MySensory: a Novel Solution for Sound Hyper-Reactivity in Autism

Olly R Player
University College London
London, United Kingdom
olivia.player.24@ucl.ac.uk

Merlin Angel Kelly
University College London
London, United Kingdom
ucabmk5@ucl.ac.uk

Youngjun Cho
University College London
London, United Kingdom
youngjun.cho@ucl.ac.uk

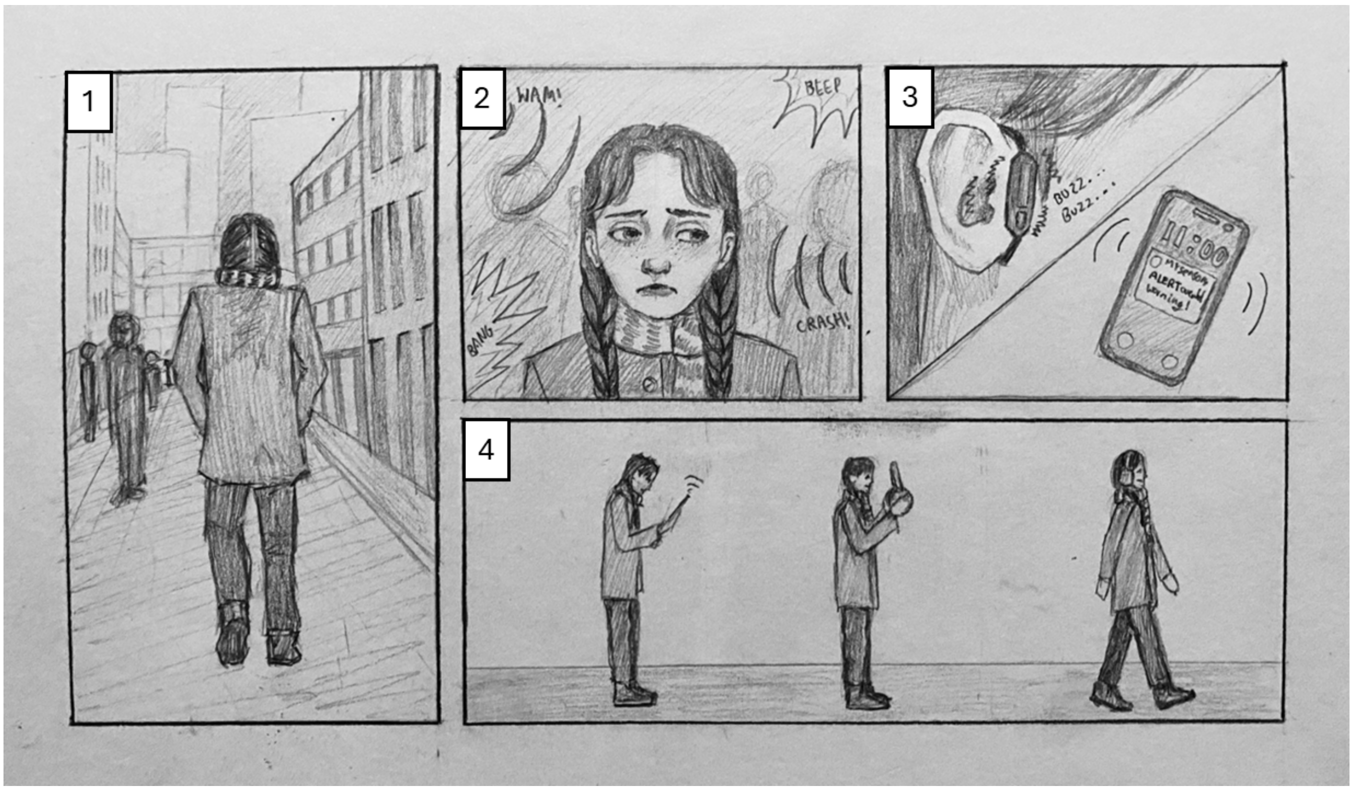

Figure 1: A storyboard showing MySensory in use. An autistic user wears the earpiece in a busy environment and receives a notification from their phone alerting them that the environment may be overwhelming for them, allowing them to take preventative action by putting on noise canceling headphones.

Abstract

Assistive technologies designed for autistic users often aim to treat the condition through training them to engage or not engage in certain behaviors. This has encompassed the disruption of self-injurious actions as well as other evidently essential interventions, but it has also expanded into areas such as 'appropriate' eye contact and other subjective communication forms. However, few technologies serve as prostheses to aid autistic people in challenging areas. Many autistic individuals face sensory processing differences, leading to over-reactions to stimuli such as loud noises, and struggle with Alexithymia which causes difficulty identifying and describing one's own emotional state. Together, these conditions can cause autistic people to become overwhelmed in certain environments without realizing until it is too late to take actions to prevent extreme distress. This paper introduces a wearable prosthetic designed to address this problem by using reported stress and noise levels to alert users about potentially overwhelming environments

DIS '25 Companion, Funchal, Portugal

ACM ISBN 979-8-4007-1486-3/2025/07
https://doi.org/10.1145/3715668.3736366

CCS Concepts

• **Human-centered computing → Interaction devices**; **Interaction paradigms**; **Accessibility design and evaluation methods**.

