

# Emotion in the Science Center:

Applying Affective Theory, Research, and Technologies in Designed Experiences

ASTC 2019 Preconference Intensive

September 20, 2019 – 9:00am-5:30pm

Toronto, Ontario, Canada

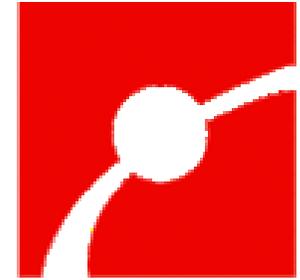
Becki Kipling – Museum of Science, Boston (MOS)

Beth Malandain – MOS

Sarah May – MOS

Alana Parkes – MOS

Gabbie Schlichtmann – EdTogether



**Museum of Science.**



# Why Emotion?

# Why Emotion?

“without emotion, all decisions and outcomes are equal – people would have no preferences, no interests, no motivation, no morality, and no sense of creativity, beauty, or purpose... Emotions are, in essence, the rudder that steers thinking”

(Immordino-Yang, 2015, pp. 27-28)

What is emotion?



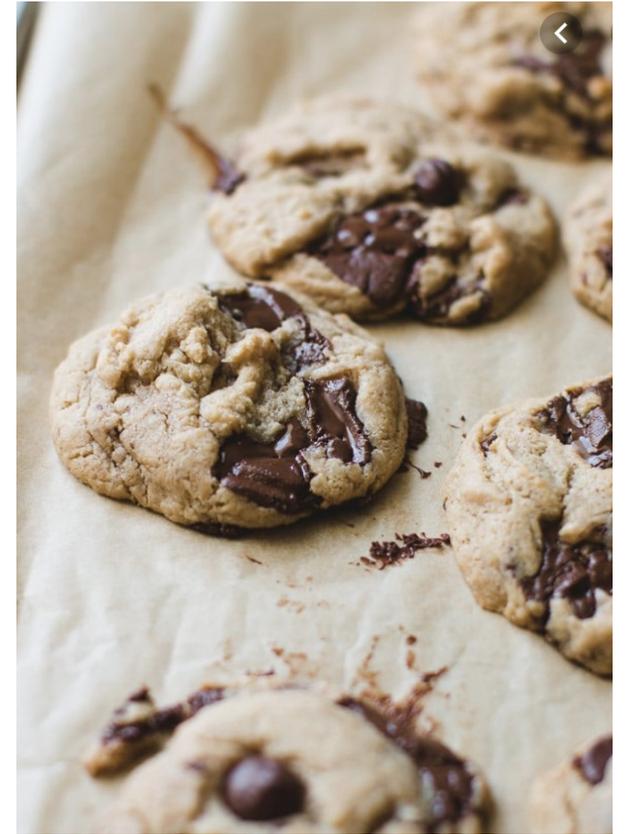
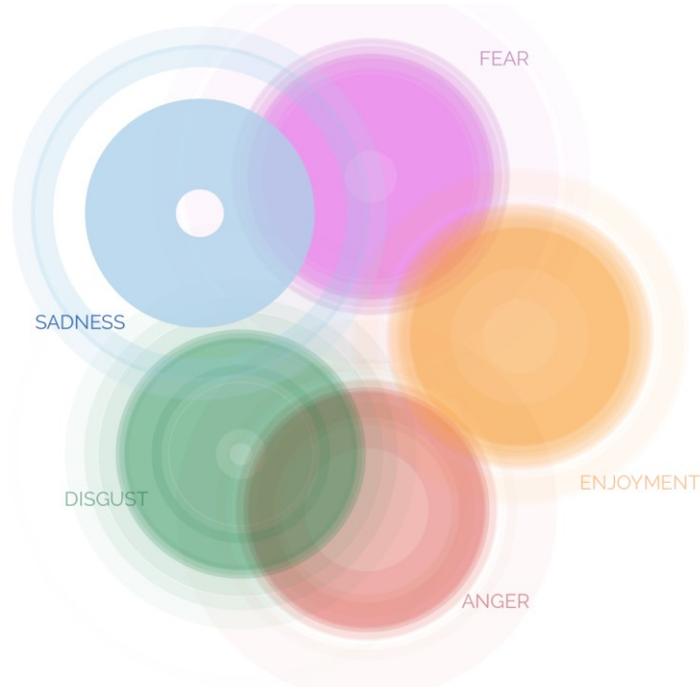


