The University of Arizona

College of Fine Arts

School of Art, Art & Visual Culture Education

HEARING THE INVISIBLE

A Project Assessment: Exhibition Analysis

by

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HEARING THE INVISIBLE

Hearing the Invisible is an immersive proof of concept across academic fields ranging from musicology to neuroscience and pharmacology for uncovering what is hidden in the human brain. It is an innovative transdisciplinary science and art collaboration that explores the unique diagnostic power of audio generated from EEG brain activity, which may screen individuals with Alzheimer's disease and dementia from healthy control subjects. To bring this research to life, Hearing the Invisible incorporates an interactive, immersive art installation with an original musical composition created and performed by UA School of Music students. The installation provides attendees with the opportunity to immerse themselves in the signals and sounds of someone with an invisible disease. This project is spearheaded by the College of Medicine, Department of Pharmacology's Dr. Tally M. Largent-Milnes and the School of Music's Professor Cynthia Stokes, MFA and their students.

PROJECT ASSESSMENT: EXHIBITION ANALYSIS

Real-Time Data Visualization: Name It, Feel It, Learn It

The data for this assessment was collected using a real-time data visualization method, where participants engaged with an interactive bulletin board. Visitors responded to three key prompts—'Name It!,' 'Feel It!,' and 'Learn It!'—using transparent sticky notes. This approach allowed for immediate, unfiltered visitor reactions and facilitated organic discussions around the exhibition themes. By utilizing a participatory and visual method, the data collection encouraged deeper engagement and provided a tangible representation of collective audience insights. The 'Name It!' section served as a recall exercise, assessing which neurological diseases visitors could identify and reinforcing key exhibition themes. The 'Feel It!' prompt encouraged emotional reflection, helping to analyze how sensory and experiential elements influenced visitor

perceptions and engagement. Finally, the 'Learn It!' component measured knowledge retention, capturing new insights visitors gained about brain function and neurological disorders. Together, these three prompts provided a holistic view of the exhibition's impact on cognition, emotional response, and conceptual understanding.

Name It

Task: Write the name of one neurological or invisible condition mentioned in the exhibition.

Objective: Capture visitors' recall of neurological diseases presented in the exhibition.

Goal: Assess which conditions were most recognized or impactful.

Feel It

Question: What emotions did you feel at each station?

Objective: Analyze emotional responses to different stations.

Goal: Understand how emotions influenced learning and engagement.

Learn It

Question: What's one new thing you learned about the brain? (Example: "I didn't know the brain could rewire itself!").

Objective: Capture new knowledge and insights gained.

Goal: Measure knowledge retention and conceptual understanding.

Processing the Data

The data for the project assessment was collected through written responses on sticky notes**,** allowing visitors to record their thoughts in real time as they engaged with the exhibition. These responses were then systematically categorized into thematic groupings to identify patterns and trends in visitor engagement. The analysis focused on determining the most frequently mentioned neurological conditions, emotional responses, and key takeaways from the

experience. By examining these responses, we were able to assess how effectively the exhibition conveyed scientific concepts, evoked emotional and sensory engagement, and facilitated learning through immersive experiences. Additionally, categorizing responses into Cognitive Engagement, Embodied & Sensory Responses, and Emotional & Relational Responses helped reveal how visitors processed information beyond traditional passive learning methods, demonstrating the power of multisensory and participatory education in shaping public understanding of neurological conditions.

Name It

This portion of the data collection aimed to capture which neurological or invisible conditions stood out to exhibition visitors. It aimed to assess visitor recall and awareness of neurological and invisible conditions presented in the exhibition. By asking participants to write down the names of diseases or concepts they encountered, this participation provided insight into which conditions were most prominently conveyed and remembered. This process not only reinforced key educational themes but also revealed gaps in public awareness. Understanding what visitors could recall helps to assess the exhibition's effectiveness in communicating essential scientific concepts.

