Åkerlund et al. (2022) concluded that a female unisensory processing advantage in ASC could very well explain the male predominance, however, "the social difficulties related to multisensory processing indicate that ASC females might be struggling as hard as males in more complex settings." Although the results of studies about sensory features between autistic males and females are mixed, Asaridou et al. (2022) suggested the possibility that sensory features could be used as sex-indifferent markers of autism. In support of this notion, a meta-analysis that included 4606 autistic individuals reported that sex was not a significant moderator of sensory features in autism (Ben-Sasson et al., 2019).

The relationship between sensory processes, social cognition, empathy, and emotional and behavioral processes is quite intricate. In a recent review, altered sensory integration in autism and schizophrenia could be associated with deficits of empathy as well as social impairments (Tordjman et al., 2019). To account for this complex relationship, we hypothesized that (a) social skills, sensory profiles, emotion regulation strategies and empathizing-systemizing skills would be different for autistic and typically developing adolescents and (b) that social skills could be affected by these differences in sensory profiles, emotion regulation, empathy and systemizing abilities. The study aims to investigate the contributions of sensory profile characteristics, emotion regulation, and empathizing-systemizing qualities of adolescents on the ASC in an effort to define the complex construct of social skills in this population and determine the factors that may guide future interventions.

Methods

Participants

We included a total of 123 participants (n = 50 autistic adolescents, n = 73 typically developing adolescents (TD)) aged between 11 and 18 years in the study. The inclusion criteria for the ASC group were as follows, being in the predefined age range of 11–18 years, meeting the K-SADS-PL-DSM-5 criteria for the autism spectrum disorder during the interview and the exclusion criteria included having a comorbid genetic or neurological condition, including a history of head trauma or epilepsy and having a WISC-R score of FSIQ lower than 80. Adolescents on the autism spectrum without ID, determined with a WISC-R score of full-scale IQ (FSIQ) greater than 80, were recruited from Ege University School of Medicine Child and Adolescent Psychiatry Department Developmental Disabilities and Autism outpatient clinic. Ege University Medical Faculty Hospital is located in Izmir, the third largest city in western Turkey with a population of 4.7 million people. It is a tertiary health care center, that also admits patients referred from other hospitals. We aimed to define the characteristics of autistic adolescents without ID and participating adolescents had to be able to follow instructions during the interview, understand the questions, and provide adequate answers for the Adolescent/Adult Sensory Profile and Emotion Regulation Questionnaire. The recent consensus statement released by the American Academy of Clinical Neuropsychology characterizes the full-scale intellectual quotient (FSIQ) between 80 and 89 as low average (Guilmette et al., 2020). For this reason, autistic adolescents with FSIQ scores corresponding to at least low-average and above in WISC-R were included in the study.

TD adolescents were recruited through social media advertisements as age-matched controls with no psychiatric history or complaints. For the TD group, 11–18 years old adolescents willing to participate in the study were included. Participants with a prominent delay in physical, cognitive or social milestones, with a previous psychiatric disorder or a history of psychotropic medication use, as assessed with K-SADS-PL-DSM-5 during the interview were excluded.

Ethical approval for the study was obtained from the Ege University Clinical Research Ethical Committee (date:28.09.2021 no:21-9.1T/6 and 21-9.1T/7). All participants were informed about the study in accordance with the Declaration of Helsinki. Written informed consent was obtained from the the parents before the study.

Materials

Schedule for Affective Disorders and Schizophrenia for School-Aged Children, Present and Lifetime Version-DSM-5 (K-SADS-PL-DSM-5)

The K-SADS-PL is a semi-structured interview to determine psychopathology in children and adolescents aged 6–18, according to the DSM-5 criteria (Kaufman et al., 1997). It is a comprehensive semistructured interview in which both the child and their caregiver are interviewed separately. The instrument is divided into two sections following the field in which demographic and developmental data are recorded: a screening interview and a diagnostic supplement for psychiatric disorders including autism spectrum disorder. The information obtained from both the child and the caregiver is coded separately and each section has a preestablished cut-off for a positive screen. A positive diagnostic screen

is followed by the appropriate diagnostic supplement to establish the diagnosis. The validity score was reported between 0.458 and 0.833; the test-retest reliability score was between 0.783 and 1.00, and the interrater reliability score was between 0.625 and 0.875 for the Turkish version. The consistency of diagnoses (κ = 0.92–1.0) and test-retest reliability were almost perfect for autism spectrum disorder (κ = 0.82) (Gökler et al., 2004; Ünal et al., 2019).

Wechsler Intelligence Scale for Children-Revised (WISC-R)

The WISC-R is a standardized intelligence test developed by Wechsler (Wechsler, 1991) for children. The test comprises 12 subtests, from which Verbal Intelligent Quotient (VIQ) and performance IQ (PIQ) scores are calculated. FSIQ is calculated by summing VIQ and PIQ scores. The Turkish adaptation was reliable, with Cronbach's alphas of 0.97 for VIQ, 0.93 for PIQ, and 0.97 for TIQ (Savaşır & Şahin, 1995). Autistic adolescents with FSIQ scores greater than 80 were included in our study.

