# The Relationship Between Autism Spectrum Disorder Traits, Sensory Sensitivity, and Quality of Life in Emerging Adults

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## Abstract

Both autism spectrum disorder (ASD) traits and sensory sensitivity are continuously distributed in the general population and affect the overall Quality of Life (QoL) of individuals. However, the interplay between the variables ASD traits, sensory sensitivity, and QoL in the general population remains unknown. Especially in emerging adults, the QoL might be impacted by ASD traits and sensory sensitivity, due to the heightened demands and ongoing cognitive development. Therefore, this study explored the influence of ASD traits and sensory sensitivity on the QoL in emerging adults. A cross-sectional study was conducted among 114 emerging adults, aged between 18 and 25 years old. Participants completed an online survey containing the Autism Quotient (AQ) short version, the Sensory Perception Quotient (SPQ) short version, and the shortened World Health Organisation Quality of Life Questionnaire (WHOQoL-BREF). Bivariate correlational analyses showed that ASD traits had a significant, weak, positive relationship with sensory sensitivity and a significant, moderate, negative relationship with QoL. Additionally, there was a significant, weak, negative relationship between sensory sensitivity and QoL. Further exploratory analyses indicated that sensory sensitivity partially mediated the relationship between ASD traits and QoL in emerging adults. Further research is needed to explore this mediating role more in-depth and to replicate the findings in different age groups and clinical samples.

## Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental disorder, with the presence of restricted, repetitive patterns of behaviour, interests, or activities and deficits in social communication and interaction as the main criteria according to the most recent version of the Diagnostic and Statistical Manual of Mental Disorders (DSM-V; American Psychiatric Association, 2013). These main criteria include symptoms such as difficulties in developing, maintaining, and understanding relationships, and an inflexible adherence to routines. Due to these symptoms, individuals with ASD may encounter challenges in their daily functioning, for example at the workplace or with friends. Although ASD is diagnosed in approximately 0.6% of the population (Salari et al., 2022), ASD symptoms are considered a trait-like phenotype that is continuously distributed in the general population (Constantino & Todd, 2003; Mayer, 2016; Robertson & Simmons, 2012). This means that the majority of people exhibit some ASD traits, without meeting the full diagnostic criteria for ASD.

According to the DSM-V, atypical sensory sensitivity is part of the ASD criterium *restricted, repetitive patterns of behaviour, interests or activities* and is described as "hyper- or hyporeactivity to sensory input or unusual interest in sensory aspects of the environment" (American Psychiatric Association, 2013, p.50). This definition of the DSM-V is focused on observable behaviour, whereas more recent literature suggests that atypical sensory sensitivity is manifested behaviourally as a result of individual differences in sensory information processing across the sensory modalities (i.e., visual, auditory, tactile, gustatory, olfactory, proprioceptive, and vestibular) (Schauder & Bennetto, 2016; Ward, 2018). These individual differences are expected to have a neural origin (Ma et al., 2023; Ward, 2018). Thus, new research focuses on the perceptual differences in sensory sensitivity, excluding the cognitive, affective, and behavioural aspects as much as possible (Schauder & Bennetto, 2016; Weiland et al., 2020). Atypical sensory sensitivity varies from hyposensitivity to hypersensitivity to

stimuli (Weiland et al., 2020). In ASD, this can be expressed as experiencing lights as unbearably bright (hypersensitivity) or having an indifference to pain (hyposensitivity). A substantial proportion, ranging from 60%–90%, of individuals with ASD experience atypical sensory sensitivity (Wada et al., 2023). Furthermore, studies consistently indicate positive associations between the level of ASD traits and sensory hypo- and hypersensitivity in individuals with ASD (Horder et al., 2013; Mayer, 2016; Tavassoli et al., 2014; Weiland et al., 2020).

However, it is crucial to note that atypical sensory sensitivity is not exclusive to ASD. It is also observed in individuals with attention-deficit/hyperactivity disorder (ADHD), specific learning disorders (SLD), and bipolar disorders (Bijlenga et al., 2017; Engel-Yeger et al., 2016; Wada et al., 2023). Therefore, atypical sensory sensitivity cannot serve as an indicator for ASD. In fact, studies by Robertson and Simmons (2012) and Weiland et al. (2020) concluded that sensory sensitivity and its abnormalities are continuously distributed in the general population, similar to ASD symptoms. In line with this is the finding that the association between ASD traits and (atypical) sensory sensitivity not only exists in individuals with ASD, but also in the general population (Horder et al., 2013; Mayer, 2016; Robertson & Simmons, 2012; Tavassoli et al., 2014; Weiland et al., 2020).

ASD traits are not only associated with sensory sensitivity, but also with *Quality of Life* (QoL). QoL is defined by the WHOQOL group (1994) as the individual's perception of "their own position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards, and concerns" (p.41). This definition emphasizes the subjective and multidimensional nature of the concept, including the domains of physical health, psychological health, social relationships, and environmental relationships. Since QoL gives insight into the subjective level of overall well-being and functioning in life, it is a crucial outcome measure. ASD traits may negatively impact QoL, for example, the

deficits in establishing and maintaining social relationships can impair the social domain of QoL. Previous research has shown that individuals with high-functioning ASD scored lowest on the social relationship domain of QoL compared to the other domains (Kamp-Becker et al., 2010; Lin, 2014). According to Kamp-Becker et al. (2010), the scores on the three domains of social relationships, physical health, and psychological health were significantly worse than those of healthy individuals. Moreover, the studies of Lin (2014) and Lin and Huang (2019) both showed that adults with ASD scored significantly lower across all four domains of QoL compared to healthy adults. Following this line of reasoning, associations between ASD traits and all domains of QoL were also found in the general population (Pisula et al., 2015).

Similar to ASD traits, sensory sensitivity is associated with QoL. Kinnealey et al. (2011) demonstrate that a hypersensitivity to stimuli is related to a lower QoL in the general population, affecting vitality, social functioning, and general health. Also, in patients with unipolar and bipolar disorders, there is a relationship between atypical sensory sensitivity (hypo- and hypersensitivity) and QoL (Engel-Yeger et al., 2016). To illustrate, individuals with hypersensitivity might avoid participation in meaningful activities, due to the high-stimuli environment in which the activities take place (Pfeiffer et al., 2014). Thus, higher sensitivity to sensory stimuli could lead to reduced participation, which then results in reduced QoL.

