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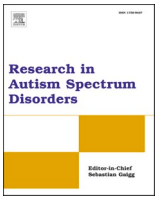

Exploring the effects of age and sex on sensory sensitivities in middle and older aged autistic adults

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ABSTRACT

Purpose: Although sensory sensitivities are common among autistic people, few studies have explored how they may be impacted by ageing. Little is known about the experiences of autistic people across adulthood or about the experiences of people assigned female-at-birth. Some results suggest that autistic people assigned female-at-birth report more sensory sensitivities, but little is known about experiences in middle-aged and older autistic people assigned female-at-birth.
Methods: This study explored self-reported sensory sensitivities and sensory acuity in 210 autistic people aged 42–80 years old. Associations between age and sensory sensitivities were examined using correlational and regression analyses, and t-tests explored differences based on sex-assigned-at-birth.
Results: No significant correlation was observed between age and sensory sensitivities, although older age was associated with poorer sensory acuity. Poorer acuity in vision and hearing was associated with more sensory sensitivities. People assigned female-at-birth reported higher scores for overall sensory sensitivities and low temperature/pain tolerance. Sex-assigned-at-birth, sensory acuity and an age-x-sensory acuity interaction term contributed significantly to a regression model explaining overall sensory sensitivity, but age did not contribute significantly.
Conclusion: This cross-sectional study suggests that sensory sensitivities are stable across middle-age and older adulthood. Results contrast with previous studies in young adults which have suggested reduction in sensory sensitivities with age. In keeping with studies of younger people, middle-age and older autistic adults assigned female-at-birth report higher rates of sensory sensitivities than comparably aged autistic adults assigned male-at-birth. If further studies examining individual change in sensory sensitives replicate these results, then they may contribute to understanding care needs of autistic older people.

Sensory sensitivities are a core feature of autism spectrum conditions (henceforth autism; American Psychiatric Association, 2022). Sensory sensitivities can manifest as hyper- or hypo- sensitivities to stimuli in any sensory domain or in multiple domains (Robertson & Simmons, 2013). The sensory environment is often reported as a source of negative experiences, when sensory stimuli are

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overwhelming for autistic individuals (Joyce et al., 2017; Kapp et al., 2019). However, sensory experiences are also reported as bringing pleasure (Charlton et al., 2021). Importantly, sensory stimuli can be judged as both positive and negative, depending on the circumstances, environment, and individual experiences of events (Boyd et al., 2009; Joyce et al., 2017; Robertson & Simmons, 2015). To date, most research has focused on the sensory experiences of autistic children (Harrop et al., 2014; South et al., 2005). Though studies of the experiences of autistic adults is increasing (Kapp et al., 2019; Nwaordu & Charlton, 2023), few studies have examined sensory experiences among middle-aged and older autistic people or included older age-groups in sufficient numbers to examine age-related differences during adulthood in a meaningful way (Mayer, 2017; Nwaordu & Charlton, 2023; Tavassoli et al., 2014).

Thus far, few studies have considered whether age across the adult lifespan is associated with sensory sensitivities among autistic people. However, where age has been explored results suggest that older age is associated with a reduction in sensory sensitivities. In a study from childhood to mid-life (3–54 years), sensory processing atypicalities decreased with age across most domains (Kern et al., 2006). A study of sensory issues among autistic young and middle-aged adults (age range 18–60 years, mean age=36 years, n = 104) reported that hyposensitivities were negatively correlated with age for autistic people with a diagnosis (n = 182) but not for autistic people without a diagnosis (n = 163) or for non-autistic (n = 146) people (Nwaordu & Charlton, 2023). In the whole sample (including autistic and non-autistic people), older age was associated with lower overall sensory sensitivities and hyposensitivities, although no age associations with hypersensitivities were observed. In contrast, one other study of autistic adults (age range 18–65 years, mean age=42 years, n = 36) found no associations between sensory sensitivities and age (Crane et al., 2009). These cross-sectional studies suggest mixed evidence for age associations with sensory sensitivities. Although a few of these studies include middle-aged and older autistic people, they represent a small proportion of each sample, therefore how age relationships might differ during these later adult years when changes in brain and cognition are accelerating remains an open question. Given the paucity of studies including middle-aged and older autistic people, it remains unclear whether older age may be associated with a reduction (or increase) in sensory sensitivities.