Autism Social Skills Profile (Autism SSP)

Autism Social Skills Profile is a parent-report questionnaire to delineate the social skill difficulties experienced by autistic children and to develop appropriate intervention programs (Bellini & Hopf, 2007). In addition to social reciprocity and communication initiation skills, information on defects in taking the perspective of others and non-verbal communication skills can also be obtained with the scale. Forty-five items in Autism SSP are grouped under three factors: "Social Reciprocity, Social Participation/Avoidance, and Detrimental Social Behavior" in the original scale. High scores from Autism SSP indicate proficiency in prosocial behaviors and social functions, and low scores indicate insufficient social functions. Turkish adaptation study of the scale was conducted by Demir and Sucuoğlu (Demir & Sucuoğlu, 2009). In the Turkish version of the scale, there are 41 items and 3 sub-dimensions, as was in the original study. Each item is scored on a 4-point Likert-type scale, and higher total scores correspond to better social skills. The Cronbach's alpha coefficient of the total scale score was found 0.84; for sub-dimensions 0.91, 0.91, 0.78.

Child Empathy and Systemizing Quotient (C-EQ/SQ)

The EQ-C/SQ-C is a parent report questionnaire, developed by combining EQ-C and SQ-C, designed for adults and later adapted for use in children and adolescent populations (Auyeung et al., 2009; Baron-Cohen et al., 2003; Baron-Cohen & Wheelwright, 2004; Lawrence et al., 2004). There are 55 items, including 27 items in the EQ-C and 28 items in the SQ-C. Higher total scores of the EQ-C and SQ-C indicate stronger empathy and systemizing traits. In the Turkish adaptation study, results of the reliability analysis show that the Cronbach's alpha value for the "Emotional Empathy Subfactor" is 0.752, for the "Cognitive Empathy Subfactor" 0.721, for the "Systematizing" quotient 0.752 and the internal consistency coefficient is high for children (Girli et al., 2017).

Emotion Regulation Questionnaire (ERQ)

ERQ, developed by Gross & John, 2003, is a self-report questionnaire to evaluate two main strategies used in emotion regulation: Cognitive reappraisal and expressive suppression. Cognitive reappraisal is the attempt to reinterpret an emotion-eliciting situation in a way that alters its meaning and changes its emotional impact (Gross & John, 2003). On the other hand, expressive suppression involves reducing the outward expression of emotions. Cognitive reappraisal is measured with six items and suppression with four items. Confirmatory factor analyzes of the ERQ-Turkish version successfully revealed the original two-factor structure. The internal consistencies were 0.78 for the reappraisal and 0.73 for the suppression subscales. Test-retest reliabilities were 0.74 for the reappraisal and 0.72 for the suppression subscales (Eldeleklioğlu & Eroğlu, 2015).

Adolescent/Adult Sensory Profile (AASP)

AASP is a standardized test consisting of 60 items and evaluating six sensory modalities and the response to different sensory stimuli (Brown & Dunn, 2002). It considers taste/smell, movement, visual, tactile, auditory development, and activity level. It is used for adolescents aged eleven and above and adults. It consists of four quadrants based on Dunn's Sensory Processing Theory (Brown & Dunn, 2002). These are low registration, sensory sensitivity, sensation avoiding, and sensation seeking. Evaluation is made according to the norm values created in 3 different age ranges for 11–18, 18–65, and over 65 years old. Adaptation of the questionnaire to Turkish and retests in reliability analyses showed a statistically significant positive correlation ($p < .001$). The internal consistency and test–retest reliability was found to be high ($r = .66$–0.82 and $r = .67$–0.82, respectively) (Üçgül et al., 2017).

Procedure

The participants in the ASC group, were informed and invited to the study during their routine outpatient follow-up visit. All interviews were carried out in a two-step fashion as follows: In the first stage, all adolescents who consented to participate were interviewed with K-SADS-PL-DSM-5, which is a semi-structured interview that comprehensively

assesses a variety of psychiatric disorders including ASC; to review the extent to which the present symptoms of the participants meet the DSM-5 ASC diagnostic criteria and to confirm the diagnosis. Later on, in the second stage, the diagnoses were confirmed by the senior member (SK) with nearly 20 years of experience in the field working with autistic individuals with a non-structured clinical interview based on DSM-5 criteria. Turkish adaptations of Autism Diagnostic Interview-Revised (ADI-R; Lord et al., 1994) and Autism Diagnostic Observation Schedule (ADOS; Lord et al., 1994) are not yet available. As such diagnostic evaluation for ASC depends on clinical judgment, as clinical assessment by experienced clinicians is considered to be the "gold standard" for autism diagnosis (Chlebowski et al., 2010; Klin et al., 2000; Spitzer & Siegel, 1990) guided by the DSM-5 criteria, which K-SADS-PL is based on. K-SADS-PL was validated specifically for neurodevelopmental disorders including autism spectrum disorder, in a recent study including 95 Japanese children with a mean age of 11 (Nishiyama et al., 2020). The ASC group also had completed the WISC-R to appraise their intellectual level.

Adolescents comprising the TD group were also interviewed with K-SADS-PL-DSM-5 to diagnose potential psychiatric disorders. Adolescents without a history of developmental delay, grade retention, academic failure, or psychiatric diagnoses as determined by K-SADS-PL were recruited as age-matched controls.

The participating adolescents were asked to complete the ERQ and the AASP, and their parents the C-EQ/SQ and the Autism SSP, in this order.

