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Ecological Momentary Assessments of Daily Sensory Experiences in Autistic Adults: A Mixed-Methods Analysis of Contextual Factors Impacting Sensory Processing

Michelle M. Luszawski, *Western University*

Supervisor: Stevenson, Ryan A., *The University of Western Ontario*

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Abstract

Autistic individuals report sensory processing issues, which may impact daily experiences and abilities in educational and employment circumstances. Research that has explored contextual impacts on sensory processing is lab-based, lacking ecological validity, or qualitative and questionnaire based, introducing recall bias. We used ecological momentary assessment to investigate the daily sensory experiences of 41 autistic adults, who completed three daily questionnaires regarding their sensory experiences for two weeks. We conducted a mixed-methods analysis of their data. Results indicated significant associations between participants' positive, negative, and neutral sensory experiences and their surroundings and other contextual factors. We found no significant relationship between these experiences and their scores on standardized measures of autistic traits. Our thematic analysis revealed themes related to stimuli impacting, reactions to, and coping mechanisms for sensory experiences. These findings have implications for autistic adults to identify coping mechanisms to negative sensory experiences and create more sensory inclusive environments.

Key words:

Autism spectrum disorder, sensory processing, daily sensory experiences, ecological momentary assessment, contextual factors.

Lay Summary

Autistic people often have problems with how they sense information like things we see, hear, touch, smell, and feel. They may feel that some things are too loud, bright, or hot, while others are too dull, quiet, or cold. Sometimes, they may feel uncomfortable depending on what they sense. We want to know what things autistic adults sense at home and at work that make them feel this way. We also want to know where they are and who they are with when they feel this way, and what they do to feel better.

Other studies have tried to find out these things using different behavioural experiments, but these experiments do not consider what you sense in everyday life. Other studies have used interviews to ask autistic adults about these things, but sometimes during interviews, you forget what you sensed in the past. We want to find out what autistic adults sense in their everyday life at the time they are sensing it.

We studied this by asking autistic adults to answer surveys about their senses and behaviours. We then texted them a short survey 3 times per day for two weeks. The survey was about the autistic adult's in-the-moment mood, senses, and surroundings. We found that things like where the person was, who they were with, and their feelings and mood impacted their sensory experiences. We also found no relationship between the responses on the first survey and those on the daily surveys. This may mean that autistic adults sense different things in real time than typical questionnaires ask them about.

This study is important for understanding which things in an autistic adult's surroundings impact their senses, how they react to these things, and what they can do to help them feel better when their senses make them feel uncomfortable. This information can help them make changes

to the home and work settings that can lower their sensory problems, improving their daily living.

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Chapter 1

1 Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental disorder that affects 1 in 68 individuals in the general public (Faja & Dawson, 2017). This disorder is characterized by weaknesses in social communicative abilities and the presence of restricted interests and repetitive behaviours (American Psychiatric Association, 2022). In addition to these core features, up to 90 percent of autistic individuals have sensory processing issues related to differences in sensitivity to various stimuli (Crane et al., 2009). These issues may lead to uncomfortable, negative sensory experiences for autistic individuals in daily life, impacting their ability in educational and employment circumstances (Kinnealey et al., 2011), and leading to problem behaviours (Schulz, Kelley, et al., 2023). For example, certain lighting, sounds, and differences in temperature can distract autistic individuals in employment or educational environments (Black et al., 2022). Further, autistic individuals may engage in repetitive behaviours in response to or to cope with different sensory experiences. For example, they may increase their movement (such as jump or spin), stim (flap their hands or rock back and forth), cover their ears or eyes, and avoid certain clothing or foods (Kirby et al., 2015). These repetitive behaviours can be stigmatizing and socially inappropriate (Lam & Aman, 2007), occupy hours of an affected individual's day (Gordon, 2000), interfere with healthy exploration of the environment (Pierce & Courchesne, 2001), and impede many types of learning (Jones et al., 2020; Koegel et al., 1974; Varni et al., 1979). Together, these behaviours may further impact autistic individuals' communication abilities and engagement in social settings.

Understanding which contextual factors impact an autistic individual's sensory processing is therefore important for helping them adjust to various sensory experiences and identify coping mechanisms that may help them during negative sensory experiences. Further, by identifying these contextual factors, changes can be implemented in educational and employment environments to make them more sensory inclusive. Sensory inclusive environments may help mitigate the amount of socially infringing behaviours autistic individuals engage in in reaction to or to cope with negative sensory experiences and may therefore contribute to increased social and educational learning opportunities for autistic individuals.

1.1 Theories of Sensory Processing in ASD

There is a high level of heterogeneity in responses to sensory stimuli, both between individuals, but also within individuals across different contexts (Kinnealey et al., 2011; Scheerer et al., 2021; Tavassoli et al., 2014). Sensory processing issues in autistic individuals can be attributed to the modality of the sensory stimuli, the individual's sensitivity level, and the various contextual factors in a given sensory experience. Autistic individuals have shown differences in sensory processing in response to all sensory modalities (Baum et al., 2015), ultimately contributing to sensory processing issues in these domains. These issues can also be defined as either hypo- or hypersensitive. Hypersensitivity is defined as an individual's enhanced ability to detect and perceive a sensory input. Hyposensitivity is an individual's diminished ability to detect and perceive a sensory input (Schulz & Stevenson, 2019).

There are numerous theories that attempt to explain the differences in sensory processing experienced by autistic individuals. Ayres' (Ayres & Tickle, 1980) theory of *Sensory Integration* *and the Child* defined sensory integration[1] as the ability to produce appropriate motor and behavioural responses to stimuli. Specifically, Ayres' theory noted that in addition to autistic individuals displaying hypo- and hypersensitivity to stimuli, they also display difficulties with registration, modulation, interacting with stimuli, and motivation. Registration is defined as an individual's ability to both detect and recognize the significant meaning of a sensory stimulus (and is therefore highly related to sensitivity), modulation is defined as an individual's ability to inhibit or propagate a sensory signal, and motivation is defined as the individual's desire or willingness to either respond to or ignore a stimulus. Ayres suggested that autistic children do not register sensory input properly, have trouble modulating the sensory input that they do register, and do not have enough motivation to carry out certain activities (Kilroy et al., 2019). Together, these factors result in difficulties with sensory processing that autistic individuals demonstrate.

Dunn (Dunn, 1997) suggests an alternative model of sensory processing. In her model, Dunn proposes that sensory processing behavioural patterns fall into four categories: low registration (a slow or lack of response to a sensory stimuli), sensory sensitivity (discomfort from certain sensory stimuli), sensation seeking (seeking out a stimulating sensory environment), and sensation avoiding (avoidance of sensory stimuli that cause discomfort or distress). These categories do not form four distinct quadrants, rather they make up an interaction of behavioural responses and neurological thresholds. According to Dunn, autistic individuals can therefore present with any or all of these behavioural patterns, depending on how their individual

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[1] Please note that this definition of sensory integration differs from multisensory integration, which is defined as the ability to integrate sensory information from multiple modalities into a unified precept (Stevenson, Ghose, et al., 2014).

behavioural responses and neurological thresholds interact. Differences in these patterns can affect sensory processing.

Though these two models are well established in the literature regarding sensory processing, recent research highlights the inconsistent use of terms such as sensory sensitivity, sensory reactivity, and sensory responsivity in the literature (He et al., 2023). As a result, different measures of "sensory sensitivity" may be assessing reactivity or responsivity. For example, standardized questionnaires commonly used to assess an autistic individual's sensory sensitivity may be assessing their reactivity (Schulz & Stevenson, 2020). This discrepancy in nomenclature may be misleading our understanding of sensory processing differences in ASD.

1.2 Differences in Sensory Processing in ASD

1.2.1 Behavioural Measures

Autistic individuals demonstrate differences in behavioural measures of sensory processing across sensory modalities in comparison to neurotypical individuals. In the auditory domain, autistic individuals demonstrate enhanced discrimination in pure-tone pitch (frequency) when compared to neurotypical individuals (Bhatara et al., 2013; Bonnel et al., 2010; Chen et al., 2022; Jones et al., 2009; Lepistö et al., 2005). However, differences in the duration (Jones et al., 2009; Kasai et al., 2005; Lepistö et al., 2007, 2008) and intensity (Bruneau et al., 1999, 2003; Jones et al., 2009; Lepistö et al., 2009) of pure tone stimuli, as well as the perception of complex tones (Cheng et al., 2017; Chowdhury et al., 2017) are not as clear (Haesen et al., 2011). Further, autistic individuals exhibit differences in sensory gating, particularly in the auditory domain (Schulz, Luszawski, et al., 2023).

Autistic individuals show patterns of hypersensitivity to visual stimuli, specifically to change detection, visual acuity, and detection thresholds. Autistic adults show improved visual acuity (Ashwin et al., 2009), increased sensitivity to minute changes in visual stimuli (Clery, Andersson, et al., 2013; Clery, Roux, et al., 2013), increased activation in sensory related brain pathways (Green et al., 2013), enhanced perception of simple (static) but not complex (with varying textures) visual stimuli (Bertone et al., 2005), and increased sensitivity to various frequencies of sensory stimuli (Kéïta et al., 2014) compared to neurotypical adults. Children show similar patterns in studies of visual change (Cléry et al., 2013) and visual detection (Pellicano et al., 2005). However, autistic individuals do not display increased sensitivity to contrast when compared to neurotypical individuals. Rather, they show the same sensitivity to these stimuli as neurotypical individuals (Matson et al., 1997; Poustka & Lisch, 1993; Shafai et al., 2015; Thompson & Berkson, 1985). Thus, while autistic individuals show increased sensitivity to various aspects of sensory stimuli compared to neurotypical individuals, this increased sensitivity does not apply to all aspects of sensory stimuli.

In the tactile domain, findings are mixed regarding autistic individuals' detection thresholds and adaptation levels (Mikkelsen et al., 2018), with some research suggesting decreased detection thresholds in autistic individuals compared to control individuals (Blakemore et al., 2006; Puts et al., 2014), while other research suggests no difference exists between groups (Cascio et al., 2008; Güçlü et al., 2007; O'Riordan & Passetti, 2006; Tavassoli et al., 2016). Similar results are found in behavioural measures of adaptation to tactile stimuli (Puts et al., 2014; Tannan et al., 2008; Tommerdahl et al., 2007, 2008).

Findings from behavioural studies regarding olfactory sensitivity in ASD are also mixed. One meta-analysis investigated olfactory sensitivity in autistic compared to non-autistic individuals using measures of odor identification and threshold (Larsson et al., 2017). Substantial differences were found in the effect sizes of included studies, suggesting there is a great level of heterogeneity in autistic individuals' olfactory sensitivities and supporting both hypo- and hypersensitivity to olfactory stimuli in autistic individuals.

Very little research has behaviourally investigated gustatory sensitivity in autistic individuals. One study examined autistic individuals' taste identification for sweet, salty, sour, and bitter tastes (Bennetto et al., 2007). Autistic children and adolescents did not differ from typically developing children in their identification of sweet and salty tastes but did display impaired identification in the sour and bitter tastes. Similar results were found in autistic adults, except for the sweet taste, where autistic adults display increased identification (Tavassoli & Baron-Cohen, 2012). Further, autistic individuals do not seem to display a difference between neurotypical individuals on detection thresholds of gustatory stimuli (Boudjarane et al., 2017; Damiano et al., 2014; Loucks & Doty, 2004).

In addition to sensory processing issues within each modality, autistic individuals also exhibit differences in how they integrate sensory information across modalities. This has been observed in audiovisual, audiotactile, visuohaptic, and visual-vestibular interactions, among others (Ainsworth et al., 2021; Bebko et al., 2014; Brandwein et al., 2013; Feldman et al., 2018; Ostrolenk et al., 2019; Russo et al., 2010; Segers et al., 2020; Stevenson, Siemann, Schneider, et al., 2014; Stevenson, Siemann, Woynaroski, et al., 2014a, 2014b; Stevenson et al., 2017; Woynaroski et al., 2013). In general, autistic individuals show a decrease in the ability to integrate information across sensory modalities into a unified perceptual Gestalt. While multisensory stimuli are more representative of the stimuli autistic individuals perceive in their everyday lives, similar to unisensory processing this appears to differ based on the type of stimulus presented, as well as where in development the individual is. There is growing evidence that differences between autistic and neurotypical individuals decreases further into development, where autistic individuals “catch up” with their neurotypical peers (Foxe et al., 2015). Issues in multisensory integration have been demonstrated to covary with sensory responsiveness (Feldman et al., 2019), and to have a cascading effect on cognitive processes that rely on sensory processing, including the social communication aspects of ASD (Siemann et al., 2013; Stevenson et al., 2018; Stevenson, Segers, et al., 2014; Wallace et al., 2020; Wallace & Stevenson, 2014).

Thus, findings from behavioural measures of sensory processing are somewhat mixed regarding how autistic individuals differ from neurotypical individuals on these tasks. It seems that differences vary across sensory domains and the age of the individuals, with autistic children showing more pronounced sensory processing differences in visual, auditory, and olfactory domains compared to tactile and taste domains.

1.2.2 Questionnaire Measures

There is vast evidence using questionnaire measures of sensory processing that suggests that autistic individuals display more severe hypersensitivity compared to non-autistic individuals. The most commonly used questionnaire of sensory processing in ASD is the Sensory Profile (SP; Brown & Dunn, 2002; Dunn, 2014). The SP is used to assess an individual’s sensitivity to various stimuli, their sensory seeking or avoiding behaviours, and their ability to register stimuli. The SP has been adapted to be used with infant, child, adolescent, and adult populations. Across all populations, evidence suggests heightened sensory sensitivity in autistic compared to non-autistic individuals (Ben-Sasson et al., 2007; K. R. Black et al., 2017; Brockevelt et al., 2013; Crane et al., 2009; Dunn et al., 2002; Kern et al., 2006; Narzisi et al., 2022; Schulz & Stevenson, 2019; Tomchek & Dunn, 2007). Some evidence also exists for increased sensation avoiding in autistic compared to neurotypical adults (Syu et al., 2020). Further, two meta-analyses have investigated sensory over-responsivity, sensory under-responsivity, and sensation seeking behaviours in autistic compared to neurotypical individuals (Ben-Sasson et al., 2009, 2019). Both meta-analyses yielded large and significant evidence in support of an increase of symptoms in autistic compared to neurotypical individuals. Specifically, across the 30 studies investigating sensation seeking behaviours, a large, positive effect size was found, (d = 0.66, *95% CI* [0.25, -1.07]; Ben-Sasson et al., 2019), suggesting increased sensation seeking behaviours in autistic individuals compared to neurotypical individuals. Interestingly, age, IQ, and self-report measures were significant moderators of this effect.

Other commonly used measures of sensory processing in ASD include the Sensory Perception Quotient (SPQ; Tavassoli et al., 2014), the Sensory Processing Measure (SPM; Parham et al., 2007), and the Sensory Processing Scale Inventory (SP Scale Inventory; Schoen et al., 2017). Results from these studies also indicate differences in sensory processing in autistic compared to neurotypical individuals, specifically demonstrating increased sensory sensitivity compared to neurotypical individuals on measures of the SPQ (Taylor et al., 2020) and the SP Scale Inventory (Tavassoli et al., 2018).

1.2.3 Limitations of Behavioural and Questionnaire Measures of Sensory Processing

Although these behavioural studies provide support for differences in sensitivity and processing to different sensory stimuli in autistic individuals, they fail to demonstrate the contextual factors that might impact their sensory sensitivity. Lab-based studies often lack ecological validity that would indicate how factors such as where the individual is, who they are with, and how they are feeling in response to a sensory experience might impact their sensory processing. Thus, additional research is needed to explain what autistic individuals are sensing and how this is affecting their sensory processing.

Similarly, although sensory questionnaires have important implications for studying sensory processing more generally, they do not provide information regarding the specific contextual factors that affect sensory processing. This is because it is difficult to parse out contextual factors when asking questions regarding sensory responses without providing any context. Additionally, responses from sensory questionnaires may be biased by recall, since participants typically complete the sensory questionnaires sometime after the sensory experience occurred. As a result, they may not remember some of the specific details or factors that contributed to the experience.

