AN INVESTIGATION INTO IMPROVING THE LISTENING EXPERIENCE OF AUTISTIC/NEURODIVERGENT PEOPLE AT LIVE MUSIC EVENTS WITH HAPTIC DEVICES AND HEARING PROTECTION

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1 INTRODUCTION

Sensory overstimulation can occur for any audience member at live music events, however it is more common in sensory sensitive individuals and the neurodivergent community. This experience can lead to avoidance of events or discomfort/pain while in attendance.

Audio triggers for sensory overstimulation can come from many/multiple sources including the music source at the event. Limited research or suggestions have been made on ways to minimize the risk of this trigger without negatively impacting their experience at the event.

Hearing protection is a common method of reducing one's personal sound exposure. The use of haptic devices has relatively recently been introduced to the entertainment industry as a method of improving the experiences of the deaf and hard of hearing communities. This paper investigates if a combination of these two assistive devices improves the live event experience of neurodivergent audience members through surveys and double blind experiments.

This paper starts with background (in section 2), briefly covering the neurodivergent community, live music events, and accessibility. Section 3 explores the methods used in this investigation, followed by the results and analysis in Section 4. Section 5 concludes the paper and suggests further research or improvements.

2 BACKGROUND

2.1 Neurodivergence

Neurodivergence is an umbrella term that can include conditions such as Autism Spectrum Disorder (ASD), Attention Deficit Hyperactivity Disorder (ADHD), Dyslexia, Tourette's Syndrome, Dyscalculia, Dyspraxia, and other cognitive variations[1].

Overstimulation, defined as "excessive stimulation"[2], most commonly manifests as sensory overstimulation due to an excess of sensory input[3] however it can also appear as emotional (excess of emotions) or cognitive (excess of information) overstimulation[4]. "Hyperreactivity to sensory input" is one of the main criteria for Autism[5]. Overstimulation can often be described as "unpleasant" or "threatening"[4], or uncomfortable and stressful[6]. Triggers for this at a live music event may include the sound (the music from the band/performer) and/or the surrounding background noise (bars, voices/conversations, equipment, clothes rubbing).

Those with heightened sensitivity may be more prone to overstimulation, so may avoid senses/experiences that might be overwhelming.

2.2 Live Music Events

The umbrella term ‘live music events’ encompasses a diverse range of indoor and outdoor performances. These events span all genres and styles, from intimate club gigs to major festivals and stadium concerts.

Both White[6] and Barlow and Castilla-Sanchez[7] suggest venues are likely to disregard regulations regarding high sound levels to “satisfy audience requirements”[7]. However, being able to ‘feel the music’ as an audience member is an important (and sometimes expected) feature at live music events, reducing the sound levels effects this.

According to Alpine[8], indoor concerts tend to sit between 90 and 120 dB, outdoor events at 90-100dB[9]. Wright Group Event Services[10] suggests that this level of SPL could damage the audience’s hearing. A participant in White’s[6] study states that venues have a “tendency to over-amplify music for the sake of loudness over experience, and poor acoustics” highlighting a disregard of sound level regulations discussed earlier. Hearing protection is a growing recommendation to limit damage done by high SPL exposure, including from the World health organisation[11] who recommend it as one of 6 of their Global standard for safe listening venues & events.

Being able to ‘feel the music’ is usually due to the vibrations from the subwoofers as the lower frequencies resonate in the body. Audioengine[12] suggest that the frequency range of subwoofers are typically between 20Hz and 200Hz. In Figure 2.1 most of the frequency ranges fall between the subwoofer frequency range of 20-200Hz. This includes, but isn’t limited to, chest wall (50-100Hz), head (20-30Hz), and hands (30-50Hz). The chest being the most likely place to be able to ‘feel the music’.

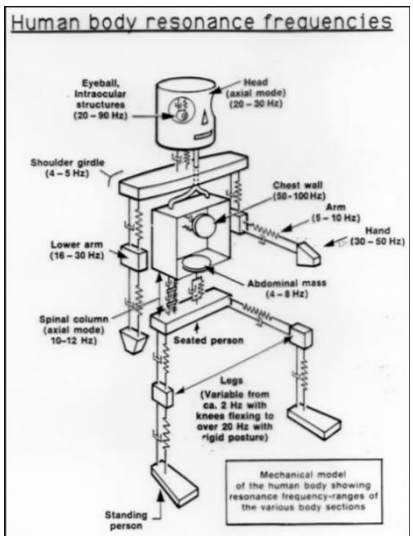

Figure 2.1 - Image showing the human body resonance frequency, to show what areas of the body may resonate with the frequencies produced by a subwoofer speaker[13]

Merchel and Altınsoy[14] state that “vibrations can have a considerable positive effect on the experience of music”, this is reinforced by Hove et al.[15] where they suggest that “auditory-tactile conditions” may create a “higher rating of groove and enjoyment”. Over 50% of responses from both pathway for this surveys study state that they enjoy being able to ‘feel the music’ (section 11.3.4).
Fajar[16] states that lowering the volume would lower the vibrations felt from the subwoofers. As Jasen[17] suggests, the physicality of low-frequency sound plays a central role in musical enjoyment; therefore,

reducing the sound level can significantly diminish the sensory and emotional impact for the audience, especially if it's expected.