Categories

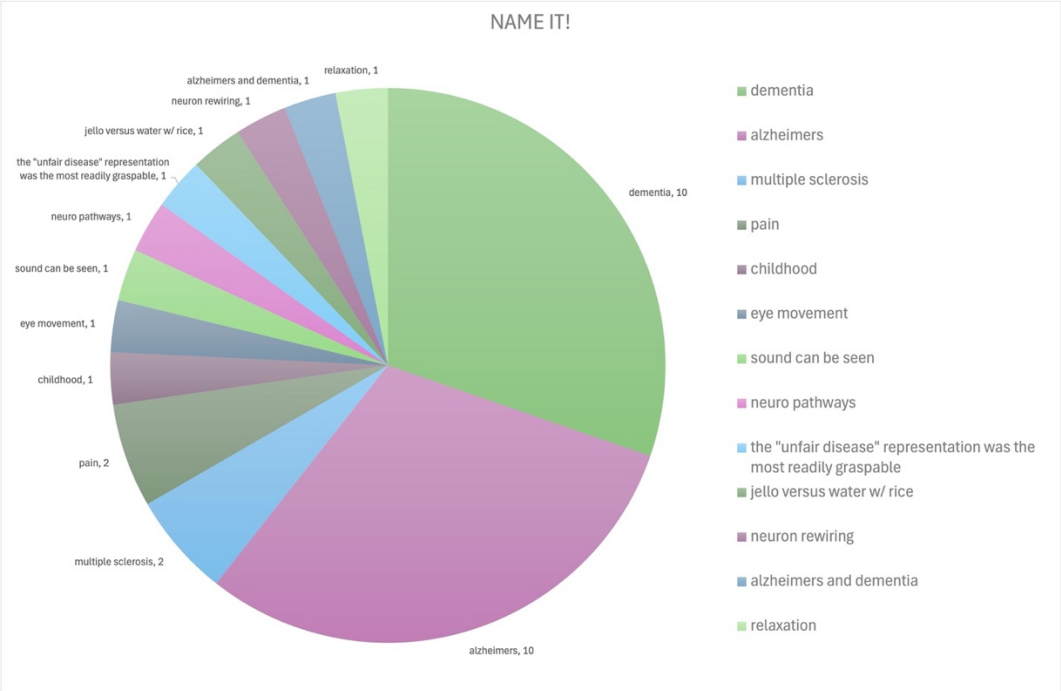
To better analyze the data, responses were categorized into three primary themes based on how visitors engaged with and recalled neurological conditions. Recognized Neurological Diseases includes conditions explicitly named by participants, such as Alzheimer’s, Dementia, and Multiple Sclerosis, reflecting either prior knowledge or successful reinforcement of key exhibition themes. Some visitors provided Conceptual or Abstract Responses, referencing neurological processes or generalized descriptions rather than specific diseases. Terms like

"Neuron rewiring" and "The Unfair Disease" suggest an engagement with broader scientific ideas, indicating that some participants processed the exhibition content beyond memorization of medical terminology. Lastly, Less Commonly Mentioned Conditions, such as Pain and Multiple Sclerosis, appeared less frequently, suggesting these topics may not be as widely recognized by the public or were not as strongly emphasized in the exhibition. The lower frequency of these responses highlights potential gaps in public knowledge, pointing to opportunities for expanding educational efforts on these conditions.

By categorizing responses in this way, we can better understand which neurological conditions were most salient to visitors, how they processed the exhibition's content, and where there may be gaps in awareness. This framework helps evaluate the effectiveness of the exhibition in conveying its themes and provides insights into how different aspects of neurological science resonate with the public.

Figure 1

Participants Responses on the Neurological or Invisible Condition Mentioned in the Exhibition.



Note. The above visual pie chart created from the Name It! data illustrates the frequency of neurological diseases and conditions mentioned by visitors.

The chart highlights that Alzheimer's disease and Dementia were the most frequently identified conditions, representing the largest portion of responses. This suggests that these diseases were either the most prominently featured in the exhibition or the most familiar to visitors prior to attending. Multiple Sclerosis and Pain were mentioned far less frequently, which may suggest that participants had less prior knowledge of these conditions compared to Alzheimer's and Dementia. The higher frequency of mentions for Alzheimer's and Dementia could indicate that these diseases are more commonly discussed in public discourse, leading to greater recognition among visitors. In contrast, Multiple Sclerosis may not be as widely known or talked about, making it less likely to be recalled by participants. Additionally, some responses focused on broader neurological concepts rather than specific diseases, such as "Neuron rewiring" and "The Unfair Disease," which suggests that some visitors were internalizing abstract themes related to brain function rather than recalling specific conditions. The pie chart visually reinforces these patterns, demonstrating which themes were most salient to visitors and providing insights into the exhibition's effectiveness in emphasizing particular neurological conditions.