## **Anatomy of a Scene**



# Anatomy of a Scene

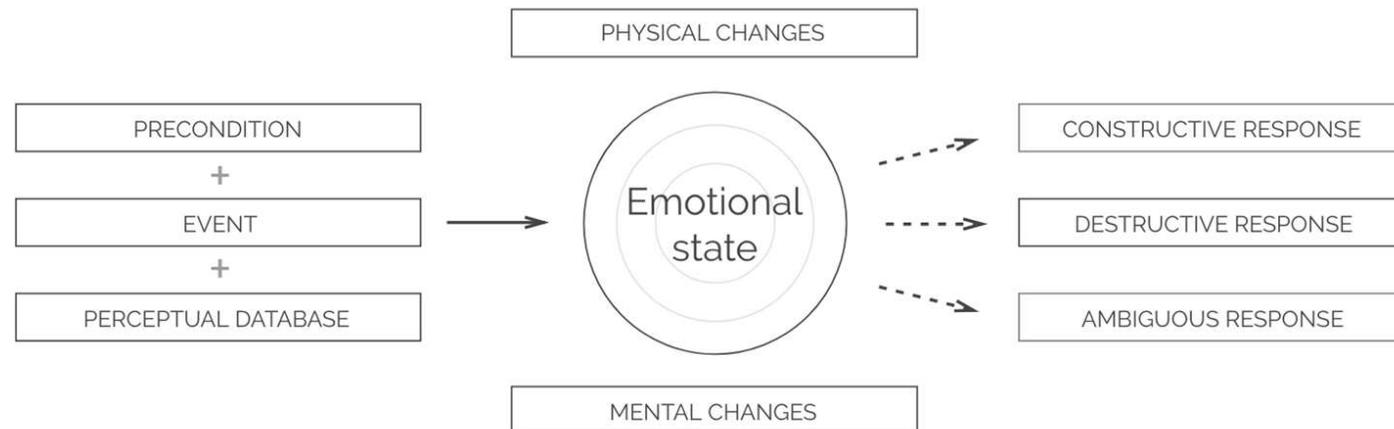
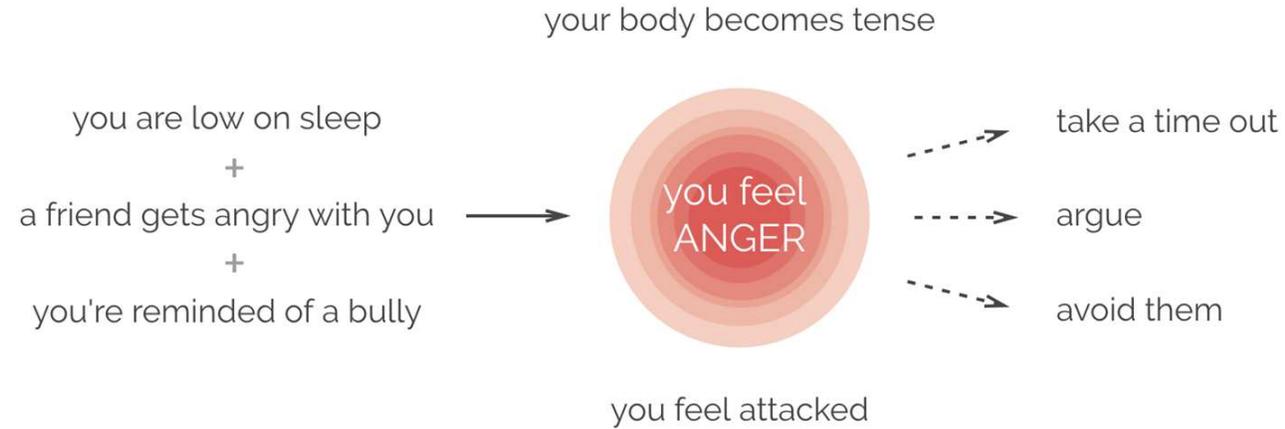
- What happens (**relational content & situational content**)?
- What is the main character(s) assessment or evaluation of the scenario (**appraisal component**)?
- Describe how you think the main character(s) feel (**subjective component**)?
- How does what the character(s) feels connect to what they do/express (**action tendency component**)?
- Describe the relationship between emotion and cognition in this scene?



# The Nature of Emotion

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# Diagnostic Features



# Emotions...

- Continuously experienced emerging from appraisals (evaluations) and interoception
- Socially learned and culturally sensitive
- Shared across human beings with some universal components
- Observable (physiological, facial, body movement and gesture, voice, social signals).
- Experienced consciously and subconsciously
- Mediate our relationship to the world
- Form the basis of other more complex social and emotional phenomenon like empathy, perspective taking, decision making, collaboration, self-regulation and motivation

Break

# Measurement of Emotions



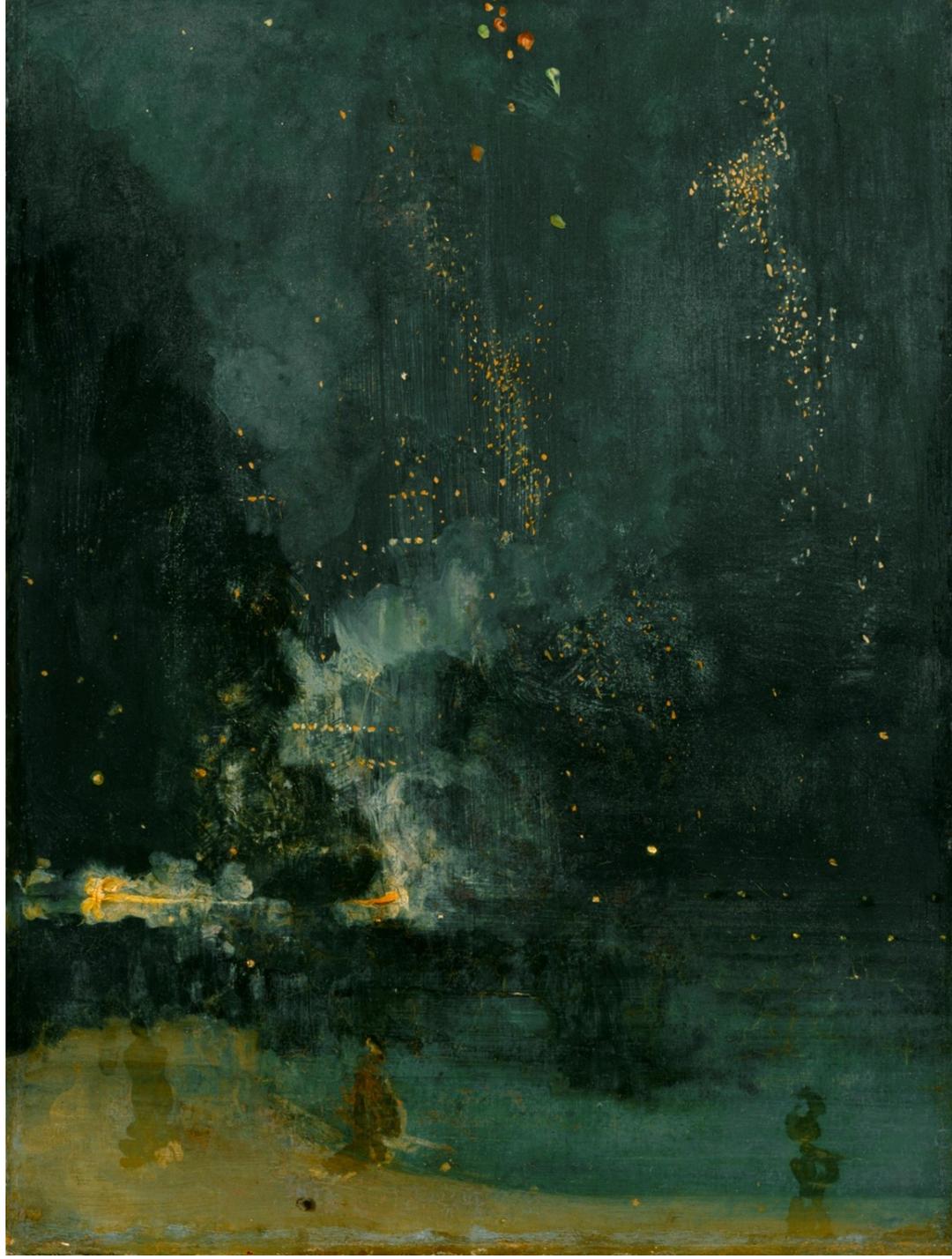
Sarah May shares an experience she had at the Detroit Institute of Arts, feeling inspired but also overwhelmed by the art experience there.