2.3 Accessibility

Vibrational haptic devices have been used in many industries as an assistive device. They use vibration as a tactile feedback method (you can feel the vibrations). In the last 10 years, it's been developing in the live event industry primarily to assist the hard of hearing and deaf community by companies like SUBPAC[18] and Music: Not Impossible Labs[19]. Essentially this technology is reinforcing and emphasising the music for those who may be hard of hearing and allowing those who are deaf to experience the different frequencies and tempos in a new way. This idea of reinforcing the music and feeling behind it without having high levels of audio input is one of the key elements of this study.

3 METHOD

3.1 Survey

The survey was conducted anonymously and voluntary on Microsoft forms, consisting of 7 sections which included multiple choice, Likert scales, and open-ended questions. These sections covered music and events, hearing protection, haptic devices and subwoofers, comfortability at live music events, and issues and solutions.

No target population or size allowed for all (over 18 years old) to answer in a useful and constructive way. A random sampling method was used. The main two methods of distribution for this survey were word of mouth, and social media – primarily Facebook and LinkedIn. Facebook groups were a key tool utilized in the distribution of this survey. A range of concerts/festivals, live event, and technical groups were contacted along with a few neurodivergent focused groups. Most were UK based groups or events, however responses were not limited to UK residents.

There were 3 filters, in the survey, that separated participants responses, after answering background questions, into neurotypical – referred to as "NT", neurodivergent (who go to events) – referred to as "ND event goers", and neurodivergent (who don't go to events) – referred to as "ND non-event goers". Participants were filtered to the neurodivergent or NT pathways through a question asked See Figure 3.1.

This method caused some limitations in the accuracy of the results regarding the distribution, filtering, and wording.

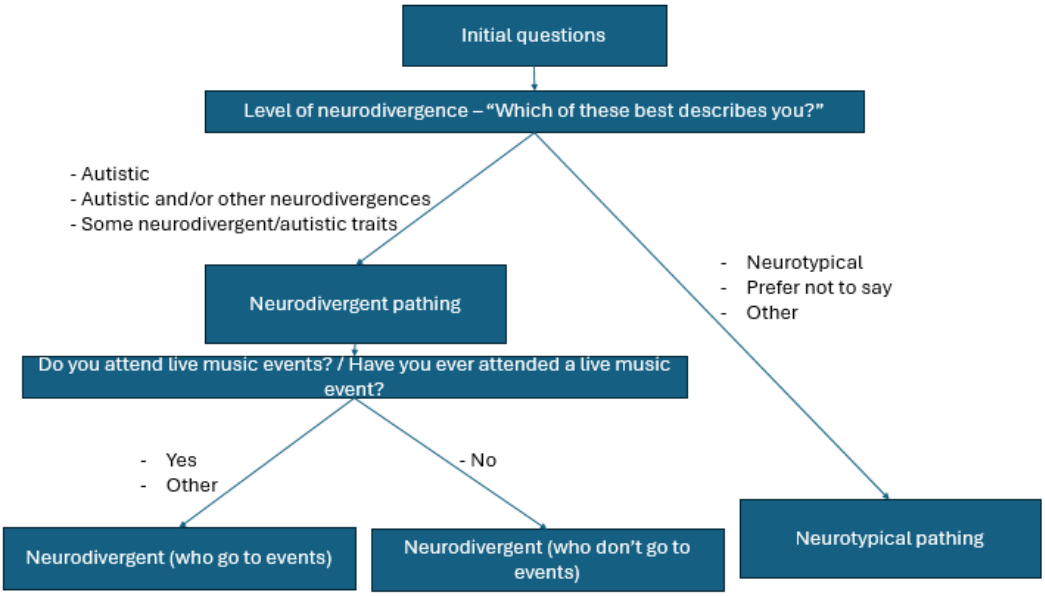

Figure 3.1 - Visual explanation of the survey question pathway separation

3.2 Experiment

The aim of this experiment was to evaluate, using participant feedback questionnaire, which of the 4 experiences, (no additional equipment, hearing protection, wearable haptic device, both a wearable haptic device and hearing protection), most effectively reduces overstimulation risk and increases enjoyment and comfort in a controlled simulated live music event environment.