Keywords

Wearables, Autism, Sensory processing

ACM Reference Format:
Olly R Player, Merlin Angel Kelly, and Youngjun Cho. 2025. MySensory: a Novel Solution for Sound Hyper-Reactivity in Autism. In *Designing Interactive Systems Conference (DIS '25 Companion), July 5–9, 2025, Funchal, Portugal.* ACM, New York, NY, USA, 7 pages. https://doi.org/10.1145/3715668.3736366

1 Introduction

Autism is a lifelong neurodevelopmental disability characterized by restricted and repetitive patterns of behavior, and difficulties with social interaction. 95% of autistic people have some degree of sensory dysfunction [46]. Sensory over-responsivity is present in individuals throughout the autistic spectrum with no link with intellectual ability [19] but there is a strong link between Autism Quotient (AQ) score and sensory processing differences (SPD) [38].

Neurological threshold theory suggests a modulation anomaly in autistic individuals which results in hypo- or hyper-reactive sensory profiles [18], where people experience sensory input as significantly weaker or stronger than the general population would. SPD has a profound impact on daily life for the individual and their family and can result in extremely risky behaviors such as running into a busy street to avoid an undesirable sensory input [7]. It has also been linked with anxiety disorders for autistic individuals [23] with evidence suggesting that SPD causes increased anxiety, particularly during social interactions [13]. Chronic stress from sensory distress has been suggested to contribute to a variety of medical conditions [30] and can contribute to poorer healthcare outcomes (and reduced lifespans) in the autistic population [41]. Meltdowns can occur in autistic people with SPD and often manifest as extreme distress, a loss of logic, and extreme behaviors such as self-harm or aggression [29]. Repeated sensory distress can contribute to burnout, and autistic people in burnout often experience a further reduced tolerance of stimulus [37], resulting in a cycle of dysfunction.

Gaining a better understanding of an individual's SPD as a mechanism for behavior could allow simple interventions to be identified [39]. However, existing systems for analyzing an individual's sensory profile tend to be in the form of questionnaires with standardized and closed-ended questions [42]. Strategies to support autistic people with SPD include sensory integration therapy, environmental modifications [4], and assistive technologies [34]. Sensory integration therapy is somewhat controversial due to its links to applied behavioral analysis therapies [51] and questions over its effectiveness [28].

The following literature review will aim to describe the prevalence and impacts of SPD for autistic people, and what solutions are currently available to address them. We then identify the lack of available assistive technology for noise sensitivity in the context of Alexithymia. A prototype design for noise sensitivity is presented which would use user reported stress and environmental noise monitoring to notify the user when they are in an environment which is likely to cause them sensory distress.

2 Background and Related Work

2.1 Audio processing differences in autism

50-70% of autistic people will experience decreased sound tolerance at some point in their lives. This can come in the form of hyperacusis, misophonia, or phonophobia [52]. Neurological thresholds for volume of sound in autistic people with hyperacusis are measurable and are demonstrably lower than non-autistic people [25].

2.2 Alexithymia

Alexithymia is a common comorbidity with autism that presents as difficulty identifying and describing one's own emotional state. This condition may be responsible for the difficulty autistic people have with recognizing the emotions of others [5]. Autistic children with higher measures of sensory responsiveness tend to also have high levels of Alexithymia and communication difficulties [17].

Uncertainty causes significant anxiety in autistic people, an issue which is compounded by the impacts of Alexithymia that prevent successful prediction of their own feelings and subsequent behaviors [32]. Treatments for anxiety in this population may need to target the mechanisms surrounding anxiety (sensory difference and Alexithymia) rather than the anxiety itself [43].

Alexithymia and sensory difference as a combined experience can create significant difficulty as individuals may not know they are becoming overwhelmed by their environment until it is too late to prevent significant distress and disruption. Due to the 50-70% of autistic people experience noise sensitivity, Alexithymia can make it difficult for them to understand, predict, and therefore prevent their own sensory distress in this scenario. This can have a devastating impact on their daily activities, health, and relationships.

2.3 Assistive technology for SPD

Assistive technology (AT) for autistic people has previously often served a therapeutic purpose rather than a prosthetic one, aiming to train the user rather than assist them directly. In one review, social skills training made up more than half of all AT for autistic people, with a high prevalence of robots and virtual environments rather than real-world support [9]. AT addressing SPD is key to greater inclusion for autistic people [49] but has received far less attention than tools that target physio-social activities [16]. This could be due to SPD being a highly complex and individual condition, making targeted solutions challenging.

Existing AT tends to be aimed at:

- Expanding sensory tolerance over time by supporting sensory integration training [45].
- Providing stimulation by facilitating self-stimulatory behaviors [22], providing desirable feedback such as pressure [26] or interactive multi-sensory devices. These solutions do not need to be specific to a form of sensitivity as their use is flexible and can often address a variety of forms of sensory difficulty within a single product.
- Facilitating avoidance of stimulation. For example, adaptive clothing that uses specific fabrics, no tags, and less trimming to accommodate tactile sensitivity [33].
- Increasing understanding that users have of their own sensory needs. No papers were found in this review that had

this as a primary aim, but it is likely that AT in the categories described above may improve understanding somewhat through exposure to a variety of sensory inputs.