Statistical Analysis

Windows IBM SPSS v.25.0 was used for statistical analysis. Pearson chi-square test was utilized to assess for gender differences and Mann Whitney-U to assess differences in age between ASC and TD groups. Exploratory correlation analyses were conducted to assess the relationship between Autism SSP and AASP, ERQ, and C-EQ/SQ. In the ASC group, participant age, FSIQ, and social reciprocity subscale scores of the SSP had nonnormal distributions. Similarly, in the TD group, participant age, sensation seeking quadrant scores on the AASP, and EQ scores also had nonnormal distributions. As such, Spearman's rho was used in place of Pearson correlation to explore the relationship between these variables. The association of the aforementioned variables was instead tested with Spearman's rho. After assumption testing which included verifying the residuals of the variables tested were normally distributed, a two-way analysis of variance (ANOVA) was conducted to assess group (ASD vs. TD) and gender (male vs. female) differences between Autism SSP, ERQ, Child EQ/SQ, AASP, and all respective subscales and quadrants with post-hoc power analysis for all variables tested. Bonferroni correction was applied to account for multiple testing and the corrected p-values are reported. The relationship between the dependent Autism SSP total scores and ERQ subscales (cognitive reappraisal and expressive suppression mean scores), C-EQ/SQ scores, AASP quadrant scores (sensory sensitivity, sensation seeking, sensation avoiding, low registration) was analyzed via a multiple hierarchical regression analysis controlling for group and gender.

Results

Demographic Characteristics

The study included 50 autistic (12 girls, 38 boys; mean age 14.1 ± 2.2 years) and 73 TD adolescents (38 girls, 35 boys; mean age: 14.6 ± 2.6 years). The mean FSIQ scores of the autistic participants were 98.02 ± 15.24. While no difference was found between the ages of the participants in the two groups ($p = .232$), male predominance was observed in the ASC group ($p = .002$). Of the 12 girls and 38 boys in the ASC group, 9 (75%) and 36 (94.7%) had at least one comorbid psychiatric condition as determined by K-SADS-PL.

Comparison of Scale and Subscale Scores

Two-way ANOVA with gender (male vs. female) and group (ASC vs. TD) as between-subjects factors revealed a significant group effect on Autism SSP total scale scores $F(1,119) = 37.187$, $p < .001$, $\eta_p^2 = .238$ and subscale scores of social reciprocity $F(1,119) = 20.264$, $p < .001$, $\eta_p^2 = .146$, social participation/avoidance $F(1,119) = 25.074$, $p < .001$, $\eta_p^2 = .174$, detrimental social behaviors $F(1,119) = 39.157$, $p < .001$, $\eta_p^2 = .248$; EQ-C ($F(1,119) = 40.846$, $p < .001$, $\eta_p^2 = .256$) and SQ-C ($F(1,119) = 9.819$, $p = .004$, $\eta_p^2 = .076$) scores; as well as AASP low registration quadrant scores $F(1,119) = 6.497$, $p = .048$, $\eta_p^2 = 0.52$; indicating significant social skill impairment, weaker empathizing and systematizing traits and higher sensory atypicality in the form of low registration in ASC compared to TD. No group effect was found in the ERQ subscales and the AASP sensory sensitivity, sensation seeking, and sensation avoidance quadrant scores. A significant gender effect was observed for sensory sensitivity $F(1,119) = 9.786$, $p = .009$, $\eta_p^2 = 0.76$ sensation avoidance $F(1,119) = 8.428$, $p = .017$, $\eta_p^2 = 0.66$ and low registration quadrants $F(1,119) = 13.934$, $p = .001$, $\eta_p^2 = .105$ as well as for EQ-C $F(1,119) = 6.853$, $p = .020$, $\eta_p^2 = .054$ with females' mean scores being higher than males', indicating stronger empathizing traits, higher sensory sensitivity, sensation avoidance and low registration features in females. There was no gender effect in sensation-seeking quadrant of the AASP, SQ-C, and Autism SSP and ERQ scale and

subscale scores. No group/gender interaction was detected for any scale. The total and subscale scores of ASC and TD children are reported in Table 1.

Exploratory Correlation Analyses

Sensory Profile and Autism Social Skills Profile

In the ASC group, the seeking quadrant scores of AASP showed a moderate positive correlation to total Social Skills Profile scores ($r = .35$, $p = .014$) as well as social reciprocity ($r = .42$, $p = .003$) and social participation/avoidance ($r = .33$, $p = .020$) subscales. In contrast, low registration quadrant scores of AASP scores were inversely correlated with total Social Skills Profile scores (r=.-39, $p = .005$), social reciprocity ($r = -.36$, $p = .011$), and social participation/avoidance ($r = -.32$, $p = .025$) scores. However, a moderate positive correlation was observed between low registration quadrant scores of AASP and detrimental social behavior subscale scores of Autism SSP($r = .34$, $p = .015$).

For the TD group, all AASP quadrants i.e. sensory sensitivity ($r = .36$, $p = .002$), sensation seeking ($r = .25$, $p = .033$), sensation avoiding ($r = .40$, $p < .001$) and low registration ($r = .42$, $p < .001$) were found to be correlated with the detrimental social behavior subscale of the Autism SSP. However, no correlation was found between the quadrant scores and total Autism SSP scores ($p > .05$).

Emotion Regulation Questionnaire and Autism Social Skills Profile

Cognitive reappraisal of the ERQ correlated positively to total Autism SSP scores (r = .29, p = .039) and negatively to detrimental social behavior scores subscale of Autism SSP ($r = -.31$, $p = .031$), while expressive suppression only correlated with social participation/avoidance subscale of the Autism SSP ($r = .31$, $p = .030$) in the ASC group. Emotion regulation strategies of cognitive reappraisal and expressive suppression subscores were not found to be correlated with Social Skills profile total or subscale scores in the TD group ($p > .05$).

Empathy-Systemizing Quotient and Autism Social Skills Profile

EQ-C was correlated with all subscales and total Autism SSP scores in the ASC group. While the EQ-C was positively correlated to social reciprocity ($r = .59$, $p < .001$), social participation/avoidance ($r = .71$, $p < .001$) and total scores ($r = .71$, $p < .001$), it showed a moderate negative correlation to detrimental social behavior scores (r =-.50, $p < .001$). In contrast, SQ-C scores were only found to be correlated with the social participation/avoidance subscale ($r = .32$, $p = .022$) and total scores ($r = .29$, $p = .041$) in the ASC group.

