



# MUSEUM ACOUSTICS

**HOW THE EVOLUTION OF ART IS DEMANDING  
ACOUSTIC INGENUITY**

**AUGUST 4, 2026**

## **ARTICLE BY**

Milena Jonas Bem  
Acoustics Consultant

T 617 499 8066  
mjonas@acentech







### Author Quick-Look

Milena's background combines architectural design, architectural acoustics, immersive audio, and human-centered research methods. Her work includes acoustic measurements, modeling, and simulation, sound isolation and room acoustics analysis, mechanical noise control support, and the development of acoustical recommendations for a range of project types.

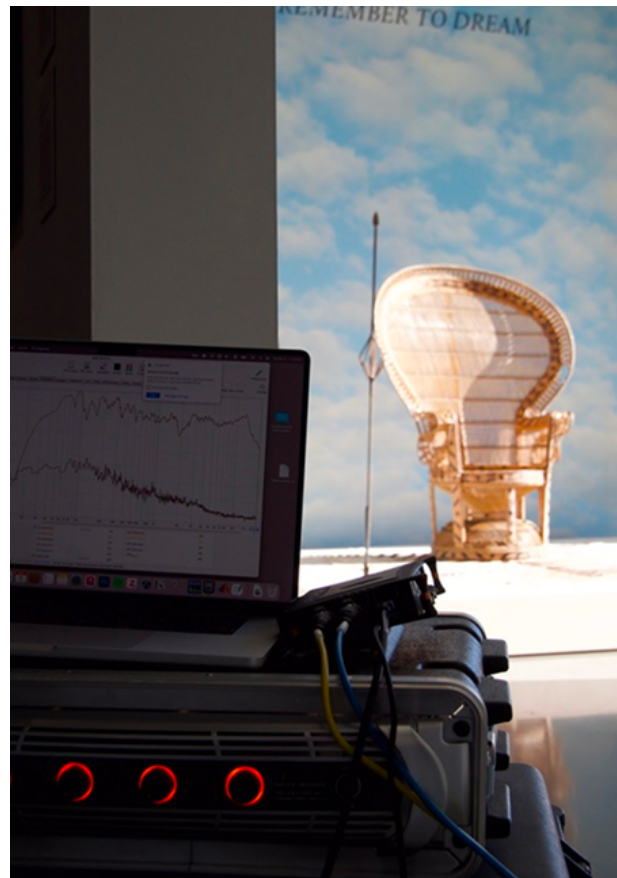
### Article Overview

As museums welcome more visitors, the sounds they create have become a larger part of the experience. Exhibitions are evolving, and interactive, multi-sensory artworks increasingly invite conversation, movement, and reflective group activities. Milena Jonas Bem teaches us about the ways acoustics affect your museum experience. She emphasizes how working with the sounds already present in a gallery can be beneficial as opposed to eliminating them.



# MUSEUM ACOUSTICS

Many people imagine museums as quiet spaces, rooms where you can slow down to notice each brushstroke on a painting or stretch your mind around a stunning abstract piece.



In reality, museums are rarely silent. Even in the calmest galleries, you'll hear footsteps, whispers, ventilation systems, a tour guide, and sometimes noise from outside.

As museums welcome more visitors, the sounds they create have become a larger part of the experience. Exhibitions are evolving, and interactive, multi-sensory artworks increasingly invite conversation, movement, and reflective group activities. Today's museums often need to support two different experiences at once:

1. Clear speech during tours, classes, and public programs
2. A sense of calm and personal space for visitors who want to reflect quietly

## Finding the Right Sound is a Balancing Act

This creates a real design challenge: how can we balance speech intelligibility and privacy? Speech intelligibility is the ability to understand someone clearly, while speech privacy aims to obscure conversations enough to preserve a sense of privacy in a space. While intelligibility may seem preferable, not every conversation in a museum is meant to be understood.