It is well known that changes in sensory acuity are common in later life in the general population (Bowl & Dawson, 2019; Pelletier et al., 2016). Importantly, age-related changes in sensory acuity are associated with reduced activities of daily living, greater cognitive difficulties and lower psychological well-being among older adults in the general population (Humes & Young, 2016; Liu et al., 2022; Merten et al., 2022). In a Scottish population-based sample including children and adults, an autism diagnosis was associated with higher rates of deafness or partial hearing loss, and blindness or partial sight loss (Kinnear et al., 2020; Rydzewska et al., 2018). However, the relationship between sensory acuity and sensory sensitivities and how these factors may interact is not clear. Among autistic people, it has been suggested that variability in sensory processing may interfere with perception which could then impact behaviour and cognitive processes (Haigh, 2018; Kargas et al., 2015). It is possible that age-related changes in sensory acuity may influence the way autistic people experience sensory stimuli, impacting sensory sensitivities and behaviours associated with an often-overwhelming sensory environment (including possible cognitive sequalae; Haigh, 2018). However, to our knowledge, there are no studies that have explicitly examined the relationship between sensory acuity and sensory sensitivity in either autistic or non-autistic people to date. Whether reductions in sensory acuity could change the experiences of sensory sensitivities (in a positive or negative direction), and whether this may impact cognition is not clear.

As well as a lack of information regarding age-effects on sensory sensitivities, how sex-assigned-at-birth in adulthood is associated with sensory sensitivities in autism is not well understood. Although many studies suggest that assigned females demonstrate greater sensitivity to sensory information across a number of domains (Osório et al., 2021), other studies have identified relatively few sensory differences related to assigned-sex (Bitsika et al., 2018; Carson et al., 2022). In the few studies which have explored assigned-sex differences in sensory sensitivities among young adults, assigned females generally report higher scores on both hyper- and hypo-reactivity to sensory stimuli (Gesi et al., 2021), and report more sensorimotor symptoms compared to assigned males (Moseley et al., 2018). However, none of these studies to date has examined assigned-sex differences in middle or later life. Finally, it is important to recognize that age and assigned-sex may not be linked to sensory sensitivities in isolation. Rather, they may interact to influence sensory sensitivities among autistic middle-aged and older people. For example, experiences in middle-age may be different for people assigned female at birth (compared to those assigned male) due to biological processes, such as menopause (Moseley et al., 2021).

In this study we explored sensory sensitivities in middle-age and older autistic adults and examined their age-associations and differences based on assigned-sex. Although there are few studies including this age group, we hypothesized that decreasing sensory sensitivities would be associated with older age as diminishing sensory acuity (e.g., decreased visual and auditory acuity) may lead sensory sensitivities (particularly those related to vision and audition) to become less bothersome in later life. We hypothesized that assigned females would report greater sensory sensitivities than assigned males. Although there is little data among middle- and older-age autistic adults, studies of children, adolescents and young adults suggest that assigned females experience more sensory sensitivities than assigned males. Finally, we explored potential interactions between age and assigned-sex; we hypothesized that assigned males would report fewer sensory sensitivities with older age, whereas assigned females would show some age-related associations with sensory sensitivities.

1. Methods

1.1. Participants

Participants were 40+ year old autistic adults recruited via the Simons Powering Autism Research (SPARK; SPARK Consortium, 2018) Research Match service for an online study of adult development/aging in autism. Participants were compensated $20 for their

time. The study was approved by the local institutional review board and followed procedures in accordance with the Declaration of Helsinki. Of the 226 autistic people who started the study, 210 completed the Sensory Sensitivities Questionnaire (SSQ; Minshew & Hobson, 2008) which constitutes the study sample (aged 42–80 years). For participant details see Table 1.