Due to the variety of sensory profiles within autism and open-ended use of designs, the above category that an individual piece of AT falls into is not definitive and often relates more to the way it is used than the design itself. Prosthetic solutions for SPD aim to immediately decrease discomfort whilst they are in use whereas therapeutic solutions aim to decrease long-term discomfort by increasing tolerance.

No papers were found where the primary aim of the AT presented was to increase understanding of an individual's sensory profile. Furthermore, no papers were found that addressed Alexithymia with AT in the context of autism. One case report used emotional training via virtual reality to treat Alexithymia in a stroke patient [15]. This was meant to support existing treatments rather than acting as a prosthetic for the user.

Current AT solutions targeted at audio SPD often focus on speech comprehension using systems like remote microphones [21] or classroom amplification [36]. AT targeted at noise hyper-reactivity are usually low-tech e.g., headphones that facilitate avoidance of loud sounds. These solutions can be insufficient in the context of Alexithymia as a user may not realize that they are reaching their tolerance limit for sound in time to use these preventative tools.

The rest of this paper will aim to address the gap in prosthetic solutions for Alexithymia in autistic people with noise hyper reactivity by exploring the following research question:

In what way could a device that combines monitoring of environmental noise with user-reported stress levels to foresee impending sensory distress engage with an autistic user?

In this project, three separate prototypes were produced, including an Arduino to test the sound and stress data capture, the 3-D printed wearable element, and the wire frame app. In a finished product, environmental noise and stress data would be collected by a wearable device connected via Bluetooth to the app which sends predictions of oncoming stress to the user.

3 Prototype design

3.1 Design considerations

Several wearables have been designed to support autistic people with social activities [2, 24, 27, 50, 53] or detect stress through physiological data collection [1, 3, 8, 44, 48] but wearables have not yet been utilized to monitor the sensory environment of an autistic user as a way of anticipating oncoming stress. Environmental monitoring wearables generally have been integrated with many smart watch devices and some have been designed for specific scenarios such as monitoring adherence to workplace noise level limits [26, 47].

When designing a wearable for autistic users (especially those with SPD), there are additional factors that must be considered. AT that is inappropriate for an autistic person's sensory needs can result in discomfort and rejection of the device [26]. However, considerations for hypo- vs hyper- reactive sensory profiles can be in direct contradiction with one another [10]. Generally, designers should be avoiding unexpected sensations like vibration or sound but the variety of requirements that SPDs can create mean that it is important to ensure the design of wearables for autistic people are flexible and allow for customization where possible [6, 31].

Personal experience of an author of this work as a person with autism has shaped our approach to the concept and design of this project. The system was also discussed extensively with three autistic individuals in an informal, friendly setting, and adjusted according to their feedback.

3.2 Wearable devices

The device is primarily worn on the ear to obtain accurate sound data by minimizing the effect of clothing and acoustic shadow from the body [14]. This position also allows the wearable to integrate with existing AT by fitting under noise canceling headphones, which would otherwise distort results by blocking the user from noise which the device would still detect. A variety of audio data elements could be considered (e.g., pitch or specific sounds) but the current design focuses on identifying the loudness of sound in the user's environment so would be useful mainly for those with hyperacusis SPD. A prototype was built for this project which used an LM393 Sound Detection Sensor Module to detect volume. This functioned adequately to illustrate the idea.

The wearable prototype features two distinct buttons (see Fig 2). The small button turns the device on and off and the large button allows the user to register that the environment they are in is too loud for them. This data is correlated with the noise in their environment in the time leading up to the button being pressed to allow future predictions of stress to be made more accurate as the device is used.

The final prototype can be worn on the ear, on the wrist, or attached to a badge via a magnet and pinned to clothes, allowing the user to decide the most comfortable way for them to wear it. This is not a functional prototype, and instead illustrates the ideas and begins to consider user interactions.

Some researchers have suggested that AT for autistic people should look as subtle and unobtrusive as possible to maximize acceptability by the user and others [40, 44]. However, making a device look 'normal' or invisible are not the only ways to improve acceptability and could perpetuate a negative stigma that visible AT carries.

Faucett et al. (2017) investigated the complexity of visibility in AT and its effect on disabled individuals, highlighting that the visibility of a disability is a complex interplay between the disabled body, their devices, and the observer's knowledge [20]. For example, hearing aid users often perform customizations on their devices to encourage themselves to wear them more often [35]. By personalizing their AT, they are integrating them within their identity and using them as a tool for self-expression.

The designed wearable will aim to increase customization to allow users to decide how their AT appears. The final prototype is 3D printed with rigid, flat surfaces to allow for easy decoration and redecoration. The 3D model of the casing could also be made available to allow for easier wrapping design by users. In the future, customization of the casing at point of manufacture could be considered, including color, texture, and perhaps even material depending on what is financially viable.