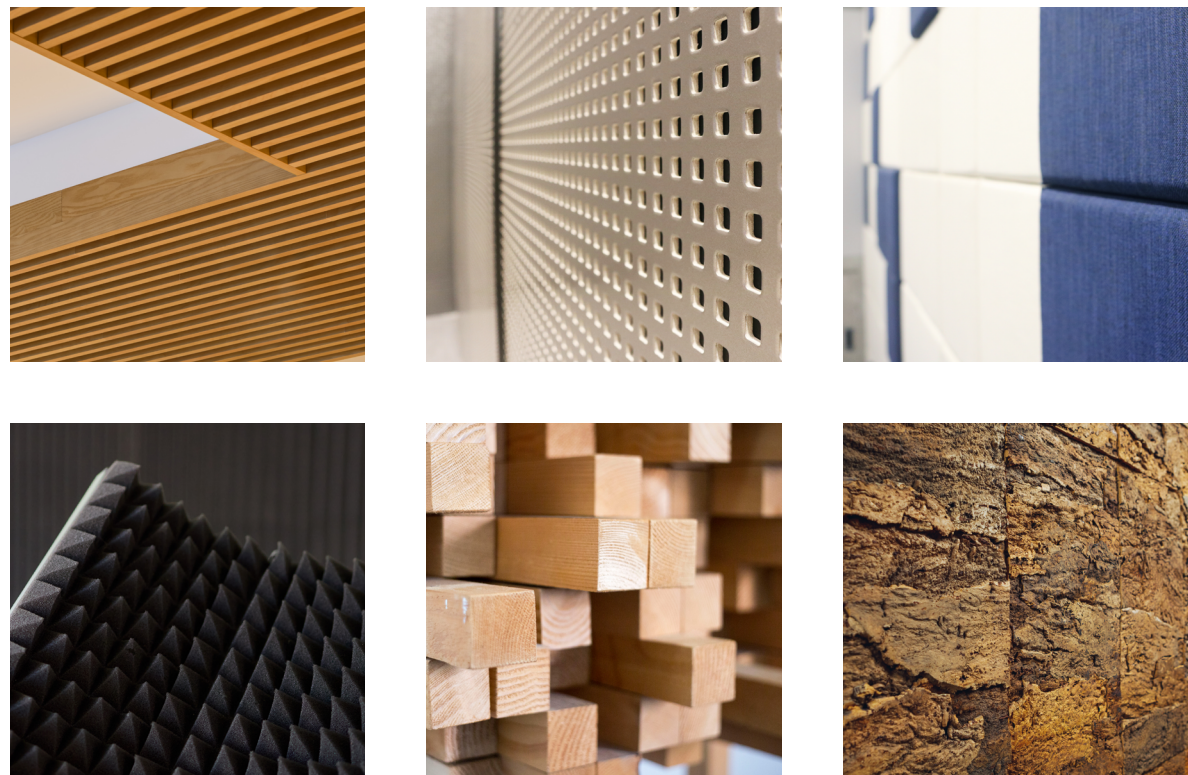
Striking the right balance between intelligibility and privacy depends on the function and design of each space. These ideas are explored in depth in an earlier article by [Ioana Pieleanu](#), who shares an [acoustician's perspective on achieving effective speech intelligibility and privacy in corporate offices and commercial environments](#).



## Weighing Out the Various Solutions

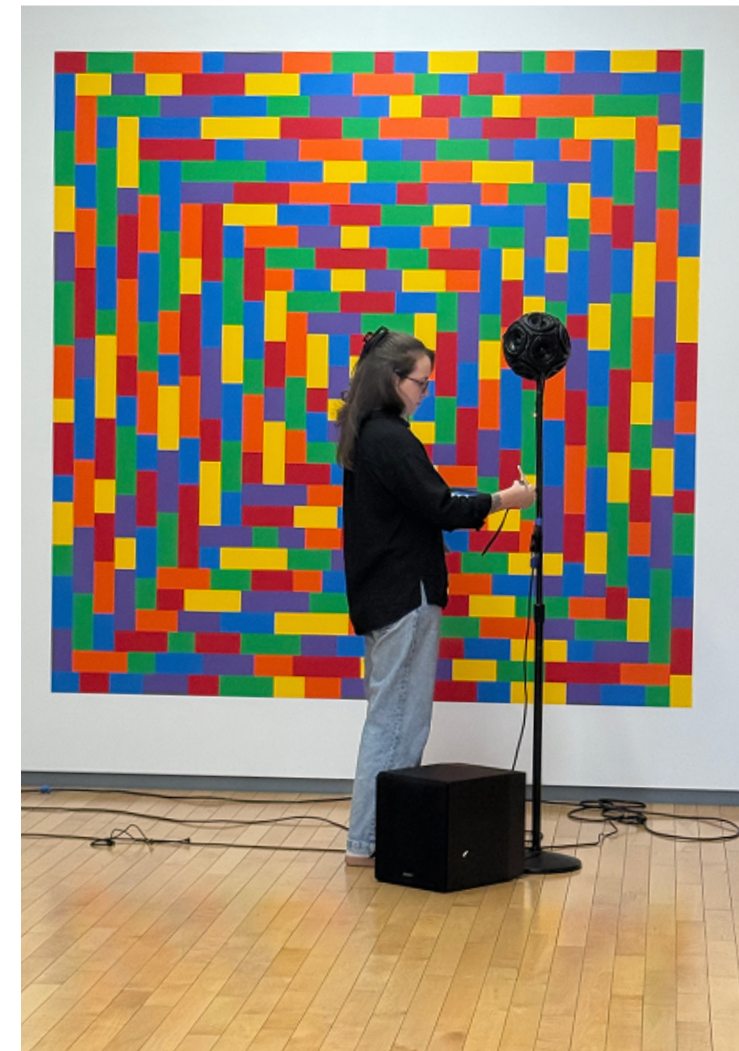
One practical way to address this challenge is by choosing finishing materials that shape how sound behaves in a room. Materials don't just affect how a space looks; they influence how sound bounces, spreads, and fades.