Observations

Dementia and Alzheimer's were overwhelmingly the most recognized conditions. This suggests that visitors either had prior knowledge or that the exhibition successfully reinforced these as key conditions. Few people mentioned Multiple Sclerosis or Pain. This could mean they were either underrepresented in the exhibition or not as strongly conveyed. Some responses were

more conceptual (e.g., "Neuron rewiring," "The Unfair Disease"). This shows that some visitors internalized abstract neurological concepts rather than listing specific conditions.

Feel It

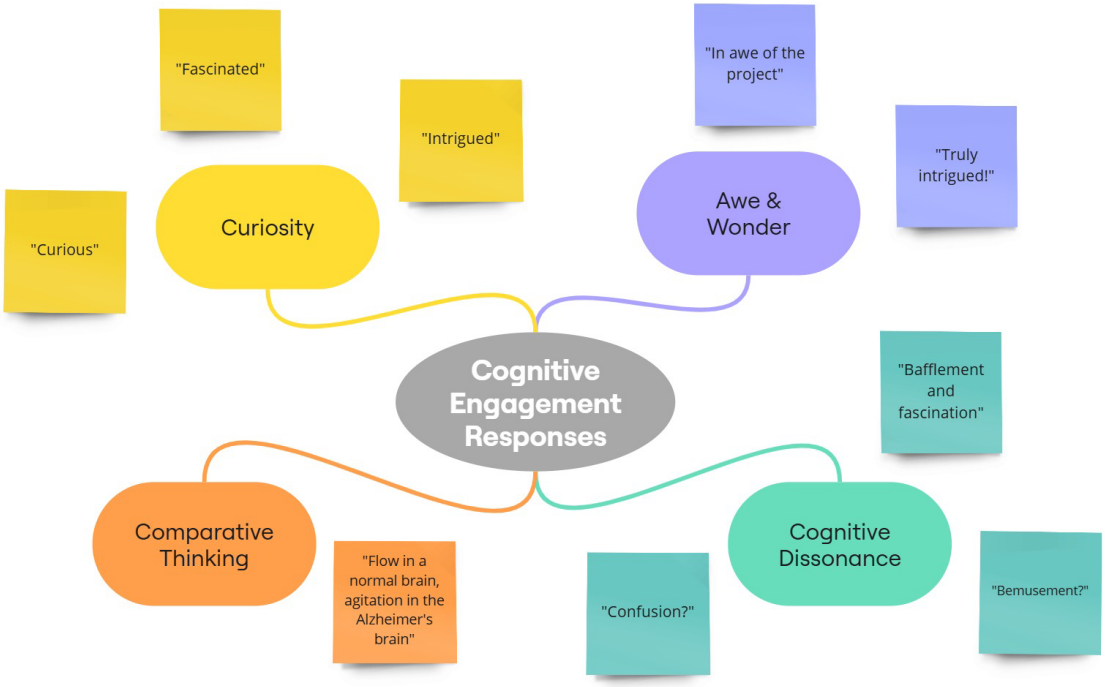
The “Feel It!” section of the data collection aimed to capture the emotional responses of visitors at different exhibition stations. Based on the visitors’ responses, the categories are framed based on how emotions contribute to learning and engagement in the exhibition. The visual maps below illustrate the classification of these emotions into three primary categories: (1) Cognitive Engagement Responses, (2) Embodied & Sensory Responses, and (3) Emotional & Relational Responses.

List of Categories

Cognitive Engagement Responses involve deep thinking, reflection, and the processing of new knowledge. Visitors who expressed curiosity, awe, or intellectual intrigue engaged in cognitive learning by making connections between scientific concepts and personal insights. Embodied & Sensory Responses reflect physical reactions to the exhibition, including sensory overload, heightened awareness, or a feeling of calmness. These responses demonstrate how the body's interaction with the environment shapes learning experiences, particularly through sound and tactile engagement. Emotional & Relational Responses capture how visitors connected personally or socially to the content. These responses include expressions of empathy, frustration, or motivation for action, indicating that the exhibition not only informed but also resonated with visitors on a personal level. Together, these three categories provide a comprehensive understanding of how visitors engaged with the exhibition on intellectual, sensory, and emotional levels (see Figures 2, 3 & 4).