She uses this story to talk about evaluating a museum experience through an emotion lens.

All images retrieved from [dia.org/](http://dia.org/)























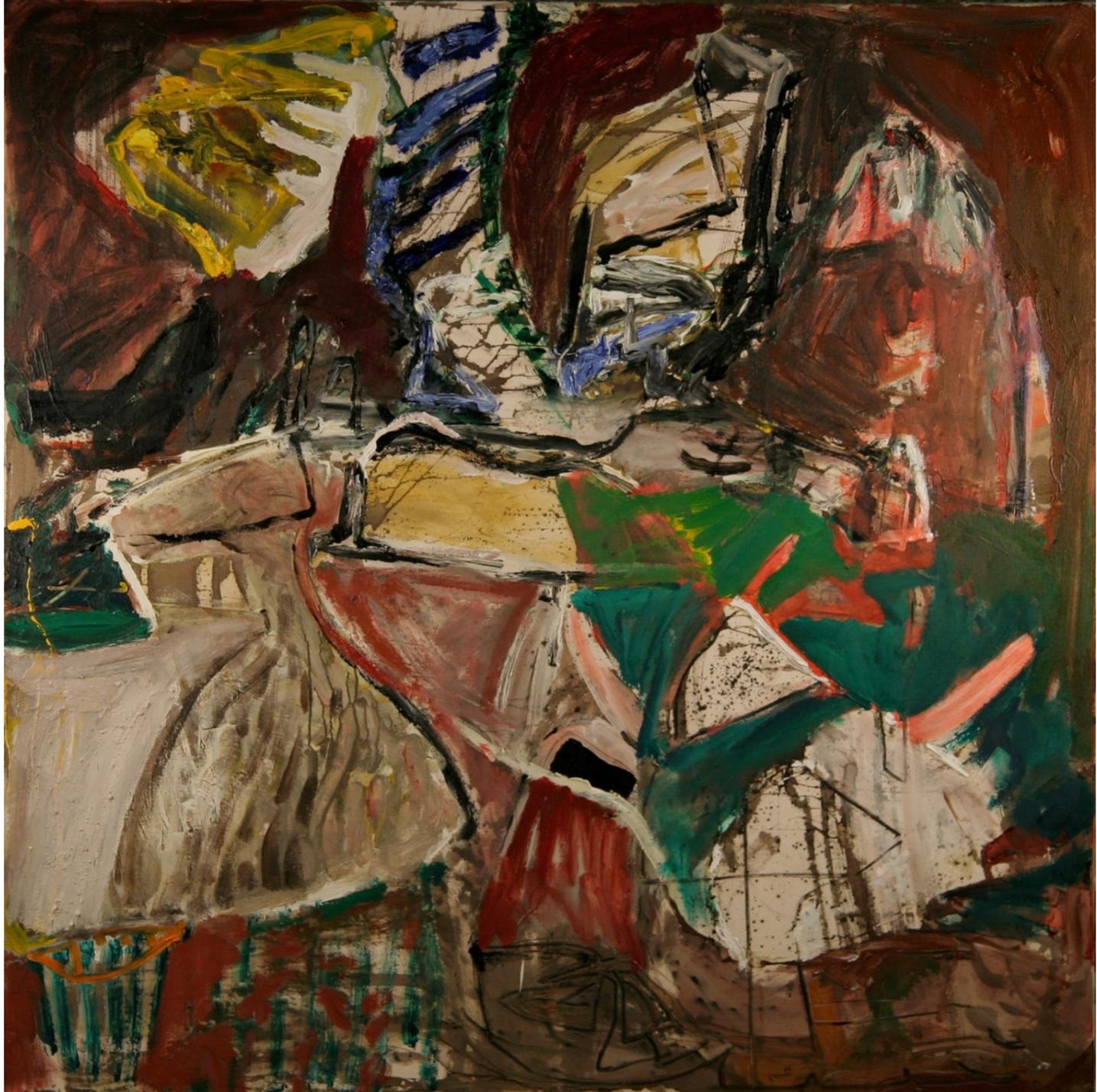




























WILLIAM BURN

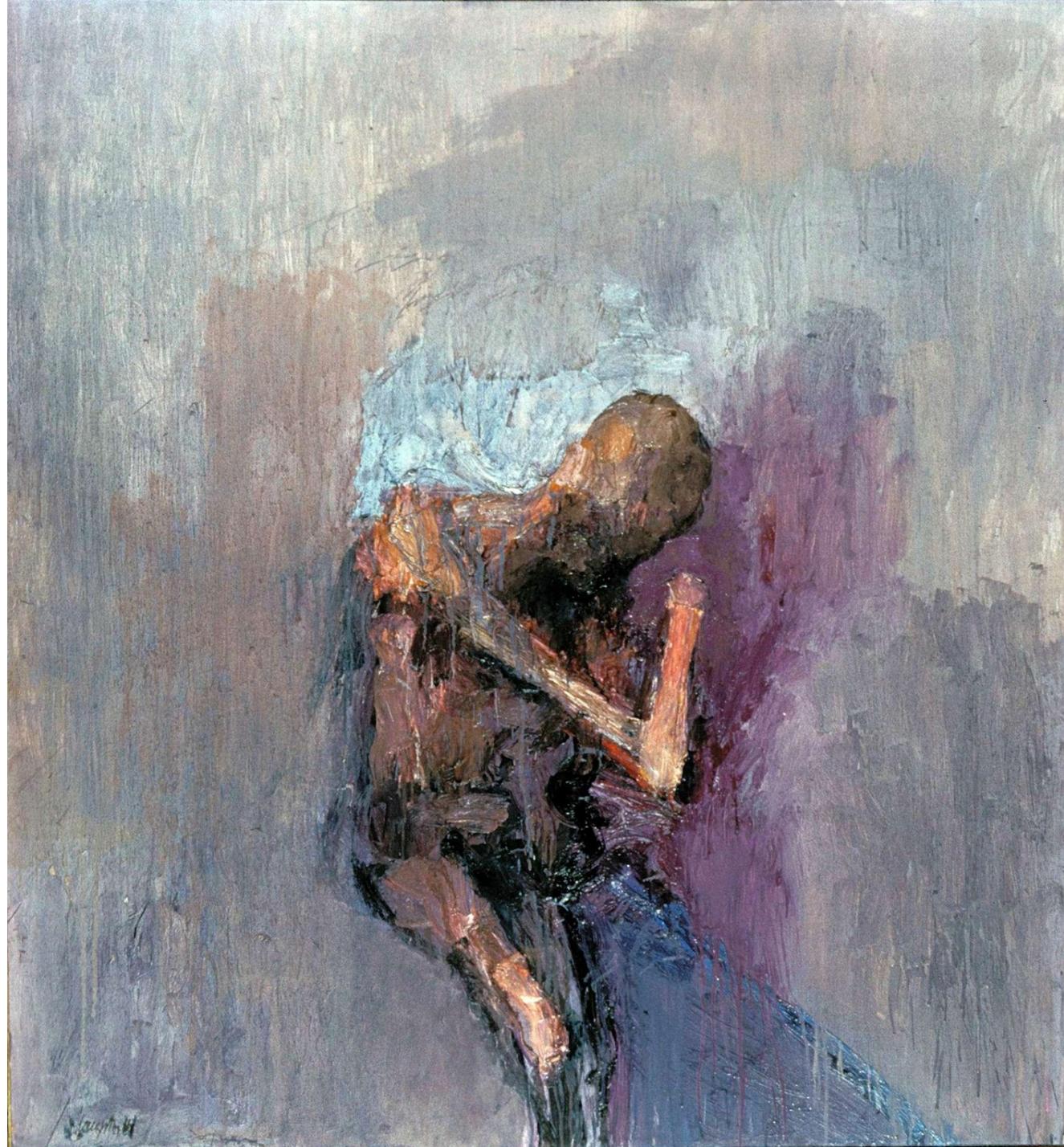


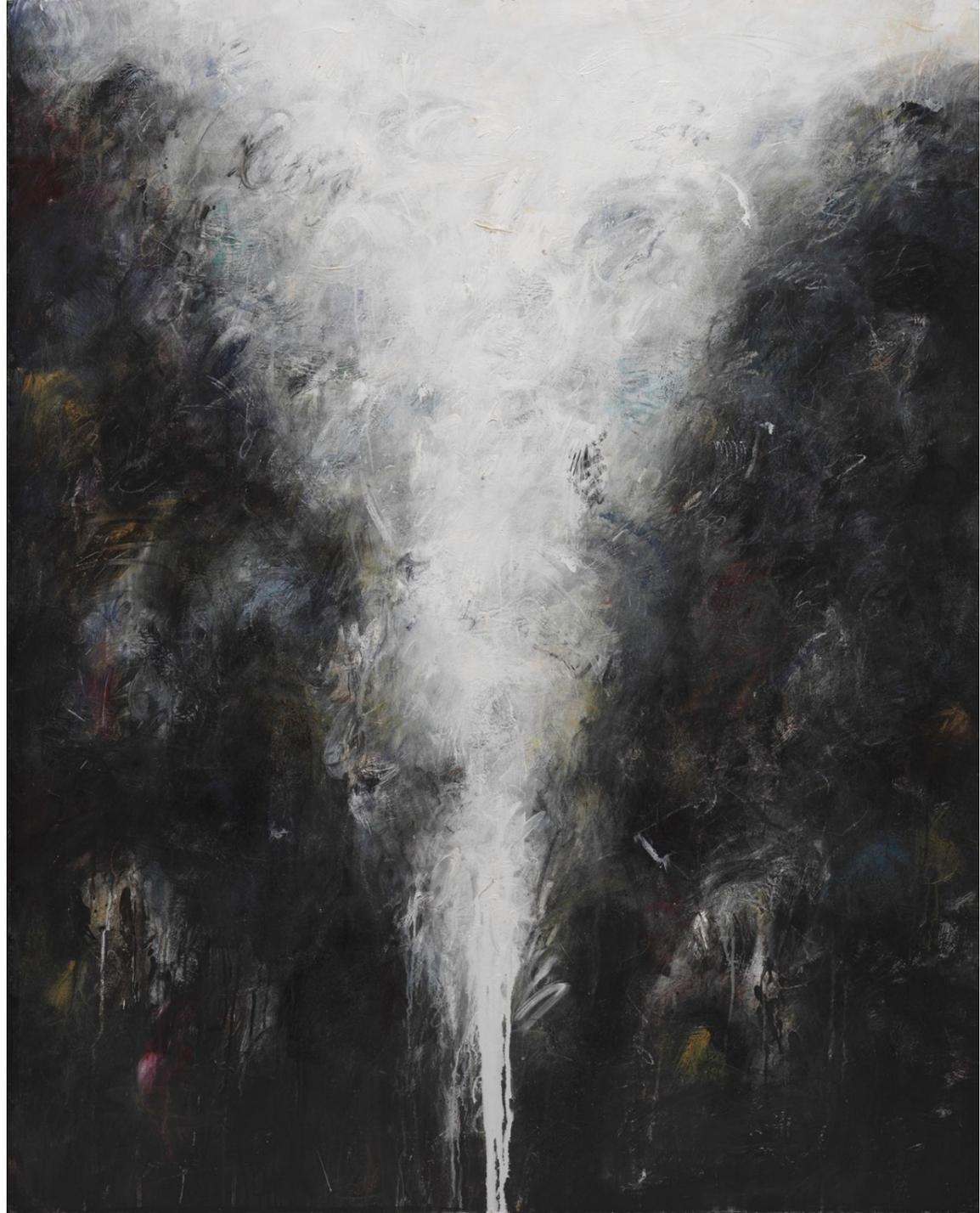