EQ-C was correlated with Autism SSP total and all subscale scores in the TD group as well. EQ-C correlated positively with social reciprocity ($r = .52$, $p < .001$), social participation/avoidance ($r = .44$, $p < .001$), and total Autism SSP scores ($r = .56$, $p < .001$), it showed a moderate negative correlation to detrimental social behavior scores ($r = -.41$, $p < .001$), similar to the relationship observed in the ASC group. In the TD group, SQ-C scores also showed a significant positive correlation to social reciprocity, $r = .42$, $p < .001$), social participation/avoidance ($r = .36$, $p = .002$), and total social skills scores ($r = .41$, $p < .001$) in the Autism SSP while no significant correlation was observed between SQ-C and detrimental social behavior subscale scores of the Autism SSP. The relationship between the Autism SSP and AASP, ERQ, and EQ/SQ-C scores of autistic and typically developing adolescents are presented in Table 2.

Further exploratory correlation analysis regarding the relationship between age, FSIQ, AASP, ERQ and EQ/SQ-C scores in the ASC group revealed a positive correlation between AASP sensory sensitivity and sensation avoiding ($r = .76$, $p < .001$) and low registration ($r = .52$, $p < .001$); AASP sensation seeking quadrant and ERQ cognitive reappraisal subscale scores ($r = .42$, $p = .003$), ERQ emotion suppression subscale scores ($r = .33$, $p = .018$) and empathy quotient ($r = .30$, $p = .038$); AASP sensation avoiding and low registration quadrants ($r = .60$, $p < .001$). Cognitive reappraisal and emotion suppression mean scores of the ERQ were also found to be correlated ($r = .51$, $p < .001$), as well as empathy and systemizing quotients ($r = .48$, $p < .001$). FSIQ and age variables were not found to be correlated to any of the sensory quadrants, emotion regulation strategies, or empathy/systemizing quotients ($p > .05$). Table 3.

After a hierarchical multiple linear regression analysis was conducted ($F(10,112) = 21.571$, $p < .001$, $R^2 = 0.658$, Adjusted $R^2 = 0.628$) controlling for group (ASC vs. TD) and gender (male vs. female), the relationship between Autism SSP total scores and AASP sensation seeking (p = .032, $\beta = 0.138$), AASP low registration quadrants (p = .012, β=-0.215), EQ-C ($p < .001$, $\beta = 0.555$) and SQ-C (p = .033, $\beta = 0.138$) remained significant. Psychiatric comorbidity variable was not included in the regression analysis as it was highly multicollinear with the group variable (r = .918, $p < .001$). Results of the Multiple Linear Regression Analysis are shown in Table 4.

Table 1 The two-way analysis of variance (ANOVA) of total and subscale scores between the ASC and TD groups (between-subjects) with gender effect, group effects and group-gender interactions of Autism Social Skills Profile (ASSP) total and subscale scores and age, Adolescent/Adult Sensory Profile (AASP) quadrant scores, Emotion Regulation Questionnaire (ERQ) subscale mean scores, EQ/SQ-C scores

	ASC ($n=50$)				TD ($n=73$)				Group effect		Gender effect		Group × Gender interaction		
	Male ($n=38$)		Female ($n=12$)		Male ($n=35$)		Female ($n=38$)		F	*p*	F	*p*	F	*p*	Observed power
	M	*SD*	M	SD	M	SD	M	SD							
Autism Social Skills Profile															
Social Reciprocity	38.82	8.49	39.92	9.12	44.4	6.95	48.42	7.08	20.264	$<0.001^{***}$	2.678	0.104	0.871	0.353	0.999
Participation/Avoidance	35.87	9.42	34.83	8.71	43.29	8.02	44.53	7.60	25.074	$<0.001^{***}$	0.004	0.952	0.444	0.507	0.997
Detrimental Social Behavior	26.63	6.03	26.67	5.25	20.91	4.16	20.63	2.92	39.157	$<0.001^{***}$	0.017	0.895	0.029	0.866	1.000
Social Skills Total	48.05	20.30	48.08	21.61	66.77	14.65	72.32	14.89	37.187	$<0.001^{***}$	0.627	0.430	0.613	0.435	1.000
Sensory Profile-AASP															
Sensory Sensitivity	36.68	8.65	42.42	10.71	34.17	7.33	39.71	9.77	2.098	0.150	9.786	0.009^{**}	0.003	0.957	0.800
Sensation Seeking	41.05	8.55	43.75	5.17	41.11	8.68	46.03	5.80	0.581	0.447	6.154	0.058	0.521	0.472	0.784
Sensation Avoiding	37.39	9.34	42.50	11.23	36.03	8.10	41.34	8.16	0.495	0.483	8.428	0.017^{*}	0.003	0.954	0.727
Low Registration	31.97	8.22	38.17	10.03	28.11	6.66	33.87	7.87	6.497	0.048^{*}	13.934	0.001^{**}*	0.019	0.891	0.952
ERQ Mean Scores															
Cognitive Reappraisal	3.73	1.16	3.40	1.14	3.92	0.87	3.80	0.79	2.259	0.135	1.325	0.252	0.264	0.608	0.243
Expressive Suppression	3.45	1.14	3.06	1.29	3.29	1.21	3.22	1.10	0.000	0.988	0.926	0.338	0.450	0.504	0.135
EQ/SQ															
Empathy	26.26	8.03	29.00	8.99	34.89	7.76	40.32	6.81	40.846	$<0.001^{***}$	6.853	0.020^{*}	0.390	0.390	1.000
Systemizing	25.63	6.52	25.25	9.10	29.11	8.54	31.45	7.24	9.819	0.004^{**}	0.399	0.529	0.381	0.381	0.872