Figure 2

Cognitive Engagement Responses Map



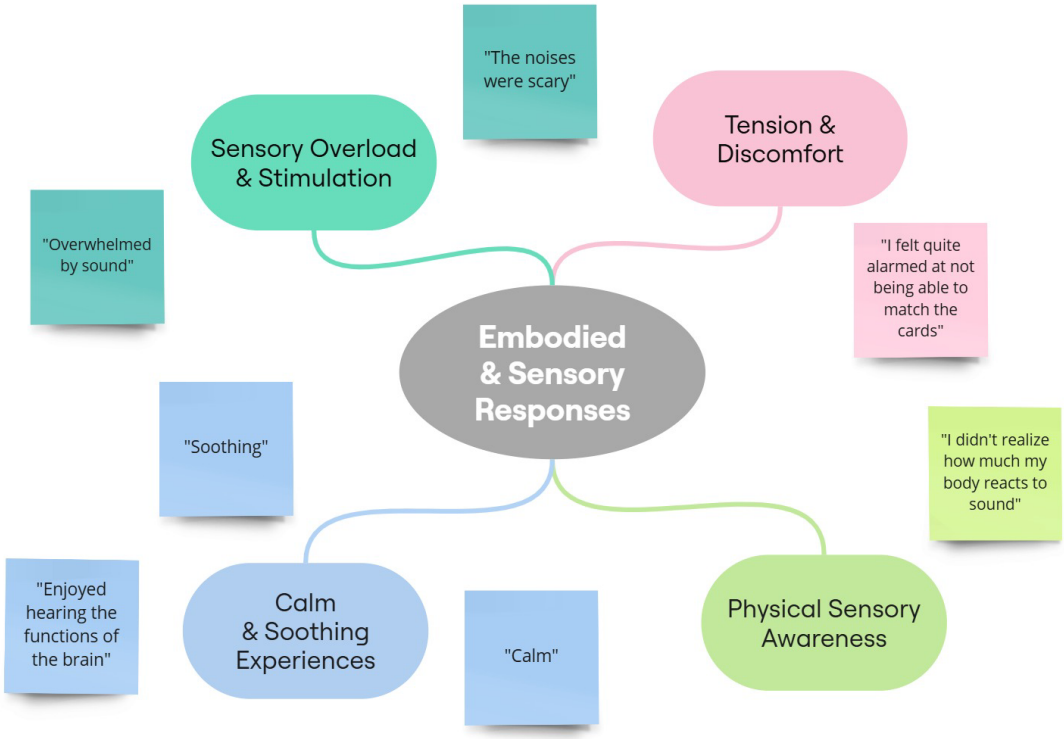
Note. The responses indicate deep thinking, reflection, or processing new information.

The above conceptual map categorizes visitor responses under Cognitive Engagement Responses, illustrating different ways participants processed and reflected on the exhibition experience. The Curiosity category includes responses such as “Curious,” “Fascinated,” and “Intrigued,” showing an eagerness to explore and understand new concepts. Awe & Wonder responses, like “In awe of the project” and “Truly intrigued!,” highlight moments of inspiration and deep appreciation for the exhibition’s content. Cognitive Dissonance, represented by responses such as “Confusion?” and “Bafflement and fascination,” reflects the challenge of grappling with new or complex information, which can lead to deeper learning. Lastly, Comparative Thinking, exemplified by “Flow in a normal brain, agitation in the Alzheimer’s brain,” shows how visitors made connections and contrasts between different neurological states.

This framework demonstrates how engagement with the exhibition fostered curiosity, critical thinking, and conceptual understanding.

Figure 3

Embodied & Sensory Responses Map



Note. This conceptual map categorizes visitor responses under Embodied & Sensory Responses**,** demonstrating how participants physically and emotionally reacted to the exhibition's sensory elements. The responses are tied to physical sensations, sensory overload, or heightened awareness.

Sensory Overload & Stimulation includes responses like "Overwhelmed by sound" and "The noises were scary," highlighting intense reactions to the auditory aspects of the exhibition, particularly its immersive and unsettling soundscapes. Tension & Discomfort, represented by statements such as "I felt quite alarmed at not being able to match the cards," reflects moments

where visitors experienced frustration or unease, particularly when engaging with simulations that conveyed the challenges of neurological conditions. Physical Sensory Awareness, including comments like “I didn’t realize how much my body reacts to sound,” demonstrates heightened self-awareness and an understanding of how external stimuli influence bodily perception. On the other hand, Calm & Soothing Experiences, illustrated by responses such as “Calm” and “Soothing,” show that some visitors found aspects of the exhibition to be grounding and relaxing, particularly when engaging with the informational and auditory elements in a more reflective way. These responses reveal how the exhibition successfully engaged visitors on a sensory and emotional level, making the experience not only intellectually stimulating but also physically immersive.