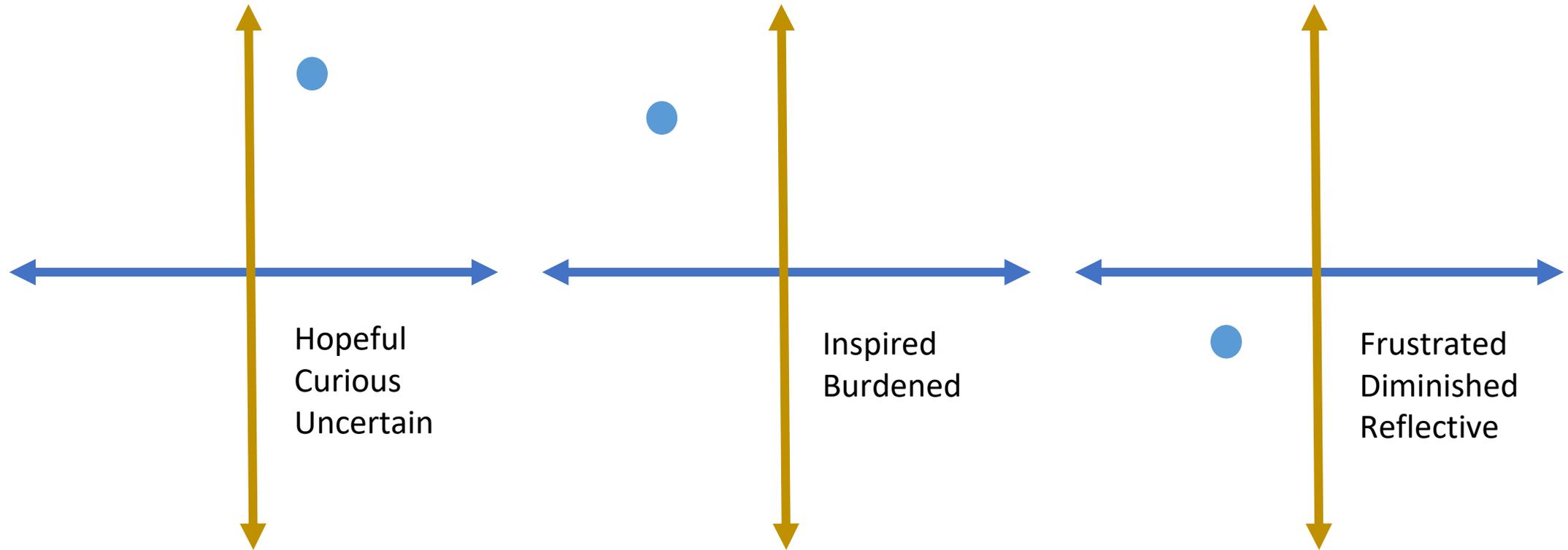






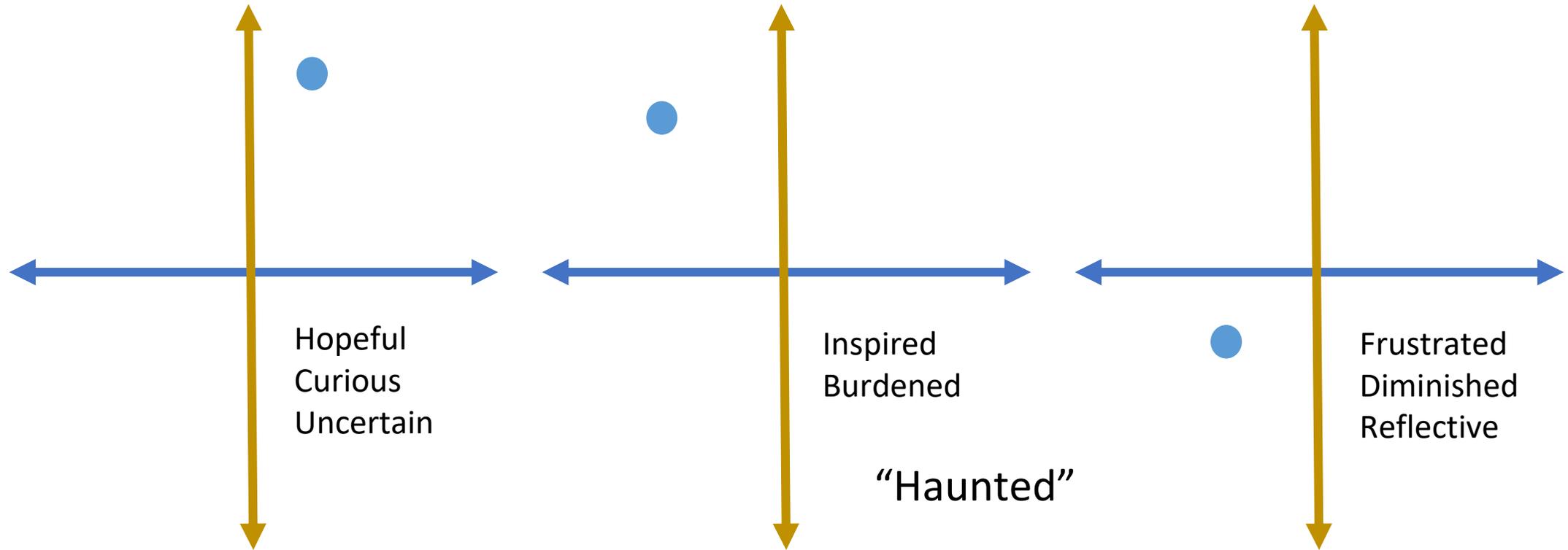
How can we richly and rigorously characterize the emotion experiences of our visitors?