Although the constructs of ASD traits, sensory sensitivity, and QoL correlate with each other, only few studies have used QoL as outcome measure when investigating sensory sensitivity in individuals with ASD. In a sample of individuals both with and without ASD, Lin and Huang (2019) found that their level of ASD traits correlated with the social relationships domain of QoL, whereas hyperresponsive behavioural reactions to sensory input was a significant predictor for a lower score on the physical and psychological health domains of QoL. Similarly, it was found that sensory sensitivity has a significant impact on daily

activities (e.g., school, social participation, and sleep) in children with ASD, and that tactile hyper-sensitivity mediates social dysfunction in adults with ASD (Ismael et al., 2018; Lundqvist, 2015). Thus, this indicates that multiple domains of QoL are affected by sensory sensitivity in individuals with ASD. Moreover, it is argued that atypical sensory sensitivity is the symptom of ASD which affects QoL most (Ward, 2018).

To conclude, a lot of research has been done and it is clear that there is an association between ASD traits and sensory sensitivity both in individuals with ASD and in the general population. Furthermore, the QoL of individuals with ASD or atypical sensory sensitivity is affected. However, despite all these findings, the interplay between the three variables ASD traits, sensory sensitivity, and QoL in the general population remains unclear. This gap in knowledge prompts the need for exploratory research into the interplay between these variables. The insight into this interplay could guide the development of future interventions which aim to increase QoL in the general population.

The current study focuses on emerging adults, as these individuals often experience heightened demands in academic, occupational, and social settings and their brains are still in development (Wood et al., 2018). The transition to adulthood is especially challenging for individuals with ASD, due to the loss of support services that were available in the school system. Challenges for students with ASD entering university include managing schedules and routines, establishing new friendships, living independently, and the absence of monitoring and guidance (Wood et al., 2018). Similarly, students who are more sensitive to sensory stimuli might be expected to find it more challenging to make friendships, as meeting new people often occurs in crowded places with multiple sensory stimuli. Therefore, ASD traits and atypical sensory sensitivity might make the transition into adulthood even more challenging.

Recognizing the potential impact of these difficulties on the QoL in emerging adults, the present study aims to explore the influence of ASD traits and sensory sensitivity on the QoL within this specific age group in the general population. Based on previous literature, it can be hypothesised that there is a significant positive relationship between the level of ASD traits and the level of sensory sensitivity, meaning that having more ASD traits is associated with a higher sensitivity to sensory stimuli (H1). It is further hypothesised that there is a significant negative relationship between the level of ASD traits and QoL, meaning that having more ASD traits is associated with a lower subjective well-being (H2). Another hypothesis is that there would be a significant negative relationship between the level of sensory sensitivity and QoL, meaning that being more sensitive to sensory stimuli is associated with a lower subjective well-being (H3). Furthermore, no hypotheses on the exact relationship between the three constructs (e.g. moderating or mediating) are formulated, since the relationship between ASD traits and sensory sensitivity on QoL will be investigated exploratively. The outcomes of this study will contribute to a better understanding of the interplay between ASD traits, sensory sensitivity, and QoL. This understanding is important to guide future interventions that support emerging adults in their transition to adulthood and aim to improve their QoL.

## Method

### Participants

Participants were recruited via convenience sampling of the researchers' personal networks. The researchers reached out to them directly or through social media. The eligibility criterion for this study was that participants needed to be between 18 and 25 years old. Participants who did not finish the last questionnaire of the survey and/or had two or more validity questions (see Procedure) wrong, were excluded from the analysis. Participants who disclosed having one or more sensory modality impairments ($n$ = 22), were carefully

analysed. In case these participants were identified in terms of outliers, they were excluded from the analysis ($n$ = 0). Participants did not receive compensation for their participation. The final sample consisted of 114 participants (83.3% female, 15.8 % male, and 0.9% other). The age ranged from 18 to 25 years ($M$ = 22.9, $SD$ = 1.6). More detailed participant characteristics can be found in Table 1.

**Table 1**
*Descriptive statistics of the sample (N = 114)*

| Variable | *M* | *SD* | *N* | *%* |
|---|---|---|---|---|
| Age (years) | 22.9 | 1.6 | | |
| Gender | | | | |
| Female | | | 95 | 83.3 |
| Male | | | 18 | 15.8 |
| Other | | | 1 | 0.9 |
| Highest completed education level[a] | | | | |
| Low | | | 2 | 1.8 |
| Medium | | | 35 | 30.7 |
| High | | | 60 | 52.6 |
| Master's degree | | | 17 | 14.9 |
| Daily Life | | | | |
| Fulltime study | | | 58 | 50.9 |
| Parttime study | | | 5 | 4.4 |
| Paid Work | | | 61 | 53.5 |
| Amount of hours per week (n = 60) | 29.7 | 11.7 | | |
| Other | | | 7 | 6.1 |
| ADHD diagnosis[b] | | | 11 | 9.7 |
| ASS diagnosis[c] | | | 8 | 7.0 |
| Other psychiatric disorder | | | 15 | 13.2 |
| Neurological disorder | | | 4 | 3.5 |
| Autism Quotient-short | 61.0 | 12.6 | | |
| Sensory Perception Quotient-short | 51.9 | 14.3 | | |
| WHOQoL-BREF | 97.5 | 13.6 | | |

[a] Low includes the Dutch education levels: VMBO, MBO1, LBO, LTS, LEAO; Medium includes: HAVO, VWO, MBO2, MBO3, MBO4, MULO, MAVO, MTS, MEAO; High includes: HBO, Bachelor WO, HEAO, HTS.

[b] According to the DSM-V. This includes the earlier Attention Deficit Disorder diagnosis.

[c] According to the DSM-V. This includes the earlier Autism, Asperger, and Pervasive Developmental Disorder-Not Otherwise Specified diagnoses.

ADHD = Attention Deficit Hyperactivity Disorder; ASS = Autism Spectrum Disorder; WHOQoL-BREF = World Health Organisation Quality of Life Questionnaire.