Traditionally, many finish choices have been made solely for appearance. But material options have expanded significantly in recent years, especially those with acoustical properties.



For example, some museums can maintain rooms similar to classic “white-box” galleries while absorbing more sound, helping reduce overall noise and distraction. While acoustically beneficial materials alone won't solve every issue, they can play an important role as museums continue to evolve and display new art forms and mediums with their own unique acoustical requirements.

## AN INTRODUCTION + THE STUDY



Over the past few years, I have conducted two studies examining how different finishing materials and room layouts/designs affect acoustic metrics, human perception, and physiological responses in museum spaces.

This work draws on acoustic measurements and listening studies from five museums:

- Williams College Museum of Art (Williamstown, MA)
- CCS Bard Hessel Museum (Annandale-on-Hudson, NY)
- Massachusetts Museum of Contemporary Art (North Adams, MA)
- University Art Museum (Albany, NY)
- Museum of Fine Arts (Boston, MA)

(Photography by [Aleksandr Tsurupa](#))



## Study 1: What the Numbers Predict

Two complementary methods can help us understand how different materials shape a room's acoustic environment: **measuring the room directly** and **using computer simulations**. In this case, we used both approaches. First, we measured the acoustics of 54 museum rooms. We then created a 3D model of each space and placed virtual sound sources and listeners throughout the room. Using the measured data, we calibrated the models so they could reproduce each room's unique acoustic fingerprint, known as its **room impulse response**.

From this acoustic fingerprint, we can analyze measures that describe how the room sounds, including reverberation time, how clearly speech can be understood, and how quickly conversations fade with distance.

For this study, we tested three levels of sound absorption (low, medium, and high) on the floors, ceilings, and walls of 54 museum rooms. We could then not only compare the predicted acoustic results, but also listen to how each design option would sound applied to a room through a process called **auralization**. You'll have the opportunity to listen to these examples at the end of the article.

### What did this data predict?

#### 1. More Sound Absorption Consistently Helped

Across all surfaces, increasing absorption from low to medium to high produced improvements: it reduced reverberation, improved speech clarity, and made speech drop off faster, supporting privacy.

#### 2. Placement Matters

1. Highly reflective floors, like concrete, performed the worst. Switching materials to wood or carpet improved the space, but floors alone did not guarantee "ideal" results. In many cases, ceiling and/or wall treatments were still needed to achieve strong clarity and privacy.
2. Ceilings produced the most significant overall improvement in speech clarity and helped reduce the distance traveled by distracting sounds. In other words, opting for more absorptive ceiling finishes can be a compelling way to improve tour experiences.
3. Walls emerged as the strongest **privacy tool**. High-absorption wall finishes produced the steepest drop-off in conversation levels with distance. This is especially useful for galleries that aim to feel whisper-quiet or include multimedia-based artwork.

## Study 2: Emotions and Bodily Responses

Ceilings are often the largest uninterrupted surface in gallery rooms and one of the easiest places to add absorption without affecting display space. Continuing from Study 1, we focused on three ceiling material options and tested how they influenced:

- Visitors' perceived balance between understanding the tour guide and avoiding distraction from background conversations
- Overall preference and satisfaction
- Physiological responses related to arousal or stress: skin conductance (EDA) and heart rate (HR)
  - (Skin conductance measures increased moisture on participants' hands caused by physiological arousal, stress, or emotional stimuli)





We designed a realistic museum scene: a visitor listening to a nearby tour guide while two other visitors talked in the background. Participants experienced three versions of the same scene, with only the ceiling material changing (from low, to medium, and to high absorption).