Figure 4

Emotional & Relational Responses Map

Note. This conceptual map categorizes visitor responses under Emotional & Relational Responses**,** showcasing how participants connected personally and socially with the exhibition. The responses suggest personal or social connection to the experience.

Empathy & Perspective-Taking is represented by responses such as "I felt sad and happy at different parts" and "Frustrated at the memory game," indicating that visitors were able to emotionally relate to the challenges of neurological conditions, particularly through experiential elements like the memory card game. Sense of Connection & Participation, reflected in statements such as "I liked having the student walk me around" and "Fabulous—hope there's a video on YouTube," highlights moments where visitors felt socially engaged, whether through interactive guidance or a desire to share the experience beyond the exhibition. Motivation for Action, captured in responses like "Eager for progress in the science of pain management" and "Hope it goes far," suggests that some participants left the exhibition feeling inspired to learn more, advocate, or support further scientific advancements.

Together, these responses illustrate how the exhibition fostered not only cognitive learning but also personal engagement, social interaction, and a drive for continued inquiry. Visitors engaged with the content in varied and meaningful ways, whether through curiosity, emotional reflection, or sensory immersion. To better understand the range of emotional responses, we categorized them into three overarching themes: Cognitive Engagement, Embodied & Sensory Responses, and Emotional & Relational Responses. These categories highlight the different ways participants processed and internalized their experiences, from deep intellectual reflection to visceral and emotional reactions. Furthermore, Table 1 below provides a breakdown of these categories, including descriptions and example responses shared by visitors.

Table 1
Emotional Engagement Categories

Category	Description	Example Responses
Cognitive Engagement Responses	Curiosity (Interest in learning more)	"Curious", "Fascinated", "Intrigued"
	Awe & Wonder (Discovery and fascination)	"In awe of the project", "Truly intrigued!"
	Cognitive Dissonance (Bafflement, confusion, processing new concepts)	"Confusion? Bemusement?", "Bafflement and Fascination"
	Comparative Thinking (Recognizing contrasts in brain function)	"Flow in a normal brain, agitation in the Alzheimer's brain"
Embodied & Sensory Responses	Sensory Overload & Stimulation (Responses to intense auditory or visual input)	"Overwhelmed by sound", "The noises were scary"
	Tension & Discomfort (Empathy-inducing challenges, frustration in simulations)	"I felt quite alarmed at not being able to match the cards"
	Calm & Soothing Experiences (Sensory relief, relaxation)	"Calm", "Soothing", "Enjoyed hearing the functions of the brain"
	Physical Sensory Awareness (Heightened perception of the body's responses)	"I didn't realize how much my body reacts to sound"
Emotional & Relational Responses	Empathy & Perspective-Taking (Emotional responses to the lived experiences of others)	"I felt sad and happy at different parts", "Frustrated at the memory game"
	Sense of Connection & Participation (Social engagement and interactive elements)	"I liked having the student walk me around", "Fabulous, hope there's a video on YouTube"

Motivation for Action (Desire for further exploration, advocacy, or research)	"Eager for progress in the science of pain management", "Hope it goes far"

Observations

The emotional responses gathered from the exhibition reveal a wide range of reactions, demonstrating the depth of visitor engagement with the multisensory experience. Many visitors expressed curiosity, awe, and fascination, indicating that the exhibition sparked intellectual and emotional intrigue. Some responses reflected discomfort, tension, or confusion, particularly during stations that simulated neurological conditions, showing that participants deeply empathized with the subject matter. Others experienced sensory overload, reacting to the sound elements with emotions such as anxiety or being overwhelmed. Despite this, moments of calmness and soothing relief were also noted, highlighting the exhibition's ability to balance intensity with reflection. Many responses suggested that the exhibition encouraged personal connections and deeper engagement**,** particularly through interactive elements and discussions with facilitators.