## Materials

### *ASD traits*

The level of ASD traits was measured with the Dutch Autism Quotient (AQ) abridged version (Baron-Cohen et al., 2001; Hoekstra et al., 2011). The AQ-short is a 28-item self-report questionnaire which contains the two higher-order factors *social behaviour* and *numbers/patterns*. Participants are asked to what extent they agree to each statement on a 4-point Likert scale, ranging from 1 (*definitely agree*) to 4 (*definitely disagree*). For example, one statement for the factor *social behaviour* is *"I enjoy meeting new people"* and one statement for the factor *numbers/patterns* is *"I usually notice car number plates or similar strings of information"*. The scoring of 13 items is reversed, so that a higher score indicates more ASD traits. The total score of the AQ-short is the sum of scores of the items, ranging from 28 (no ASD traits) to 112 (full endorsement of ASD traits). The internal consistency of the AQ-short was acceptable to good ($\alpha$ = .77 - .86) in the general Dutch and English population and an English sample with individuals with Asperger Syndrome (AS; Hoekstra et al., 2011). Moreover, the AQ-short showed excellent test accuracy in distinguishing individuals with AS from controls (Hoekstra et al., 2011). In the current study, the internal consistency of the AQ-short was good ($\alpha$ = .88).

### *Sensory Sensitivity*

Sensory sensitivity was measured with the Dutch Sensory Perception Quotient (SPQ) abridged version (Tavassoli et al., 2014; Weiland et al., 2020). The SPQ-short is a self-report questionnaire developed to measure basic sensory sensitivity across the five sensory modalities (i.e., visual, auditory, tactile, gustatory, and olfactory), based solely on the perceptual component. The SPQ-short consists of 35 statements containing both

hypersensitivity (e.g., *"If I look at a pile of blue sweaters in a shop that are meant to be identical, I would be able to see differences between them"*) and hypo-sensitivity (e.g., "*I couldn't detect if bread is stale purely by its smell*"). Participants are asked to what extent they agree with each item on a 4-point Likert scale ranging from 0 (*definitely agree*) to 3 (*definitely disagree*). The scoring of the 5 hypo-sensitive items is reversed. The total score of the SPQ-short is the sum of scores of the items, ranging from 0 to 105, where a *lower* score indicates *higher* sensitivity to sensory stimuli (hypersensitivity). The internal consistency was high ($\alpha$ = .93; Weiland et al., 2020). In this study, the internal consistency of the SPQ-short was good ($\alpha$ = .89).

***Quality of Life***

QoL was measured with the Dutch version of the World Health Organisation Quality of Life Questionnaire (WHOQoL-BREF; de Vries & van Heck, 1996; WHOQOL group, 1994). The WHOQoL-BREF is a self-report questionnaire measuring the level of overall QoL and general health in the past two weeks. It contains a four-factor structure, similar to the four domains of physical health, psychological health, social relationships, and environment. The questionnaire consists of 26 statements (e.g., *"To what extent do you feel your life to be meaningful?"*). Two of these statements are related to the overall QoL and general health. Participants are asked to what extent they agreed with each of the statements using a 5-point Likert scale ranging from 1 (*disagree strongly*/*very dissatisfied*) to 5 (*agree strongly*/*very satisfied*). The scoring of three items is reversed. Despite the inclusion of two statements specifically addressing overall QoL, in this study it was chosen to use the total score of all 26 statements to assess QoL. The reason for using the total score was that this is expected to give a more complete picture of QoL, as it includes all four domains of QoL. The total score, calculated as the sum of item scores, ranged from 26 to 130, where higher scores indicated a better QoL. The internal consistency of the total score is excellent ($\alpha$ = .90; Schrier et al.,

2015). In the current study, the internal consistency of the total score was also considered excellent ($\alpha$ = .91).

**Procedure**

This study was approved by the Ethics Committee of the Behavioural and Social Sciences Department at the University of Groningen (PSY-2223-S-0515). The data collection took place from the 15th until 28th of November 2023. Participants received a hyperlink to the online Qualtrics survey (https://www.qualtrics.com). First, participants received information about the study, which stated that the topics under investigated where sensory sensitivity, social behaviour and routines, and QoL. Participants were not informed that social behaviour and routines referred to traits of ASD, in order to minimise response bias. It was stated that completing the survey would take approximately 20-30 minutes. In order to give active consent, participants had to select the statement whereby they stated that they had read the information and agree to participate. After giving informed consent, participants filled out questions on demographic information, including age, gender, education level, and whether they were diagnosed with ASD, ADHD, or any sensory disorder. Then, they answered the AQ-short, WHOQoL-BREF, SPQ-short, and two additional questionnaires relevant for another study. Four validity questions were included (e.g., "*Here, I choose the answer option 'rarely', so that the researchers know I am carefully reading the questions*.") and evenly distributed throughout the survey. After filling in all the items, participants were informed that their responses had been recorded and thanked for their participation.

**Data Analysis**

The data analysis was conducted in R (version 4.3.2) and RStudio (version 2023.09.1+494) using the packages *datarium* (Kassambara, 2019), *ez* (Lawrence, 2016), *ggpubr* (Kassambara, 2023a), *haven* (Wickham & Miller, 2020), *Hmisc* (Harrell & Dupont, 2023), *jtools* (Long, 2022), *mediation* (Tingley et al., 2019), *psych* (Revelle, 2023), *Rmisc*

(Hope, 2022), and *rstatix* (Kassambara, 2023b). The cut-off point of $p < .05$ was used in the analyses to test for statistical significance.

This study investigated the relationships between the three variables *ASD traits* (total score AQ-short), *Sensory sensitivity* (total score SPQ-short), and *QoL* (total score WHOQoL-BREF) exploratory. To examine the relationships, bivariate Pearson's correlation coefficients were calculated. To interpret the strengths of the Pearson's correlation coefficients, Cohen's classification (1988) was used. Following this classification, a score between 0.1 – 0.3 is interpreted as small effect size, 0.3 – 0.5 as moderate effect size, and larger than 0.5 as large effect size. Based on the findings of the correlational analyses, the hypotheses were answered.