1.3 Sensory Experiences of Autistic Individuals

In addition to differences in sensory related behaviours, the context of a given sensory experience may also impact an autistic individual's sensory processing, given that who the individual is with, what they are doing, and where they are, are all important factors that can contribute to heterogeneity in sensory experiences within individuals. Current research on these contextual factors is limited and inconsistent due to the lack of ecological validity in questionnaires of sensory experiences in ASD and the potential for recall bias in qualitative studies of sensory processing in ASD.

1.3.1 Questionnaire Measures

Beyond measuring sensory processing and sensory related behaviours more generally, questionnaires are also used to evaluate autistic individuals' sensory experiences. The Sensory

Experiences Questionnaire (SEQ; Baranek et al., 2006) is a caregiver report of autistic children's sensory features in social and non-social contexts. Based on their scores on the SEQ, autistic children display increased levels of sensory features and patterns of hyporesponsiveness in social and non-social contexts when compared to children with other developmental delays (Baranek et al., 2013). Autistic children's scores on the SEQ have also been positively associated with hyporesponsiveness and social-communicative symptom severity (Watson et al., 2011). Taken together, these findings suggest sensory features of autistic children have impacts across various contexts, contributing to potentially negative sensory experiences.

1.3.2 Qualitative Studies

Qualitative studies (including semi-structured interviews, focus groups, and open-ended, qualitative questionnaires) allow participants to describe their sensory experiences, their reactions to these experiences, and the coping strategies they use to deal with negative sensory experiences. During semi-structured interviews with children with varying levels of autistic traits, children described reacting to negative sensory stimuli with uncontrollable physical responses (such as crying, pain, nausea, dizziness) and feelings of fear and anxiety. To cope with these negative experiences, children avoided the situation which led to the negative sensory experience (Kirby et al., 2015). Similar coping mechanisms have been used by autistic adolescents, who during semi-structured interviews described avoiding challenging sensory situations as a strategy. They also identified increased control and predictability of a situation as a factor that contributed to positive sensory experiences, while uncontrollable, unexpected, and unpredictable sensory experiences were negatively perceived (Ashburner et al., 2013).

Autistic adults report different reactions and coping mechanisms to their sensory experiences. During a focus group, six autistic adults described how the intensity and frequency of the stimuli impacted their sensory experiences, such as how an intense smell or a sound of high frequency contributed to negative sensory experiences (Robertson & Simmons, 2015). However, they reported that factors such as being in control of their environment and being in a good mood contributed to positive sensory experiences. Physical responses to negative sensory experiences included headaches and nausea, while responses to positive experiences included relaxation and help falling asleep. Autistic adults also report hypersensitivities to visual stimuli, including to light, motion, patterns, and particular colours (Parmar et al., 2021). These visual hypersensitivities can be distracting to autistic adults and can impact their ability to integrate information from multiple sensory modalities.

Autistic adults have identified adapting their environment and increasing their understanding of their sensory experiences as coping mechanisms to negative sensory experiences (Parmar et al., 2021; Robertson & Simmons, 2015; Talcer et al., 2023). Similar results were found in a study of 160 autistic adults, who identified their sensory sensitivity as having negative physical, cognitive, and emotional effects on themselves. Specifically, this sensitivity contributes to feelings of nausea, anxiety, and confusion. These adults identified stimming as a coping mechanism for negative sensory experiences (Charlton et al., 2021).

1.3.3 Limitations to Qualitative Studies of Sensory Experiences

Although the results from qualitative studies provide context behind participants' responses, interviews and qualitative questionnaires are completed after the sensory experiences that participants describe. This after-the-fact method of obtaining data is subject to recall bias. In other words, participants may make errors in their recall of previous sensory events. A method of collecting more in-the-moment data would help to decrease the likelihood of recall bias, and thus may give a more accurate representation of sensory experiences. Further, very few qualitative studies have assessed the contextual factors that impact the sensory experience an autistic individual has. Thus, more research is needed to better understand how factors such as where the individual is, who they are with, and what they are feeling impact their sensory experiences.

1.4 Contextual Factors Impacting Sensory Experiences

There has been limited research that has reported on the specific contextual factors that impact autistic individuals' sensory experiences. In a mixed-methods study, 49 autistic adults completed online surveys regarding their sensory experiences (MacLennan et al., 2022). Researchers conducted a quantitative and thematic analysis of participants' responses and identified themes related to outcomes, control, tolerance and management, and the role of other people as affecting their sensory experiences. Autistic adults reported positive sensory experiences when they felt they had a high level of control over their environment and had positive emotions. Furthermore, they identified that being surrounded by close family or friends helped them cope with negative sensory experiences.

Work environments also seem to have an impact on autistic adults' sensory experiences, with research from interviews with autistic adults suggesting that the various voices, bright florescent lights, and glossy paint on the walls in an office environment are distracting and affect their cognitive, physical, and emotional well-being while at work (Bontempo, 2009). Similar findings occur for autistic adults at university or college, where noises like the clicking of pens and people's voices contribute to negative sensory experiences, whereas piano playing in a common room contribute to positive sensory experiences. Alternatively, various smells such as food, cigarette smoke, or coffee can contribute to positive or negative olfactory experiences depending on the individual (Howe, 2023).

Additional research suggests the type of auditory stimuli impacts decision-making and perception in autistic compared to non-autistic individuals. Specifically, autistic adults reported qualitative experiences of non-social (i.e., fridge humming) and social sounds (i.e., people talking) more negatively than no sounds during a shopping decision-making task (Bellamy et al., 2021). They also experienced social sound conditions more negatively compared to non-autistic individuals. Interestingly, during the same task, their decision-making latency and consistency were measured, along with their heart rate. No statistically significant differences were found in these subjective measures between autistic and non-autistic individuals, suggesting that negative sensory experiences of autistic individuals may not translate to subjective differences in cognitive tasks such as decision making.

1.4.1 Evidence from Indoor Environmental Quality Design

Other research has sought to determine how indoor environmental factors impact perception in autistic individuals. One scoping review investigated indoor environmental quality design (IEQ), specifically, the sensory response of autistic individuals to thermo-reception, sight, olfaction, and hearing (Zaniboni & Toftum, 2023). The review is inconclusive in its suggestions for creating comfortable indoor environments for autistic individuals. This is due to many studies focusing on children and school environments, discrepancies between study suggestions (such as natural light through windows which some studies suggest is distracting while others suggest it help circulate circadian cycles), and suggestions based on studies with small sample sizes that do not generalize to the larger autistic community. Another study reported important considerations for improving IEQ for autistic individuals and suggested recommendations for designers, policymakers, and clinicians (Black et al., 2022). Recommendations for design and construction, lighting, sound, and temperature were provided; however, researchers noted the challenge of creating sensory inclusive environments given the large heterogeneity of preferences for sensory stimuli in autistic adults. Though important, these findings stem from improving the quality of indoor environments and does not consider how these environments impact sensory processing in autistic individuals. Further, these reviews did not consider outdoor environments, or contextual factors in addition to indoor environmental factors that may be impacting sensory perception in autistic individuals. More research regarding the degree to which these environments impact sensory processing and sensory sensitivity in autistic individuals is needed.

1.5 Current Study

Understanding the contextual factors that impact autistic individuals' sensory experiences, their reactions to these sensory experiences, and their coping mechanisms to negative sensory experiences is an area of interest to researchers, autistic individuals, and their parents and educators. The contextual factors that affect sensory processing in autistic individuals are unclear, likely due to the lack of ecological validity in lab-based studies and recall bias in questionnaire and qualitative studies. We had two major goals for this study. The first was to address the limitations of previous studies to gain a greater understanding of the in-the-moment sensory experiences of autistic adults and the contextual factors that affect these experiences. Identifying these factors is the first step to creating more sensory inclusive environments and positive sensory experiences for autistic individuals. The second goal for this study was to determine whether the daily sensory experiences of autistic individuals relate to standardized questionnaires of sensory processing and autistic traits, such as the Sensory Profile and the Social Responsiveness Scale. Determining this relationship is important for understanding the ecological validity of standardized questionnaires of sensory processing and autistic traits. Thus, this study sought to improve our understanding of everyday sensory experiences and processing of autistic adults.

In this study, we assessed the contextual factors that affected autistic adults' sensory experiences using ecological momentary assessment (EMA), a technique used to obtain in-the-moment questionnaire responses. This method works by repeatedly sampling an individual's behaviour and experiences in real time, prompting them to complete an online survey multiple times a day, in different contexts. In the past, EMA has been used in mindfulness studies, behavioural medicine studies, and studies with deaf individuals to personalize hearing aid fitting (Enkema et al., 2020; Galvez et al., 2012; McKeon et al., 2018; Moore et al., 2016; Wu et al., 2015). Few studies have used EMA with autistic individuals (Khor et al., 2014; van der Linden et al., 2021); however, to my knowledge, no study to date has used EMA to investigate the sensory experiences of autistic individuals.

EMA does seem to be a feasible and valid measure to use with autistic individuals. One study of 31 autistic adolescents used a cellphone EMA application to respond to a questionnaire that assessed their stressors and coping mechanisms (Khor et al., 2014). They completed the questionnaire four times a day over the course of two weeks. Feedback from the responses indicated that the EMA of stressors and coping mechanisms was valid and feasible. EMA has also been used with autistic adolescents to study depressive symptoms and depression, using 6 daily reports of these factors for one week. Similar results were found in autistic adults who completed one survey a day for 30 days regarding their leisure activities. Feedback from these adults suggested that the survey timing was convenient and easy to respond to (Song et al., 2023). These findings suggest that EMA is a useful technique for assessing in-the-moment responses from autistic individuals. However, these studies did not specifically address sensory experiences.

Thus, we investigated the daily sensory experiences of autistic adults using EMA. We predicted that contextual factors such as an individual's surroundings and affect would impact their sensory experiences. Specifically, we predicted there would be an association between the proportion of the participant's positive, negative, and neutral sensory experiences, and where they were (with low proportions of negative sensory experiences reported at home), who they were with (with low proportions of negative sensory experiences reported when participants were with family and close friends), and their affective states (with positive affective states being associated with high proportions of positive sensory experiences and negative affective states being associated with high proportions of negative sensory experiences). We also predicted that there would be a significant, positive relationship between participants' proportion of negative sensory experiences and the severity of their autistic traits as indicated by their scores on standardized measures of sensory processing and autistic traits.

Chapter 2

2 Methods

2.1 Participants

A total of 41 adults (M_{age} = 30.02 years; *SD* = 8.96 years; range = 17 – 51 years) who had received a community diagnosis of ASD participated in the study. Additional demographic information can be found in Table 1. Participants were recruited using OurBrainsCAN: Western University's Cognitive Neuroscience Research Registry, as well as through community groups such as Facebook, and through snowballing recruitment (i.e., by word of mouth). Participants over the age of 17 were invited to participate. If participants were unable to respond to the questionnaires themselves, their parents or caregivers responded on their behalf. Inclusion criteria consisted of a community diagnosis of ASD, fluency in English, and access to a phone that received SMS text messages and connected to the internet. Participants were excluded from the study if they had known visual or hearing impairments that were not corrected to normal or if they did not have a phone that met the technological requirements. Participants were given $20 for their participation in the study. Western University's Non-Medical Research Ethics Board approved all study procedures and materials (see Appendix A and Appendix B). All methods were performed in accordance with the relevant guidelines and regulations and informed e-consent was obtained from all study participants (Appendix C and Appendix D).

Table 1

Descriptive Statistics of Participants

Group	*N*	M_{age}	SD_{age}
Male	6	30.8	8.1
Female	34	29.5	9.1
Non-Binary	1	43.0	0.0

Note: Age is measured in years.

2.2 Materials

2.2.1 Initial Questionnaire

Participants completed an initial questionnaire that provided background information. The questionnaire included demographic information, any treatments they were receiving, any other diagnoses they had (including anxiety, depression, ADHD, OCD, PTSD), and an outline of their daily schedule (i.e., when they typically woke up, went to bed, any off-limit times, and when they were at work/school). The schedule provided was important to ensure participants were prompted at times when they were awake and had their phones on them to be able to respond to the Ecological Momentary Assessment survey (described below).

Participants also completed pre-existing questionnaires including the Adolescent/Adult Sensory Profile (AASP; Brown & Dunn, 2002; Dunn, 2014) and the Social Responsiveness Scale – Second Edition (SRS – 2; Constantino & Gruber, 2012). The AASP contains 60 items that assess sensory processing in both sensory and behavioural domains. Individuals respond to 5-point Likert scale items (ranging from “Almost Never” to “Almost Always”) regarding their sensitivity to various stimuli, their sensory seeking or avoiding behaviours, and their ability to register to stimuli. Higher scores on the AASP indicate higher sensory dysfunction. The SRS-2 assesses behaviour as well as social responsiveness and provides information regarding the severity of an individual's autistic traits. The adult version, the Social Responsiveness Scale – 2 Adult Self-Report (Constantino & Gruber, 2012), contains 65 items on a 4-point Likert scale (ranging from "Not True" to "Almost Always True"). Higher scores on the SRS-2 indicate severe deficits in social interaction and are strongly associated with a clinical diagnosis of ASD. Including questions from the AASP and the SRS-2 into the Initial Questionnaire provided information on participants' sensory processing differences and the severity of their autistic traits.

2.2.2 Ecological Momentary Assessment Survey

After completing the initial survey, participants were sent three opportunities a day to respond to a short, online survey. The survey was specifically designed to assess participants' in-the-moment sensory experiences. It was created by two researchers (S.S. and M.L.) based on findings from the literature regarding sensory processing problems related to hyposensitivity and hypersensitivity in individuals with ASD, as well as the contextual factors that contribute to these problems (Ashburner et al., 2013; Robertson & Simmons, 2015). The survey assessed the participants' momentary level of control over their environment, their emotions and mental states, their reactions to sensory stimuli in their environment, and the aspects of the sensory stimuli. The survey was then reviewed and piloted by two community partners (one parent of an autistic child and one autistic adult) and research members to assess its clarity and ensure it asked questions that were pertinent to participants' sensory experiences.

After revisions were made based on feedback from reviewers with lived experience, the final survey (see Appendix E) included both closed- and open-ended questions. This ensured that we received a mix of both categorical responses, as well as more in-depth responses which provided greater context behind the participants' sensory experiences. Participants were asked to state their location (home, school, work, other), who they were with (alone, parents/caregivers, someone else they live with, significant other, friends/extended family, classmates/coworkers, with someone virtually, someone else), whether their sensory experience was positive, negative, or neutral, which senses was their experience impacting (sight, sound, touch, taste, hearing), and whether they were feeling overstimulated, understimulated, neither, or both. Participants were then asked three open-ended questions, including to describe their current sensory experience and what sense was most strongly impacting their sensory environment, describe their reaction to that sensory experience, and describe any coping mechanisms they used to deal with the sensory experience. Participants were also asked (using 5-point Likert scale questions ranging from "Strongly Agree" to "Strongly Disagree") to rate how factors such as their mood, hunger, fatigue, level of control over their environment, transitioning of activities/places, and emotions were impacting their current sensory experience. Finally, participants were given the chance to let us know anything else about their sensory experience.

Taken together, the responses from these questions provided information regarding the contextual factors that contribute to different sensory experiences in autistic individuals.

2.3 Procedure

Participants were sent three text messages each day over the course of two weeks which included the link to the Ecological Momentary Assessment survey and the participant's ID number. Text messages were sent using AutoSender, an application that allows users to schedule SMS text messages to be sent automatically at a specified time from a private number. A random time generator was used to determine the times at which participants were prompted, within the daily schedules they provided in the Initial Questionnaire. Participants were asked to complete the task as quickly after receiving the text message as possible, given they were able to do so safely in that moment. If not, they were asked to respond whenever they were able to do so safely.