3.2.1 The Pilot Method

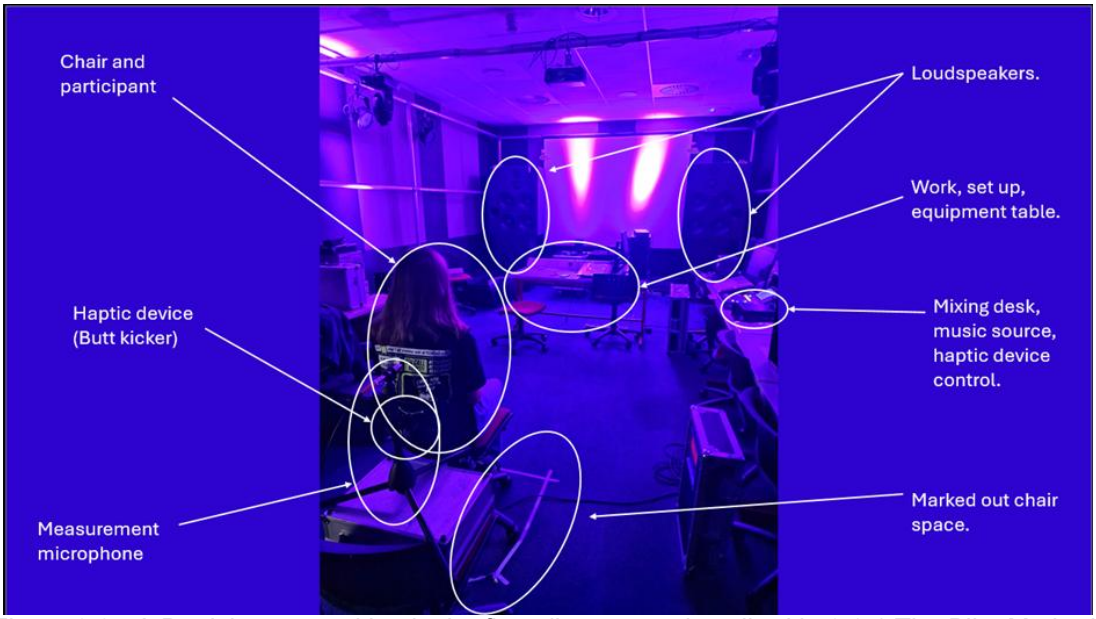

Figure 3.2 - A Participant partaking in the first pilot test as described in 3.2.1 The Pilot Method, showing the setup, layout, and equipment used

Figure 3.2 shows the set up and equipment used in this experiment, designed to be comfortable and minimize distractions allowing the participants to be fully focused and engaged in the experiments whilst in a controlled environment. The haptic device, for this phase of research, was usually positioned on the lower back of the participant.

The participants were unaware of the exact aim of this study and had no prior knowledge of it to minimise bias. Participants received a verbal initial briefing that includes, but isn't limited to: what will happen, safety and uncomfortability procedures, and initial instructions. These initial instructions include reading through and filling out a few surveys/consent forms and testing the size of the earplugs to ensure they were comfortable and adjusting the size accordingly. Each experiment included the same music for the same amount of time, chair, hearing protection (if used), and a haptic device (if used).

The experiment is sectioned into:

Experiment 1 - No Haptics or Hearing Protection.
When conducted, listening to the music played.

Experiment 2 - No Haptics, just Hearing Protection.
When conducted, this experiment was similar to number 1. It involved wearing the pre-prepared hearing protection, listening to the music.

Experiment 3 - Haptics and No Hearing Protection.
When conducted, this experiment involved listening to the music while using the haptic device. For this experiment, the participants felt the music through the haptic device as well as being able to perceive it audibly.

Experiment 4 - Haptics and Hearing Protection.
When conducted, this experiment was a combination of experiment 2 and 3. This time they had both the hearing protection and the haptic device for the duration.

Participants filled out the survey questions relating to that experiment and then, to minimise bias based on order these experiments, rolled an evenly weighted die to determine the order. After all four experiments were completed the participants went to the final section of the survey. The participants would then receive a verbal debrief and a pre-prepared written debrief sheet.

3.2.2 The Changes to the Experiment method

The method is very similar to the pilot experiment, but with some modifications to lighting, environment and the type of haptic device.

The Haptic Device – A haptic vest was used, allowing participants to sit or stand freely without needing to maintain contact with a fixed haptic device, this was required in the pilot study. This increased mobility enabled participants to behave more naturally, closely reflecting how they might act at a real live music event and enhancing the realism of the simulated environment.

The experiment area - Roughly a metre deep and the majority of the room width (limited by equipment and tables). This area allowed for a range of movement with the option to sit too.

Lighting – The lighting for this experiment was a white light. This was because communication, visible body language, and gestures were vital to ensuring comfortability and safety of the participants. This was more of a risk in this experiment, than the pilot, due to the haptic device being strapped to the participant so any signs of discomfort or overwhelm needed to be acted upon quickly and a lower light level may not have allowed for this.

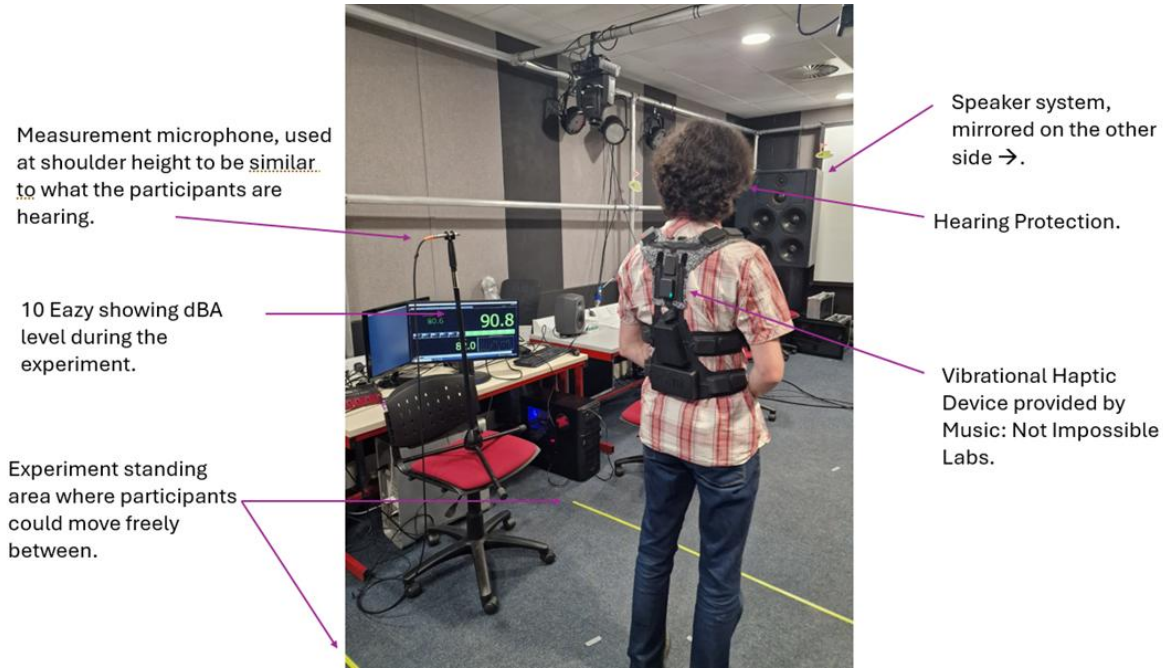

Figure 3.3 - A participant running experiment 4 (hearing protection and Haptic devices) demonstrating the equipment and setup