The autistic adult sample included "independent" adults as designated by SPARK. These independent autistic adult participants are able to consent for themselves and self-report responses to the surveys. No participants reported intellectual disability in the health history questionnaire. To be included in the SPARK registry, participants self-disclosed that they had received an autism spectrum diagnosis from a medical/clinical professional. (Note, self-disclosure of diagnosis has been shown to be accurate when compared against electronic health records in a sample of individuals from the SPARK participant registry; Fombonne et al., 2022). To further validate the ASD clinical diagnosis information provided, participants completed the 28-item self-report Autism spectrum Quotient-28 (AQ28; Hoekstra et al., 2011). Scores > 65 are considered to indicate a positive screen for ASD. In the current sample, 99% of participants (207/209) scored > 65, with one participant not completing the AQ28. An AQ28 score of 65 or lower was not an exclusion criterion. We report these statistics for characterization purposes.

2. Materials

2.1. Demographic information

Participants provided detailed demographic information including age, sex-assigned-at-birth, highest educational level, and current problems with visual or hearing acuity or the need for aids to correct acuity. Visual and hearing acuity were assessed by using responses to two questions that asked if participants have vision problems even when using corrective eyewear and if they have been identified as having a hearing problem (resulting in an ordinal scale of 0-no to both, 1-yes to either, or 2-yes to both).

2.2. Sensory questionnaire

Sensory sensitivities were measured using the self-reported Sensory Sensitivities Questionnaire (SSQ; Minshew & Hobson, 2008). The SSQ includes 13 items exploring sensory sensitivities with a binary response option (Yes/No). Positive (yes) responses were summed to create subscale scores for low temperature/pain tolerance (two items; e.g. more sensitive to pain than others), high temperature/pain tolerance (two items; e.g. high pain tolerance), tactile sensitivity/seeking (three items; e.g. made uncomfortable by touch or texture of clothing), and overall sensitivity (six items; e.g. bothered by sounds). The items included in the overall sensitivity score do not overlap with items included in any of the other subscales, and includes items that reflect sensitivity to sound, light, smell or taste and overall sensitivity to the environment. The items included in the SSQ include characteristics that can be classified as both affective reactivity and behavioural responsivity (see He et al., 2023 for a description of terms), therefore we use the more generic term of sensory sensitivity in keeping with the description of the SSQ. For each subscale, higher scores indicate greater sensory sensitivity within each domain. In the original paper describing the SSQ, good convergent validity was demonstrated through a moderately strong association (rho=.42, $p < .001$) between self- and parent-ratings on this instrument for autistic people (Minshew & Hobson, 2008).

2.3. Statistical analysis

A correlation matrix examined the associations between the variables, particularly associations between sensory sensitivity scores and age. A t-test was run to examine assigned-sex differences in self-reported sensory sensitivities. A regression model was run with sensory sensitivities as the dependent variable and age, assigned-sex, an age x assigned-sex interaction term, visual and hearing acuity/

Table 1
Demographic Information.

	Total N = 210	Female (sex assigned at birth) N = 121	Male (sex assigned at birth) N = 89
Demographic			
Age, mean (SD)	54.86 (9.31)Range 42–80	54.06 (9.13)Range 42–76	55.95 (9.49)Range 42–80
Vision and Hearing Acuity Measure	0, n = 126; 1, n = 66; 2, n = 17; missing, n = 1	0, n = 73; 1, n = 37; 2, n = 10; missing, n = 1	0, n = 53; 1, n = 29; 2, n = 7; missing, n = 0
Race, count (White, African-American, Asian, Native American/Alaska Native, Multiracial, Other)	175, 3, 6, 3, 17, 6	105, 3, 1, 3, 7, 2	70, 0, 5, 0, 10, 4
Ethnicity, count (Latinx, Not Latinx, Unknown, Missing)	8, 198, 2, 2	3, 116, 2, 0	5, 82, 0, 2
Education, count ǂ			
Less than Bachelors degree	72	41	31
Bachelors degree or higher qualification	137	80	57
Mean (SD) Scores			
Low Temperature/Pain Tolerance	0.51 (0.36)	0.57 (0.33)	0.44 (0.40)
High Temperature/Pain Tolerance	0.40 (0.34)	0.42 (0.33)	0.38 (0.36)
Tactile Sensitivity	0.85 (0.45)	0.89 (0.42)	0.80 (0.48)
Overall Sensitivity	0.73 (0.29)	0.78 (0.25)	0.66 (0.32)