# Characterizing an emotion experience



Overall: Stimulated but overwhelmed

# Characterizing an emotion experience



Overall: Stimulated but overwhelmed

# We can make (some) assumptions based on what we can observe...

## Selected Emotions

happy  
uneasy

## Selected Video Frame



## Selected Camera Frame



# We can make (some) assumptions based on what we can observe...

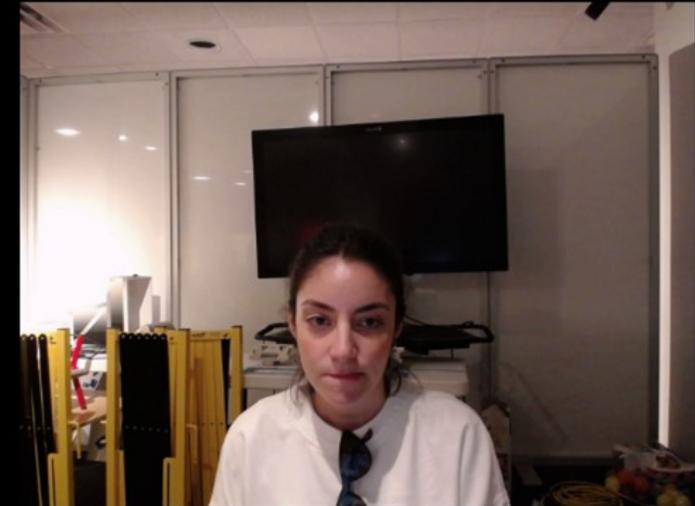
Selected Emotions

surprised

Selected Video Frame



Selected Camera Frame



# We can make (some) assumptions based on what we can observe...



This visitor's facial movements varied depending on if he got an answer wrong:

- **Jaw dropped 40% more** than if he got it right
- **Smiled 10% less**

# We can measure (some) subconscious changes...



Eye movements (attention)

Heart rate



Download from Dreamstime.com  
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Electroencephalograph (Brain waves)

Electrodermal (Sweat!)



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We can relate emotions to events and behaviors...

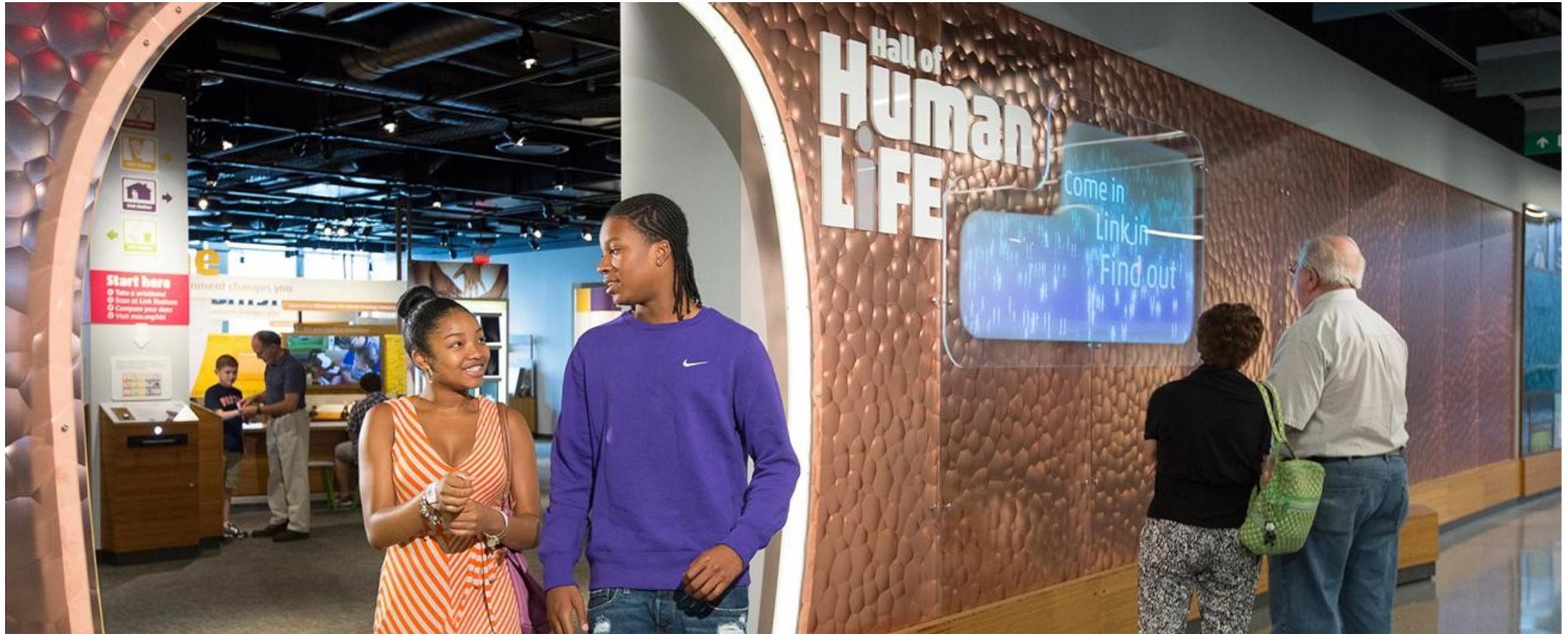
# Epistemic (knowledge construction)