After each version, participants rated how clearly they could hear the guide, how distracting the background conversation felt, and which environment they preferred. We also recorded EDA and HR to determine whether different sound environments were associated with calmer or more activated responses.



**SMOOTH PAINTED CONCRETE**  
LOW ABSORPTION



**WOOD CEILING**  
MEDIUM ABSORPTION



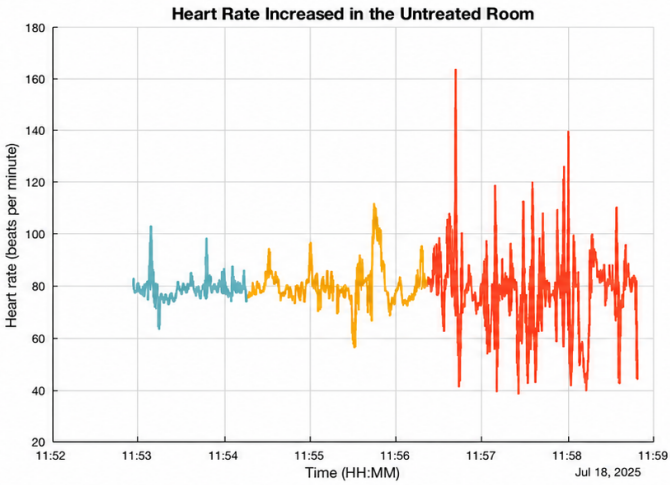
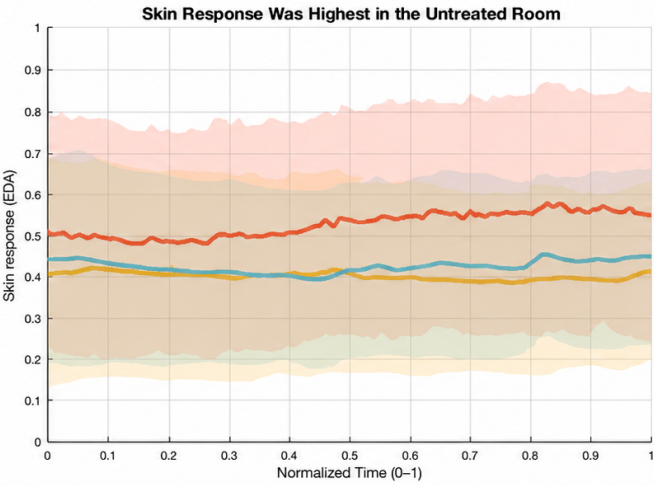
**PERFORATED ACOUSTIC PANELS**  
HIGH ABSORPTION

To keep comparisons fair and controlled, we used acoustic measurements from real spaces to calibrate a virtual model, then presented the scenarios in an immersive listening environment ([Acentechs 3DListening Room](#)).

# THE STORY THE NUMBERS TELL

Overall, the high-absorption ceiling produced the most favorable responses for the museum scenario. Participants reported:

- Less distraction and interference from background conversations
- A clearer understanding of the tour guide
- Higher satisfaction and preference compared to the lower-absorption ceilings