Figure 2: Iterated prototypes made of wire and paper, clay, and 3D printed materials in the left, middle and right image, respectively

3.3 Corresponding app

The connected app has been designed as a wireframe and begins to consider what additional data may be useful or viable to collect from users to improve the accuracy of their stress predictions (see Fig 3). It notifies users when they are near to a predicted overwhelm or meltdown and allows users to track trends to better understand their personal sensory profile. Settings such as time between prediction and notification, and form of notification can be controlled by the user. Predictions can be made more accurate with a simple and short morning survey asking the user about other stress predictors such as sleep [3]. Users can also log sensory distress in the app, which allows them to contribute data for past distress that they may not have registered at the time. Additionally, for individuals with higher support needs, a caregiver could have access to the app. Machine learning frameworks used previously in literature for stress detection [11, 12] would allow for stress predictions in noisy environments based on previous examples when the user was overwhelmed.

4 Conclusion and Future Work

SPDs in the context of Alexithymia can cause immense distress for autistic individuals, making an already challenging experience of certain environments even more unpredictable. The design for MySensory presents the beginnings of an assistive technology to address this complex issue by focusing on giving maximum control and choice to the user, rather than dictating a particular behavioral response to the information it provides.

The design would need further research and testing before the device is evaluated. Beyond the technical considerations of gaining more accurate noise data, it would be a vital first step to establish that an accurate prediction model for sensory distress can be created based on the system described and that receiving these predictions would provide value to the user. This will require testing of different machine learning algorithms that can produce the best experience for users with Alexithymia.

There are limitations if a user does not give correct feedback due to not recognizing they were overwhelmed which may lead to bad prediction performance in the machine learning model. Future investigations might explore additional data collection methods that could enhance prediction accuracy, like sleep monitoring or measuring biometric stress through galvanic skin response and heart rate variability, minimizing the required manual input from users. Additionally, examining which types of system interactions significantly affect users may also be beneficial. Furthermore, it would be essential to consider the wide range of autism experiences and ensure that our research explores how the device may support those with high and low support needs, where possible.

Future developments will involve autistic individuals actively in the co-design and evaluation phases, particularly to verify assumptions regarding stress notification timing, the design of devices, and notification methods. This will allow users input on the ethics of monitoring and predicting stress of autistic populations.

Acknowledgments

This work was produced as a coursework for Research Methods and Making Skills (COMP0145) from the Disability, Design and Innovation MSc programme at UCL.

References

[1] Ahmad Qadeib Alban, Malek Ayesh, Ahmad Yaser Alhaddad, Abdulaziz Khalid Al-Ali, Wing Chee So, Olcay Connor, and John-John Cabibihan. 2021. Detection of Challenging Behaviours of Children with Autism Using Wearable Sensors during Interactions with Social Robots. In *2021 30th IEEE International Conference on Robot & Human Interactive Communication (RO-MAN)*. IEEE, 852–857. doi:10.1109/RO-MAN50785.2021.9515459 ISSN: 1944-9437.

[2] Aiya Alchaar, Rahaf Jaber, Majed Alharbi, Ibrahim Al Megren, and Rahmah Alyaseen. 2022. A Wearable Device for Non-communicative Children Preliminary Investigation. In *HCI International 2022 Posters*, Constantine Stephanidis, Margherita Antona, and Stavroula Ntoa (Eds.). Springer International Publishing, Cham, 477–485. doi:10.1007/978-3-031-06417-3_64

[3] Alaleh Alivar, Charles Carlson, Ahmad Suliman, Steve Warren, Punit Prakash, David E. Thompson, and Balasubramaniam Natarajan. 2020. Smart bed based daytime behavior prediction in Children with autism spectrum disorder - A Pilot Study. *Medical Engineering & Physics* 83 (Sept. 2020), 15–25. doi:10.1016/j.medengphy.2020.07.004

[4] Georgina A. Amos, Graeme Byrne, Philippe A. Chouinard, and Timothy Godber. 2019. Autism Traits, Sensory Over-Responsivity, Anxiety, and Stress: A Test of Explanatory Models. *Journal of Autism and Developmental Disorders* 49, 1 (Jan. 2019), 98–112. doi:10.1007/s10803-018-3695-6

[5] G Bird and R Cook. 2013. Mixed emotions: the contribution of alexithymia to the emotional symptoms of autism. *Translational Psychiatry* 3, 7 (July 2013), e285. doi:10.1038/tp.2013.61