# Achievement



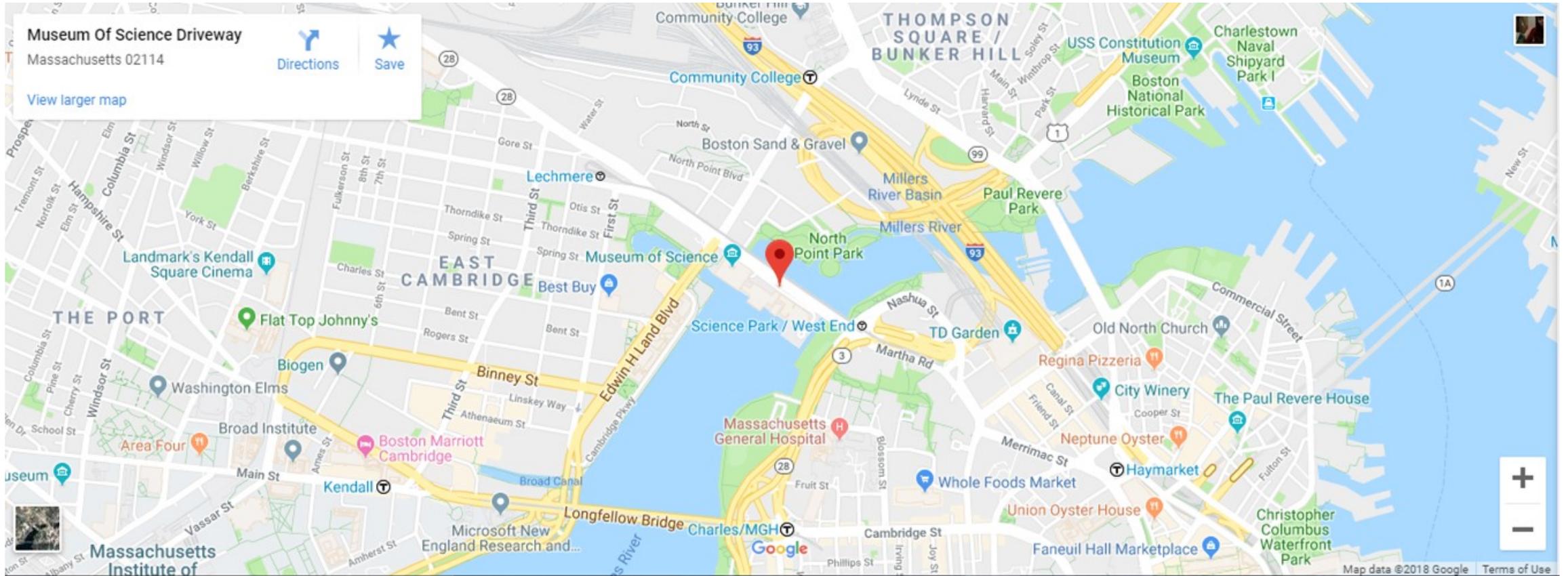
# Social



# Topical – content and experience



# Incidental



# Characterizing an emotion experience

Scaling Shapes!

# Characterizing an emotion experience

Think about your experience with the Scaling Shapes activity.

# Characterizing an emotion experience

Interview your neighbor about their  
experience...

# Characterizing an emotion experience

In-depth data exploration with volunteers...

# Characterizing an emotion experience

Share out:

- What was it like to reflect on your experience through an emotion lens?
- In what ways were the different questions and measures able to capture something important about your experience?
- Where did they miss the mark?
- Did these interview questions prompt any deeper conversations or new insights?

# A final note: Emotion reflection as intervention



**Were there any ideas about emotions that you think the museum was trying to communicate through this activity?**

P1: "I guess it's like, I notice sometimes when I come here that, depending on if you're here for an hour or if you're here a lot longer, you'll start to rush through more things. You sometimes come in to see the things you want to see and the rest of it you're kind of like, look at it and go ... It would be kind of cool actually, if you go through the whole Museum, if we had something to indicate, 'How did you feel at this exhibit? How did you feel walking through the halls?' To show what people are feeling as they go through the museum."

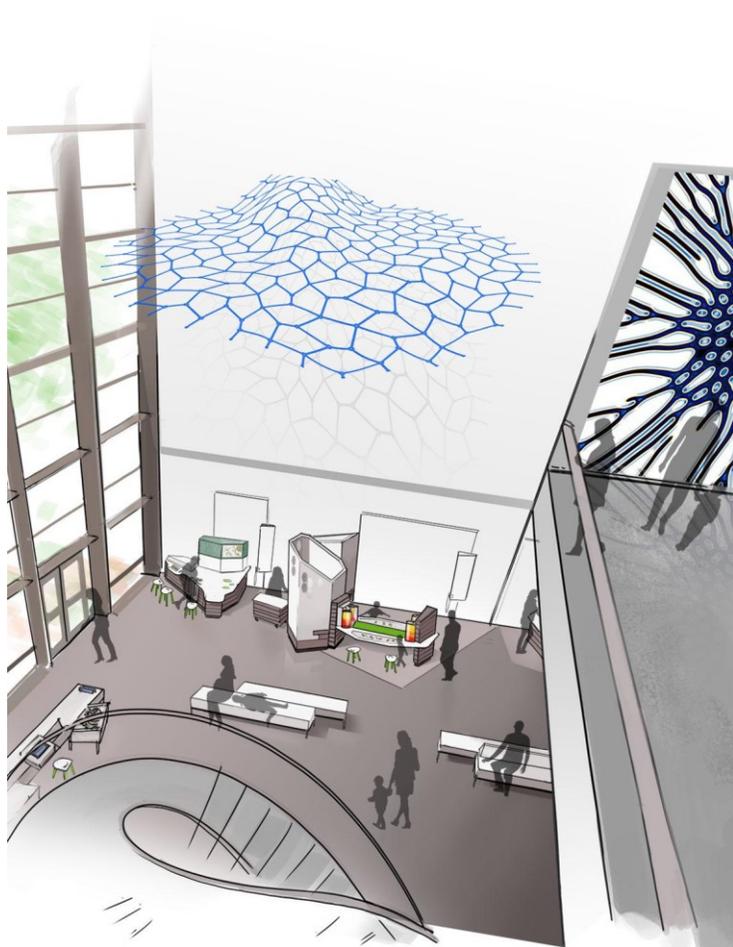
P2: "For me, what I would have thought about after the activity is thinking about stopping more, actually taking in stuff instead of just like rushing through. But also ... like how people use their emotions to express what they're feeling to people in general..."