Following the correlational analyses, three scenarios of correlational outcomes were defined. Further statistical analyses were dependent on which scenario occurred. The first scenario was: if there were significant correlations between all three variables, a mediation analysis was performed using the nonparametric bootstrapping method. Based on the theoretical background that sensory sensitivity is an aspect of the DSM-V criteria of ASD, *Sensory sensitivity* was chosen as mediating variable. If the strength of the relationship between *ASD traits* and *QoL* weakened when the mediating variable was included in the analysis, it was concluded that there is a mediation effect. The second scenario was: if there was a significant correlation between one or two of the independent variables (*ASD traits* or *Sensory sensitivity*) and the dependent variable *QoL*, a moderation analysis was performed next. The moderation analysis was done by computing the interaction term (*ASD traits x Sensory sensitivity*) first. Next, a multiple linear regression analysis using the forced entry method was performed with *QoL* as dependent variable and *ASD traits, Sensory sensitivity*, and the interaction term as independent variables. If the interaction term was significant, it was concluded that there is a moderation effect present. Prior to the moderation analysis, the assumptions for linear regression analysis were checked. Although the distributions of *ASD*

*traits* and *QoL* were slightly skewed, there were no severe violations of the assumptions for linear regression analysis. There were six influential observations identified, but no reasons for excluding these data were found during further inspection. The third scenario was: if there were no significant correlations in the bivariate correlation analysis, no further exploratory analyses were conducted.

## Results

The mean scores and standard deviations of the sample on the AQ-short, the SPQ-short, and the WHOQoL-BREF can be found in Table 1.

### Bivariate correlations

Firstly, there was a significant, weak, positive Pearson's correlation coefficient between *ASD traits* and *Sensory sensitivity* ($r$ = .22, $p$ = .021), meaning that having more ASD traits is associated with a higher sensitivity to sensory stimuli. Secondly, there was a significant, moderate, negative correlation between *ASD traits* and *QoL* ($r$ = -.56, $p$ < .001), which means that having more ASD traits is associated with a lower level of QoL. Thirdly, there was a significant, weak, negative correlation between *Sensory sensitivity* and *QoL* ($r$ = -.30, $p$ = .001), meaning that being more sensitive to sensory stimuli is associated with a lower level of QoL.

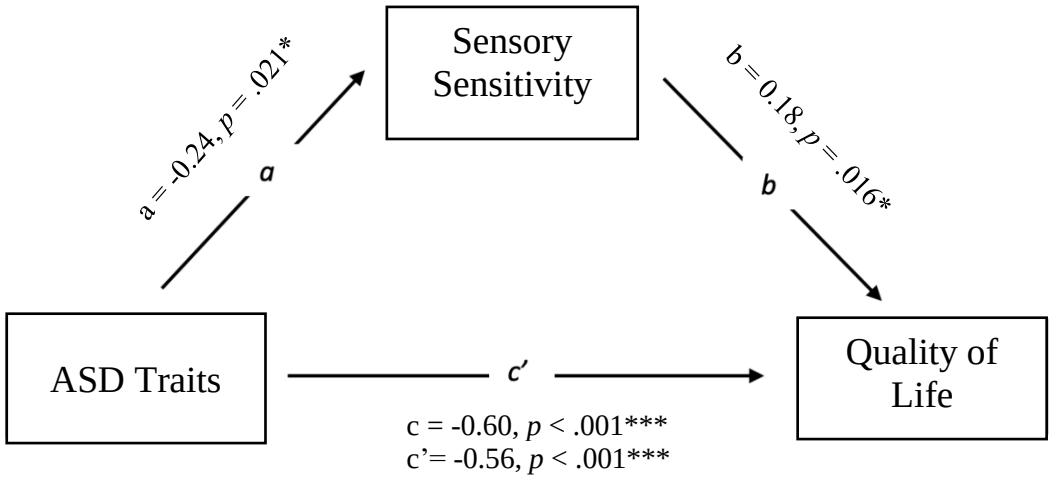
### Mediation analysis

Based on the findings that there were significant relationships between the three variables *ASD traits*, *Sensory sensitivity*, and *QoL*, the mediation analysis was conducted, as illustrated in Figure 1. The analysis showed that the effect of *ASD traits* on *QoL* did significantly weaken when *Sensory sensitivity* was included in the regression (path c = -0.60, $p$ < .001; path c' = -0.56, $p$ < .001). The results of the nonparametric bootstrap analysis (see Table 2) also showed that ASD traits affect QoL both directly (Average Direct Effect = -0.56, $p$ < .001) and indirectly (Average Causal Mediation Effect = -0.04, $p$ = .036) through sensory

sensitivity, suggesting a partial mediation effect of sensory sensitivity on the relationship between ASD traits and QoL.

**Figure 1**

*Mediation Analysis and Pathway Outcomes with Quality of Life as Dependent Variable, ASD Traits as Independent Variable and Sensory Sensitivity as Mediator*




*Note*. Path c is without mediator, path c' is with mediator.

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

**Table 2**

*Causal Mediation Analysis with Quality of Life as Dependent Variable, ASD Traits as Independent Variable and Sensory Sensitivity as Mediator*

| | Estimate | 95% CI | *p* |
|---|---|---|---|
| ACME | -0.04 | [-0.09, 0.00] | .036* |
| ADE | -0.56 | [-0.72, -0.41] | <.001*** |
| Total Effect | -0.60 | [-0.76, -0.44] | <.001*** |
| Proportion Mediated | 0.07 | [0.00, 0.15] | .036* |

*Note*. CI = Confidence Interval; ACME = Average Causal Mediation Effect; ADE = Average Direct Effect; *N* = 114; Simulations = 500.

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

**Moderation Analysis**

Based on the findings that there was a significant relationship between the two independent variables (*ASD traits* and *Sensory sensitivity*) and the dependent variable *QoL*, a moderation analysis was conducted (see Table 3). The main effects of the variables *ASD traits* and *Sensory sensitivity* were non-significant. More importantly, the interaction term *ASD traits x Sensory sensitivity* was non-significant ($t(3, 110) = -.27$, $p = .786$, $sr^2 < .001$), indicating no moderating role of ASD traits in the relationship between sensory sensitivity and QoL and no moderating role of sensory sensitivity in the relationship between ASD traits and QoL.