Figure 3.3 shows some of the room set up, demonstrating the equipment and how the haptic vest may sit on a participant. This vest originally wasn't delayed at all and nor was the audio from the speakers. After participant 1, 300ms of delay was added to the vest and after participant 3 another 50ms was added totalling 350ms delay on the vest. This was added to compensate for the signal processing latency, ensuring the time alignment of the audio and the haptic suit.

4 RESULTS

4.1 Experiments

4.1.1 Pilot

Experiment 1 – No Haptics or Hearing Protection
The results from this experiment were relatively expected. There are lots of factors that may have affected an individual's experience during this experiment. Participant J struggled with the experiment suggesting that the volume level was too much without any form of hearing protection. Participants C/E/I/K seemed to react in a similar way to the rest of the (neurotypical) participants.

Experiment 2 – No Haptics, just Hearing Protection
The results suggested the added hearing protection appeared to make participants I and J more comfortable and the experience more enjoyable than in Experiment 1.

Experiment 3 – Haptics and No Hearing Protection
The results suggest that the added haptic device and lack of hearing protection made some people more uncomfortable than experiment 2 and 1. Whereas others enjoyed the added haptics. Participant J found having both full volume (without hearing protection) and the haptics to be overstimulating. Similarly participant I suggested that they didn't enjoy the experiment and were uncomfortable.

Experiment 4 – Haptics and Hearing Protection

Overall the results from this experiment were fairly positive and that with a bit more testing and level balancing the results may improve even more. The results from this were unanimous across everyone neurotypical and neurodivergent, showing a greater improvement in the comfortability and enjoyment compared to experiments 1 and 3, especially for some of the participants who stated they were autistic or had neurodivergent traits.

Ending Questions

The final questions encouraged the participants to compare and provide feedback. The first question in this section is about preferred enjoyment between all the experiments. Most selected that they enjoyed either experiment 3 or 4 most (See Figure 4.1). This was expected and lines up with the hypothesis. The next question, however, was a little bit different. It asked about enjoyment of the experience. Experiment 3 was the most preferred followed by 2 and then 4 (See Figure 4.2). This was somewhat expected and the results may differ if the haptics and volume are balanced more evenly in the next pilot.

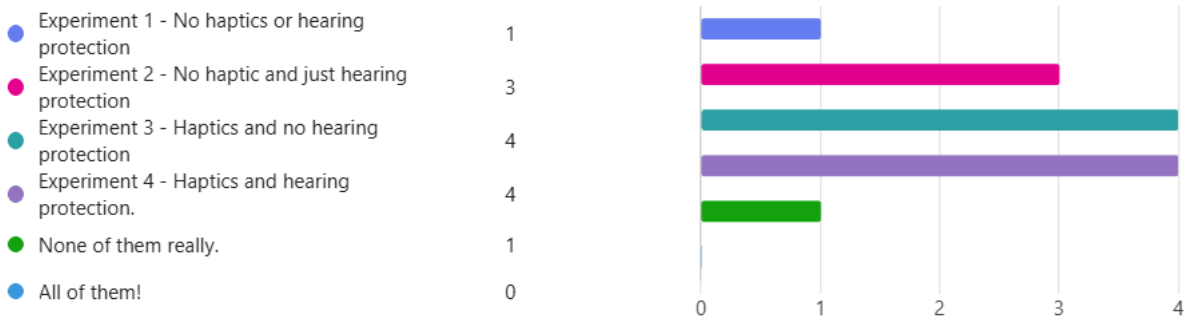

Figure 4.1 - Pilot ending question on preferred enjoyment

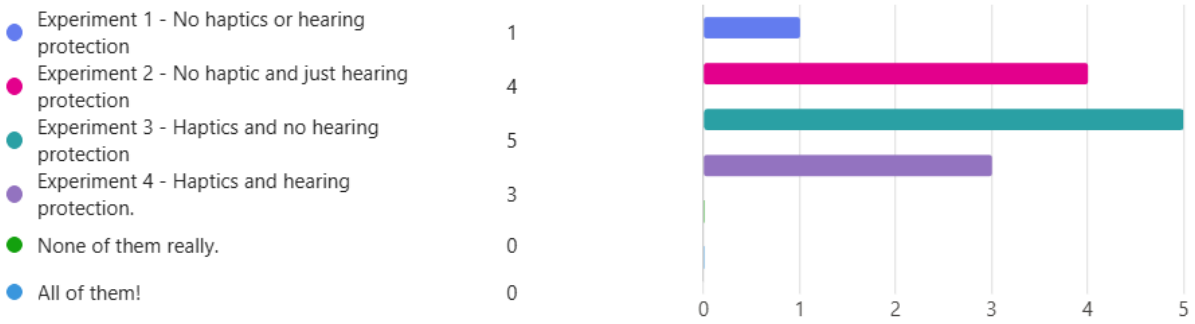

Figure 4.2 - Pilot ending question on preferred experience)

The first statement (“I feel like having hearing protection limited my experience”) has a high disagree response (53.8%), followed by agree (23%), neutral (15.4%), and strongly disagree (7.7%). Suggesting that most people didn’t feel like the hearing protection in 2 out of 4 of the experiments limited their experience. The following statements results somewhat reinforces this with 46.2% stating that they are neutral about preferring hearing protection, 30.8% Agreeing that they prefer using them, 15.4% strongly agreeing, and only 7.7% disagreeing to this statement.