Learn It

This section of the data collection aimed to capture what visitors took away from the exhibition—what new knowledge they gained or what insights resonated with them. The majority of responses were about brain function and waves. Visitors learned about brainwave frequencies, EEG nodes, how brain waves correlate with emotions, and the impact of neurological diseases on brainwave activity. A significant number of responses reflected new insights about neurological diseases. Many visitors were surprised by how much Alzheimer's and Dementia affect brain waves and that different diseases have distinct brainwave patterns.

List of categories

The visitor responses were categorized into four primary themes to better understand how participants engaged with and interpreted the exhibition's content. These categories provide insight into the different ways knowledge was acquired and processed through multisensory and participatory experiences.

Brain Function & Waves

This category includes responses that reflect an understanding of brainwaves, EEG technology, and how neural activity translates into sound. Many visitors were fascinated by the scientific process of converting brain activity into an auditory experience, which helped them grasp complex neurological concepts in an intuitive way.

Neurological Diseases

Responses in this category indicate knowledge gained about conditions such as Alzheimer's, dementia, and multiple sclerosis. This category captures how visitors understood the physiological and cognitive effects of these diseases, as well as the importance of research and early detection.

Scientific Discovery & Curiosity

This category highlights responses that express interest in the broader implications of brain research, including the potential for new diagnostic tools and medical applications. Visitors who engaged with this category demonstrated a forward-thinking perspective, linking exhibition content to scientific innovation and future possibilities.

Reflections on Performance & Discussion

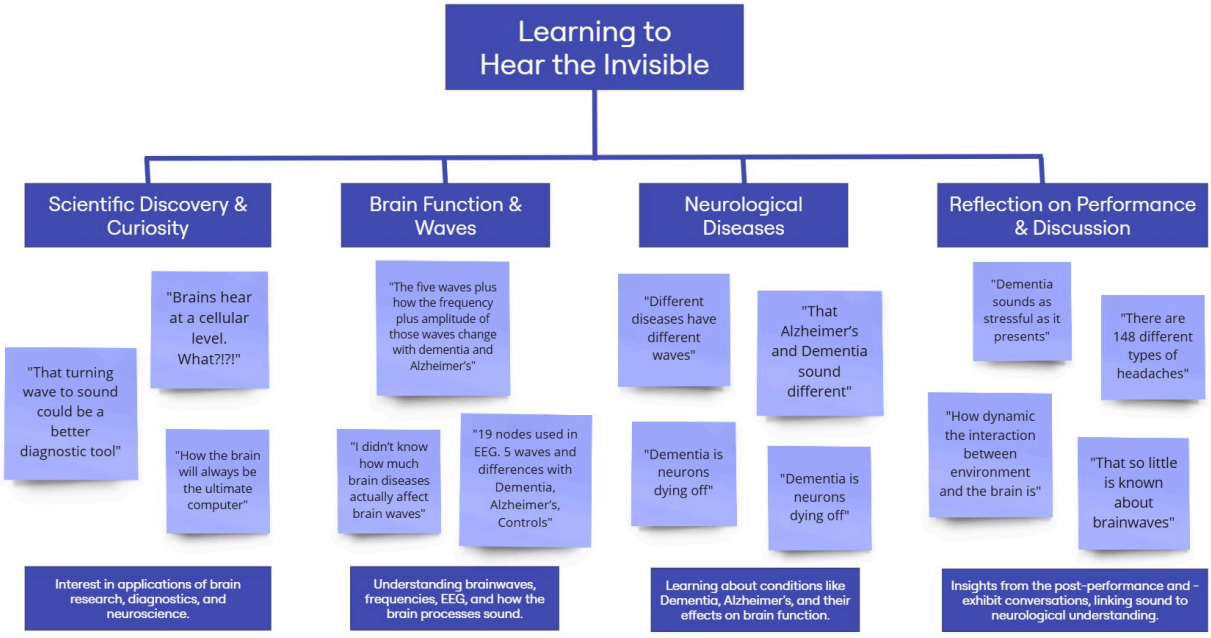
This category captures responses that were influenced by the musical performance and post-exhibition discussions. Many visitors reflected on how the progression from healthy to

diseased brain function was made tangible through sound, deepening their emotional and intellectual connection to the subject matter.

By categorizing responses in this way, we were able to identify distinct patterns in visitor engagement, highlighting the exhibition's success in conveying both scientific knowledge and personal reflection through interactive and artistic methods (see Figure 5).