**Table 3**

*Multiple Regression Analysis with Quality of Life as Dependent Variable, ASD Traits and Sensory Sensitivity as Independent Variables and the Interaction Term as Moderator*

| variable | *B* | *SE B* | 95% CI for *B* | β | *t*(3, 110) | *p* | $sr^2$ |
|---|---|---|---|---|---|---|---|
| (Intercept) | 117.24 | 18.52 | [80.53, 153.94] | - | 6.33 | < .001 *** | - |
| ASD traits | -0.48 | 0.30 | [-1.06, 0.11] | -0.45 | -1.62 | .108 | .02 |
| Sensory Sensitivity | -0.28 | 0.35 | [-0.42, 0.97] | 0.29 | 0.79 | .432 | .00 |
| ASD traits x Sensory sensitivity | -0.00 | 0.01 | [-0.01, 0.01] | -0.11 | -0.27 | .786 | .00 |

*Note.* CI = Confidence Interval; $sr^2$ = semi-partial correlation squared; Standard errors: Ordinary Least Squares. Continuous variables are mean-centered and scaled by 1*SD*. $R^2 = 0.349$; $R^2_{adj} = 0.331$; $F(3, 110) = 19.67$, $p < .001$.

*** $p < .001$.

## Discussion

The aim of this study was to investigate the influence of ASD traits and sensory sensitivity on the QoL in emerging adults. In short, the results show that ASD traits are positively related to sensory sensitivity and negatively related to QoL. Additionally, there is a

negative relationship between sensory sensitivity and QoL. Furthermore, exploratory analyses indicate that sensory sensitivity is a partial mediator in the relationship between ASD traits and QoL in emerging adults.

Firstly, as hypothesized, this study found a significant, weak, positive relationship between the level of ASD traits and the level of sensory sensitivity, indicating that having more ASD traits is associated with a higher sensitivity to sensory stimuli. This finding is in line with previous studies that found a relationship between the level of ASD traits and sensory hypo- and hypersensitivity in both individuals with and without ASD (Horder et al., 2013; Mayer, 2016; Robertson & Simmons, 2012; Tavassoli et al., 2014; Weiland et al., 2020). More specifically, the correlation found in this study is most comparable to those observed in Tavassoli et al. (2014) and Weiland et al. (2020), both of which also used the SPQ as measurement instrument. Studies using different sensory measures tend to yield stronger correlations (Horder et al., 2013; Mayer, 2016; Robertson & Simmons, 2012). This might be explained by the focus of the SPQ on basic sensory perception, which represents a lower-order of sensory information processing. Perhaps, higher-order sensory information processing, including affective and behavioural responses to stimuli, better explains the ASD traits, which are also behavioural in result.

The found correlation between ASD traits and sensory sensitivity could be explained by the idea that hypersensitivity causes sensory overload, thereby reinforcing behavioural ASD traits. According to the sensory overload concept of Scheydt et al. (2017), routine behaviours and avoidance behaviours serve as mechanisms to restore the internal homeostasis following sensory overload. For instance, individuals with ASD may avoid crowded rooms or repetitively run their hands up and down their thighs to alleviate sensory overload experienced in social settings. This concept is in line with the DSM-V, which categorises sensory sensitivity into the criterium *restricted, repetitive patterns of behaviour, interests, or*

*activities* of ASD. However, given that the current study is correlational, no causal effect between sensory sensitivity and ASD traits can be inferred.

Secondly, as hypothesized, this study found a significant, moderate, negative relationship between the level of ASD traits and QoL, indicating that having more ASD traits is associated with a lower subjective well-being. This finding is in line with previous studies that found that individuals with ASD or more ASD traits have a lower QoL (Lin & Huang, 2019; Pisula et al., 2015). ASD traits such as deficits in developing and maintaining relationships and adherence to routines can negatively affect the individual's daily functioning and thus, influence their perceived QoL. Moreover, it is likely that multiple factors further explain this relationship between ASD traits and QoL. Firstly, individuals with ASD traits often experience more symptoms of anxiety, which in turn affects their physical QoL (Lin & Huang, 2019). This might be explained by a cognitive association between experienced physiological symptoms of anxiety and perceived physical health. Another reason for the lower QoL could be a higher level of loneliness, which is associated with decreased self-esteem and life satisfaction, and thus result in lower psychological health (Lin & Huang, 2019). However, the use of only a total score combining all QoL domains in the current study limits the ability to confirm the validity of these explanations.

Another explanation for the relationship between ASD traits and QoL is based on the exploratory analyses, i.e., the mediation analysis showed that sensory sensitivity serves as a partial mediator in the relationship between ASD traits and QoL. This partial mediation effect could be explained by the fact that atypical sensory sensitivity is part of the DSM-V criterium *restricted, repetitive patterns of behaviour, interests, or activities* for ASD, thereby affecting QoL (American Psychiatric Association, 2013). However, this criterium alone is insufficient for an ASD diagnosis; the second criterium is *persistent deficits in social communication and social interaction*. The necessity of both criteria, one of which includes atypical sensory

sensitivity, may explain why the relationship is not fully mediated. Although the presence of this mediation effect has not yet been investigated in a clinical sample of individuals with ASD, this could be expected based on the current finding in the general population. Given that the three constructs ASD traits, sensory sensitivity, and quality of life are known to be present at different levels in both the general population and within individuals with ASD, this explains why the mediation effect is present in the current sample of emerging adults.

Thirdly, as already became clear from the mediation analysis, this study found a significant, weak, negative relationship between sensory sensitivity and QoL, indicating that being more sensitive to sensory stimuli is associated with a lower subjective well-being. This finding is in line with previous studies that found that individuals (both with and without ASD) who are more sensitive to stimuli have a lower health-related QoL, participation in daily life, and social functioning (Ismael et al., 2018; Kinnealey et al., 2011; Lundqvist, 2015; Pfeiffer et al., 2014). This might be explained by the fact that hypersensitivity to stimuli influences the way individuals behave and thus function in daily life (Miller et al., 2007, as cited in Schauder & Bennetto, 2016; Pfeiffer et al., 2014). For example, one might avoid certain situations that involve sensory overload, but this avoidance could cause isolation and loneliness, and thus reduce one's well-being. Additionally, individuals with sensory sensitivity disorders often report a decrease in social support, due to a lack of understanding of family members and friends (Kinnealey et al., 2011). This lack of social support could also lead to further social isolation, which again reduces one's perceived well-being.