* $p<.05$; ** $p<.01$; ***$p<.001$

Table 2 The relationship between Autism Social Skills Profile total and subscale scores and age, Adolescent/Adult Sensory Profile (AASP) quadrant scores, Emotion Regulation Questionnaire (ERQ) subscale mean scores, EQ/SQ-C scores in ASC and TD groups

	ASC ($n=50$)				TD ($n=73$)			
	Social reciprocity	Participation/ Avoidance	Detrimental social behavior	Social skills total	Social reciprocity	Participation/ Avoidance	Detrimental social behavior	Social skills total
Age	0.07	−0.063	−0.022	−0.011	0.016	0.141	− 0.01	0.09
FSIQ	0.038	0.062	0.002	0.055	–	–	–	–
Sensory profile (AASP)								
Sensory sensitivity	−0.176	−0.183	0.188	− 0.21	0.106	0.165	**0.358****	0.054
Sensation seeking	**0.415****	**0.327***	−0.087	**0.347***	0.123	0.002	**0.250***	0.013
Sensation avoiding	−0.106	−0.009	0.049	−0.063	0.104	0.106	**0.400****	0.017
Low registration	**0.356***	**0.318***	**0.342***	**0.390****	−0.127	−0.098	**0.423****	−0.223
ERQ								
Reappraisal	0.218	0.256	−0.306	**0.293***	0.174	0.117	−0.156	0.164
Suppression	0.133	**0.308***	−0.027	0.202	−0.078	0.005	0.179	−0.087
EQ/SQ-C								
Empathy	**0.593*****	**0.709*****	**− 0.497*****	**0.710*****	**0.519*****	**0.435*****	**− 0.411***	**0.560*****
Systemizing	0.248	**0.323***	−0.143	**0.290***	**0.417*****	**0.355****	−0.023	**0.412*****

Both bold and * signify significance, as such the use of bold is redundant

$^{*}p<.05$; $^{**}p<.01$; $^{***}p<.001$

Table 3 Exploratory correlation analysis for age, Full Scale IQ, Adult/Adolescent Sensory Profile (AASP) quadrant scores, Emotion Regulation Questionnaire (ERQ) subscale mean scores, EQ/SQ-C scores in the ASC group

Variable	*n*	*M*	*SD*	1	2	3	4	5	6	7	8	9	10
1. Age[a]	50	14.08	2.24	–									
2. FSIQ[a]	50	98.02	15.24	0.03	–								
AASP	50												
3. Sensory Sensitivity[b]	50	38.06	9.40	−0.05	0.03	–							
4. Sensation Seeking[b]	50	41.7	7.91	−0.08	0.20	0.14	–						
5. Sensation Avoiding[b]	50	38.62	9.95	−0.04	0.06	**0.76*****	0.23	–					
6. Low Registration[b]	50	33.46	8.98	−0.21	−0.01	**0.53*****	0.16	**0.60*****	–				
ERQ	50												
7. Cognitive reappraisal[b]	50	3.65	1.32	0.21	−0.06	0.05	**0.42****	0.11	−0.17	–			
8. Expressive suppression[b]	50	3.36	1.17	0.14	−0.01	0.08	**0.33***	−0.01	−0.14	**0.51*****	–		
EQ-C/SQ-C	50												
9. Empathy[b]	50	26.92	8.26	−0.05	−0.01	0.01	**0.30***	0.13	−0.18	0.12	0.18	–	
10. Systemizing[b]	50	25.54	7.12	0.06	0.13	0.13	0.22	0.17	0.01	0.15	0.18	**0.348****	–

Both bold and * signify significance, as such the use of bold is redundant

[a]Spearman's rho

[b]Pearson correlation coefficient

$^{*}p<.05$; $^{**}p<.01$; $^{***}p<.001$

Table 4 Multiple Linear Regression Analysis for Autism Social Skills Profile (ASSP) total scores $F(10,112) = 21.571$, $p < .001$, $R^2 = 0.658$, Adjusted $R^2 = 0.628$

	B	Std. Error	Beta	*t*	*p*	95% CI	
						LL	*UL*
Group	4.906	2.793	0.119	1.757	0.082	−0.627	10.439
Gender	0.547	2.770	0.013	0.198	0.844	− 4.94	6.035
Sensory sensitivity	−0.153	0.186	−0.069	−0.825	0.411	−0.522	0.215
Sensation seeking	0.360	0.166	0.138	2.166	**0.032***	0.031	0.689
Sensation avoiding	0.185	0.201	0.083	0.924	0.358	−0.212	0.582
Low registration	−0.521	0.205	−0.215	− 2.546	**0.012***	−0.926	−0.116
Cognitive reappraisal	1.187	1.298	0.057	0.914	0.362	− 1.385	3.758
Expressive suppression	−0.529	1.047	−0.030	−0.506	0.614	− 2.604	1.545
Empathy	1.180	0.164	0.555	7.193	**<0.001*****	0.855	1.505
Systemizing	0.352	0.163	0.138	2.155	**0.033***	0.028	0.676

Both bold and * signify significance, as such the use of boldis redundant

*$p < .05$; **$p < .01$; ***$p < .001$

Discussion

This study investigated the relationship between social skills and sensory profile, emotion regulation, and empathy-systematization skills in adolescents on the autism spectrum compared to TD. We found that autistic adolescents had challenges regarding social skills (lower scores in social reciprocity, social participation/avoidance, and higher scores in detrimental social behaviors), which is in line with the extant literature as these struggles become more pronounced during adolescence due to increasing demands on social interactions and competence (Lüddeckens, 2021). Adolescents on the ASC also had demonstrable differences in sensory profiles (low registration) and empathizing/systemizing quotients compared to TD. No significant differences in emotion regulation strategies were found between ASC and TD groups.