Participants also had the option to self-report their sensory experiences outside of the three daily prompts if a sensory experience occurred on which they wanted to report. This was accomplished by keeping the survey link constant so that participants could go back to the link they were previously sent if they wanted to self-report on a sensory experience that had occurred when they were not prompted to respond. It should be noted that any such response was in addition to the three daily prompts.

Chapter 3

3 Quantitative Analysis of Contextual Factors

3.1 Initial Survey

3.1.1 Analysis

Participants' responses to the AASP were scored and full-scale and Sensory Sensitivity subscale scores were computed. Similarly, participants' responses to the SRS-2 were scored and full-scale and Restricted Interests and Repetitive Behaviours (RRB) subscale scores were computed. The proportion of each participant's positive, negative, and neutral sensory experiences were determined based on the number of sensory experiences they reported on. We investigated the relationship between the proportion of participants' positive, negative, and neutral reported sensory experiences and their full-scale scores on both the AASP and the SRS-2, their Sensory Sensitivity subscale scores, and their RRB subscale scores using Pearson's and Kendall's correlations conducted in *jamovi* (The jamovi project, 2024). Pearson's r correlations were initially used to test these correlations; however, certain assumptions of the test were not met or resulted in us in removing participants to be met. We therefore also conducted Kendall's Tau b correlations for which we met all assumptions and did not have to remove any participants.

3.1.2 Results

Participants' average total scores for the AASP and SRS-2, and their RRB and Sensory Sensitivity subscales are summarized in Table 2. The relationships between the proportion of participants' positive, negative, and neutral reported sensory experiences and their full-scale scores on both the AASP and the SRS-2, their Sensory Sensitivity subscale scores, and their

RRB subscale scores are reported in Table 3. Shapiro Wilk test was used to assess the normality of the participants' scores. Participants' AASP (W = .968, p = .316), SRS-2 (W = .970, p = .348), RRB (W = .970, p = .528), and Sensory Sensitivity (W = .955, p = .116) scores were all approximately normally distributed.

Table 2

Average Questionnaire Scores

Group	N	AASP Total	Sensory Sensitivity Subscale	SRS-2 Total	RRB Subscale
Male	6	193.8 (42.3)	42.2 (10.2)	126.5 (20.5)	28.2 (6.9)
Female	33	183.3 (25.4)	50.6 (11.3)	106.2 (27.5)	22.3 (7.2)
Non-Binary	1	182.0	57.0	99.0	22.0

Note: Test scores represent raw scores, not T-scores. Higher scores on the AASP indicate higher sensory dysfunction. Higher scores on the SRS-2 indicate severe deficits in social interaction and are strongly associated with a clinical diagnosis of ASD. Standard deviation values are in the brackets.

3.1.2.1 Pearson's Correlations.

We initially conducted Pearson's correlations between participants' questionnaire responses and the proportion of their positive, negative, and neutral sensory experiences. 1 participant did not complete the initial questionnaire and was removed from the correlation analyses (n = 40). Shapiro-Wilk test was conducted to determine the normality of the data. The distribution of the proportion of positive (W = .858, $p < .001$) and neutral sensory experiences (W = 0.880, $p < .001$) departed significantly from normality. No significant correlations were found between participants' total AASP scores and the proportion of their positive (r(38) = .06, p = .708, 95% CI [-0.26, 0.37]), negative (r(38) = -.05, p = .780, 95% CI [-0.35, 0.27]), or neutral (*r*(38) = -.01, *p* = .947, 95% CI [-0.32, 0.30]) sensory experiences. Similarly, no significant correlations were found between participants' Sensory Sensitivity subscale scores and the proportion of their positive (*r*(38) = .06, *p* = .710, 95% CI [-0.26, 0.37]), negative (*r*(38) = .04, *p* = .809, 95% CI [-0.28, 0.34]), or neutral (*r*(38) = -.11, *p* = .504, 95% CI [-0.41, 0.21]) sensory experiences. No significant relationship was found between participants' total SRS-2 scores and the proportion of their positive (*r*(38) = .04, *p* = .790, 95% CI [-0.27, 0.35]), negative (*r*(38) = -.21, *p* = .202, 95% CI [-0.49, 0.11]) or neutral sensory experiences (*r*(38) = -.19, *p* = .231, 95% CI [-0.13, 0.48]). No significant relationships were found between participants' RRB subscale scores and the proportion of their positive (*r*(38) = -.01, *p* = .935, 95% CI [-0.32, 0.94]), negative (*r*(38) = -.07, *p* = .650, 95% CI [-0.38, 0.24]), or neutral (*r*(38) = .10, *p* = .541, 95% CI [-0.22, 0.40]) sensory experiences.

Table 3

Correlations Between the Proportion of Sensory Experiences and Standardized Questionnaire Scores

	Correlations with Proportion of Sensory Experiences		
Standardized Questionnaire Score	Positive	Negative	Neutral
AASP Total	.06	-.05	-.01
Sensory Sensitivity Subscale	.06	.04	-.11
SRS-2 Total	.04	-.21	-.19
RRB Subscale	-.01	-.07	.10

Note: Pearson's *r* values are reported. **p* < .05

3.1.2.2 Outliers Removed.

We also ran Pearson's correlations after removing participants who had reported all positive (*n* = 2), negative (*n* = 4), or neutral (*n* = 2) sensory experiences, and thus had a proportion of one for a single experience and zero for the other two. These participants were outliers, as a proportion of one was contributing to the non-normal distribution of the data. After removing these participants, Shapiro-Wilk test of normality was non-significant for all data, thus the proportion of positive (W = .927, *p* = .031), negative (W = .979, *p* = .031), and neutral (W = .945, *p* = .105) sensory experiencers were all approximately normally distributed.

We still found no significant correlations between the participants' responses to standardized questionnaires and their proportion of positive, negative, and neutral sensory experiences. No significant correlations were found between participants' total AASP scores and the proportion of their positive (*r*(30) = .08, *p* = .669, 95% CI [-0.28, 0.42]), negative (*r*(30) = -.04, *p* = .811, 95% CI [-0.39, 0.31]), or neutral (*r*(30) = -.03, *p* = .852, 95% CI [-0.38, 0.32]) sensory experiences. Similarly, no significant correlations were found between participants' Sensory Sensitivity subscale scores and the proportion of their positive (*r*(30) = -.01, *p* = .952, 95% CI [-0.36, 0.34]), negative (*r*(30) = .04, *p* = .848, 95% CI [-0.32, 0.38]), or neutral (*r*(30) = -.03, *p* = .875, 95% CI [-0.37, 0.32]) sensory experiences. No significant relationship was found between participants' total SRS-2 scores and the proportion of their positive sensory experiences (*r*(30) = -.03, *p* = .863, 95% CI [-0.65, -0.40]), negative (*r*(30) = -.19, *p* = .288, 95% CI [-0.51, 0.16]) or neutral sensory experiences (*r*(30) = .26, *p* = .151, 95% CI [-0.10, 0.56]). No significant relationships were found between participants' RRB subscale scores and the proportion of their positive (*r*(30) = .04, *p* = .826, 95% CI [-0.31, 0.38]), negative (*r*(30) = -.08, *p* = .678, 95% CI [-0.41, 0.28]), or neutral (*r*(30) = .05, *p* = .808, 95% CI [-0.31, 0.39]) sensory experiences.

It is important to note, however, that removing these participants may not be an accurate representation of participants' experiences. Given that we were interested in determining whether a relationship existed between participants sensory experiences according to standardized questionnaires and their daily self-reported sensory experiences, removing these participants may not accurately indicate the relationship between these two variables. Thus, we also conducted Kendall's Tau correlations with all participants included to further investigate this relationship.

Table 4

Correlations Between the Proportion of Sensory Experiences and Standardized Questionnaire Scores After Removing Outliers

	Correlations with Proportion of Sensory Experiences		
Standardized Questionnaire Score	Positive	Negative	Neutral
AASP Total	.08	-.04	-.03
Sensory Sensitivity Subscale	-.01	.04	-.03
SRS-2 Total	-.03	-.19	.26
RRB Subscale	.04	-.08	.04

Note: Pearson's *r* values are reported with outliers removed ($n = 32$). $^{*}p < .05$

3.1.2.3 Kendall's Tau B Correlations.

Kendall's Tau is another analysis that measures the correlation between two variables; however, does not require the assumption that the data is normally distributed. We conducted Kendall's Tau correlations including all participants ($n = 40$) since the data did not meet the assumptions for normality of data for Pearson's correlation. Still, no significant correlations were found between participants' questionnaire scores and the proportion of their positive, negative, and neutral sensory experiences. No significant correlations were found between participants' total AASP scores and the proportion of their positive (r_τ = .05, p = .677), negative (r_τ = -.06, p = .615), or neutral (r_τ= .00, p = .991) sensory experiences. Similarly, no significant correlations were found between participants' Sensory Sensitivity subscale scores and the proportion of their positive (r_τ = .04, p = .739), negative (r_τ = .02 p = .879), or neutral (r_τ = -.06, p = .627) sensory experiences. No significant relationship was found between participants' total SRS-2 scores and the proportion of their positive sensory experiences (r_τ = .05, p = .652), negative (r_τ = -.15, p = .178) or neutral sensory experiences (r_τ= .16, p = .159). No significant relationships were found between participants' RRB subscale scores and the proportion of their positive (r_τ = .07, p = .560), negative (r_τ = -.07, p = .519), or neutral (r_τ = .11, p = .349) sensory experiences.

Table 5

Correlations Between the Proportion of Sensory Experiences and Standardized Questionnaire Scores

	Correlations with Proportion of Sensory Experiences		
Standardized Questionnaire Score	Positive	Negative	Neutral
AASP Total	.05	-.06	.00
Sensory Sensitivity Subscale	.04	.02	-.06
SRS-2 Total	.05	-.15	.16
RRB Subscale	.07	-.07	.11

Note: Kendall's tau correlations are reported with all participants included (n = 40). *p < .05

3.2 EMA Survey

3.2.1 Analysis

The proportion of each participant's positive, negative, and neutral sensory experiences were determined based on the number of sensory experiences they reported on. We determined the overall frequency of positive, negative, and neutral sensory experiences reported by all participants. The impact of participants' contextual factors, including their location, their emotions immediately before the sensory experience, and who they were with on the frequency of their positive, negative, and neutral sensory experiences were computed using Pearson's χ^2 analyses in *jamovi* (The jamovi project, 2024). Pearson's χ^2 test of independence was used to assess the association between participants' sensory experiences and their location, mood and affective states, and their stimulation levels. We could not run Pearson's χ^2 test of independence to assess the association between who participants were with during a sensory experience and the valence of the sensory experience. This was because participants could report being with multiple people at once, therefore, we failed to meet the assumption of independence of observations needed to Pearson's χ^2 test of independence. Instead, we ran Pearson's χ^2 goodness-of-fit tests to assess these associations.

3.2.2 Results

On average, participants responded to 1299 survey prompts (72.57% of surveys), ranging from 16.67% to 100.00% response rate. 11 participants self-reported survey responses when they were not prompted, for an additional 69 survey responses (ranging from 1 to 23 additional responses). 897 (65.57%) survey responses indicated that participants had no sensory experiences to report on. Of sensory experiences that were reported on (471; 34.42%), participants reported 42.52% negative (199), 31.20% positive (146), and 26.28% neutral (123) sensory experiences.

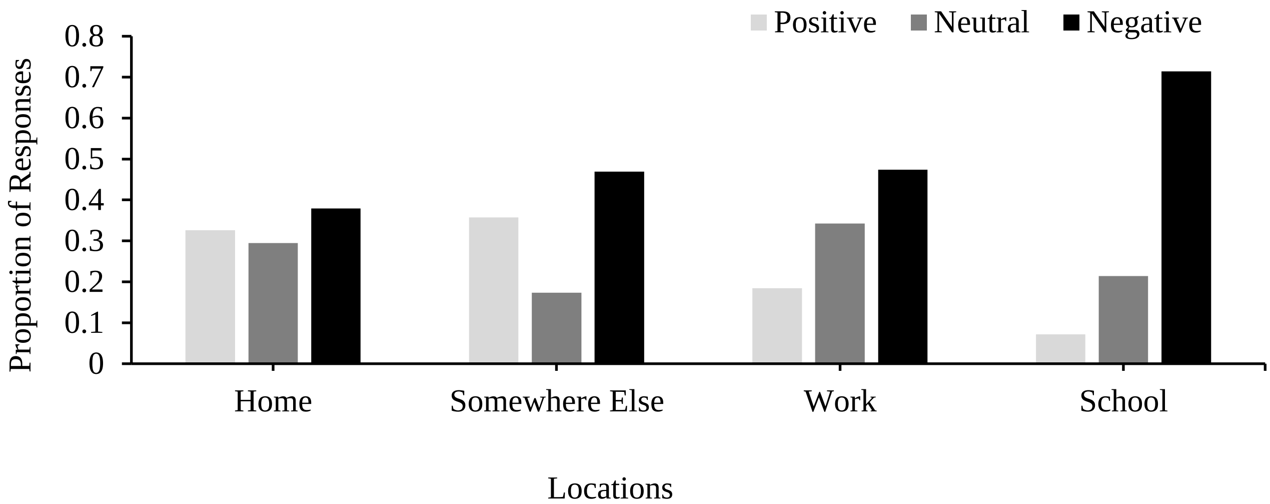
3.2.2.1 Surroundings.

Pearson's χ^2 test of independence showed a significant association between the valence of the sensory experience (positive, negative, or neutral) and the location where participants reported the sensory experience $\chi^2(6) = 15.5$, $p = .017$, Cramer's V = .12. While at school (n = 14), participants reported 71.4% negative compared to neutral (21.4%) or positive (7.1%) sensory experience. The R by C table was examined and the contribution of the school location on the chi-square test was determined. A large proportion of the chi-square (19.75%) can be explained by the fact that there was a large proportion of negative sensory experiences reported at school. Thus, the significant association was driven primarily by an increased proportion of negative responses at school. Participants reported 38.0% negative sensory experiences when they were at home (n = 353) compared to positive (32.6%) or neutral sensory experiences (29.5%). Similar results were reported when participants were at work (n = 38), participants reported 47.4% negative compared to neutral (34.2%) or positive (18.4%) sensory experiences. Finally, while at another location (n = 98), participants reported 46.9% negative, 35.7% positive, and 17.32% neutral sensory experiences. The association between the valence of the sensory experience reported and the participant's location during the sensory experience are summarized in Figure 1.

We could not conduct Pearson's χ^2 test of independence to determine whether there was a significant association between the valence of the sensory experience and who the participant was with, as this violated the assumption of independence given that participants could indicate that they were with multiple people at once. Instead, we conducted Pearson's χ^2 goodness-of-fit

Figure 1

Proportion of Participants' Positive, Negative, and Neutral Sensory Experiences at Different Locations



Note. Proportions of participants' responses at each location are reported.

tests to determine whether the proportion of participants' positive, negative, and neutral sensory experiences with different people differed significantly from the overall proportions of positive, negative, and neutral sensory experiences reported (Wanzer, 2023). There was only a significant difference between the proportion of positive, negative, and neutral sensory experiences when participants were with their significant others (n = 70) compared to their overall proportions of positive, negative, and neutral sensory experiences ($\chi^2(2) = 6.42$, $p = .040$). No significant differences were found between overall proportions of positive, negative, and neutral sensory experiences and the proportion of positive, negative, and neutral sensory experiences when participants were with their parents/caregivers ($\chi^2(2) = 3.12$, $p = .210$, $n = 47$), alone ($\chi^2(2) = 5.73$, $p = .057$, $n = 220$) or with their classmates/coworkers ($\chi^2(2) = 4.43$, $p = .109$, $n = 37$), although these were trending significance. Additionally, no significant differences were found between overall proportions of positive, negative, and neutral sensory experiences and the proportion of positive, negative, and neutral sensory experiences when participants were with their friends/extended family ($\chi^2(2) = 0.43$, $p = .806$, $n = 30$), someone they lived with ($\chi^2(2) = 0.32$, $p = .854$, $n = 114$), or with someone else ($\chi^2(2) = 1.76$, $p = .415$, $n = 30$). Pearson's χ^2 goodness-of-fit tests could not be conducted for when participants were with someone virtually, as there were less than 5 counts per experience, thus violating the assumption that the frequencies are sufficiently large (Wanzer, 2023). The frequency of participants' positive, negative, and neutral sensory experiences with different people are summarized in Figure 2a.