ǂ missing, n = 1

correction, and an age x visual and hearing acuity/correction interaction term as the independent variables.

3. Results

3.1. Associations between variables of interest

Age correlated significantly with the vision and hearing acuity measure, indicating increased difficulties with acuity in older age. Age was not significantly associated with any of the sensory measures. The vision and hearing acuity measure correlated significantly with the overall sensory sensitivity score, indicating that diminished sensory acuity was associated with reporting more sensory sensitivities. Among the sensory sensitivity measures, low temperature/pain tolerance negatively correlated with high temperature/pain tolerance and positively with overall sensory sensitivity (but not with tactile sensitivity). High temperature/pain tolerance showed a significant negative correlation with tactile sensitivity, but its correlation with overall sensitivity was not statistically significant. Overall sensory sensitivity and tactile sensitivity were significantly correlated. See Table 2 for full details.

3.2. Differences by assigned-sex

Significant differences based on assigned-sex were observed for self-reported low temperature/pain tolerance ($t = -2.38$, $p = .019$) and overall sensory sensitivity ($t = -3.05$, $p = .003$) among autistic middle- and older-age adults. Results indicated that autistic people assigned female at birth reported higher scores on both low temperature/pain tolerance and overall sensory sensitivity than autistic people assigned male at birth. No significant sex differences were observed for high temperature/pain tolerance ($t = -0.785$, $p = .433$) or tactile sensitivity ($t = -1.32$, $p = .190$).

3.3. Regression to explore variables contributing to overall sensory sensitivity

A linear regression was performed with overall sensory sensitivity as the dependent variable. Included as independent variables were age, assigned-sex, an age x assigned-sex interaction term, the vision and hearing acuity measure, and an age x visual and hearing acuity interaction term. The model was significant (F=4.64, $p = .001$) and explained 8.4% of the variance. Assigned-sex ($\beta = .219$, $p = .001$), the vision and hearing acuity measure ($\beta = .221$, $p = .003$), and the age x visual and hearing acuity interaction term ($\beta = -.146$, $p = .042$) contributed significantly to the model. Age ($\beta = .065$, $p = .364$) and the age x assigned-sex interaction term ($\beta = .036$, $p = .587$) did not contribute significantly to the model.

4. Discussion

The aim of this paper was to examine sensory sensitivities and their potential links to age and sex-assigned-at-birth among middle-aged and older autistic adults. Importantly, no significant associations between age and sensory sensitivities were observed, suggesting that sensory sensitivities may remain stable across middle-age and older adulthood. These results are in contrast to previous cross-sectional studies of autistic adults which showed diminished sensory sensitivities linked to older age (Crane et al., 2009; Kern et al., 2006; Nwaordu & Charlton, 2023). However, it is worth noting that the age range of people in the current study is older (mean age ~55 years, maximum age 80 years) than previous studies (where the oldest mean age was 42 years). It is not yet clear whether the difference in results relates to age alone or to other sample-specific characteristics. It is important to note that all of the studies to date rely on cross-sectional data, and it is only through longitudinal studies that we will better understand individual differences in sensory sensitivity changes across adulthood.

In the current sample, vision and hearing acuity were worse among older people, indicating that autistic people demonstrate similar age-related differences in acuity as non-autistic people (Bowl & Dawson, 2019). Vision and hearing acuity were not significantly associated with pain tolerance or tactile sensitivity. Results indicated that the vision and hearing acuity measure, assigned-sex

Table 2
Correlation matrix showing associations between age and sensory measures.