Sensory Profile

Regarding the differences in sensory features, the ASC group displayed significantly higher scores in the low registration quadrant in our study. In addition, all quadrants with the exception of sensation seeking showed a positive moderate correlation amongst themselves, while sensation seeking was positively correlated with mean scores of both emotion regulation strategies and empathy quotient in the ASC group. Low registration scores were found to be inversely correlated with total SSP scores, social reciprocity, and social participation/avoidance scores and positively correlated with detrimental social behavior scores in the ASC group. While a positive association was found between the detrimental social behavior subscale and low registration scores, no correlation was observed between the low registration and SSP in the TD group. Regression analysis also revealed that the negative association between low registration and Social Skills Profile total scores was significant when the group variable was controlled for. In contrast, while no significant difference between groups was found, sensation seeking was positively correlated to social skills total scores of Autism SSP as well as to social reciprocity and social participation/avoidance subscales in the ASC group. The sensation-seeking profile scores in the typically developing adolescents were moderately correlated with detrimental social behavior scores but not Social Skills Profile total scores in our study.

Basic sensory stimuli processing and integrating multisensory stimuli are essential for perceiving complex social information. There is evidence that sensory dysregulation arises early in the progression of autism spectrum and impacts social interactions (Thye et al., 2018), has been associated with reduced social functioning (Ben-Sasson et al., 2019; Glod et al., 2015) and has been shown to interplay with communication and language difficulties (Glod et al., 2015; Tomchek et al., 2015). These findings support the hypothesis that atypical sensory function is related to the broader range of social struggles observed in autistic individuals. This complex process requires sensory modulation, and dysfunction in this area may generate difficulties in initiating interaction with peers, collaborating, sharing, making friends, empathy, or providing emotional support in daily life (Pfeiffer et al., 2005). There are also reports that auditory and visual stimuli integration is correlated with difficulties in communication (Woynaroski et al., 2013) and poor social skills (Lang et al., 2012) in autistic individuals, further underlining the role of sensory processing and integration of different stimuli in social behavior. Thus, detecting amodal information is a prerequisite for sensory integration; alterations in early integration abilities could limit the salience to social stimuli and cascade into social difficulties across development. Disruptions in this sequence

of perception and integration of a sensory input with other sensory and non-sensory stimuli resulting in social attention may have contributed to the difference in low registration scores between the ASC and TD groups, as well as the contradictory effects of sensation seeking and low registration on social skills scores in our study.

Both low registration and sensation seeking have been reported to be negatively associated with adaptive behavior (Baker et al., 2008; Liss et al., 2006; Reynolds et al., 2011), school performance (Ashburner et al., 2008), and activities in the community (Bagby et al., 2012; Hochhauser & Engel-Yeger, 2010) in the literature. However, sensation seeking was found to be a positive predictor of social skills in our study. The contrarious contributions of sensation seeking and low registration sensory profiles to social skills in our study could potentially be explained by the role of social salience and the detection of social cues in reciprocity and interaction. Social skill difficulties could arise due to the inadequacy of understanding social cues, which could potentially result from atypical sensory processing. Both sensation seeking and low registration quadrants are postulated by Dunn (1997) to display hyposensitive profiles, corresponding to a higher neurological threshold. Both these profiles indicate a need for stronger sensory input to operate. The one crucial difference between these profiles, however, is that sensation seeking is associated with active self-regulation while low registration profile is associated with passive self-regulation (Brown et al., 2001). Even though hypersensitivity to stimuli seems to influence social tasks in neuroimaging studies (Green et al., 2013, 2017), the results from our study implicate a more dynamic relationship between sensory integration and the end result of social behavior as hyposensitivity to social stimuli self-regulation strategies (active vs. passive) seem to determine the direction of the effect. Interpreting social cues in tandem with previous social information, transforming them into appropriate behaviors by self-regulating, and sharing interests are paramount in establishing healthy peer relationships, all of which are components of the construct that is "social skills".

A difference between genders was also observed in the sensory profile scale scores in all quadrants (sensory sensitivity, sensation seeking, sensation avoiding, low registration) in our study, with females scoring higher than males, indicating a difference between the genders among adolescents in processing sensory stimuli without a significant group effect. As much as there is a debate on a possible female-specific profile in autism (Lai et al., 2015) extending to sensory processing difficulties as well (Osório et al., 2021), it should be noted that sensory processing differences are not specific to ASC but also may arise from different environmental demands, which varies significantly for adolescent males and females (Little et al., 2018).