Lastly, the exploratory analyses show that there is no moderation effect since the interaction term *ASD traits x Sensory sensitivity* is non-significant. Furthermore, the multiple regression analysis fails to show any correlation with QoL, which contradicts the bivariate analysis findings. The discrepancy between the findings could be explained by the overlap between the constructs ASD traits and sensory sensitivity. While the bivariate analysis

overlooks this overlap, the multiple regression analysis takes the overlap into account. Consequently, this suggests that only the overlap between ASD traits and sensory sensitivity is significantly related to QoL, which is in line with the finding that sensory sensitivity is a mediator between ASD traits and QoL. However, given the exploratory nature of these findings, further research is needed.

**Strengths and Limitations**

The present study has several strengths and limitations. First of all, the use of well-established questionnaires with high internal consistency is a strength of this study. Second, the scores of the AQ-short and SPQ-short are normally distributed. Therefore, this study supports the spectrum approach for both ASD traits and sensory sensitivity in the general population. Lastly, a strength of the study is the newness of the research. To my knowledge, no other studies have investigated the mediating and moderating role of sensory sensitivity on the relationship between ASD traits and QoL.

On the other hand, there are two main limitations in this study. First, the use of the SPQ-short as measure of sensory sensitivity should be discussed. The SPQ can be seen as a basic measure of sensory perception, and it correlates less with the AQ-short than other measures that include higher-order processing of stimuli, such as the Adult/Adolescent Sensory Profile (AASP; Horder et al., 2013; Mayer, 2016). However, more importantly, these measures rely on self-report questionnaires to measure sensory sensitivity, which is common in the clinical field. On the contrary, in the neuroscience field, the degree and timing of neural response to sensory stimuli are measured, as this gives insight into processing patterns that might underlie sensory sensitivity difficulties. Schauder and Bennetto (2016) have already emphasized to integrate both perspectives of sensory sensitivity into an interdisciplinary approach. Thus, different measurements could have been used to measure sensory sensitivity,

especially since modality-specific measurements are found to be more accurate than questionnaire-based measures (Schauder & Bennetto, 2016).

Another limitation is related to the sample of this study. The percentages of females, individuals diagnosed with ASD, and those who followed higher education are all notably high. Since the study aimed to gain insight into the general population of emerging adults, the current sample may lack sufficient representativeness, raising concerns about the generalisability of the findings. These concerns are especially relevant since it is known that females with ASD tend to have higher scores on the SPQ compared to men with ASD (Weiland et al., 2020), as well as because females are less frequently diagnosed with ASD (Hutson & Hutson, 2023). Consequently, the SPQ scores of this sample might be overestimated, if the current sample includes undiagnosed females with ASD. Moreover, the percentage of individuals already diagnosed with ASD in this sample is higher compared to the prevalence in the general population, respectively 7% against 0.6% (Salari et al., 2022). Therefore, the sample may not be well representative, which reduces the generalisability of the findings.

**Directions for future research**

The findings of this study have two theoretical implications. First, a direction for future research is concerned with the partial mediation of sensory sensitivity between the relationship between ASD traits and QoL. Replication of this mediation effect is needed, and it would be useful to further investigate the partial mediation more in-depth. For example, the mediation could be partial due to the two-factor structure – *social behaviour* and *numbers/patterns* – of the AQ-short and the two criteria of the DSM-V for ASD. Possibly, only the factor *numbers/patterns* is related to sensory sensitivity, since this factor is similar to the criterium *restricted, repetitive patterns of behaviour, interests, or activities* of the DSM-V that includes hypo- and hypersensitivity to sensory stimuli. Furthermore, the mediation may

only be partial due to specific sensory modalities. For example, Tavassoli et al. (2014) previously found that adults with ASD were more sensitive to visual, auditory, tactile, and gustatory stimuli, but not to olfactory stimuli than healthy individuals and Wada et al. (2023) found that individuals with ASD most often report auditory and tactile problems as most stressful. These differences across the sensory modalities could play a role in the partial mediation. As a result, gaining more insight into the specific role of sensory sensitivity could help in identifying and designing interventions to support individuals who are hypersensitive to sensory stimuli, both with and without ASD.

Second, replicating this study in different samples is a direction for further research. In the current study, the mediation effect was assessed in a sample of emerging adults, including individuals both with and without an ASD diagnosis. It would be useful to investigate whether the same mediation effect would be found in different age groups of the general population or in a clinical sample with ASD. This would be expected based on the current findings and the spectrum approach of ASD and sensory sensitivity. Moreover, since atypical sensory sensitivity is also present in other clinical samples, such as ADHD and SLD, it is interesting to investigate whether the relationship between those symptoms and QoL would also be partly mediated by sensory sensitivity. Thus, directions for future research are to look more in-depth into the mediation effect and the subdomains of ASD traits and sensory modalities, and to replicate this study with different samples.

**Practical implications**

The current study builds upon the existing knowledge regarding ASD traits, sensory sensitivity, and QoL. Moreover, the current findings have practical implications for treatment. Since QoL is an important outcome variable in the daily lives of all individuals, it is useful to design interventions that intend to improve QoL by targeting sensory sensitivity. Previously, Yuan et al. (2022) found that physical activity, cognitive behavioural therapy, mindfulness-

based cognitive therapy, and sensory integration therapy are all effective interventions for children and adolescents with ASD and sensory sensitivity difficulties. These interventions aim to establish useful coping strategies for managing attention and emotional responses to sensory stimuli. It can be expected that especially emerging adults could benefit from these interventions, since they experience heightened demands in academic, occupational, and social settings. Also, an exposure-based virtual reality game was investigated in a pilot study, which was found to be effective in managing auditory stimuli in adults with ASD (Johnston et al., 2020). Since individuals without ASD also experience sensory hypo- and hypersensitivity, it would make sense that these interventions could help them cope with sensory stimuli. Therefore, adapting existing interventions that address sensory sensitivity could be useful for enhancing QoL in individuals without ASD diagnosis who are more sensitive to sensory stimuli.