	Age	Vision & Hearing Acuity	Low Temperature/Pain Tolerance	High Temperature/Pain Tolerance	Tactile
Vision & Hearing Acuity	$r = .340$, $p < .001$	-	-	-	-
Low Temperature/Pain Tolerance	$r = .054$, $p = .436$	$r = .104$, $p = .133$	-	-	-
High Temperature/Pain Tolerance	$r = .054$, $p = .439$	$r = .125$, $p = .073$	$r = -.254$, $p < .001$	-	-
Tactile	$r = .089$, $p = .201$	$r = -.035$, $p = .616$	$r = .122$, $p = .078$	$r = -.167$, $p = .016$	-
Overall Sensory Sensitivity	$r = .074$, $p = .289$	$r = .193$, $p = .005$	$r = .256$, $p < .001$	$r = .118$, $p = .089$	$r = .259$, $p < .001$

and an age x acuity interaction term were significantly associated with overall sensory sensitivity. The overall sensitivity scale includes items relating to being bothered by sound and light, but also smell, taste, and the broader sensory environment, including crowds. Poorer acuity and being assigned female at birth were associated with more overall sensory sensitivities. Results may reflect that as acuity in vision and hearing is reduced in later life, people may feel less able to cope with busy environments more generally (Haigh, 2018; Kargas et al., 2015). However, the age x acuity interaction term suggests that people who were younger and had better acuity reported higher overall sensory sensitivities, which is in keeping with the suggestion that decrements in vision and hearing acuity with age may reduce sensory sensitivities (Kern et al., 2006; Nwaordu & Charlton, 2023). Results indicate different patterns of associations for the acuity measure compared to the age x acuity interactions term. Caution should be taken in interpreting these findings as the acuity measure is skewed with very few people indicating difficulties with both visual and hearing acuity. Furthermore, although acuity was queried (and reduced) in vision and hearing, other sensory domains such as touch or pain tolerance may be less impacted by age. There may be value in examining a more nuanced view of how age impacts different sensory domains.

Assigned-sex was found to be associated with experiences of some but not all sensory sensitivities. In keeping with some studies in younger autistic people, within this middle- and older-aged group, those assigned female sex at birth reported higher rates of overall sensory sensitivity (Gesi et al., 2021; Osório et al., 2021). Middle- and older-age autistic people assigned female at birth also reported higher rates of low temperature/pain tolerance, but no assigned-sex differences were observed for high temperature/pain tolerance or tactile sensitivity. This is partly in keeping with at least one study of autistic children, where no sex differences were noted for tactile and many other domains of sensory sensitivity (Bitsika et al., 2018). Further studies examining patterns of hypo- and hyper-sensitivity across different domains, and in different situations are likely to be important for better understanding differences related to assigned-sex among autistic adults.

It is important to consider limitations of this study. Middle- and older-age autistic adults in this study agreed to participate in an online survey. Therefore, task demands and confidence using computers may have biased participation towards people with likely higher levels of education. Additionally, findings from the current study may not apply to autistic people with higher support needs. However, a strength of this study is that it measures self-reported sensory sensitivities in a large group of middle- and older-aged autistic people, many of whom were assigned female at birth. Both older autistic people and those assigned female at birth have previously been underrepresented in research.

To our knowledge, this is the first study to explore sensory sensitivities among middle- and older-aged autistic people. Results suggest that age associations with sensory sensitivities are minimal during this period of adulthood, but assigned-sex differences persist. Although further studies are required to replicate these findings, if supported, they have substantial implications for understanding the experiences of autistic adults as they age. Further studies exploring the longitudinal change and association between sensory sensitivities and other variables including sensory acuity changes are sorely needed.

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Declaration of Competing Interest

The authors have no conflicts of interest to declare.

Data availability

The authors do not have permission to share data.

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