The next set of statements on the Likert scale was regarding the haptic device. The next statement being “I could ‘feel the music’ without the additional haptics”. Most disagreed with this statement (46.2%) suggesting that they couldn’t ‘feel the music’ despite the high volumes. However, 30.8% of them agreed with this statement.

The next statement asked about enjoying using the haptic device. There was an event split across most people with disagree, agree, and strongly agree all at 30.8%, with 1 neutral response. Most people agreed/strongly agreed with the next statement stating that the haptic device added to the experience. However, the results were split as to whether the haptic device added more to their experience with the use of hearing protection. This is an important result as it shows that the combination of hearing protection and a haptic device may not be the solution to the problem in question. Although a larger participant group or one with a higher neurodivergent count may produce a different result. Despite the issues with the haptic device and the mixed results about its use and effect, everyone but 1 person agreed that they enjoyed being able to 'feel the music', whether that was with or without the haptic device.

4.1.2 Experiment

This experiment had 9 participants over 2 days. Their ages ranged from 20 to 58, with the most common age being 21. There was a relatively even split of participant genders with 5 male and 4 female. 7 of the 9 participants stated that they were neurotypical, and the final 2 stated "some neurodivergent/autistic traits" (these participants will be referred to as participant E and H).
Participant E also stated that they do not attend events, along with another participant, all others stated that they do. The participants for this experiment had an average hearing ability rating of 8.89 out of 10, with nobody rated theirs lower than a 7. Most participants don't or only sometimes typically wear hearing protection while 1 person stated that they do.

5 out of 9 participants stated that they never get overwhelmed by sound or noise in everyday situations, participants E and H both stated that they sometimes do, and B and F both stated that they are frequently overwhelmed by sound and noise in everyday situations. Similarly, at live music events, most are never overwhelmed, C and D are sometimes or are often overwhelmed, while B and H are often overwhelmed by sound or noise.

Experiment 1 – No Haptics or Hearing Protection
Figure 4.3 shows the results for 3 statements on a Likert scale. This shows that during experiment 1 most felt comfortable, however a higher percentage of people stated that they thought the music was too loud. This didn't stop anyone from enjoying the experience though. However participant E strongly disagreed with the statement "I felt comfortable", along with participant H who disagreed too. Despite participant E stating that they didn't feel comfortable, they still suggested that they enjoyed the experience.

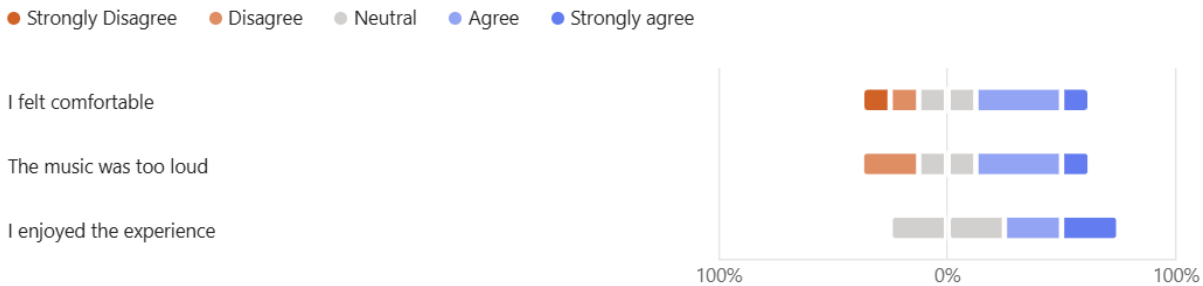

Figure 4.3 - Experiment 1 Likert scale results

Experiment 2 – No Haptics, just Hearing Protection
Figure 4.4 shows the results for 3 statements on a Likert scale. This shows that during experiment 1 all felt comfortable (responses from neutral-strongly agree). For this experiment most disagreed with the statement "the music was too loud". All still enjoyed the experience.

Participant C stated "it reduced some high frequencies and that was overwhelming without the earplugs". As participant C stated previously that they often/sometimes get overwhelmed at live music

events, suggesting that the use of hearing protection does help reduce the likelihood of getting overwhelmed for someone who is sensory sensitive.