Following this analysis, we ran a Pearson's χ^2 test of independence to determine whether there was a significant association between the proportion of negatively reported sensory experiences and whether the participant was with someone else during the experiences. We were able to do so given that participants could not be alone and with someone else at the same time, therefore the assumption of independence was met. It should be noted that when running this analysis, we collapsed all people participants reported being with into one group ($n = 334$), including parents/caregivers. When participants were with parents/caregivers, they reported 38.3% positive compared to 31.9% neutral and 29.8% negative sensory experiences, which was a similar pattern as when participants were alone. However, because these were a small count of the total responses, we decided to collapse these with the other people participants reported being with during sensory experiences. We found that there was a significant association between the proportion of negatively reported sensory experiences and whether the participant was with someone else during the experience, $\chi^2(1) = 7.51$, $p = .006$, Cramer's V = .123. This association is summarized in figure 2b.

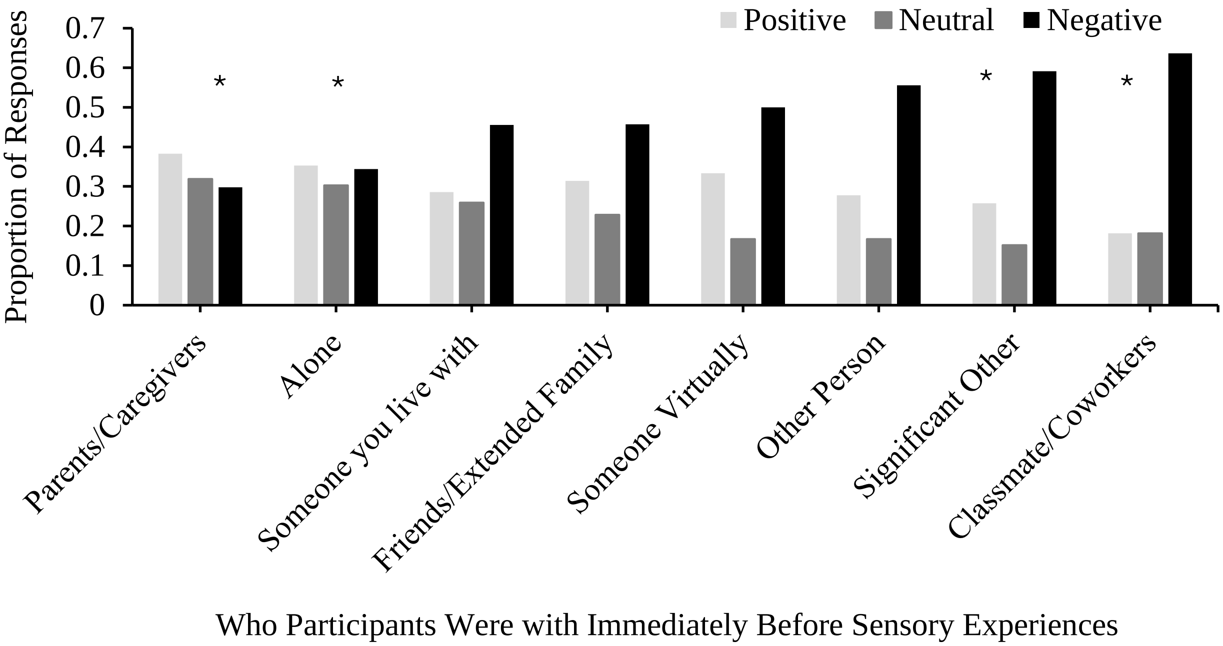
3.2.2.2 Other Contextual Factors.

We ran χ^2 test of independence for each remaining context to determine which contexts contributed significantly to the valence of responses to sensory experiences. There was a statistically significant association between participants' proportion of positive, negative, and neutral sensory experiences when they were in a good mood ($\chi^2(4) = 62.30$, $p < .001$). When participants were in a good mood ($n = 340$), 39.1% of their responses were positive, 37.1% were negative, and 23.8% were neutral. There was a statistically significant association between the valence of participants' sensory experiences when they felt they were in control over their environment ($\chi^2(4) = 68.20$, $p < .001$). When participants felt this way ($n = 289$), they reported 42.6% positive, 29.8% negative, and 27.7% neutral sensory experiences. Similarly, there was a significant association between participants' proportion of positive, negative, and neutral sensory experiences when they felt tired ($\chi^2(4) = 16.40$, $p = .003$). Participants reported 44.1% of their sensory experiences as negative when they were tired ($n = 358$), compared to 26.8% positive and 29.1% neutral. There was also a significant association between participants' proportion of positive, negative, and neutral sensory experiences when they felt anxious/overwhelmed ($\chi^2(4) = 70.90$, $p < .001$). They reported 58.4% negative, 27.6% neutral, and 14.0% positive sensory experiences when they felt this way ($n = 214$). Finally, there was a significant association between participants' proportion of positive, negative, and neutral sensory experiences when they felt physically unwell ($\chi^2(4) = 48.60$, $p < .001$) They reported 57.0% negative compared to 26.8% neutral and 16.2% positive sensory experiences when they felt this way ($n = 179$).

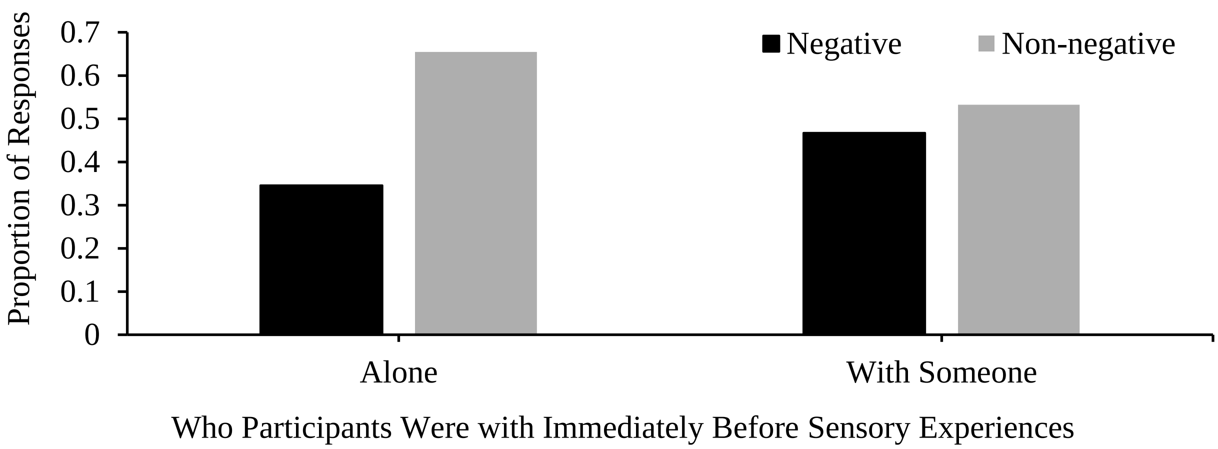
Figure 2

Proportion of Participants' Positive, Negative, and Neutral Sensory Experiences with Different People

a.



b.



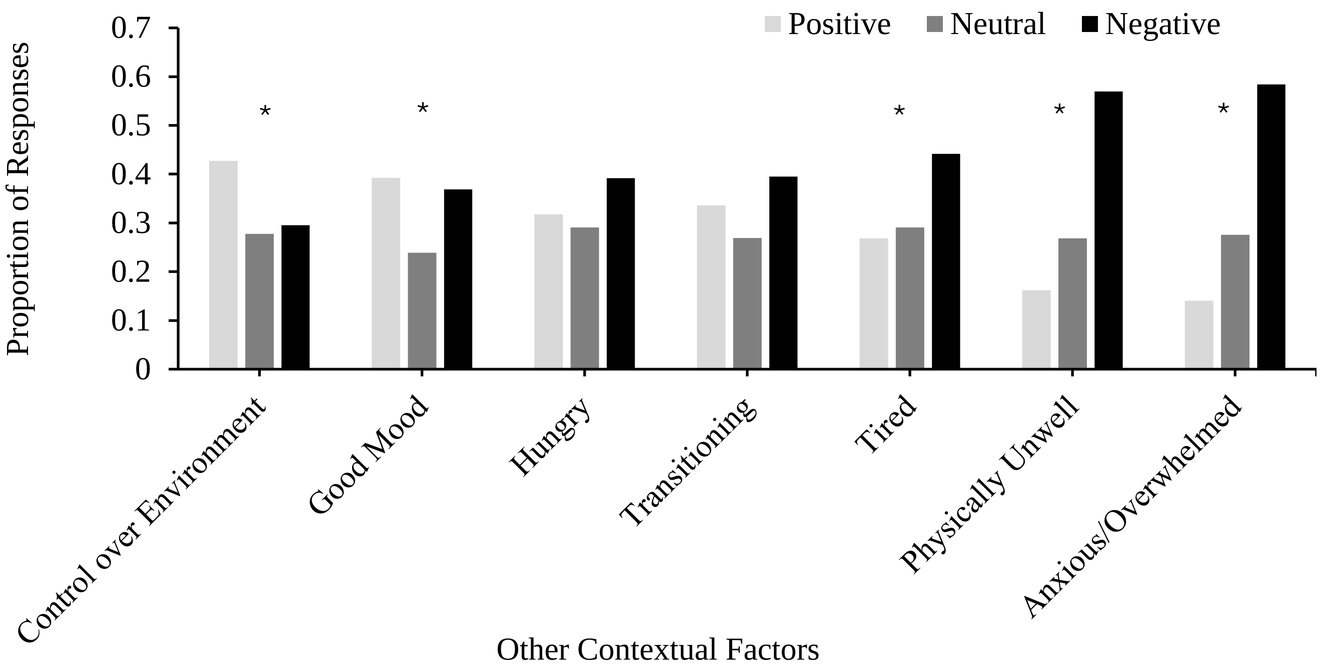
Note. Proportions of participants' responses with different people.
a.Represents participants' proportion of positive, negative, and neutral sensory experiences when they were with different people immediately before their sensory experience.
b.Represents the association between participants' proportion of negative and non-negative responses when they were with someone or alone immediately before their sensory experience.
* represents a significant ($p < .05$) or nearly significant difference ($p < .220$) between the proportions of overall positive, negative, and neutral sensory experiences and those reported with different people.

No significant associations were found between participants positive, negative, or neutral sensory experiences and feelings of hunger ($\chi^2(4) = 6.45$, $p =.168$) or feelings of transitioning between places/ activities ($\chi^2(4) = 1.62$, $p =.860$). When participants were hungry immediately before their sensory experience ($n = 189$), they reported 39.2% negative, 31.7% positive, and 29.1% neutral sensory experiences. Finally, when participants were transitioning between activities and places ($n = 238$) they reported 39.5% negative compared to positive (33.6%) or neutral (26.9%) sensory experiences. The association between the valence of the sensory experience reported and other contextual factors immediately before the sensory experience are summarized in Figure 3.

Participants were also asked about their stimulation level when they reported a positive or negative sensory experience. Pearson's χ^2 test of independence showed a significant association between the valence of the sensory experience (positive or negative) and the stimulation level, χ^2 (4) = 244, $p < .001$, Cramer's V = .82. Please note that participants were not asked to report on their stimulation level if they were reporting on a neutral sensory experience. When participants were feeling overstimulated immediately before their sensory experience ($n = 165$), they reported 90.9% negative compared to positive (9.1%) sensory experiences. When they were feeling understimulated ($n = 13$) they reported 76.9% negative compared to positive (23.1%) sensory experiences. Similar results were reported when they were feeling neither over- nor understimulated ($n = 51$): they reported negative (66.7%) sensory experience 66.7% of the time compared to 33.3% positive (33.3%) sensory experiences. When participants were feeling both over- and understimulated, they reported 84.6% negative compared to positive (15.4%) sensory experiences.

Figure 3

Proportion of Participants' Positive, Negative, and Neutral Sensory Experiences at Other Contextual Factors



Note. Proportions are of participants responses when having different feelings immediately before their sensory experience. * represents a significant association between the proportion of participants positive, negative, and neutral sensory experiences and the contextual factors.

Participants were only asked to report whether they were at an optimal stimulation level (n = 120) if they reported on a positive sensory experience, given that an optimal stimulation level would be positively perceived by participants. Thus, when participants reported they were at an optimal stimulation level, 100.0% of their responses were on positive sensory experiences. Participants also reported positive sensory experiences 9.6% of the time when they were feeling overstimulated, 1.9% of the time when they were feeling understimulated, 10.8% of the time when they were feeling neither over- nor understimulated, and 1.3% of the time when they were feeling both over- and understimulated. Interestingly, participants reported negative sensory experiences 73.2% of the time when they were feeling overstimulated, 4.9% of the time when they were feeling understimulated, 16.6% of the time when they were feeling neither over- nor understimulated, and 5.4% of the time when they were feeling both over- and understimulated.

Chapter 4

4 Thematic Analysis of Open-Ended Questions

4.1 Analysis

Participants' responses to open-ended questions were analyzed using *NVivo* (Lumivero, 2023). We conducted a thematic analysis of these responses using the framework described by Braun and Clarke (Braun & Clarke, 2006) According to this framework, there are six phases of thematic analyses: (1) reading over the raw data to familiarize yourself with it, (2) generating initial codes across the entire data set, (3) categorizing codes into potential themes, (4) reviewing the themes ensuring they work in relation to the codes and entire data set, (5) defining and naming themes, and (6) producing the final report. A good thematic analysis according to this framework includes themes that work for the data, themes that do not have much overlap, and themes that are internally coherent and consistent. Finally, all aspects of the theme should relate to the central idea or concept of the data.

Within our thematic analysis, we used a combination of deductive and inductive coding. Deductive analyses aim to test whether data are consistent with previous assumptions, theories, or hypotheses (Strauss & Corbin, 1998). Deductive coding of qualitative responses therefore consisted of using pre-determined themes or codes created based on existing literature on the topic of sensory experiences in autism. Inductive analyses, on the other hand, include determining themes and concepts from the raw data (Strauss & Corbin, 1998). Inductive coding of qualitative responses therefore consisted of reading participants' raw data and creating themes or codes that stemmed from this data. Combinations of deductive and inductive coding are beneficial for conducting mixed-method analyses (Fereday & Muir-Cochrane, 2006; Proudfoot, 2023).