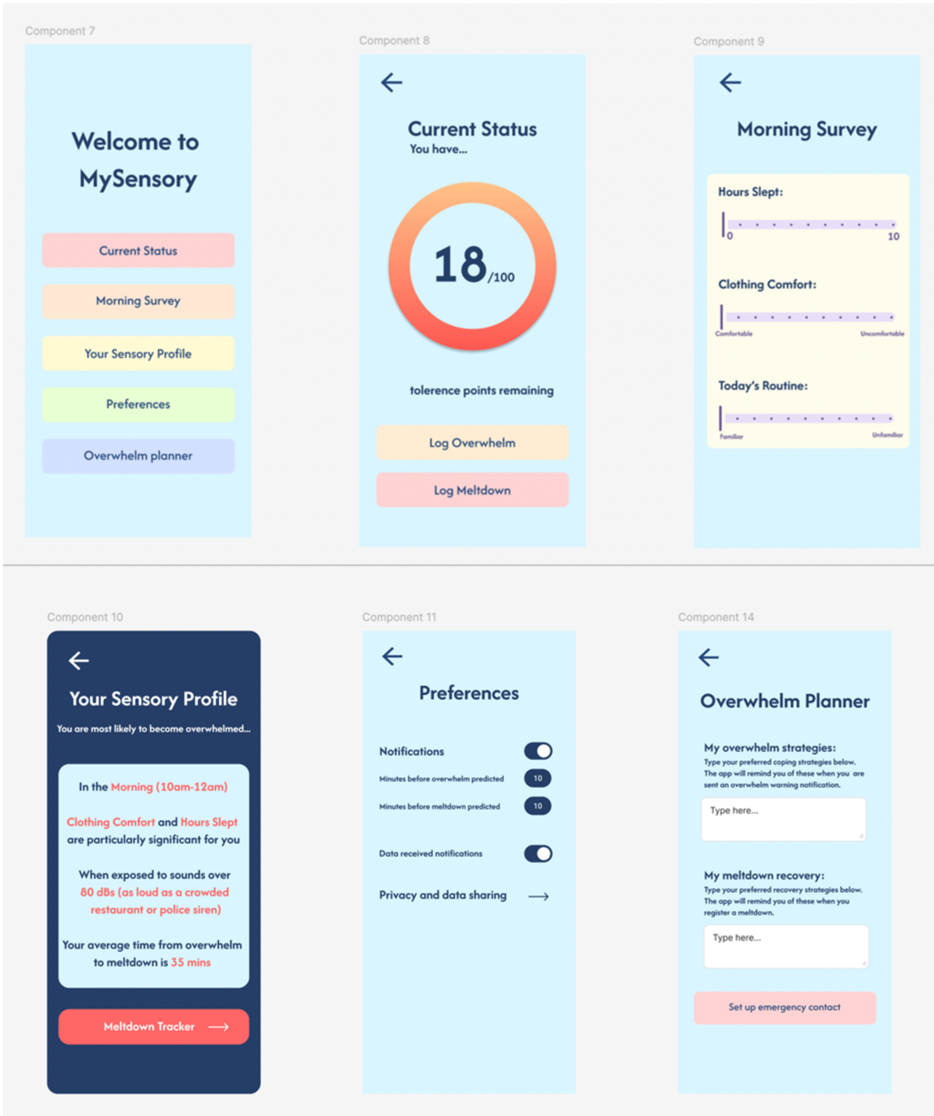

Figure 3: Screenshots of the app wireframe. Seven different frames from the app are shown including a home page, current stress status, morning survey, your sensory profile, meltdown tracker, preferences, and an overwhelm planner

[6] Melissa H. Black, Benjamin Milbourn, Nigel T. M. Chen, Sarah McGarry, Fatema Wali, Armilda S. V. Ho, Mika Lee, Sven Bölte, Torbjorn Falkmer, and Sonya Girdler. 2020. The use of wearable technology to measure and support abilities, disabilities and functional skills in autistic youth: a scoping review. *Scandinavian Journal of Child and Adolescent Psychiatry and Psychology* 8 (2020), 48–69. doi:10.21307/sjcapp-2020-006

[7] Sandra Brouche, Natalie Rigal, and Fabienne Cazalis. 2024. Parental descriptions of sensory processing in Autism. *Research in Autism Spectrum Disorders* 118 (Oct. 2024), 102488. doi:10.1016/j.rasd.2024.102488

[8] Kristine D. Cantin-Garside, Zhenyu Kong, Susan W. White, Ligia Antezana, Sunwook Kim, and Maury A. Nussbaum. 2020. Detecting and Classifying Self-injurious Behavior in Autism Spectrum Disorder Using Machine Learning Techniques. *Journal of Autism and Developmental Disorders* 50, 11 (Nov. 2020), 4039–4052. doi:10.1007/s10803-020-04463-x

[9] Raquel Cañete and Estela Peralta. 2022. Assistive Technology to Improve Collaboration in Children with ASD: State-of-the-Art and Future Challenges in the Smart Products Sector. *Sensors (Basel, Switzerland)* 22, 21 (Oct. 2022), 8321. doi:10.3390/s22218321

[10] Raquel Cañete and M. Estela Peralta. 2023. Applying Technology to Adapt Assistive Products to the Sensorial Characteristics of Children with Autism: A Review. In *2023 IEEE 11th International Conference on Serious Games and Applications for Health (SeGAH)*. IEEE, 1–6. doi:10.1109/SeGAH57547.2023.10253810 ISSN: 2573-3060.

[11] Youngjun Cho. 2021. Rethinking Eye-blink: Assessing Task Difficulty through Physiological Representation of Spontaneous Blinking. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*. ACM, Yokohama Japan, 1–12. doi:10.1145/3411764.3445577

[12] Youngjun Cho, Simon J. Julier, and Nadia Bianchi-Berthouze. 2019. Instant Stress: Detection of Perceived Mental Stress Through Smartphone Photoplethysmography and Thermal Imaging. *JMIR Mental Health* 6, 4 (April 2019), e10140. doi:10.2196/10140 Company: JMIR Mental Health Distributor: JMIR Mental Health Institution: JMIR Mental Health Label: JMIR Mental Health Publisher: JMIR Publications Inc., Toronto, Canada.