Emotion Regulation

There were no differences in emotion regulation strategies between groups or genders in our study, although females demonstrating better emotional and behavioral control resulting in better social functioning is reported in the literature (Key et al., 2022). Neither cognitive reappraisal nor expressive suppression of the ERQ mean scores were associated with Social Skills Profile total or subscale scores in typically developing adolescents. In contrast, cognitive reappraisal correlated positively to total social skills and negatively to detrimental social behaviors, while expressive suppression only correlated with the social participation/avoidance subscale in the ASC group. Poor emotion regulation coincided with worsening of internalizing and externalizing behaviors, and the use of effective emotion regulation strategies were reported to correlate to better social skills and social functioning (Berkovits et al., 2017). However, in another study, suppression as an emotion regulation strategy did not predict social functioning, (Goldsmith & Kelley, 2018), similar to ours. Cognitive reappraisal is implicated in the downregulation of negative social experiences (Zhao et al., 2021). Less frequent use of cognitive reappraisal and more frequent use of suppression than typically developing individuals have been reported in autistic children and adolescents without ID between the ages of 8–20 years (Samson et al., 2015). This corroborates the negative correlation of cognitive reappraisal to detrimental social behaviors and positive correlation to SSP total scores in the ASC group in our study. The two emotion regulation strategies of cognitive reappraisal and emotion suppression mean scores were also positively correlated in the ASC group, indicating autistic adolescents used both cognitive reappraisal and suppression in regulating their emotions rather than as competing strategies. In addition, the positive correlation between cognitive reappraisal and total social skills score did not remain significant after the regression analysis.

Empathy-Systemizing Quotients

Autistic adolescents scored lower on both EQ-C and SQ-C than the TD group in our study. Typically, autism without ID is associated with higher systemizing scores than the general adult population and higher systemizing/empathizing ratios (Baron-Cohen, 2010). However, age differences regarding the EQ-C and SQ-C scores are also reported. Autistic children are reported to score significantly lower on the EQ-C (Auyeung et al., 2009; Makris et al., 2021; Wang et al., 2019), and the same as or higher on the SQ-C (Makris et al., 2021; Wang et al., 2019) than TD children. A recent study by Pan et al. (2022) reported that autistic children with and without ID showed lower empathizing and systemizing than TD children, coinciding with our results (Pan et al., 2022).

However, it must be noted that the difference in systemizing between autistic children without ID and TD children was attenuated to null after adjusting FSIQ. Our sample consisted of adolescents who were older than Pan et al.'s study sample, who included only boys 6–12 years of age. Another difference that should be considered is the mean FSIQ score of our sample. While 80 was selected as the cut-off for autistic participants, the mean FSIQ was still 98 and the distribution was positively skewed, indicating that adolescents with FSIQ scores above but closer to 80 were over-represented in our sample, which could account for the lower scores on SQ-C in the ASC group in our study.

There was a significant effect of gender on empathy scores in our study. This difference is in accordance with the existing literature (Chaidir et al., 2020). Typically, females are reported to score higher in empathy and males in systemizing (Greenberg et al., 2018) however, no gender effect was significant for systemizing scores in our study. This may be attributed to the varying ages of the participants in studies, with empathizing and systemizing dimensions reported to be relatively independent in young adult females in one study (Valla et al., 2010).

The empathy quotient correlated extensively with social skills total scores and all subscale scores, positively in prosocial subscales and negatively in detrimental social behavior subscale, across both groups. This effect persisted and was observed again in the regression analysis, as empathy quotient was a strong predictor of Social Skills Profile total scores, while controlling for group and gender. Affective empathy or responding affectively to social cues is conceivably important in forming healthy peer relationships. Empathy is shown to be a modulator of social attention, and social awareness is thought to be an essential component of the broader social skills (Hedger et al., 2018). It is known that the difficulties in the theory of mind and scant empathy in autistic individuals cause social and transactional incompetency that may affect positive interactions (Goldstein & Winner, 2012).

Another interesting finding is higher systemizing scores correlating to prosocial subscales and total social skills scores in our study. Also, systemizing quotient remained significant in predicting Social Skills Profile total scores when group and gender were controlled for. This may be explained by the complex hierarchical social ecosystem of adolescent peer relationships. Systemizing skills are commonly associated with non-social aspects of autism. However, they are also crucial in navigating social systems, as explained in the original empathy-systemizing theory (Baron-Cohen, 2009). Peer interactions among adolescents are arguably more complex than the typical adult social society (McFarland et al., 2014). Complicated social structures may demand higher systematization skills, as understanding complex social networks is paramount in navigating the social scene and gaining acceptance among peers. The complex adolescent social environment may explain the variety of seemingly contradicting findings in empathizing-systemizing scores. The adolescent social ecosystem may be complex enough to require similar utilization in both systemizing and empathizing skills for acceptance, the difference between males and females becoming more apparent with age and changing social demands from the young adult and adult social environments.

Strengths and Limitations

The sample size of the present study is relatively modest. As such, the results cannot be generalized to represent all autistic adolescents. A significant strength of the present study is the inclusion of girls with autism and studying gender effects as well as group effects because autism studies including girls are very few. However, even though ASC and TD groups were matched in age, the ASC group consisted of significantly more boys due to a limited number of autistic girls met the inclusion and exclusion criteria and wanted to participate in the study, which is a considerable limitation.

The inclusion of WISC-R was both a strength, and a limitation as the newer version of WISC-IV could not be utilized due to its limited accessibility. In this study, autistic individuals with intellectual disabilities were excluded to provide a better understanding in the interplay of sensory processing, emotion regulation, empathy and systemizing skills on social functioning by controlling for cognitive functioning with the cut-off of 80 but Wechsler tests of intelligence are prone to the Flynn effect (Flynn, 1984, 2020), characterized by an increase in population IQ test scores in time, which could potentially effect scores. In addition, TD adolescents were assessed clinically regarding their intelligence. As such, the participants in ASC and TD groups were not matched for IQ in our study. Studies assessing TD adolescents verbal, performance and total IQ scores may shed light on unidentified liaisons among predictors of social skills.