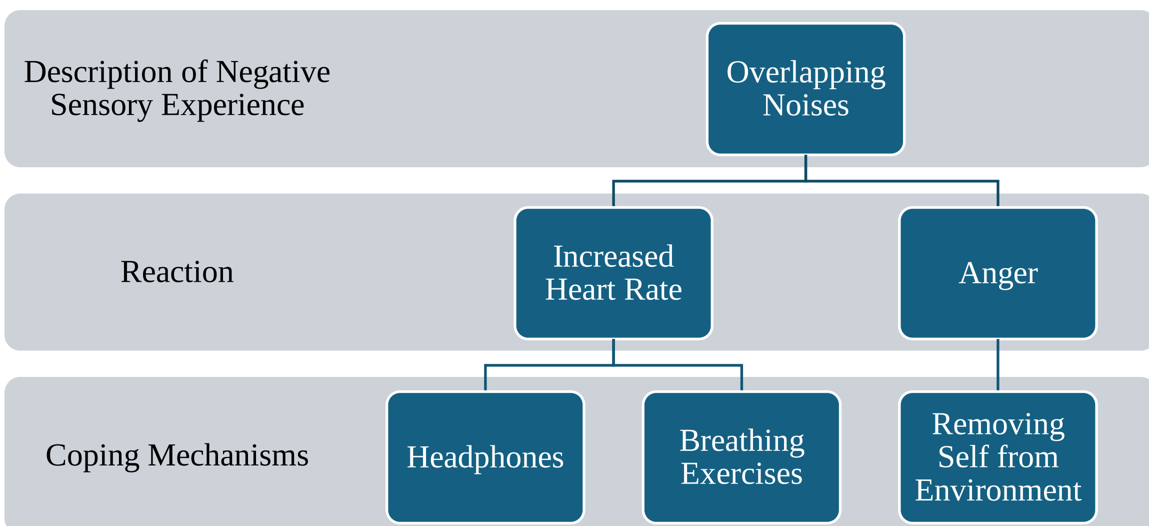
Responses were deductively coded by three researchers, M.L., T.R., and G.C., and classified according to one of three predetermined themes: description of the sensory experience, reaction to the sensory experience, and coping mechanisms used. These themes were determined based on previous literature on sensory experiences in autistic individuals (Ashburner et al., 2013; Charlton et al., 2021; Kirby et al., 2015; Parmar et al., 2021; Robertson & Simmons, 2015; Talcer et al., 2023). Codes were determined using inductive coding. Specifically, we used a general inductive approach (Thomas, 2006). According to this approach, we read over the raw data and became familiar with the patterns or themes that were consistent in the data. We then created low level codes from the data. These codes were then attributed to one of three upper-level themes. All three researchers completed the inductive coding independently. Initial sentence coding comparisons yielded moderate agreement between M.L. and T.R. ($\kappa = 0.75$), M.L. and G.C. ($\kappa = 0.77$), and T.R. and G.C. ($\kappa = 0.78$) (McHugh, 2012). Character coding comparisons also yielded moderate agreement between M.L. and T.R. ($\kappa = 0.64$), M.L. and G.C. ($\kappa = 0.66$), and T.R. and G.C. ($\kappa = 0.68$). They then met to discuss any discrepancies between the codes and come to an agreement on the code names. Following this meeting and discussion of discrepancies, sentence coding comparisons yielded moderate agreement between M.L. and T.R. ($\kappa = 0.76$), M.L. and G.C. ($\kappa = 0.78$), and T.R. and G.C. ($\kappa = 0.77$) and moderate agreement between M.L. and T.R. ($\kappa = 0.65$), M.L. and G.C. ($\kappa =0.66$), and T.R. and G.C. ($\kappa = 0.68$) of character coding comparisons. In accordance with the thematic analysis framework, we reviewed and revised the themes to ensure that they worked in relation to the codes and entire data set, and agreed on final codes counts.

4.2 Results

A single response from participants described various sensory stimuli in their environment, multiple reactions to these stimuli, and various coping mechanisms used to deal with the sensory experience. A commonly reported response to the EMA survey is depicted in Figure 4. Participants commonly described a negative sensory experience where they heard multiple overlapping noises. They then had various reactions, including an increased heart rate and a feeling of anger. Their reactions to this sensory experience included wearing noise cancelling headphones or engaging in breathing exercises or removing themselves from the environment. Details and frequencies of responses of the three themes are expanded upon below.

Figure 4

Example of EMA Survey Responses



Note. One example of a negative sensory experience participants reported on.

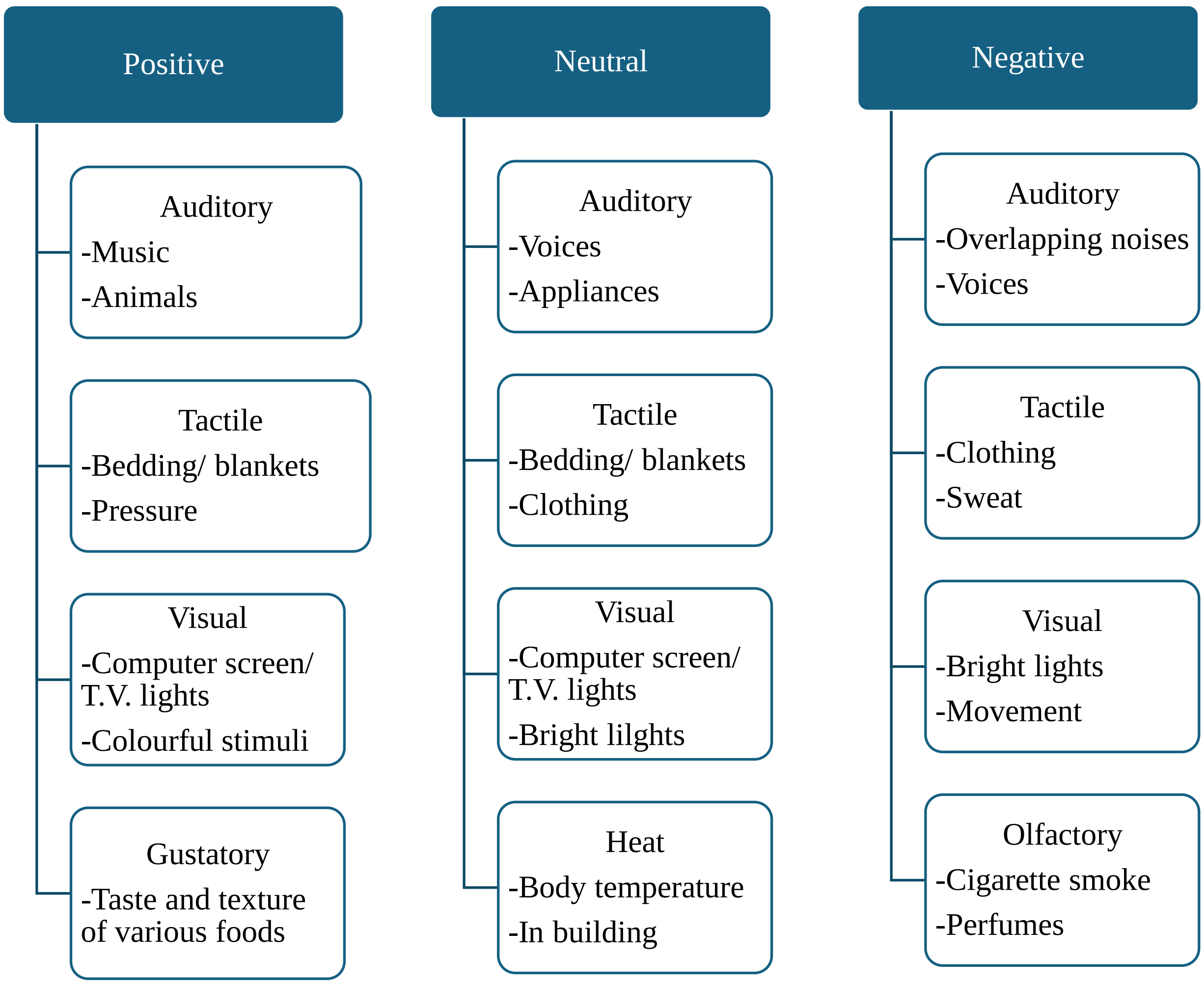
4.2.1 Description of Sensory Experience

Qualitative analyses revealed common themes among participants' responses regarding their descriptions of positive, negative, and neutral sensory experiences. Sounds and tactile stimuli contributed most to all sensory experiences. Participants commonly reported that sounds such as music and audio from the TV and tactile stimuli such as fuzzy blankets, soft fur from pets, and a breeze contributed most to positive sensory experiences. Sounds such as loud noises and people's voices and tactile stimuli such as clothing and other people in crowds contributed most to negative sensory experiences. Music, voices, and noises were commonly identified sounds that contributed to neutral sensory experiences and soft blankets, breeze, and clothing were commonly identified tactile stimuli that contributed to neutral sensory experiences. Participants varied in the amount of detail they provided in responses, ranging from brief responses such as the "sound is too loud" to more in-depth responses such as "We were arriving in class and as more people came, the class became noisier and noisier. It's a lot of different conversations and voices and sounds one atop another converging into a blend of noises that's loud and uncomfortable and painful to work around". Commonly reported descriptions of participants' sensory experiences are summarized in Figure 5.

Temperature was an interesting theme that came up across positive, negative, and neutral sensory experiences. Heat or warmth was more commonly reported in positive, negative, and neutral sensory experiences compared to cold. Participants described heat or warmth negatively impacting their sensory experiences more than positively or neutrally. Pain was another sensory experience commonly reported on. Pain contributed to negative and neutral sensory experiences; however, did not have an impact on positive sensory experiences. Additional descriptions of participants' sensory experiences are depicted in Table 6.

Figure 5

Common Contextual Factors Contributing to Participants' Descriptions of their Sensory Experiences



Note. Subthemes reported in order of most frequent responses.

4.2.2 Reactions to Sensory Experience

Participants' reactions to their sensory experiences were categorized as either physical reactions or psychological reactions. The most common physical reactions participants reported were feeling physically unwell (feeling pain, nausea, an increased heart rate), relaxed, and tense.

Table 6

Thematic Analysis of Participants' Descriptions of Their Sensory Experiences

	Number of responses		
	Positive	*Neutral*	*Negative*
Auditory	83	67	107
Tactile	87	43	66
Visual	63	26	45
Olfactory	24	10	30
Gustatory	38	8	9
Heat/warmth	17	15	20
Cold	3	3	3
Hyposensitivity	-	3	5
Hypersensitivity	-	5	4
Pain	-	16	40
Overstimulation	-	-	4
Proprioception	2	2	-
Hunger	-	5	-
Lack of Control	-	-	1
Dizziness	-	1	4
Other	6	2	9

Note: Frequency of participant reports on descriptions of their sensory experiences. Final frequencies computed following discussions between the three coders.

The most common psychological reactions to sensory experiences included positive emotions (happiness and calmness) and negative emotions (anxiety, anger, sadness, and annoyance). Being tired was also a commonly reported reaction to both positive and negative sensory experiences. Other reactions to sensory experiences are summarized in Table 7.

4.2.3 Coping Mechanisms Used

Participants used various coping mechanisms to help them cope with negative and neutral sensory experiences. Most participants did not report coping mechanisms in response to positive sensory experiences. Most frequently, participants reported focusing their attention on something else besides the stimulus that was affecting their sensory experience. This included listening to music, going on one's phone, or watching TV. Participants also frequently reported either eliminating a bothersome stimulus (such as turning off a bright TV/lights, removing uncomfortable clothing, brushing teeth to eliminate bad taste in mouth, and turning on the AC to eliminate heat) or blocking out one's senses (such as wearing headphones, covering ears, and closing/covering eyes) as useful coping mechanisms. Participants also chose to remove themselves from the environment if possible or engaged in stimming behaviours to help them cope.

Participants' responses regarding their coping mechanisms varied in detail, with some participants stating that they "Listened to music" to help cope with certain sensory experiences, while others stated that they were "Watching favorite show- giving all my senses (attention) to the show. End of the show I receive them [senses] back in balance." Additional coping mechanisms that participants used are summarized in Table 8.

Table 7

Thematic Analysis of Participants' Reactions to Their Sensory Experiences

	Number of Responses
Physical Reactions	
Physically Unwell	207
Relaxed	99
Tense	70
Slowed Heart Rate	2
Jittery	11
Increased Heart Rate	6
Hunger	2
Other	12
Psychological Reactions	
Negative Emotion	211
Positive Emotion	110
Neutral Emotion	8
Tired	30
Dissociating	4
Reduced Sensory Tolerance	2
Restless	6
Distracted	7
Other	8

Note: Final frequencies computed following discussions between the three coders.

Table 8

Thematic Analysis of Participants' Coping Mechanisms

	Number of Responses
Focus Attention Elsewhere	66
Block out senses	52
Eliminate Stimulus	44
Remove Self from Environment	30
Stimming	14
Powering Through It	10
Medication	6
Fidgeting	8
Meditation	2
Hiding My Discomfort	2
Nothing	7
Breathing Exercises	9
Cuddling	3
Dissociating	7
Weighted Blanket	2
Other	14

Note. Coping mechanisms were not always reported by participants and were typically only reported to negative or neutral sensory experiences. Final frequencies computed following discussions between the three coders.

Chapter 5

5 Discussion

The aim of the current study was to investigate the daily sensory experiences of autistic adults and the contextual factors that impact these experiences. We used EMA to assess these experiences, to bridge the gap between behavioural studies (that often lack ecological validity) and qualitative studies (that are often subject to recall bias). Our quantitative analysis of contextual factors that impact the sensory experiences of autistic adults revealed significant associations between participants' proportions of positive, negative, and neutral sensory experiences and their physical surroundings and other contextual factors. In particular, we found that location, being with other people, and feelings of control over the environment, good mood, fatigue, physically unwell, and anxiety/overwhelmed impacted the sensory experiences reported by participants. These results were also supported by findings from our qualitative analysis, which revealed themes related to descriptions of participants' sensory experiences, their reactions to these experiences, and any coping mechanisms they used.

Participants reported positive, negative, and neutral experiences at home, school, work, and elsewhere. At each location, there was a larger proportion of negative sensory experiences reported than positive or neutral sensory experiences. Interestingly, the proportion of positive, negative, and neutral sensory experiences were closer to 1:1 when participants were at home compared to the proportions of positive, negative, and neutral sensory experiences when participants were at school or work. At school and work, participants more frequently reported negative sensory experiences compared to positive or neutral. This finding is consistent with previous research that investigated the negative sensory experiences associated with work and school environments (Anderson et al., 2020; Bontempo, 2009.; Danker et al., 2019; Howe, 2023; Humphrey & Lewis, 2008; Smith & Sharp, 2013). Specifically, factors such as harsh fluorescent lights, patterned or colourful walls, and noises from appliances were distracting for autistic individuals in public settings such as office buildings and schools (Black et al., 2022; Zaniboni & Toftum, 2023). Research suggests that autistic individuals experience anxiety when in uncontrollable environments (Acker et al., 2018; Spain et al., 2020). As a result, these experiences were perceived as distressing and/or negative for participants since they likely had less control over their environments while at work and school. This is consistent with our findings as well, given that we found a significant association between participants' feelings of control over their environment and the sensory experiences they reported. Conversely, at home, participants likely have more control over their sensory environments, thus are able to eliminate negative sensory stimuli more easily than at school or work. This is supported by our qualitative analysis, where participants frequently reported removing themselves from an environment that was contributing to a negative sensory experience or eliminating a distressing stimulus (turning off a T.V. with a bright screen, reducing volume of music). In instances where participants had less control over their environments, they would cope by attempting to block out their senses (wearing headphones or sunglasses, physically covering their eyes) or to distract themselves from the stimulus by focusing their attention on a different stimulus (playing music they enjoy, smelling a hand sanitizer/candle, watching T.V.). This likely contributes to a larger proportion of positive compared to negative or neutral sensory experiences that are reported at home, where participants have more control over their environment, compared to those reported at school or work.

We also investigated whether having other people present influences autistic adults' sensory experiences. We found a significant association between participants' proportion of negative sensory experiences and being with anyone else during a sensory experience, suggesting that there is a significant association between negative sensory experiences and being with other people. Conversely, being alone is suggested to be associated with the proportion of positive and neutral sensory experiences. This is likely because when autistic adults are alone, they have a greater level of control over their environment, enabling them to create optimal sensory experiences without having to accommodate others' feelings or preferences.

These findings are consistent with previous research that has investigated the role of other people in autistic individuals' sensory experiences. As revealed in our qualitative analysis, participants frequently engaged in stimming behaviours or fidgeting as a coping mechanism to negative or neutral sensory experiences. Research suggests that sensory related behaviours (such as stimming) are perceived as frightening, unusual, and unpredictable by neurotypical individuals who do not know the autistic individual (Davidson, 2010; Kapp et al., 2019; Knott & Taylor, 2014; Landon et al., 2016; Rogers et al., 2017; Smith & Sharp, 2013). These stigmatizing reactions from strangers, coworkers/classmates, or less close family members and friends (such as extended family) may contribute to negative sensory experiences as autistic individuals may feel they cannot express distressing sensory stimuli or cannot engage in effective coping mechanisms.