[13] Blythe A. Corbett, Rachael A. Muscatello, and Scott D. Blain. 2016. Impact of Sensory Sensitivity on Physiological Stress Response and Novel Peer Interaction in Children with and without Autism Spectrum Disorder. *Frontiers in Neuroscience*

10 (2016), 278. doi:10.3389/fnins.2016.00278

[14] Ryan M. Corey, Naoki Tsuda, and Andrew C. Singer. 2019. Acoustic Impulse Responses for Wearable Audio Devices. In *ICASSP 2019 - 2019 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*. IEEE, 216–220. doi:10.1109/ICASSP.2019.8682733 ISSN: 2379-190X.

[15] Rosaria De Luca, Francesca Sciarrone, Alfredo Manuli, Michele Torrisi, Bruno Porcari, Carmela Casella, Alessia Bramanti, and Rocco Salvatore Calabrò. 2020. Can emerging technologies be effective in improving alexithymia due to brain lesion?: Lessons from a case report. *Medicine* 99, 38 (Sept. 2020), e22313. doi:10.1097/MD.0000000000022313

[16] Lingling Deng, Prapa Rattadilok, Gabrielle Saputra Hadian, and Haoyang Liu. 2021. Effect of Sensory-based Technologies on Atypical Sensory Responses of Children with Autism Spectrum Disorder: A Systematic Review. In *2021 5th International Conference on E-Society, E-Education and E-Technology (ICSET 2021)*. Association for Computing Machinery, New York, NY, USA, 208–218. doi:10.1145/3485768.3485782

[17] Madeleine Diepman and Nuala Brady. 2023. *Sensory responsiveness and alexithymia in autistic children*. Research Gate. doi:10.31234/osf.io/aryhc

[18] Winnie Dunn. 2007. Supporting Children to Participate Successfully in Everyday Life by Using Sensory Processing Knowledge. *Infants & Young Children* 20, 2 (June 2007), 84. doi:10.1097/01.IYC.0000264477.05076.5d

[19] Marie Elwin, Ek , Lena, Kjellin , Lars, , and Agneta Schröder. 2013. Too much or too little: Hyper- and hypo-reactivity in high-functioning autism spectrum conditions. *Journal of Intellectual & Developmental Disability* 38, 3 (Sept. 2013), 232–241. doi:10.3109/13668250.2013.815694 Publisher: Taylor & Francis _eprint: https://doi.org/10.3109/13668250.2013.815694.

[20] Heather A. Faucett, Kate E. Ringland, Amanda L. L. Cullen, and Gillian R. Hayes. 2017. (In)Visibility in Disability and Assistive Technology. *ACM Trans. Access. Comput.* 10, 4 (Oct. 2017), 14:1–14:17. doi:10.1145/3132040

[21] Jacob I. Feldman, Emily Thompson, Hilary Davis, Bahar Keceli-Kaysili, Kacie Dunham, Tiffany Woynaroski, Anne Marie Tharpe, and Erin M. Picou. 2022. Remote Microphone Systems Can Improve Listening-in-Noise Accuracy and Listening Effort for Youth With Autism. *Ear and Hearing* 43, 2 (2022), 436–447. doi:10.1097/AUD.0000000000001058

[22] Stephanie Flattery. 2023. *Stim Joy: Using Multi-Sensory Design to Foster Better Understanding of the Autistic Experience*. M.F.A. Iowa State University, United States – Iowa. https://www.proquest.com/docview/2829366211/abstract/DC26D02A0F094584PQ/1 ISBN: 9798379749071.

[23] Shulamite A. Green and Ayelet Ben-Sasson. 2010. Anxiety disorders and sensory over-responsivity in children with autism spectrum disorders: is there a causal relationship? *Journal of Autism and Developmental Disorders* 40, 12 (Dec. 2010), 1495–1504. doi:10.1007/s10803-010-1007-x

[24] Xinlong Jiang, LouAnne E. Boyd, Yiqiang Chen, and Gillian R. Hayes. 2016. ProCom: designing a mobile and wearable system to support proximity awareness for people with autism. In *Proceedings of the 2016 ACM International Joint Conference on Pervasive and Ubiquitous Computing: Adjunct (UbiComp '16)*. Association for Computing Machinery, New York, NY, USA, 93–96. doi:10.1145/2968219.2971445

[25] Stéphanie Khalfa, Nicole Bruneau, Bernadette Rogé, Nicolas Georgieff, Evelyne Veuillet, Jean-Louis Adrien, Catherine Barthélémy, and Lionel Collet. 2004. Increased perception of loudness in autism. *Hearing Research* 198, 1-2 (Dec. 2004), 87–92. doi:10.1016/j.heares.2004.07.006

[26] Sumin Koo, Kim Gaul, Susan Rivera, Tingrui Pan, and Daniel Fong. 2018. Wearable Technology Design for Autism Spectrum Disorders. *Archives of Design Research* 31 (Feb. 2018), 37–55. doi:10.15187/adr.2018.02.31.1.37

[27] Yiannis Koumpouros and Theodoros Kafazis. 2019. Wearables and mobile technologies in Autism Spectrum Disorder interventions: A systematic literature review. *Research in Autism Spectrum Disorders* 66 (Oct. 2019), 101405. doi:10.1016/j.rasd.2019.05.005