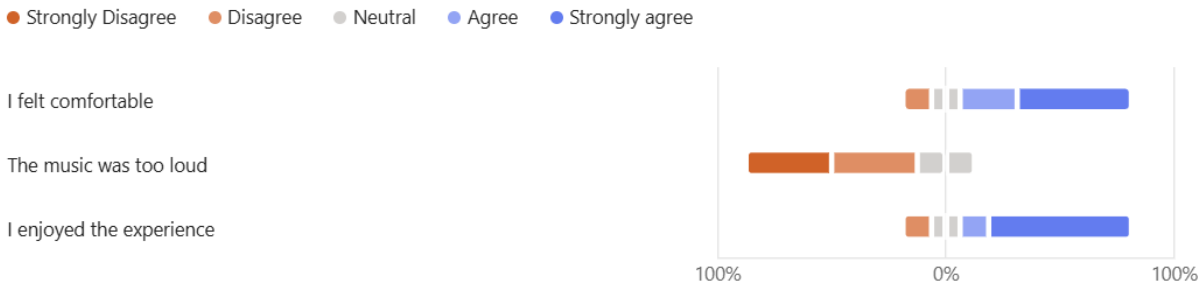

Figure 4.4 - Experiment 2 Likert scale results

Experiment 3 – Haptics and No Hearing Protection

Figure 4.5 shows the results for 3 statements on a Likert scale. Similar to experiment 2, most stated that they were comfortable, most disagreed that the music was too loud, and most enjoyed the experience. The biggest difference was that more people stated neutral for the volume statement, and one person disagreed with enjoying the experience. Participant A disagreed with the statement "I enjoyed the experience".

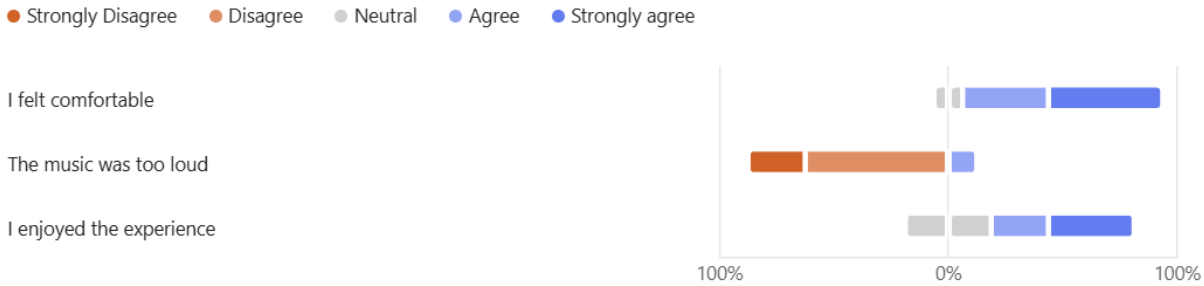

Figure 4.5 - Experiment 3 Likert scale results

Experiment 4 – Haptics and Hearing Protection

Figure 4.6 shows the results for 3 statements on a Likert scale. This experiment shows some interesting results. Most followed a similar pattern to experiment 2 and 3, however there were a few who didn't. Participant A disagreed with the statement "I felt comfortable". Most somewhat disagreed with the statement "the music was too loud". All but 2 agreed or strongly agreed with the statement about enjoying the experience. Participant A disagreed and participant B selected neutral. Both A and B had adjustments made to the delay of the haptic vests as discussed in 3.2.2 which may account for the difference in selection compared to the other participants.

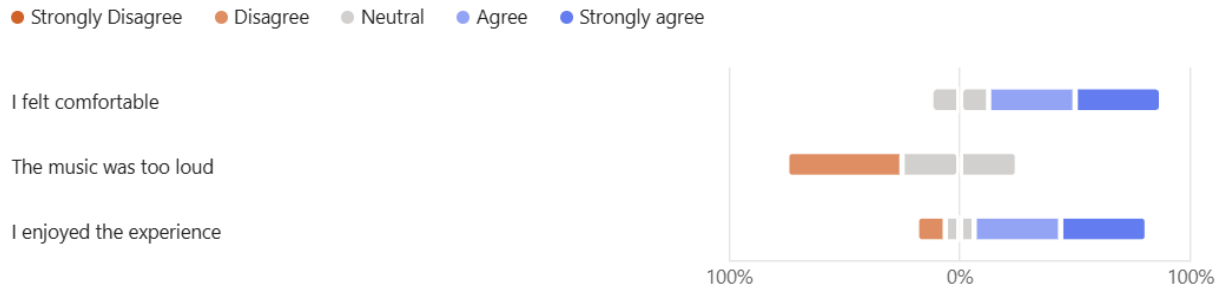

Figure 4.6 - Experiment 4 Likert scale results

Ending Questions

The final questions were completed after all 4 of the experiments had been run. These questions were aimed to compare the 4 experiments, and gather information on experience and comfortability.

The first question asked is a comparative multi-choice question asking which experiment the participants enjoyed more (Figure 4.7). The results for this are very spread over Experiment 2, 3, 4, and All, suggesting that no additional equipment at a live event just might not provide the best experience. Participant E selected experiment 4 and H selected experiment 2.

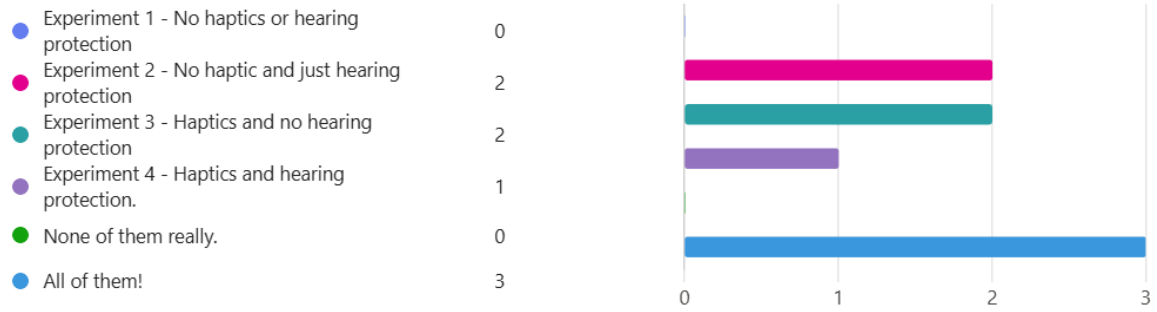

Figure 4.7- Experiment ending question on preferred enjoyment

The following question is very similar, it is again a multiple choice asking which experiment the participants enjoyed the experience of more (Figure 4.8). This was spread over 4 answers again however it was experiment 4 with experiment 5 having the most selections by far. Both participants E and H selected experiment 4.