Research also suggests that sensory factors are important for autistic adults to discuss with potential roommates, as these can impact their sensory and living experiences (Bailey & Mullins, 2022). Further, not all individuals are necessarily close with their roommates, and thus may not feel comfortable expressing preferences for their sensory environments (Sibeoni et al., 2017, 2022). Thus, it could be that roommates, siblings, or significant others with whom participants were living were not supporting the autistic individual or helping them create more positive sensory environments. Future research should test the association between who autistic adults are with and the proportions of their positive, negative, and neutral sensory experiences directly, to draw more concrete conclusions on how the people autistic adults are with impact their experiences.

Our analyses of which people significantly impacted participants' sensory experiences indicated that participants reported a statistically significant difference between their overall reported sensory experiences and those reported when they were with their significant others. This was consistent with research suggesting that autistic individuals report emotional and sexual relationships with their significant others as problematic for their sensory experiences (Barnett & Maticka-Tyndale, 2015; Robledo et al., 2012). Interestingly, while being with other people was associated with more negative sensory experiences, being with a parent/caregiver showed similar patterns of sensory experiences as being alone. This finding is consistent with previous research that found that autistic adults identified that being with close family helped them cope with negative sensory experiences (MacLennan et al., 2022). Additionally, research indicates that close family and friends of autistic adults understand their sensory experiences and adapt their behaviours to help them overcome negative sensory experiences (Davidson, 2010; Elwin et al., 2012; Humphrey & Lewis, 2008; Knott & Taylor, 2014; Landon et al., 2016; Robertson & Simmons, 2015; Robledo et al., 2012; Rogers et al., 2017; Schaaf & Miller, 2005; Smith & Sharp, 2013). Thus, the parents/caregivers of the autistic adults in our study likely were more aware of how their behaviours may impact the sensory experiences of autistic adults and therefore were better able to adapt these actions to not trigger negative sensory experiences.

Thus, future research should investigate the role parents/caregivers play in the sensory experiences of autistic individuals, and how they contribute to positive sensory experiences compared to other individuals.

We found that autistic adults' feelings of good mood, control over their environment, fatigue, physically unwell, and anxiety/overwhelmed were also significantly associated with their sensory experiences. As predicted, being in a good mood and feeling in-control over one's environment was significantly associated with the proportion of participants' positive, negative, and neutral sensory experiences, which is consistent with research regarding positive affective states (Jones et al., 2003; Milner et al., 2019; Robertson & Simmons, 2015; Smith & Sharp, 2013) and feelings of control over one's environment (Louis-Delsoin et al., 2024) and positive sensory experiences.

Similarly, feeling anxious/overwhelmed was significantly associated with the proportion of positive, negative, and neutral sensory experiences. Participants reported a greater proportion of negative compared to positive or neutral sensory experiences when they were feeling anxious/overwhelmed. These findings may be due to intolerance of uncertainty (the tendency to react negatively to situations or events that are unforeseen/unpredictable; Buhr & Dugas, 2006). Research suggests that there are significant relationships between intolerance of uncertainty, anxiety, repetitive behaviours, and sensory sensitivities in autistic adults (Boulter et al., 2014; Hwang et al., 2020; Normansell-Mossa et al., 2021; Rodgers et al., 2023). Thus, increased anxiety or intolerance of uncertainty may be related to heighted sensory sensitivities, which may result in increased proportions of negative sensory experiences. These findings are also consistent with participants' frequently reported psychological reactions to sensory experiences. Psychological reactions were mostly related to participants' positive and negative emotions.

Positive emotions included feelings of happiness and satisfaction while negative emotions included feelings of anxiety, fear, and anger. These findings are consistent with studies of positive (Jones et al., 2003; Milner et al., 2019; Robertson & Simmons, 2015; Smith & Sharp, 2013) and negative (Hwang et al., 2020) affective states and sensory experiences.

Feelings of fatigue and physically unwell were also significantly associated with the proportion of positive, negative, and neutral sensory experiences, with autistic adults reporting a greater proportion of negative compared to positive and neutral sensory experiences. Little research has investigated the association between feelings of fatigue and physically unwell and sensory processing. While autistic adults do report worse sleep quality, which may contribute to negative sensory experience (McLean et al., 2021), additional research on the effect of these contextual factors on the sensory experiences of autistic adults is needed to confirm our findings. However, participants did report physical reactions to sensory experiences including feeling tense or relaxed, and feeling physically unwell (physical pain, discomfort, increased heart rate, and gagging/nausea). These reactions are similar to those that have been reported by autistic children and adults in qualitative studies of their sensory experiences (Ashburner et al., 2013; Kirby et al., 2015; Robertson & Simmons, 2015). Understanding the possible reactions autistic adults have in response to adverse sensory experiences can be beneficial for identifying effective coping mechanisms to deal with these reactions. For example, if an autistic adult knows they get a headache or feel anxious when they experience negative sensory experiences (for example, from loud noises or strong perfume), they may be more likely to carry noise cancelling headphones with them or scented hand sanitizer they like.

Further, no significant associations were found between participants' feelings of hunger or transitioning between activities/places and the proportion of their positive, negative, and neutral sensory experiences. This was a somewhat surprising finding given that research suggests associations between sensory sensitivity and dysfunctional eating (Nisticò et al., 2023) and that autistic adults report difficulties transitioning between activities and events (American Psychiatric Association, 2022). Additional research is needed to determine the impact of these contextual factors on sensory experiences.

Finally, stimulation levels were also significantly associated with the proportion of positive, and negative sensory experiences. Only when participants were at an optimal stimulation level did they report a large proportion of positive sensory experiences. Otherwise, participants reported large proportions of negative sensory experiences. Interestingly, participants reported negative sensory experiences 73.2% of the time when they were feeling overstimulated, 4.9% of the time when they were feeling understimulated, 16.6% of the time when they were feeling neither over- nor understimulated, and 5.4% of the time when they were feeling both over- and understimulated. This finding suggests that sensory environments that are overstimulating may contribute to negative sensory experiences while optimally stimulating environments may contribute to positive sensory experiences. Little research has directly investigated the association between participants' stimulation level and their sensory experiences, although feelings of overstimulation and understimulation are often reported in autistic adults' descriptions of their sensory experiences (Black et al., 2022).

Our thematic analysis of participants' responses to the daily EMA survey also revealed stimuli in their environments that impacted their sensory experiences. Interestingly, tactile and auditory stimuli were the most frequently reported stimuli impacting positive, negative, and neutral sensory experiences. While behavioural studies have investigated the impact of tactile (Blakemore et al., 2006; Cascio et al., 2008; Puts et al., 2014; Tavassoli et al., 2016) and auditory stimuli (Haesen et al., 2011) on sensory processing, the findings are more mixed than behavioural studies that have investigated the impact of visual stimuli on sensory processing (Ashwin et al., 2009; Clery, Andersson, et al., 2013; Clery, Roux, et al., 2013; Green et al., 2013). Visual stimuli were the third most frequently reported sensory stimuli participants described across positive, negative, and neutral sensory experiences. Thus, while visual stimuli do seem to impact sensory processing behaviourally and in the daily experiences of autistic adults, it is possible that tactile and auditory stimuli may have similar, if not more impact on these experiences. Future research is needed to determine both the positive and negative impacts that these stimuli have on sensory processing.

Another interesting finding in our results was the impact pain, temperature, and hunger played in participants' sensory experiences. Previous studies of interoceptive perception in ASD reported that autistic individuals have limited awareness to pain or hunger (Elwin et al., 2013; Fiene & Brownlow, 2015) and the DSM-5 diagnostic criteria for ASD includes "apparent indifference to pain/temperature" as an example of hyper- or hyporeactivity to sensory stimuli (American Psychiatric Association, 2022). However, more recent experimental and behavioural designs have reported that autistic people are not insensitive or indifferent to interoceptive stimuli. Rather, autistic adults may have similar pain thresholds as non-autistic adults (Failla et al., 2020). Additionally, some research suggests that autistic adults may demonstrate difficulties in interoceptive perception if they have co-occurring alexithymia (Brewer et al., 2015). Alexithymia is a dimensional personality trait defined by difficulties identifying and describing one's emotions (Nemiah et al., 1976) and is characterized by general interoceptive impairment (Brewer et al., 2015; Gaigg et al., 2018; Herbert et al., 2011; Longarzo et al., 2015; Näring & van der Staak, 2010; Shah et al., 2016). Thus, it is suggested to contribute to interoceptive impairment in autistic adults with co-occurring alexithymia (Murphy et al., 2017). While alexithymia frequently co-occurs with ASD (Berthoz & Hill, 2005), only two participants in our study self-reported co-occurring alexithymia. Thus, it is possible that participants in our study reported an awareness of interoceptive stimuli such as pain, temperature, and hunger due to low levels of alexithymia in our sample. We did not specifically assess alexithymia; therefore, additional research is needed to better understand the potential impact it has on the sensory experiences of autistic adults. Additional research is also needed to investigate pain, hunger, and temperature sensitivity and perception in autistic individuals, to determine whether autistic individuals really display reduced sensitivity and perception of interoceptive stimuli.

We also investigated the relationships between participants' momentary sensory experiences and their scores on measures of sensory processing and the severity of their autistic traits. We had predicted that as participants' scores on standardized questionnaires of autistic traits and sensory processing increased (indicated greater severity of autistic traits and differences in sensory processing), so would the proportion of their negatively reported sensory experiences. Contrary to our predictions, we found no significant relationships between the proportion of participants' positive, negative, or neutral sensory experiences and their full-scale scores on the AASP and the SRS-2, or subscale scores on the RRB and Sensory Sensitivity.

Though surprising, this finding may be attributed to differences between sensory reactivity and sensory sensitivity. Some research has found no significant relationships between objective (behavioural) and subjective (self-report) measures of sensory sensitivity, suggesting that these measures are assessing different constructs (Schulz & Stevenson, 2020, 2022). Specifically, behavioural measures may be assessing sensory sensitivity (our ability to perceive a stimulus as either increased (hypersensitivity) or decreased (hyposensitivity) in intensity) whereas self-report measures may instead be assessing sensory reactivity (the overt (hyperreactive) or covert (hyporeactive) response to a stimulus). The proportion of participants' positive, negative, and neutral sensory experiences were calculated based on the descriptions of their sensory experiences and were commonly responses such as the lights were too bright, the noise was too loud, or my clothing was itchy. It is therefore possible that no relationship was found between participants' responses and the AASP, as participants' descriptions were of their sensory sensitivity, whereas the AASP measures the reactivity to sensory stimuli.

It would be interesting to compare the proportion of participants' positive, negative, and neutral sensory experiences and a behavioural measure of their sensory sensitivity, such as a psychophysical task or an observational assessment of sensory sensitivity, such as the Sensory Assessment for Neurodevelopmental Disorders (SANDS; Siper & Tavassoli, 2017). This may provide a true comparison between autistic adults' subjective and objective sensory sensitivity, instead of a comparison between their sensory sensitivity and sensory reactivity. Alternatively, it would be interesting to compare participants' scores on the AASP and their reactions or coping mechanisms to their sensory experiences. Since reactions and coping mechanisms to sensory experiences are typically observable behaviours, these may be more greatly associated with the AASP. Further, some research has specifically addressed autistic adults' sensory reactivity using both quantitative and qualitative analyses (MacLennan et al., 2022). In their design, researchers specifically asked participants to report on their sensory reactivity to sensory stimuli in different modalities. Thus, their questionnaires were designed to assess sensory reactivity. It would be interesting to compare these results to standardized measures such as the AASP, which may be assessing sensory reactivity, to determine whether a relationship exists.

Finally, although the AASP and the SRS-2 are commonly used questionnaires to assess the severity of one's autistic traits, there are limitations of these questionnaires that may be contributing to our findings. The AASP, for example, does not assess interoception (internal sensory processing) (DuBois et al., 2016). This includes sensations such as pain, temperature, and hunger, which were commonly reported sensory experiences in our results. Thus, a significant proportion of the positive, negative, and neutral sensory experiences that participants reported on are not assessed by this measure, which may be contributing to the lack of a relationship we found. Further, while the SRS-2 is strongly associated with a clinical diagnosis of ASD, it is designed to assess social interaction and not sensory processing. The RRB subscale does include items related to sensory processing; however, does not include items specifically assessing different sensory stimuli that may impact an individual's sensory experiences. Thus, despite assessing the severity of one's autistic traits, the SRS-2 may not be assessing sensory experiences thoroughly enough for a significant relationship to be found. Future research may investigate how differences in social communication impact sensory experiences in autistic adults, such as communicating with others their preferences for sensory environments for example. While we did not ask this in our EMA survey, it is possible that these differences may have impacted participants' sensory experiences and may therefore be related to scores on measures of social communication, such as the SRS-2.

5.1 Implications

Our findings can have implications for creating sensory inclusive environments. Our finding that auditory, tactile, and visual stimuli are most frequently reported to impact sensory experiences suggests that these stimuli are important to consider when creating sensory inclusive environments. While tactile stimuli reported in our study were more proximal (i.e., itchy clothing, sweat, water or makeup on skin), auditory and visual stimuli were more distal. Specifically, participants reported auditory stimuli such as hearing other people's voices, noises from appliances, children playing or crying and visual stimuli such as bright, aggressive lights, many colours, and the sight of people or movement. These findings are consistent with research proposed by indoor environmental quality (IEQ) design for creating sensory inclusive environments (Black et al., 2022; Zaniboni & Toftum, 2023). Specifically, light intensity, quality, and fixtures, as well as sound intensity and quality have been identified as impacting IEQ for autistic individuals. However, large discrepancies are reported in IEQ design research due to the large heterogeneity of preferences of stimuli for autistic adults. For example, while some prefer low intensity lightning (Nagib & Williams, 2017; Shabha & Gaines, 2013), others who have a hyposensitivity to light, find this lighting disruptive (Nagib & Williams, 2017). Similarly, our results suggest that autistic adults experience both positive and negative sensory experiences from differences in light and sound. For example, in our results, bright lights also contributed to positive sensory experiences in some instances, as did listening to movies or music. Thus, our findings are consistent with previous research that has investigated IEQ design for autistic individuals and contribute to this research by having specific accounts of autistic adults. Implementing suggestions from IEQ design may therefore be beneficial for reducing autistic adults' negative sensory experiences, although more research is needed to determine optimal environments for autistic adults with various sensitivities.

Our findings also have implications for optimizing quality of life for autistic adults. Although all autistic adults' traits and sensory experiences will differ, understanding what has helped other autistic adults in periods of negative sensory experiences may be beneficial for identifying coping mechanisms they can implement in their daily life. Additionally, identifying coping strategies that are beneficial for oneself during negative sensory experiences may be beneficial for autistic adults when they have little control over their environments or are in a situation where they cannot remove themselves from the environment. This can help autistic adults prepare for potential negative sensory experiences in advance.

5.2 Limitations and Future Research Directions

There are numerous limitations to our study to be mindful of when interpreting our results. First, the amount of information participants reported in their sensory experiences. While some participants reported detailed responses, others reported short responses that did not provide as much contextual information regarding their sensory experiences. As a result, while participants may have described their sensory experience as negative due to “noises”, they did not elaborate on what aspect of the noises were contributing to the negative sensory experience (such as the volume, the overlap with other noises) or the origin of these noises (such as noise from other people, noise from the outdoors, noise from appliances). In order to obtain more information regarding the sensory experiences participants reported on in their daily EMA surveys, and their overall sensory processing, we are inviting a subsample of participants to complete a semi-structured interview. In the interview, we ask participants to explain the factors that in general impact their sensory experiences (such as specific stimuli, people, or places), as well as provide information regarding the sensory experiences they reported on in their EMA surveys. Information from these interviews will help us fill in some of the gaps in participants’ daily responses and better understand other factors that impact autistic adults’ sensory experiences. Another follow-up analysis that would be beneficial to include would be a multilevel modelling analysis, that would test how each contextual factor impacted the valence of the sensory experiences reported. This analysis would also allow us to test the interaction of various contextual factors on the sensory experiences of autistic adults. For example, we could test how participants' social communicative abilities impacted their sensory experiences or test the combined associations between who participants were with and their location on their experiences (such as the impact that being at school but being with close friends compared to classmates has on participants' experiences. Since we now know that contextual factors are associated with autistic individuals' sensory experiences, such an analysis would give us a better understanding of how each of these contextual factors impacts these experiences.