[28] Russell Lang, Mark O'Reilly, Olive Healy, Mandy Rispoli, Helena Lydon, William Streusand, Tonya Davis, Soyeon Kang, Jeff Sigafoos, Giulio Lancioni, Robert Didden, and Sanne Giesbers. 2012. Sensory integration therapy for autism spectrum disorders: A systematic review. *Research in Autism Spectrum Disorders* 6, 3 (July 2012), 1004–1018. doi:10.1016/j.rasd.2012.01.006

[29] Laura Foran Lewis and Kailey Stevens. 2023. The lived experience of meltdowns for autistic adults. *Autism: The International Journal of Research and Practice* 27, 6 (Aug. 2023), 1817–1825. doi:10.1177/13623613221145783

[30] Heidi Morgan. 2019. Connections Between Sensory Sensitivities in Autism; the Importance of Sensory Friendly Environments for Accessibility and Increased Quality of Life for the Neurodivergent Autistic Minority. *PSU McNair Scholars Online Journal* 13, 1 (Nov. 2019). doi:10.15760/mcnair.2019.13.1.11

[31] Vivian Genaro Motti. 2019. Designing emerging technologies for and with neurodiverse users. In *Proceedings of the 37th ACM International Conference on the Design of Communication (SIGDOC '19)*. Association for Computing Machinery, New York, NY, USA, 1–10. doi:10.1145/3328020.3353946

[32] Louise Neil, Nora Choque Olsson, and Elizabeth Pellicano. 2016. The Relationship Between Intolerance of Uncertainty, Sensory Sensitivities, and Anxiety in Autistic and Typically Developing Children. *Journal of Autism and Developmental Disorders* 46, 6 (June 2016), 1962–1973. doi:10.1007/s10803-016-2721-9

[33] J Oetojo. 2019. Factors Affecting Clothing Design for Autistic Children: A Study of A Sustainable Development Brand Kiddie Pal in Jakarta. In *Proceedings of the Proceedings of The 1st Workshop Multimedia Education, Learning, Assessment and its Implementation in Game and Gamification, Medan Indonesia, 26th January 2019, WOMELA-GG*. EAI, Medan, Indonesia. doi:10.4108/eai.26-1-2019.2283124

[34] Om Patil and Meghali Kaple. 2023. Sensory Processing Differences in Individuals With Autism Spectrum Disorder: A Narrative Review of Underlying Mechanisms and Sensory-Based Interventions. *Cureus* 15, 10 (Oct. 2023), e48020. doi:10.7759/cureus.48020

[35] Halley P. Profita, Abigale Stangl, Laura Matuszewska, Sigrunn Sky, and Shaun K. Kane. 2016. Nothing to Hide: Aesthetic Customization of Hearing Aids and Cochlear Implants in an Online Community. In *Proceedings of the 18th International ACM SIGACCESS Conference on Computers and Accessibility (ASSETS '16)*. Association for Computing Machinery, New York, NY, USA, 219–227. doi:10.1145/2982142.2982159

[36] Gary Rance, Donella Chisari, Kerryn Saunders, and Jean-Loup Rault. 2017. Reducing Listening-Related Stress in School-Aged Children with Autism Spectrum Disorder. *Journal of Autism and Developmental Disorders* 47, 7 (July 2017), 2010–2022. doi:10.1007/s10803-017-3114-4

[37] Dora M. Raymaker, Alan R. Teo, Nicole A. Steckler, Brandy Lentz, Mirah Scharer, Austin Delos Santos, Steven K. Kapp, Morrigan Hunter, Andee Joyce, and Christina Nicolaidis. 2020. "Having All of Your Internal Resources Exhausted Beyond Measure and Being Left with No Clean-Up Crew": Defining Autistic Burnout. *Autism in Adulthood* 2, 2 (June 2020), 132–143. doi:10.1089/aut.2019.0079 Publisher: Mary Ann Liebert, Inc., publishers.

[38] Ashley E. Robertson. 2012. *Sensory experiences of individuals with Autism Spectrum Disorder and autistic traits: a mixed methods approach*. PhD. University of Glasgow. https://eleanor.lib.gla.ac.uk/record=b2955666

[39] Samantha E. Schulz, Elizabeth Kelley, Evdokia Anagnostou, Rob Nicolson, Stelios Georgiades, Jennifer Crosbie, Russell Schachar, Muhammad Ayub, and Ryan A. Stevenson. 2023. Sensory Processing Patterns Predict Problem Behaviours in Autism Spectrum Disorder and Attention-Deficit/Hyperactivity Disorder. *Advances in Neurodevelopmental Disorders* 7, 1 (March 2023), 46–58. doi:10.1007/s41252-022-00269-3

[40] Moushumi Sharmin, Md Monsur Hossain, Abir Saha, Maitraye Das, Margot Maxwell, and Shameem Ahmed. 2018. From Research to Practice: Informing the Design of Autism Support Smart Technology. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems (CHI '18)*. Association for Computing Machinery, New York, NY, USA, 1–16. doi:10.1145/3173574.3173676

[41] Sebastian CK Shaw, Laura Carravallah, Mona Johnson, Jane O'Sullivan, Nicholas Chown, Stuart Neilson, and Mary Doherty. 2024. Barriers to healthcare and a 'triple empathy problem' may lead to adverse outcomes for autistic adults: A qualitative study. *Autism* 28, 7 (July 2024), 1746–1757. doi:10.1177/13623613231205629 Publisher: SAGE Publications Ltd.