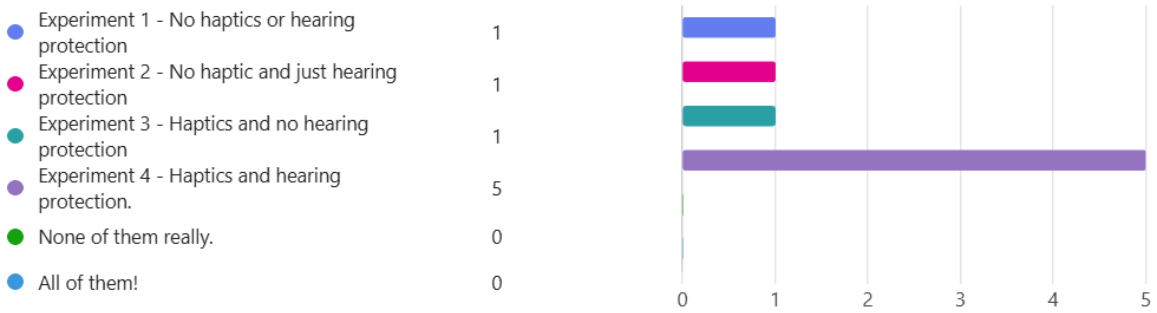

Figure 4.8 - Experiment ending question on preferred experience

The next section of questions was a range of statements on a Likert scale covering experience with hearing protection and the haptic device. The first 2 statements were on hearing protection. Firstly, “I feel like hearing protection limited my experience”. Most disagreed, with a few strongly disagreeing or neutral responses. Secondly, “I prefer having hearing protection”. This was split evenly across 2 options (with the exception of 2 responses). Most participants selected Neutral or Agree, participant F disagreed, and participant G strongly agreed.

The following selection of statements are about haptic devices and vibrations. The first question asks about whether the participant can ‘feel the music’ without additional haptics (Figure 4.9). A higher percentage selected either strongly disagree or disagree, with a few selecting the other options. Next asked if the participant enjoyed using the haptic device, this had a strong positive response with the exception of participant A however this was expected (3.2.2). Similarly, the next question asks if the device added to the experience where all but A and B responded positively. The next question is one of the most important question in determining whether these results align with the hypothesis. The statement asks if the experience with the haptic device was better with hearing protection. Like the previous question all but participant A and B agreed or strongly agreed with this statement. The final question in this section, except participant A, stated that they enjoy being able to feel the music (this could be without the addition of a device).

Figure 4.9 - Experiment ending question Likert scale (experience with hearing protection and haptic devices)

The final 2 questions where about if participants got overwhelmed and when. 50% stated that they didn't at all, 38% stated that they did, and 1 person stated other (this was explained that yes they did a little bit at one point but it was manageable). Most responses suggested that the participants who did get overwhelmed to some degree at some point felt this when using the haptic device with no hearing protection.

Summary
Excluding the results of participant A, these results tended to show a positive alignment to the use of this haptic device especially with additional hearing protection. Interestingly, many compared experiment 1 and 3 to a normal live music event, however those who got overwhelmed suggested that experiment 3 may have been the reason. Experiment 4 was generally the most preferred and enjoyed experiment, strongly suggesting a positive benefit, for all, from the combination of both the haptic device and hearing protection.

Participant E, specifically, (neurodivergent traits) had a much more positive response to experiment 4 in terms of their comfortability and enjoyment. Participant F, (who stated that they commonly get overwhelmed in everyday situations) had a much more positive response to experiment 2, 3, 4 compared to experiment 1. Both of these suggests that this combination, could significantly improve the experience for people who may be neurodivergent or sensory sensitive as the combination provided higher results in both enjoyment and comfortability.

4.2 Survey

The purpose of this survey is to assess audience's experiences with each topic in a way that allows a comparison, between neurodivergent and neurotypical experience, to be made. This was successfully achieved as it highlights the similarities and differences between the people on the 3 pathways.

Responses from the NT and ND event goers pathways had similar reasons for going to events, not going to events, frequency of attending, sorts of music, and to some extent types and sizes of venues. However, the results of these questions may have been affected by the design of this survey. Although the neurodivergent pathway was split again into those who do and don't attend events, the

NT pathway wasn't, meaning that those who didn't go to live music events were still included in all questions by default. This, specifically, may have affected the results in the question "Roughly, how frequently do you go to live music events" as even those who may not go (on the NT pathway) had to answer this question.

Both the people on the ND event goers and the NT pathway had an increase in possibly wearing hearing protection from everyday situations to at live music events. Although the NT pathway did see an increase in their percentages overall, they were noticeably lower to the other pathways. This could be due to people on the ND pathway experiencing the senses differently/more intensely than those on the NT pathway. More recently information and recommendations about hearing health at live events has increased, so people may be less likely to wear hearing protection if they're used to not wearing it, or due to potential stigma that may still be surrounding wearing hearing protection at events. However, a common brand for those who do wear hearing protection is Loops, this was a common response from both pathways.