There were some limitations with our sample as well. We had primarily female participants. This is not reflective of the gender ratio in autistic individuals, which is primarily male, and may suggest that our results are not generalizable to the general autistic population. Only two studies have investigated the gender differences in sensory perception in autistic adults. One found little to no differences between males and females in their expression of autistic traits and sensory processing (Cardon et al., 2023). The other found that only previously misdiagnosed autistic females reported significantly higher scores than previously misdiagnosed autistic males in hyper- and hyporeactivity to sensory stimuli (Gesi et al., 2021). No sex differences in hyper- and hyporeactivity were found between autistic adults who were not previously misdiagnosed. Taken together, these results suggest that autistic females have similar differences in sensory processing as autistic males do, thus the unequal gender distribution in our sample may not be a problem. However, additional research is needed to better understand gender and sex differences in autistic adults, specifically in potential differences pertaining to their sensory processing and experiences.

Further, our study only examined the sensory experiences of autistic adults with low-support needs. Although we recruited autistic adults of all abilities and invited caregivers to respond on an autistic adult's behalf if they were unable to respond on their own, we did not have any autistic adults participate this way. Thus, our results are somewhat limited to autistic adults with low-support needs and future research should investigate the sensory experiences of autistic adults with high-support needs. Future research should also investigate the sensory experiences of autistic children. Completing the same study with parents and educators of autistic children can help us better understand the contextual factors that impact the daily sensory experiences of autistic children at home and at school. Comparing the sensory experiences of autistic children and adults can help researchers understand differences in these experiences across the lifespan. It can also increase our understanding of how reactions and coping mechanisms to sensory experiences change throughout the lifespan. This research can be beneficial for optimizing quality of life for autistic children and adults to help them cope with difficult sensory experiences and create more sensory inclusive environments for all ages.

5.3 Conclusion

This study investigated the contextual factors that impact the daily sensory experiences of autistic adults. Our findings indicate that factors such as who an autistic adult is with, where they are, and their mood and affective states are associated with their positive, negative, and neutral sensory experiences. The sensory domain the stimulus was in also had an impact on sensory experiences, with autistic adults most frequently reporting auditory and tactile stimuli as impacting their sensory experiences. Both physical and psychological reactions to sensory experiences were reported and commonly reported coping mechanisms included removing oneself from the environment, eliminating the disruptive stimulus, or focusing one’s attention on a different stimulus. These results are consistent with previous qualitative studies of sensory experiences of autistic individuals and have implications for creating sensory inclusive environments and optimizing quality of life. Further, we investigated the relationship between participants' scores on standardized questionnaires of sensory processing and autistic traits and the proportion of their positive, negative, and neutral sensory experiences. No significant correlations were found between these measures, suggesting a potential discrepancy between measures of sensory sensitivity and sensory reactivity. Future research is needed to investigate this discrepancy further, as well as investigate the sensory experiences of autistic children, to determine whether these findings are consistent or change across the lifespan.

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Appendices

Appendix A: Initial Western University's Non-Medical Research Ethics Board Approval Letter (December, 2021)

Date: 20 December 2021

To: Prof. Ryan Stevenson

Project ID: 119201

Study Title: Ecological Momentary Assessments of Sensory Experiences in Autism

Application Type: HSREB Initial Application

Review Type:
Delegated

Full Board

Reporting Date:

11/January/2022

Date Approval

Issued:

20/Dec/2021 13:54

REB Approval
Expiry Date:
20/Dec/2022

Dear Prof. Ryan Stevenson

The Western University Health Science Research Ethics Board (HSREB) has reviewed and approved the above mentioned study as described in the WREM application form, as of the

HSREB Initial Approval Date noted above. This research study is to be conducted by the investigator noted above. **All other required institutional approvals and mandated training must also be obtained prior to the conduct of the study**.

Documents Approved:

Document Name	Document Type	Document Date	Document Version
Ethics Protocol 28-10-2021	Protocol	28/Oct/2021	3
Study Ad (1)	Recruitment Materials	29/Oct/2021	2
Email Script	Email Script	29/Oct/2021	2
assent	Assent Form	11/Nov/2021	2
EMA 2021 - Child	Online Survey	17/Nov/2021	2
Prompts - other	Online Survey	17/Nov/2021	2
Prompts - self	Online Survey	17/Nov/2021	2
EMA 2021 - Adult	Online Survey	01/Dec/2021	3
Letter of Information and Consent - Autistic Adult	Written Consent/Assent	16/Dec/2021	5
Letter of Information and Consent - Autistic Child	Written Consent/Assent	16/Dec/2021	5
Letter of Information and Consent - Neurotypical Adult	Written Consent/Assent	16/Dec/2021	5
Letter of Information and Consent - Neurotypical Child	Written Consent/Assent	16/Dec/2021	5

Documents Acknowledged:

Document Name	Document Type	Document Date	Document Version
budget	Study budget	06/Oct/2021	1
AutoSender Approval	Technology Review document	17/Dec/2021	1

No deviations from, or changes to, the protocol or WREM application should be initiated without prior written approval of an appropriate amendment from Western HSREB , except when necessary to eliminate immediate hazard(s) to study participants or when the change(s) involves only administrative or logistical aspects of the trial.

REB members involved in the research project do not participate in the review, discussion or decision.

The Western University HSREB operates in compliance with, and is constituted in accordance with, the requirements of the TriC ouncil Policy Statement: Ethical Conduct for Research Involving Humans (TCPS 2); the International Conference on Harmonisation Good Clinical Practice Consolidated Guideline (ICH GCP); Part C,

Division 5 of the Food and Drug Regulations; Part 4 of the Natural Health Products Regulations; Part 3 of the Medical Devices Regulations and the provisions of the Ontario Personal Health Information Protection Act (PHIPA 2004) and its applicable regulations. The HSREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000940.

Please do not hesitate to contact us if you have any questions. Sincerely,

Ms. Nicola Geoghegan-Morphet , Ethics Officer on behalf of Dr. Philip Jones, HSREB Chair

Note: This correspondence includes an electronic signature (validation and approval via an online system that is compliant with all regulations).

Appendix B: Revised Western University's Non-Medical Research Ethics Board Approval Letter (April, 2024)

Western Research

Date: 30 April 2024

To: Prof. Ryan Stevenson

Project ID: 119201

Review Reference: 2024-119201-92318

Study Title: Ecological Momentary Assessments of Sensory Experiences in Autism

Application Type: HSREB Amendment Form

Review Type: Delegated

Full Board Reporting Date: 14/May/2024

Date Approval Issued: 30/Apr/2024 09:52

REB Approval Expiry Date: 20/Dec/2024

Dear Prof. Ryan Stevenson ,

The Western University Health Sciences Research Ethics Board (HSREB) has reviewed and approved the WREM application form for the amendment, as of the date noted above.

Documents Approved:

Document Name	Document Type	Document Date	Document Version
Assent_Form_2024_01_11	Assent Form	11/Jan/2024	1
Study Ad - Interview - 01-11-2024	Recruitment Materials	11/Jan/2024	1
Interview Script_02_20_2024	Interview Guide	20/Feb/2024	1
EMA_AA_LOI_Including_Interview_02_20_2024	Consent Form	20/Feb/2024	1
EMA_AC_LOI_Consent_Including_Interview_02_20_2024	Consent Form	20/Feb/2024	1
EMA_Parent_LOI_Interview_02_20_2024	Consent Form	20/Feb/2024	1
EMA_AA_LOI_RETURNING_INTERVIEW	Consent Form	21/Apr/2024	1
EMA_AC_LOI_RETURNING_INTERVIEW	Consent Form	21/Apr/2024	1
EMA_Educator_LOI_Consent_Incuding_Interview_2024_04_21	Consent Form	21/Apr/2024	1
Ethics Protocol 04-25-2024	Protocol	25/Apr/2024	1
Interview Email Script 04.30.2024	Protocol	30/Apr/2024	1

Documents Acknowledged:

Document Name	Document Type	Document Date	Document Version
Ethics Protocol 04-25-2024_track_changes	Summary of Changes	25/Apr/2024	1

REB members involved in the research project do not participate in the review, discussion or decision.

The Western University HSREB operates in compliance with, and is constituted in accordance with, the requirements of the TriC ouncil Policy Statement: Ethical Conduct for Research Involving Humans (TCPS 2); the International Conference on Harmonisation Good Clinical Practice Consolidated Guideline (ICH GCP); Part C, Division 5 of the Food and Drug Regulations; Part 4 of the Natural Health Products Regulations; Part 3 of the Medical Devices Regulations and the provisions of the Ontario Personal Health Information Protection Act (PHIPA 2004) and its applicable regulations. The HSREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000940.

Please do not hesitate to contact us if you have any questions.

Electronically signed by:

Nicola Geoghegan-Morphet , Ethics Officer on behalf of Dr. Naveen Poonai, HSREB Chair, 30/Apr/2024 09:52

Reason: I am approving this document.

Note: This correspondence includes an electronic signature (validation and approval via an online system that is compliant with all regulations).

Appendix C: Initial Letter of Information and Consent Form (December, 2021)

EMA - AA - Letter of Information and Consent Form

Start of Block: Study Info

Q1 Letter of Information and Consent

1. Study Title

Ecological Momentary Assessments of Sensory Experiences in Autism

2. Principal Investigator

Prof. Ryan Stevenson
Department of Psychology
Western University

3. Conflict of Interest

There are no conflicts of interest to declare related to this study.

4. Introduction

You're invited to participate in a study about how we understand what we see and hear and feel influences how we interact with the world because you are an autistic adult.

5. Why is this study being done?

Sensory processing issues are common for autistic individuals. Autistic individuals experience differences in what they sense, for example, what they see and hear and touch. These differences may result in discomfort from negative sensory experiences in daily life.

Behavioural experiments are often inconsistent in their reports of sensory processing in autism. This inconsistency could potentially occur because in-lab procedures are not always representative of real life. The purpose of this study is to better understand sensory processing in real life by collecting small amounts of information throughout the day in relation to participants' current sensory environment and experiences.

6. How long will you be the study?

This study will take place over the course of two weeks. The initial intake survey will take up to one hour. You will be sent prompts to fill out short surveys a few times per day. The short surveys throughout the day will take up to five minutes to complete. In total, participation in this study will take between 2-4 hours.

7. What are the study procedures?

There will be four groups of participants recruited: 50 autistic adults (18 and older); 50 neurotypical adults (18 and older); 50 autistic children (4 to 18 years); and 50 neurotypical children (4 to 18 years). All participants must have access to a cell phone that can receive text messages and connect to the internet.

If you agree to participate you will be asked to complete two separate parts.

1) Questionnaires: You will be asked to complete several online questionnaires about your personal skills and characteristics. This portion will take up to one hour.

2) Smart Phone Tasks: You will be asked to respond to quick online surveys that are prompted and linked through SMS texts. Questions will be about your sensory experiences, environment, mood state, etc. You will be randomly prompted 2 to 5 times per day over the course of two weeks (14 days).

8. What are the risks and harms of participating in this study?

This study does not take place in the privacy of a lab setting so we cannot control the surroundings of participants when they receive the prompts to complete the survey. Links will be sent through SMS text message. Please be advised that SMS text is not a secure communication platform. Because these prompts are sent randomly throughout the day, we ask that participants ensure they respond to the prompts when they can do so safely and confidentially.

9. What are the benefits?

You may not directly benefit from participating in this study, but you could potentially benefit from realizing connections between your mood, energy levels, etc. and how you respond to your sensory environment. Additionally, information we learn from this study may provide benefits to society as a whole. We are trying to understand how different peoples' brains process what we see and hear differently. This might help us to find ways to help people whose brains process sights and sounds differently, such as people with autism spectrum disorder.

10. Can participants choose to leave the study?

Participation in this study is completely voluntary. You may choose to skip any question you do not want to answer. You may decide not to be in this study, or to be in the study now and then change your mind later. You may leave the study at any time. If you decide to stop participating, you will still be eligible to receive the promised compensation for agreeing to be in this project. If you decide to withdraw from the study, you have the right to request (e.g. by phone, in writing, etc.) withdrawal of information collected about you. If you wish to have your information removed, please let the researcher know and your information will be destroyed from our records. Once the study has been published, we will not be able to withdraw your information.

11. What are the rights of participants?

Your participation in this study is voluntary. You may decide not to be in this study. Even if you consent to participate you have the right to not answer individual questions or to withdraw from the study at any time. You do not waive any legal right by consenting to this study.

12. Are participants paid to be in this study?

You will be compensated $20.00 for your participation in this study. Compensation will be provided by e-transfer.

13. How will participant's information be kept confidential?

Representatives of Western University's Health Sciences Research Ethics Board may require access to your study-related records to monitor the conduct of the research. Your survey responses will be collected anonymously through a secure online survey platform called Qualtrics. Qualtrics uses encryption technology and restricted access authorizations to protect all data collected. The data will then be exported from Qualtrics and securely stored on Western University's server.

The information we get in this study may be used for teaching, be presented at meetings, published, shared with other scientific researchers, or used in future studies. However, we will make sure that every participant is completely anonymous. Your name or other personal information will not be used in any publication or teaching materials without your specific permission. Because this study includes open ended responses, we may use direct quotes from your responses, this data will be de-identified.

With all studies, including this study, there is a small risk related to confidentiality. In other words, because you are giving us information about yourself, there is a risk that that information could accidentally be shared. However, we do as much as we can to make sure this does not happen. We will keep all personal information about you in a secure and confidential database for a minimum of 7 years. A list linking your participant number with your name, birthdate, any other identifiable information, and your contact information will be kept separately from your study information in an encrypted, password protected file on a locked desktop computer in a secure location.

Your data may be retained indefinitely and could be used for future research purposes (e.g., to answer a new research question). By consenting to participate in this study, you are agreeing that your data can be use beyond the purposes of this present study by either current or other researchers.

De-identified data may also be accessible by the study investigators as well as the broader scientific community. More specifically, the data may be made available to other researchers upon publication so that data may be inspected and analyzed by other researchers.

14. Whom do participants contact for questions?

If you have any questions about the study, you may contact:

Prof. Ryan Stevenson

Department of Psychology, Western University

If you have any questions about your rights as a research participant or the conduct of this study, you may contact:

The Office of Human Research Ethics

The REB is a group of people who oversee the ethical conduct of research studies. The

HSREB is not part of the study team. Everything that you discuss will be kept confidential. This letter is yours to keep for future reference.

Q1 I consent to being contacted in the future for additional studies.

- Yes (1)
- No (2)

Q2 I consent to the use of unidentified quotes obtained during the study in the dissemination of this research.

- Yes (1)
- No (2)

Q3 I consent to the use of my data for future purposes.

- Yes (1)
- No (2)

Q4
This study has been explained to me and any questions I had have been answered. I know

that I may leave the study at any time. I agree to take part in this study.

First name of participant.

____

Q5 Last name of participant.

____

Signature Signature of participant.

Date Today's Date (dd-mm-yyyy)

____

End of Block: Study Info

Appendix D: Revised Letter of Information and Consent Form (April, 2024)

EMA_AA_LOI_Including_Interview

Start of Block: Study Info

Q1 Letter of Information and Consent

1. Study Title
Ecological Momentary Assessments of Sensory Experiences in Autism

2. Principal Investigator
Prof. Ryan Stevenson
Department of Psychology
Western University

3. Conflict of Interest
There are no conflicts of interest to declare related to this study.

4. Introduction
You're invited to participate in a study about how we understand what we see and hear and feel influences how we interact with the world because you are an autistic adult.