[42] Kate Simpson, Dawn Adams, Clair Alston-Knox, Helen S. Heussler, and Deb Keen. 2019. Exploring the Sensory Profiles of Children on the Autism Spectrum Using the Short Sensory Profile-2 (SSP-2). *Journal of Autism and Developmental Disorders* 49, 5 (May 2019), 2069–2079. doi:10.1007/s10803-019-03889-2

[43] Mikle South and Jacqui Rodgers. 2017. Sensory, Emotional and Cognitive Contributions to Anxiety in Autism Spectrum Disorders. *Frontiers in Human Neuroscience* 11 (Jan. 2017), 20. doi:10.3389/fnhum.2017.00020

[44] Mohammed Taj-Eldin, Christian Ryan, Brendan O'Flynn, and Paul Galvin. 2018. A Review of Wearable Solutions for Physiological and Emotional Monitoring for Use by People with Autism Spectrum Disorder and Their Caregivers. *Sensors (Basel, Switzerland)* 18, 12 (Dec. 2018), 4271. doi:10.3390/s18124271

[45] Fei Tang, Ryan P. McMahan, and Tandra T. Allen. 2014. Development of a low-cost tactile sleeve for autism intervention. In *2014 IEEE International Symposium on Haptic, Audio and Visual Environments and Games (HAVE) Proceedings*. 35–40. doi:10.1109/HAVE.2014.6954328

[46] Scott D. Tomchek and Winnie Dunn. 2007. Sensory processing in children with and without autism: a comparative study using the short sensory profile. *The American Journal of Occupational Therapy: Official Publication of the American Occupational Therapy Association* 61, 2 (2007), 190–200. doi:10.5014/ajot.61.2.190

[47] Jesse Trawick, Jeremy Slagley, and Robert Eninger. 2019. Occupational Noise Dose Reduction via Behavior Modification Using In-Ear Dosimetry among United States Air Force Personnel Exposed to Continuous and Impulse Noise. *Open Journal of Safety Science and Technology* 09, 02 (2019), 61–81. doi:10.4236/ojsst.2019.92005

[48] Toni R. Van Laarhoven, Jesse W. Johnson, Natalie R. Andzik, Lavisha Fernandes, Michael Ackerman, Maria Wheeler, Katherine Melody, Veronica Cornell, Gretta Ward, and Heather Kerfoot. 2021. Using Wearable Biosensor Technology in Behavioral Assessment for Individuals with Autism Spectrum Disorders and Intellectual Disabilities Who Experience Anxiety. *Advances in Neurodevelopmental Disorders* 5, 2 (June 2021), 156–169. doi:10.1007/s41252-020-00191-6

[49] Lina J. Wali and Filippo Sanfilippo. 2019. A Review of the State-of-the-Art of Assistive Technology for People with ASD in the Workplace and in Everyday Life. In *Digital Transformation for a Sustainable Society in the 21st Century*, Ilias O. Pappas, Patrick Mikalef, Yogesh K. Dwivedi, Letizia Jaccheri, John Krogstie,

and Matti Mäntymäki (Eds.). Springer International Publishing, Cham, 520–532. doi:10.1007/978-3-030-29374-1_42

[50] Peter Washington, Catalin Voss, Aaron Kline, Nick Haber, Jena Daniels, Azar Fazel, Titas De, Carl Feinstein, Terry Winograd, and Dennis Wall. 2017. SuperpowerGlass: A Wearable Aid for the At-Home Therapy of Children with Autism. *Proc. ACM Interact. Mob. Wearable Ubiquitous Technol.* 1, 3 (Sept. 2017), 112:1–112:22. doi:10.1145/3130977

[51] Daniel A. Wilkenfeld and Allison M. McCarthy. 2020. Ethical Concerns with Applied Behavior Analysis for Autism Spectrum "Disorder". *Kennedy Institute of Ethics Journal* 30, 1 (2020), 31–69. doi:10.1353/ken.2020.0000

[52] Zachary J. Williams, Jason L. He, Carissa J. Cascio, and Tiffany G. Woynaroski. 2021. A review of decreased sound tolerance in autism: Definitions, phenomenology, and potential mechanisms. *Neuroscience and Biobehavioral Reviews* 121 (Feb. 2021), 1–17. doi:10.1016/j.neubiorev.2020.11.030

[53] Zhefan Ye, Yin Li, Alireza Fathi, Yi Han, Agata Rozga, Gregory D. Abowd, and James M. Rehg. 2012. Detecting eye contact using wearable eye-tracking glasses. In *Proceedings of the 2012 ACM Conference on Ubiquitous Computing (UbiComp '12)*. Association for Computing Machinery, New York, NY, USA, 699–704. doi:10.1145/2370216.2370368

Received 21 March 2025; revised 12 May 2025; accepted 16 May 2025