## Conclusion

In summary, this study investigated the role of ASD traits and sensory sensitivity on the QoL in emerging adults. The results showed significant relationships between ASD traits and sensory sensitivity, ASD traits and QoL, as well as sensory sensitivity and QoL. Moreover, a partial mediation effect of sensory sensitivity was found in the relationship between ASD traits and QoL. This could be explained by the fact that sensory sensitivity is one aspect of the ASD criteria in the DSM-V and that a large percentage of individuals with ASD experiences sensory sensitivity difficulties. Future research is needed to explore this mediating role more in-depth on the subdomains of ASD traits and the specific sensory modalities, and to replicate the findings in different age groups and clinical samples. Additionally, it is recommended to adapt and investigate existing interventions designed to address atypical sensory sensitivity in individuals with ASD, aiming to improve the QoL in individuals who are more sensitive to sensory stimuli, regardless of ASD diagnosis.

## References

American Psychiatric Association. (2013). *Diagnostic and Statistical Manual of Mental Disorders (DSM-5)* (5th ed.). American Psychiatric Association. https://doi.org/10.1176/appi.books.9780890425596

Baron-Cohen, S., Wheelwright, S., Skinner, R., Martin, J., & Clubley, E. (2001). The Autism-Spectrum Quotient (AQ): Evidence from Asperger Syndrome/High-Functioning Autism, Males and Females, Scientists and Mathematicians. *Journal of Autism and Developmental Disorders*, *31*(1), 5–17. https://doi.org/10.1023/a:1005653411471

Bijlenga, D., Tjon-Ka-Jie, J., Schuijers, F., & Kooij, J. J. S. (2017). Atypical sensory profiles as core features of adult ADHD, irrespective of autistic symptoms. *European Psychiatry*, *43*, 51–57. https://doi.org/10.1016/j.eurpsy.2017.02.481

Cohen, J. (1988). Statistical power analysis for the behavioral sciences (2nd ed.). Lawrence Erlbaum Associates.

Constantino, J. N., & Todd, R. D. (2003). Autistic traits in the general population. *Archives of General Psychiatry*, *60*(5), 524. https://doi.org/10.1001/archpsyc.60.5.524

Engel-Yeger, B., Gonda, X., Muzio, C., Rinosi, G., Pompili, M., Amore, M., & Serafini, G. (2016). Sensory processing patterns, coping strategies, and quality of life among patients with unipolar and bipolar disorders. *Revista Brasileira De Psiquiatria*, *38*(3), 207–215. https://doi.org/10.1590/1516-4446-2015-1785

Harrell, F. E., & Dupont, C. (2023). *Hmisc: Harrell Miscellaneous* (version 5.1-0) [R package]. https://cran.r-project.org/package=Hmisc

Hoekstra, R. A., Vinkhuyzen, A. a. E., Wheelwright, S., Bartels, M., Boomsma, D. I., Baron-Cohen, S., Posthuma, D., & Van Der Sluis, S. (2011). The construction and validation of an abridged version of the Autism-Spectrum Quotient (AQ-Short). *Journal of*

*Autism and Developmental Disorders*, *41*(5), 589–596. https://doi.org/10.1007/s10803-010-1073-0

Hope, R. M. (2022). *Rmisc: Ryan Miscellaneous* (version 1.5.1) [R package]. https://cran.r-project.org/package=Rmisc

Horder, J., Wilson, C. E., Méndez, M. A., & Murphy, D. (2013). Autistic traits and abnormal sensory experiences in adults. *Journal of Autism and Developmental Disorders*, *44*(6), 1461–1469. https://doi.org/10.1007/s10803-013-2012-7

Hutson, P., & Hutson, J. (2023). Autism in females: Understanding the overlooked diagnoses unique challenges and recommendations. *Journal of Clinical and Medical Images Case Reports*, *3*(3), 1461. https://doi.org/10.55920/2771-019x/1461

Ismael, N., Lawson, L. M., & Hartwell, J. (2018). Relationship between sensory processing and participation in daily occupations for children with autism spectrum disorder: A systematic review of studies that used Dunn's sensory processing framework. *American Journal of Occupational Therapy*, *72*(3), 7203205030. https://doi.org/10.5014/ajot.2018.024075

Johnston, D., Egermann, H., & Kearney, G. (2020). SoundFields: A Virtual Reality Game Designed to Address Auditory Hypersensitivity in Individuals with Autism Spectrum Disorder. *Applied Sciences*, *10*(9), 2996. https://doi.org/10.3390/app10092996

Kamp-Becker, I., Schröder, J., Remschmidt, H., & Bachmann, C. J. (2010). Health-related quality of life in adolescents and young adults with high functioning autism-spectrum disorder. *Psycho-social Medicine*, *7*, Doc03. https://doi.org/10.3205/psm000065

Kassambara, A. (2019). *Datarium: Data Bank for Statistical Analysis and Visualization* (version 0.1.0) [R package]. https://cran.r-project.org/package=datarium

Kassambara, A. (2023a). *ggpubr: 'ggplot2' Based Publication Ready Plots* (version 0.6.0) [R package]. https://cran.r-project.org/package=ggpubr

Kassambara, A. (2023b). *rstatix: Pipe-Friendly Framework for Basic Statistical Tests* (version 0.7.2) [R package]. https://cran.r-project.org/package=rstatix

Kinnealey, M., Koenig, K. P., & Smith, S. (2011). Relationships between sensory modulation and social supports and health-related quality of life. *American Journal of Occupational Therapy*, *65*(3), 320–327. https://doi.org/10.5014/ajot.2011.001370

Lawrence, M. A. (2016). *Ez: Easy Analysis and Visualization of Factorial Experiments* (version 4.4-0) [R package]. https://cran.r-project.org/package=ez

Lin, L.-Y. (2014). Quality of Life of Taiwanese Adults with Autism Spectrum Disorder. *PLoS ONE*, *9*(10), e109567. https://doi.org/10.1371/journal.pone.0109567

Lin, L.-Y., & Huang, P. C. (2017). Quality of life and its related factors for adults with autism spectrum disorder. *Disability and Rehabilitation*, *41*(8), 896–903. https://doi.org/10.1080/09638288.2017.1414887

Long, J. A. (2022). *jtools: Analysis and Presentation of Social Scientific Data* (version 2.2.1) [R package]. https://cran.r-project.org/package=jtools