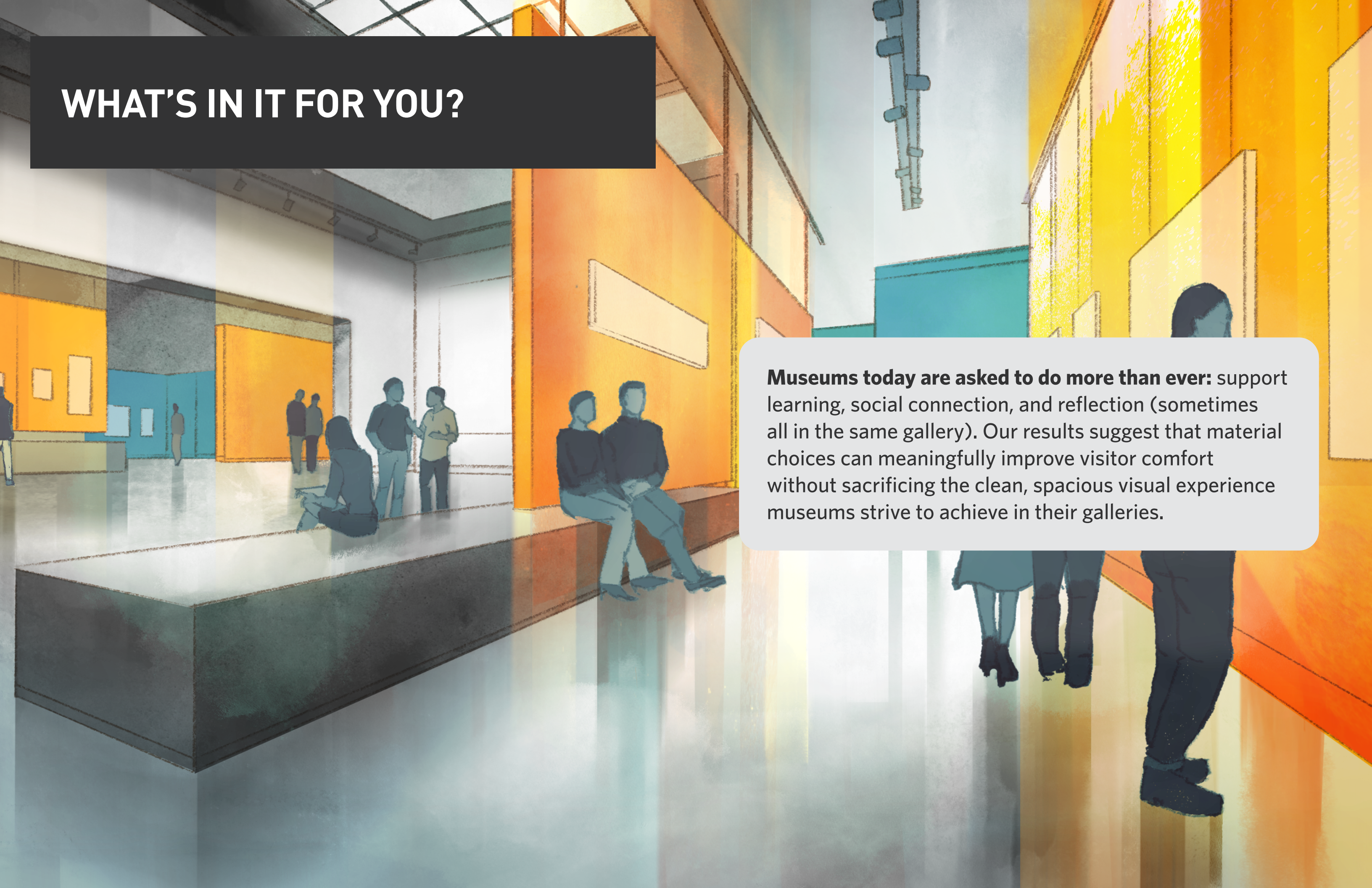
● Untreated Room      ● Moderated Absorption      ● High Absorption

One seemingly negative, yet ultimately positive, aspect of the high-absorption ceiling was that it made background conversations more understandable. Despite this, participants still described the condition as the least distracting overall, likely because the room felt quieter and less “noisy” in general.

We also saw differences in physiological responses across the three conditions reflected in changes in EDA and HR. The graphs below show one example participant: both measures were higher in the untreated room (orange-red), which had the lowest sound absorption. These measurements add another layer of evidence beyond surveys by showing how the body can react automatically, responses that happen in the background and are not something we intentionally control.



# WHAT'S IN IT FOR YOU?



**Museums today are asked to do more than ever:** support learning, social connection, and reflection (sometimes all in the same gallery). Our results suggest that material choices can meaningfully improve visitor comfort without sacrificing the clean, spacious visual experience museums strive to achieve in their galleries.





## About the author

Milena holds a Ph.D. in Architectural Sciences with a concentration in Architectural Acoustics from Rensselaer Polytechnic Institute, where her research focused on museum acoustics, immersive sound environments, subjective evaluation, and physiological responses to acoustic conditions.

Her doctoral work integrated in-situ acoustic measurements, room acoustic simulations, immersive listening experiments, and human-response data to better understand how acoustic design affects visitor experience.

## About the Lab @ Acentech

Innovation is in the Acentech DNA stretching back to our earliest origins at Bolt Beranek and Newman (BBN). In the early days, BBN was likened to a university faculty where research and development was encouraged, nurtured and supported. A culture of curious and rigorous inquiry lies at the core of what we do, stemming from a desire to advance our knowledge, and share our findings with the world. We are more than a workplace - Acentech is also a research lab, playground, support system, jam space, and vehicle for positive social change.

The Lab @ Acentech is a space where we can share some of the exciting things we have been working on. The projects you will read about are but a small sample of the innovation culture at Acentech. The Lab is where our passion intersects with our clients, colleagues, and future coworkers. The work described herein builds on ideas inherited from our founders, and is nurtured by generations of consultants and scientists along the way. We are delighted to share it with you.