5. Why is this study being done?
Sensory processing issues are common for autistic individuals. Autistic individuals experience differences in what they sense, for example, what they see and hear and touch. These differences may result in discomfort from negative sensory experiences in daily life. Behavioural experiments are often inconsistent in their reports of sensory processing in autism. This inconsistency could potentially occur because in-lab procedures are not always representative of real life. The purpose of this study is to better understand sensory

processing in real life by collecting small amounts of information throughout the day in relation to participants' current sensory environment and experiences.

6. How long will you be the study?

This study will take place over the course of two weeks. The initial intake survey will take up to one hour. You will be sent prompts to fill out short surveys a few times per day. The short surveys throughout the day will take up to five minutes to complete. In total, participation in this study will take between 2-4 hours. After the two weeks, you will then be invited to participate in a one-hour interview to elaborate on some of daily sensory experiences you reported and let us know about any other information that impacts your sensory experiences.

7. What are the study procedures?

There will be four groups of participants recruited: 50 autistic adults (18 and older); 50 neurotypical adults (18 and older); 50 autistic children (4 to 18 years); and 50 neurotypical children (4 to 18 years). All participants must have access to a cell phone that can receive text messages and connect to the internet.

If you agree to participate you will be asked to complete two separate parts.

1) Questionnaires: You will be asked to complete several online questionnaires about your personal skills and characteristics. This portion will take up to one hour. 2) Smart Phone Tasks: You will be asked to respond to quick online surveys that are prompted and linked through SMS texts. Questions will be about your sensory experiences, environment, mood state, etc. You will be randomly prompted 2 to 5 times per day over the course of two weeks (14 days).

3) Qualitative Interview: You will be invited to participate in a one-hour virtual interview with a researcher. The researcher will ask you to elaborate on some of your responses from the daily questionnaires and about your sensory experiences more generally. The interview will take place over Zoom. You have the option to keep your video on or off.

8. What are the risks and harms of participating in this study?

This study does not take place in the privacy of a lab setting so we cannot control the surroundings of participants when they receive the prompts to complete the survey. Links will be sent through SMS text message. Please be advised that SMS text is not a secure communication platform. Because these prompts are sent randomly throughout the day, we ask that participants ensure they respond to the prompts when they can do so safely and confidentially. The qualitative interviews will take place over Zoom. Please be advised that Zoom is not a secure communication platform.

9. What are the benefits?

You may not directly benefit from participating in this study, but you could potentially benefit from realizing connections between your mood, energy levels, etc. and how you respond to your sensory environment. Additionally, information we learn from this study may provide benefits to society as a whole. We are trying to understand how different peoples' brains process what we see and hear differently. This might help us to find ways to help people whose brains process sights and sounds differently, such as people with autism spectrum disorder.

10. Can participants choose to leave the study?

Participation in this study is completely voluntary. You may choose to skip any question you do not want to answer. You may decide not to be in this study, or to be in the study now and then change your mind later. You may leave the study at any time. If you decide to stop participating, you will still be eligible to receive the promised compensation for agreeing to be in this project. If you decide to withdraw from the study, you have the right to request (e.g. by phone, in writing, etc.) withdrawal of information collected about you. If you wish to have your information removed, please let the researcher know and your information will be destroyed from our records. Once the study has been published, we will not be able to withdraw your information.

11. What are the rights of participants?

Your participation In this study ”s vo’untary. You may decide not to be in this study. Even if you consent to participate you have the right to not answer individual questions or to withdraw from the study at any time. You do not waive any legal right by consenting to this study.

12. Are participants paid to be in this study?

You will be compensated $20.00 for completing the questionnaires and daily surveys. You will be compensated $20.00 for participating in the qualitative interviews. Compensation will be provided by e-transfer.

13. How will participant's information be kept confidential?

Representatives of Western University's Health Sciences Research Ethics Board may require access to your study-related records to monitor the conduct of the research. Your survey responses will be collected anonymously through a secure online survey platform called Qualtrics. Qualtrics uses encryption technology and restricted access authorizations to protect all data collected. The data will then be exported from Qualtrics and securely stored on Western Universit''s server.
Zoom will be used at the virtual platform for the interview. Please find information regarding Zoom's privacy here: https://explore.zoom.us/en/privacy/ The video recording will be deleted immediately. The audio recording of your verbal responses will be transcribed by researchers using Microsoft Word These will be securely stored on Western University's server for seven years before being destroyed.
The information we get in this study may be used for teaching, be presented at meetings, published, shared with other scientific researchers, or used in future studies. However, we will make sure that every participant is completely anonymous. Your name or other personal information will not be used in any publication or teaching materials without your specific permission. Because this study includes open ended responses, we may use direct quotes from your responses, this data will be de-identified.
With all studies, including this study, there is a small risk related to confidentiality. In other words, because you are giving us information about yourself, there is a risk that that information could accidentally be shared. However, we do as much as we can to make sure this does not happen. We will keep all personal information about you in a secure and confidential database for a minimum of 7 years. A list linking your participant number with your name, birthdate, any other identifiable information, and your contact information will be kept separately from your study information in an encrypted, password protected file on a locked desktop computer in a secure location.
Your data may be retained indefinitely and could be used for future research purposes (e.g., to answer a new research question). By consenting to participate in this study, you are agreeing that your data can be use beyond the purposes of this present study by either current or other researchers.
De-identified data may also be accessible by the study investigators as well as the broader scientific community. More specifically, the data may be made available to other researchers upon publication so that data may be inspected and analyzed by other researchers.

14. Whom do participants contact for questions?
If you have any questions about the study, you may contact:
Prof. Ryan Stevenson
Department of Psychology, Western University

If you have any questions about your rights as a research participant or the conduct of this study, you may contact:
The Office of Human Research Ethics

The REB is a group of people who oversee the ethical conduct of research studies. The HSREB is not part of the study team. Everything that you discuss will be kept confidential. This letter is yours to keep for future reference.

Q1 I consent to being contacted in the future for additional studies.

○ Yes (1)

○ No (2)

Q2 I consent to the use of unidentified quotes obtained during the study in the dissemination of this research.

○ Yes (1)

○ No (2)

Q3 I consent to the use of my data for future purposes.

- ○ Yes (1)
- ○ No (2)

Q4
This study has been explained to me and any questions I had have been answered. I know that I may leave the study at any time. I agree to take part in this study.

First name of participant.

____

Q5 Last name of participant.

____

Signature Signature of participant.

Date Today's Date (dd-mm-yyyy)

____

End of Block: Study Info

Appendix E: EMA Survey

EMA - Prompts - Self

Start of Block: ID

Q1 Please enter your participant number.

____

Event Is there an event you would like to report on since the last prompt you received? (Don't forget, you can click this link again if something comes up).

○ Yes (1)

○ No (2)

Skip To: End of Survey If Is there an event you would like to report on since the last prompt you received? (Don't forget,... = No

End of Block: ID

Start of Block: General

Q2 Where are you currently?

- ☐ Home (1)
- ☐ School (2)
- ☐ Work (3)
- ☐ Somewhere else? Please specify (mall, park, restaurant, etc.) (4) ____

Q3 Who are you currently with? Select all that apply.

- ☐ I'm alone (1)
- ☐ Parent(s)/Caregiver(s) (2)
- ☐ Someone you live with (i.e. partner, sibling, child, roommate) (3)
- ☐ Significant other/girlfriend/boyfriend (4)
- ☐ Friends/extended family (5)
- ☐ Classmates/coworkers (6)
- ☐ With someone virtually (i.e. class, meetings, facetime call) (8)
- ☐ Someone else? Please specify. (7) ____

Q4 Please rate how you feel based on your sensory experience.

	Very bad (1)	Bad (2)	Not bad or good (3)	Good (4)	Very Good (5)
⊗How does your current sensory experience make you feel? (1)	○	○	○	○	○

Page Break

End of Block: General

Start of Block: Negative

Display This Question:

If Please rate how you feel based on your sensory experience. = How does your current sensory experience make you feel? [Very bad]

Or Please rate how you feel based on your sensory experience. = How does your current sensory experience make you feel? [Bad]

Q5 You said you were feeling bad or very bad. Which sense makes you feel that way? Select all that apply.

- ☐ Touch (1)
- ☐ Sight (2)
- ☐ Hearing (3)
- ☐ Taste (4)
- ☐ Smell (5)

Display This Question:

If Please rate how you feel based on your sensory experience. = How does your current sensory experience make you feel? [Very bad]

Or Please rate how you feel based on your sensory experience. = How does your current sensory experience make you feel? [Bad]

Q6 Are you feeling bad or very bad because you are:

- ○ Overstimulated (1)
- ○ Understimulated (2)
- ○ Both (3)
- ○ Neither (4)

End of Block: Negative

Start of Block: Positive

Display This Question:

If Please rate how you feel based on your sensory experience. = How does your current sensory experience make you feel? [Good]

Or Please rate how you feel based on your sensory experience. = How does your current sensory experience make you feel? [Very Good]

Q5 You said you were feeling good or very good. Which sense makes you feel that way? Select all that apply.

- ☐ Touch (1)
- ☐ Sight (2)
- ☐ Hearing (3)
- ☐ Taste (4)
- ☐ Smell (5)

Display This Question:

If Please rate how you feel based on your sensory experience. = How does your current sensory experience make you feel? [Good]

Or Please rate how you feel based on your sensory experience. = How does your current sensory experience make you feel? [Very Good]

Q6 Are you feeling good or very good because you are:

- ○ Overstimulated (1)
- ○ Understimulated (2)
- ○ Both (3)
- ○ Neither (4)
- ○ I'm at an optimal stimulation level (5)

End of Block: Positive

Start of Block: Details

Q7 Please describe what you are currently sensing and what is most strongly impacting you from your sensory environment (focus on what you're sensing, not what you're doing).

____

____

____

____

____

Q8 What was your immediate reaction to your sensory experience? (i.e. felt tense, nauseous, or pain; ears ringing; heart rate increased; felt angry, annoyed, relaxed, or happy)

____

____

____

____

____

Display This Question:

If Please rate how you feel based on your sensory experience. = How does your current sensory experience make you feel? [Very bad]

Or Please rate how you feel based on your sensory experience. = How does your current sensory experience make you feel? [Bad]

Q9 What are you doing to cope or change your environment (i.e. wearing headphones, turning off lights, playing music, playing with fidgit spinner)?

____

____

____

____

____

End of Block: Details

Start of Block: Factors

Q10 Please rate your agreement with the following statements about how you were feeling immediately before you started reacting to your sensory environment.

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
I was in a good mood. (1)	○	○	○	○	○
I was hungry. (2)	○	○	○	○	○
I was tired. (3)	○	○	○	○	○
I felt I had control over my sensory environment. (4)	○	○	○	○	○
I was switching between activities or places. (5)	○	○	○	○	○
I was feeling irritated or stressed or overwhelmed or anxious. (6)	○	○	○	○	○
I physically felt unwell. (7)	○	○	○	○	○

End of Block: Factors

Start of Block: Final

Q11 Is there anything else you would like to share about your sensory experience?

____

End of Block: Final

Curriculum Vitae

Michelle Luszawski

Education

- 2022-Present — Western University, London, ON, Canada
  M.Sc. Candidate in Clinical Science and Psychopathology
  Advisor: Dr. Ryan Stevenson
- 2018-2022 — Western University, London, ON, Canada
  H.BSc. Honours Specialization in Psychology and Major in French Studies
  Advisor: Dr. Ryan Stevenson

Awards and Scholarships

- 2024-2025 — Ontario Graduate Scholarships Winner ($15,000 CAD)
- 2023-2024 — Canada Graduate Scholarships – Master's (SSHRC) Winner ($17,500 CAD)
- 2023-2024 — Ontario Graduate Scholarship Winner ($15,000 CAD) (declined)
- 2023 — Science of Intelligence Travel Grant ($1,587 CAD)
- 2023 — INSAR Student and Trainee Workshop Travel Award ($300 USD)
- 2023 — INSAR Student and Trainee Award ($500 USD)
- 2022-2023 — Ontario Graduate Scholarship Winner ($15,000 CAD)
- 2022 — Canada Graduate Scholarships – Master's (SSHRC) Winner ($17,500 CAD) (declined)
- 2022 — University of Western Ontario Gold Medal Award for the Highest Academic Average in the HBSc Psychology program
- 2021 — Western University Experiential Learning Storytelling Project Winner ($700)
- 2018 – 2022 — Dean's Honor List
- 2020, 2021 — University of Western Ontario In-Course Scholarships ($750 each)
- 2018 — Brescia University College Dean's Entrance Scholarship
- 2018 — Brescia University College Arts and Humanities Entrance Award

Relevant Experience

- 2023-2024 — Undergraduate Honors Thesis Supervision, Western University
- 2022-2024 — Graduate Teaching Assistant, Western University

Publications

- Schulz, S.E., **Luszawski, M**., Hannah, K.E., & Stevenson, R.A. Sensory Gating in Neurodevelopmental Disorders: A Scoping Review. Research on Child and Adolescent Psychopathology (2023). https://doi.org/10.1007/s10802-023-01058-9

Conference Presentations

- **Luszawski, M.**, Hare, C., Shannon, J., Li, Y., Schulz, S., & Stevenson, R. (April 15th, 2024) *Effect of Autism Spectrum Disorder on Behavioural and Neural Measures of Multisensory Integration.* Poster presentation at the Cognitive Neuroscience Society Annual Meeting, Toronto, Ontario, Canada.
- Hare, C., **Luszawski, M.,** Atta, C., Zhai, G., Shannon, J., Li, Y., McCombe, K., & Stevenson, R. (April 15th, 2024) *Sensory Sensitivity and Multisensory Integration in adults with ADHD: An EEG Investigation.* Poster presentation at the Cognitive Neuroscience Society Annual Meeting, Toronto, Ontario, Canada.
- Li, Y., Hare, C., **Luszawski, M.**, Shannon, J., Schulz, Leung, B., & Stevenson, R. (February 9th, 2024) *Audiovisual Multisensory Integration in Youth with ADHD.* Poster presentation at the Lake Ontario Visionary Establishment Conference, Niagara Falls, Ontario, Canada.
- Shannon, J., **Luszawski, M.**, Hare, C., Li, Y., Schulz, S., & Stevenson, R. (February 9th, 2024) *Behavioural Investigation of Multisensory Integration in Autistic and Non-Autistic Children.* Poster presentation at the Lake Ontario Visionary Establishment Conference, Niagara Falls, Ontario, Canada.
- Hare, C., **Luszawski, M.**, Atta, C., Zhai, G., & Stevenson, R. (November 14, 2023) *Neural underpinnings of audiovisual multisensory integration in adults with ADHD: An EEG investigation.* Poster and oral presentation at the Society for Neuroscience Annual Meeting, Chicago, Illinois, United States of America.
- Hare, C., Atta, C., Zhai, G., **Luszawski, M.**, & Stevenson, R. (June 28, 2023) *An EEG Investigation of Multisensory Integration in ADHD Adults.* Poster presentation at the International Multisensory Research Forum, Brussels, Belgium.
- **Luszawski, M.**, Schulz, S., & Stevenson, R. (May 5th, 2023) *Ecological Momentary Assessments of Sensory Experiences in Autism.* Poster presentation at the International Society for Autism Research, Stockholm, Sweden.
- **Luszawski, M.**, Schulz, S., & Stevenson, R. (February 9th, 2023) *An Investigation of Daily Sensory Experiences in Autism.* Poster presentation at the Lake Ontario Visionary Establishment Conference, Niagara Falls, Ontario, Canada.
- **Luszawski, M.**, & Stevenson, R. (August 25th, 2022) *Electrophysiological Study of Sensory Sensitivity and Multisensory Integration in Autism.* Poster presentation at the Undergraduate Student Research Internship Conference, London, Ontario, Canada.

- **<u>Luszawski, M.</u>**, Schulz, S., & Stevenson, R. (August 24th, 2021) *Qualitative Study of Sensory Processing in Autism Spectrum Disorder*. Poster presentation at the Undergraduate Student Research Internship Conference, London, Ontario, Canada.