Another difference in results that may be explained by different sensory experiences, concerns being able to 'feel the music'. 97% of both the NT and the ND event goers pathway stated that they can or can sometimes feel the music. However, the difference occurs when the results are split up a bit more. A higher percentage of people on the NT pathway stated that they could sometimes feel the music compared to the other pathway where yes they can feel it was the more common answer of the two. Several things could explain this difference, the difference in sensory experience and sensitivities being one or it could be something as simple as how close to the speakers they normally stand at an event, the type of event, or simply the type of music as there was a wide spread of genres. However, whether they enjoyed the experience (of being able to 'feel the music') is a personal sensory experience that may differ between people. 91% of people on the ND pathway stated that they do or do sometimes enjoy this feeling whereas the neurotypical pathway has 95% stating that they do/sometimes enjoy the feeling. Many factors could cause this slight difference in people enjoying the feeling including sensory experiences during the event, personal preference, and difference between events, etc.

The idea of a difference in sensory experience and sensitivities reinforces the results relating to overstimulation. There is a slight difference in responses between the ND event goers and the neurotypical pathways for the questions about overstimulation in everyday situations and at live music events. But, the main difference for these questions is between those two pathways and those on the ND non-event goers pathway as this shows a much higher response towards "very often" and "Always" than the other two pathways in both scenarios. Similarly, there is very little difference between the two scenarios for both the NT pathway and the ND event goers. However, there is a noticeable difference between the two scenarios for the ND non-event goers; where the "Never" and "Sometimes" options significantly decrease and the "Unsure" options have a similar response percentage as the "Always" selection. Suggesting that the people on this pathway significantly struggle with overstimulation at live music events which adds to the suggestion that this may be a large contributing factor as to why they may not go to live music events. Similarly, the people on the ND (who don't attend events) pathway hinted at being more likely to feel uncomfortable at live music events than the other two pathways. Whereas the NT pathway had a spread across all answers but was more focused on the end of always comfortable. The ND pathway also have a spread across most answers however they were more focused around the "Often" comfortable option compared to the ND (doesn't go to events) pathway which is heavily focused at the "Rarely" comfortable option.

The final section of the survey highlighted some significant differences between people's experiences with accessibility. Those that are on the ND non-event goers pathway struggled with answering this section as they don't experience the events. The ND event goers pathway had a higher response to noticing accessibility issues and were able to highlight more than just physical mobility issues at these live music events. Whereas the NT response suggested limited knowledge of other accessibility issues that weren't physical mobility issues. This highlights the gap in knowledge and information about other disabilities, their accessibility needs, and what is already out there for them.

These results show the need for more research and accessibility for a wider range of disabilities. It suggests that events are heading in the right direction but that more needs to be done. There are lots of people who may be comfortable at events but there are still those that may not be and some events may not be doing enough for those that aren't. Being uncomfortable or the risk of overstimulation may be putting people off attending and are therefore potentially missing out on a big experience. To improve this survey and research, a more equal level of participants would be needed for each pathway and the survey would need to be structured to have 4 sections to allow for those who may be neurotypical and who don't go to events to answer separately too. The filtering method could also have been improved to help make the pathways more accurate. Overall, this survey helped identify differences and similarities between potentially neurodivergent and neurotypical people. It highlighted the difference in sensory experiences, comfortability and overstimulation levels. It provided valuable information about their experiences with hearing protection and vibrational haptic devices.

5 CONCLUSION

The aim of this study was to look at the neurodivergent/autistic experience at a live music event and to investigate the effect of a haptic device and hearing protection on comfort and enjoyment levels. With objectives that include the effects of post and pre SPL reduction on experience, comfort, and enjoyment levels, using a haptic device to compensate for reduced auditory stimulation, collecting data on the experience of the autistic/neurodivergent community at live music events, and if a combination of a haptic device and hearing protection will decrease the likelihood of overstimulation.

The experiment revealed that the proposed combination of a haptic device and hearing protection is often the preferred configuration. That there is a significant difference between the comfort and enjoyment responses to experiment 1 (no hearing protection or haptic device) and experiment 4. Despite limitations the experiment results positively support the hypothesis. The survey for this study also successfully completes its goal, providing data and gathering information on the experiences of the neurodivergent community.

These results and the information collected in the study could impact the live event industry in a big way as it will add to the ongoing conversation about accessibility. This experiment, could also have a huge impact on the neurodivergent/sound sensitive community as it rethinks the use of two existing accessibility aids for a new purpose. Potentially improving the experience for some audience members reducing the barriers for those who may have been deterred because of the risk of overstimulation.

This study, however, only looks into one method of reducing sensory overstimulation for one sense so may only affect some. If the limitations of the experiment were reduced then the results for this study may give a much clearer picture of who it can and can't help. For further development of this study, a more focused neurodivergent (sound sensitive) confirmed selection group for the experiment is needed. A more accurate simulation or real world experiment at a live music event would provide a much more effecting and precise experiment result. To add another layer to this study, the use of vibrations as a grounding or stimming technique in the neurodivergent community could be investigated to see if this plays a part in why the vibrations from the vest work as a compensation for the audio without adding to the risk of overstimulation, along with more development of the control for the haptic devices for this purpose.

In conclusion, this study takes the first steps in what looks like a promising addition to live music event accessibility for the neurodivergent community.

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