Lundqvist, L.-O. (2015). Hyper-responsiveness to touch mediates social dysfunction in adults with autism spectrum disorders. *Research in Autism Spectrum Disorders*, *9*, 13–20. https://doi.org/10.1016/j.rasd.2014.09.012

Ma, Z., Xu, L., Li, Q., Li, X., Shi, Y., Zhang, X., Yang, Y., Wang, J., Fan, L., & Wu, L. (2023). Prediction model for Sensory perception abnormality in autism spectrum Disorder. *International Journal of Molecular Sciences*, *24*(3), 2367. https://doi.org/10.3390/ijms24032367

Mayer, J. (2016). The Relationship between Autistic Traits and atypical sensory functioning in Neurotypical and ASD Adults: A Spectrum Approach. *Journal of Autism and Developmental Disorders*, *47*(2), 316–327. https://doi.org/10.1007/s10803-016-2948-5

Pfeiffer, B., Brusilovskiy, E., Bauer, J. A., & Salzer, M. S. (2014). Sensory processing, participation, and recovery in adults with serious mental illnesses. *Psychiatric Rehabilitation Journal*, *37*(4), 289–296. https://doi.org/10.1037/prj0000099

Pisula, E., Danielewicz, D., Kawa, R., & Pisula, W. (2015). Autism spectrum quotient, coping with stress and quality of life in a non-clinical sample – an exploratory report. *Health And Quality Of Life Outcomes*, *13*(1). https://doi.org/10.1186/s12955-015-0370-x

Revelle, W. (2023). *psych: Procedures for Psychological, Psychometric, and Personality Research* (version 2.3.6) [R package]. https://cran.r-project.org/package=psych

Robertson, A., & Simmons, D. R. (2012). The Relationship between Sensory Sensitivity and Autistic Traits in the General Population. *Journal of Autism and Developmental Disorders*, *43*(4), 775–784. https://doi.org/10.1007/s10803-012-1608-7

Salari, N., Rasoulpoor, S., Rasoulpoor, S., Shohaimi, S., Jafarpour, S., Abdoli, N., Khaledi-Paveh, B., & Mohammadi, M. (2022). The global prevalence of autism spectrum disorder: A comprehensive systematic review and meta-analysis. *Italian Journal of Pediatrics*, *48*, 112. https://doi.org/10.1186/s13052-022-01310-w

Schauder, K. B., & Bennetto, L. (2016). Toward an interdisciplinary understanding of sensory dysfunction in autism spectrum Disorder: an integration of the neural and symptom literatures. *Frontiers in Neuroscience, 10*. https://doi.org/10.3389/fnins.2016.00268

Scheydt, S., Staub, M. M., Frauenfelder, F., Nielsen, G. H., Behrens, J., & Needham, I. (2017). Sensory overload: A concept analysis. *International Journal Of Mental Health Nursing*, *26*(2), 110–120. https://doi.org/10.1111/inm.12303

Schrier, E., Schrier, I., Geertzen, J. H. B., & Dijkstra, P. U. (2015). Quality of life in rehabilitation outpatients: normal values and a comparison with the general Dutch population and psychiatric patients. *Quality of Life Research*, *25*(1), 135–142. https://doi.org/10.1007/s11136-015-1060-1

Tavassoli, T., Hoekstra, R. A., & Baron-Cohen, S. (2014). The Sensory Perception Quotient (SPQ): development and validation of a new sensory questionnaire for adults with and without autism. *Molecular Autism*, *5*(1), 29. https://doi.org/10.1186/2040-2392-5-29

Tingley, D., Yamamoto, T., Hirose, K., Keele, L., Imai, K., Trinh, M., & Wong, W. (2019). *Mediation: Causal Mediation Analysis* (version 4.5.0) [R package]. https://cran.r-project.org/package=mediation

De Vries, J., & Van Heck, G. L. (1996, December). *Dutch WHOQOL-BREF*. World Health Organization. Retrieved December 6, 2023, from https://www.who.int/tools/whoqol/whoqol-bref/docs/default-source/publishing-policies/whoqol-bref/dutch-netherlands-whoqol-bref

Wada, M., Hayashi, K., Seino, K., Ishii, N., Nawa, T., & Nishimaki, K. (2023). Qualitative and quantitative analysis of self-reported sensory issues in individuals with neurodevelopmental disorders. *Frontiers in Psychiatry*, *14*. https://doi.org/10.3389/fpsyt.2023.1077542

Ward, J. (2018). Individual differences in sensory sensitivity: A synthesizing framework and evidence from normal variation and developmental conditions. *Cognitive Neuroscience*, *10*(3), 139–157. https://doi.org/10.1080/17588928.2018.1557131

Weiland, R. F., Polderman, T. J. C., Hoekstra, R. A., Smit, D. J., & Begeer, S. (2020). The Dutch Sensory Perception Quotient-Short in adults with and without autism. *Autism*, *24*(8), 2071–2080. https://doi.org/10.1177/1362361320942085

WHOQOL Group. (1994). The Development of the World Health Organization Quality of Life Assessment Instrument (the WHOQOL). In: Orley, J., Kuyken, W. (Eds.), *Quality of Life Assessment: International Perspectives* (pp. 41-57). Springer. https://doi.org/10.1007/978-3-642-79123-9_4

Wickham, H., & Miller, E. (2020). *haven: Import and Export "SPSS", "Stata" and "SAS" Files* [R package version 2.3.1]. https://CRAN.R-project.org/package=haven

Wood, D., Crapnell, T., Lau, L., Bennett, A., Lotstein, D., Ferris, M., & Kuo, A. (2018). Emerging adulthood as a critical stage in the life course. In N. Halfon, C. B. Forrest, R. M. Lerner, & E. M. Faustman (Eds.), *Handbook of life course health development* (pp. 123–143). Springer. https://doi.org/10.1007/978-3-319-47143-3_27

Yuan, H., Lai, C. Y. Y., Wong, M. N. K., Kwong, T. C., Choy, Y. S., Mung, S. W. Y., & Chan, C. C. (2022). Interventions for Sensory Over-Responsivity in Individuals with Autism Spectrum Disorder: A Narrative Review. *Children (Basel)*, *9*(10), 1584. https://doi.org/10.3390/children9101584