Figure 5

Learning to Hear the Invisible



Note. The conceptual map illustrates how visitor responses from the 'Learn It!' section were categorized into four main themes: Scientific Discovery & Curiosity, Brain Function & Waves, Neurological Diseases, and Reflection on Performance & Discussion.

The categories and themes mentioned in the above map represent the different ways participants engaged with and internalized information from the exhibition. Responses under Scientific Discovery & Curiosity highlight interest in the diagnostic potential of brain research, while Brain Function & Waves responses reflect learning about EEG, brain frequencies, and

neural processes. Neurological Diseases responses show awareness of how conditions like Alzheimer's and dementia affect brain activity, and Reflection on Performance & Discussion captures insights gained from the post-performance and exhibit conversations. This framework demonstrates how visitors connected scientific concepts with sensory experiences, reinforcing the exhibition's impact on both cognitive and experiential learning.

Observations

A smaller but notable group of responses focused on scientific curiosity and implications. Some visitors expressed interest in diagnostic applications, the connection between sound and brainwaves, and the use of EEG for brain mapping. Many visitors reported learning about brain function and waves, particularly in relation to EEG technology and how brain activity translates into sound. Others deepened their knowledge of neurological diseases, with a focus on conditions such as Alzheimer's and dementia, and their effects on cognitive function. A number of responses reflected scientific discovery and curiosity, as visitors expressed interest in emerging research applications, diagnostic tools, and the broader implications of brainwave studies. Additionally, several visitors provided reflections on performance and discussion, highlighting how the musical progression in the exhibition deepened their understanding of the transition from healthy brain function to neurological deterioration. These themes illustrate the exhibition's success in facilitating both scientific learning and personal contemplation through a multisensory experience.

Final Outcomes

The findings from the project assessment highlight the significant impact of multisensory, participatory exhibitions in fostering visitor engagement and understanding. By analyzing responses beyond traditional 'positive' or 'negative' emotional reactions, we were able to capture

a more nuanced understanding of visitor engagement. Rather than focusing on whether visitors felt good or bad, our categorization demonstrates that learning occurred through a variety of cognitive, sensory, and emotional experiences.

The 'Feel It!' responses revealed that emotions such as overwhelm, frustration, and anxiety were not merely discomforts but indicators that visitors were actively embodying and processing what it might feel like to live with dementia or Alzheimer's. These reactions show that participants were not just passively observing but were deeply engaged in the subject matter, experiencing it in ways that fostered empathy and a more profound understanding of neurological conditions. Similarly, moments of curiosity, awe, and reflection within 'Cognitive Engagement Responses' demonstrate that visitors were grappling with complex scientific concepts and making meaningful connections.

This argument is further supported by the 'Learn It!' responses, where participants articulated new knowledge gained about brain function, neurological diseases, and scientific research. However, learning was not limited to that section alone—it was embedded throughout the emotional and sensory responses as well. The presence of embodied and relational reactions shows that the exhibition successfully bridged intellectual understanding with personal experience.

Key Takeaways

Experiential learning fosters deeper engagement

Visitors demonstrated a strong level of cognitive and emotional engagement, particularly when interacting with the exhibition's sound-based elements. The immersive nature of the experience allowed them to actively participate in meaning-making, rather than just passively absorbing information.

Confusion as a catalyst for learning

Responses in the 'Feel It!' section revealed that emotions such as frustration, discomfort, and confusion were not barriers to learning but rather signs of deeper processing. These moments encouraged visitors to question, reflect, and seek further understanding, highlighting the role of productive struggle in experiential education.

Multisensory experiences enhance memory retention

The 'Learn It!' data indicated that visitors retained information more effectively when they could connect scientific concepts with embodied experiences. Engaging multiple senses—such as hearing and feeling neurological deterioration through sound—helped solidify learning in ways that traditional text-based or visual methods alone might not achieve.

Overall, the exhibition successfully created an immersive learning environment that encouraged personal connection, curiosity, and a greater appreciation for neurological complexity. These findings emphasize that learning is not always linear; it happens through feeling, engaging, and even struggling to make sense of new information. By structuring responses around Cognitive Engagement, Embodied & Sensory Responses, and Emotional & Relational Responses, we demonstrate that visitors were not only absorbing information but internalizing and experiencing it in a transformative way.