Regarding the diagnosis of autism, Turkish adaptations of ADI-R and ADOS (Lord et al., 1994, 2000) are not available, which is a significant limitation in the standardization of autism diagnosis. As such, the diagnosis of ASC in our study depends on the clinical judgment of experienced clinicians. The semi-structured clinical interview of K-SADS-PL which is based on the DSM-5 criteria, is used to determine and guide the clinical judgement regarding autism spectrum disorder in the present study. However, it should also be noted that clinical judgment by experienced clinicians is considered to be the "gold standard" for autism diagnosis (Chlebowski et al., 2010; Klin et al., 2000; Spitzer & Siegel, 1990).

The effects of comorbid psychiatric diagnoses on social skills, sensory profiles, emotion regulation strategies and

empathizing/systemizing skills in ASC group could not be investigated in our study. This was due to most of our participants in the ASC group having at least one comorbid psychiatric condition determined by K-SADS-PL. Which, in essence, resulted in a multicollinear relationship between a diagnosis of autism and another psychiatric disorder. As such, the potential confounding effect of other psychiatric conditions could not be controlled for, as we opted to control for the group variable in our study.

The ERQ was chosen to assess the emotion regulation strategies in the present study as it identifies strategies of emotion regulation instead of subdomains of this complex and intricate construct, which better aligns with our research question of emotion regulation strategies' contribution to the observable social behavior. While it is used to identify two major emotion regulation strategies and is widely utilized in the literature, the self-report nature of the questionnaire makes it especially prone to bias, considering autistic individuals may have a hard time answering questions relating to emotions. The EQ-C/SQ-C and Autism Social Skills Profile scales rely on the parent's avid observation and assessment of their child's behavior as both these measures are parent reports. Sensory profile and ERQ are self-report questionnaires; by definition, they are both prone to self-report bias. Autistic youth's difficulties in recognizing and reporting their social and emotional struggles should also be considered. Behavioral experiments and objective data collection methods would better assess these qualities in adolescents.

This study also has a multidimensional approach to social skills in autistic adolescents, taking emotion regulation sensory profiles and empathizing-systemizing qualities into account, providing a unique understanding and perspective regarding social skills in autism.

Implications

Adolescents on the autism spectrum are at high risk of being isolated, ridiculed, and bullied by their friends due to their struggles in socializing (Church et al., 2016; Laugeson et al., 2012). The comorbidity of depression and anxiety disorders is high in autistic adolescents (Ghaziuddin et al., 2002; Mukaddes et al., 2010) and it has been reported that social difficulties and peer problems also cause unhappiness (Yoo et al., 2014). Emotion regulation, sensory processing, and empathy have all been candidates for explaining the observed social differences between autistic and typically developing adolescents.

Although emotion regulation strategies could potentially contribute to social behavior, atypical sensory processing profiles consistent with a high neurological threshold with passive and active self-regulation strategies (i.e. low registration and sensation seeking, respectively), and empathizing/systemizing abilities seem to be the major predictors of social skills in our study. Neither cognitive reappraisal nor expressive suppression as emotion regulation strategies were found to be associated with social skills in the present study. In contrast, both low registration and sensation-seeking profiles were significant in predicting social skills, albeit in different directions, as the first profile impacted social skills negatively and the latter positively. Early sensory differences precede impairments in later cognitive, social, and linguistic skills in autistic individuals, suggesting that sensory processing may affect selective attention to social stimuli, deciphering intentions, social reciprocity, and adherence to social behavior norms (Cascio et al., 2016). The potential positive effects of targeting self-regulation (advocating for active-self regulation strategies as opposed to passive ones) instead of modulating the neurological threshold, perhaps through behavioral interventions to improve social skills, remains an interesting focus for future studies.

Furthermore, increased emphasis on both empathy and systematization skills when working with autistic adolescents is implicated to have a positive impact on social skills, as both empathy and systemizing were found to be significant in the prediction of social skills in our study. It is crucial that the empathy skills of autistic individuals are measured and empathy training implemented in the education programs (Senland & Higgins-D'Alessandro, 2013). Promoting empathy can improve social skills, effectively protecting autistic teens from the negative effects of poor social skills, such as isolation and exclusion from social groups. This in turn, would make their integration into their peer's societies easier and support the mental health and well-being of autistic adolescents.

Acknowledgements The authors would like to thank the participating adolescents and their families for their support and cooperation throughout this study. The authors would also like to thank Prof. Dr. Mehmet N. Orman for his valuable contributions and guidance in the statistical analysis of the data.

Author contributions SK has been involved in the design and execution of the study, the establishment of the hypothesis, diagnostic evaluation and supervision, interpretation of results, and the writing of the manuscript. FT was involved in the study's design, communicating with children and their parents, diagnostic evaluation, administering the questionnaires, and contributed to the final manuscript. II-K was involved in the study's design, performed the statistical analysis, and contributed to the interpretation of the results and the finalization of the manuscript. HNC and DO participated in administering the questionnaires and contributed to writing the manuscript. TB was involved in the design and execution of the study and the interpretation of its results. All authors read and approved the final manuscript.

Funding The authors declare that the work reported in this manuscript was undertaken with their financial resources, and they did not receive any financial help from any individual, group, or agency.

Data Availability The raw data in the manuscript is only available on request from those who wish to collaborate with us by e-mailing the corresponding authors.

Declarations

Conflict of interest The authors have no conflicting/competing interests to declare.

Ethical Approval Ege University Clinical Research Ethical Committee approved the study. Participants were informed of the aim of the study in accordance with the Declaration of Helsinki. Adolescents gave verbal assent to be included in the study, and written informed consent was obtained from the parents.

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