# Design with Emotion in Mind

# Evolution of Emotion Thinking

**at the Museum of Science, Boston**

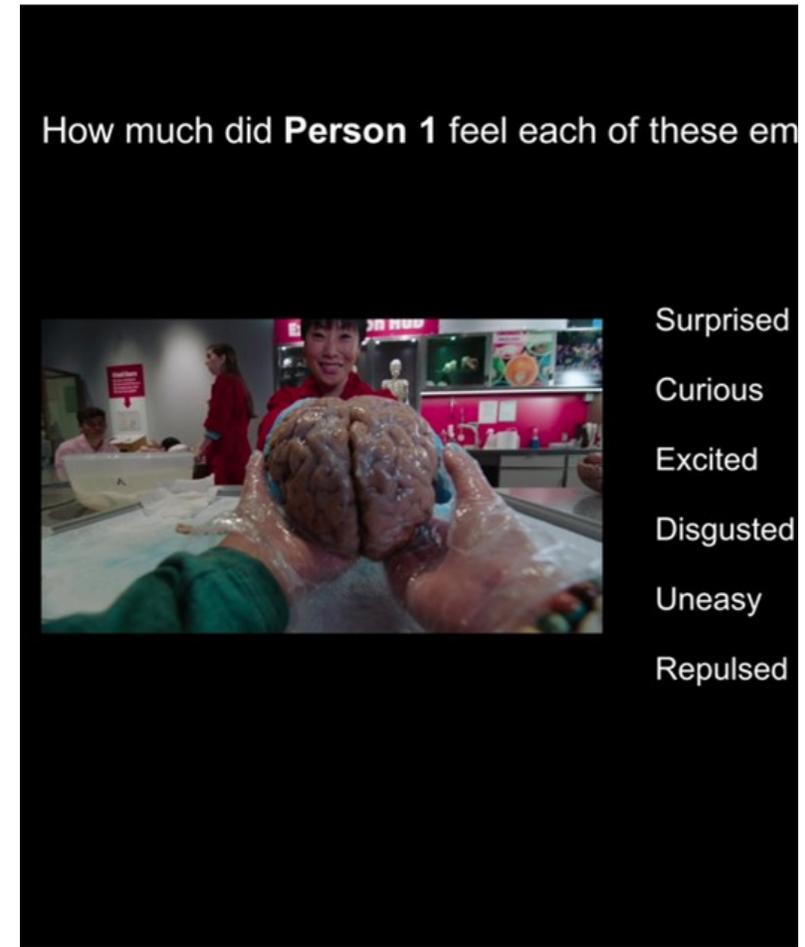
# Designing for Emotion



Gallery



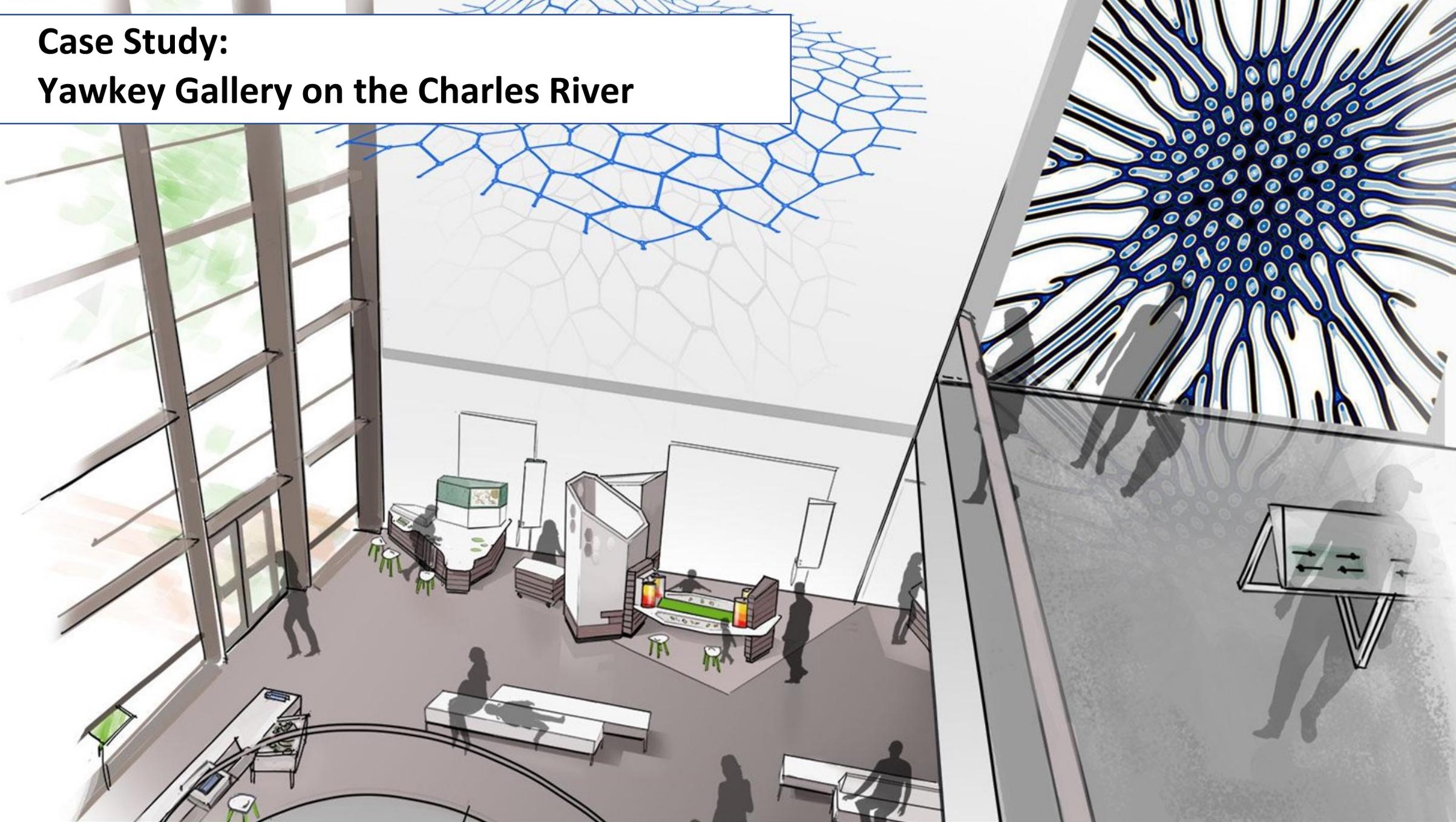
Component



Educator/Program

- Surprised
- Curious
- Excited
- Disgusted
- Uneasy
- Repulsed

# Case Study: Yawkey Gallery on the Charles River



# Yawkey Gallery Goals and Messages

Main message:

***The natural and engineered worlds interact together as one.***

Goals:

- 1. Visitors will **engage in observation activities** to interpret the interactions between the natural and engineered parts of the Charles River.***
- 2. Visitors will **engage in engineering design process activities** and test the impacts of their engineering decisions to solve problems encountered by scientists and engineers in the Charles River.***
- 3. Visitors will **be inspired to think about the connections** between the natural and engineered parts of systems present in their everyday lives.***

## Setting the Scene:

*The natural and engineered worlds interact together as one*



# Reflective Spaces



Serene Art Piece



Observation Benches

# Active Spaces

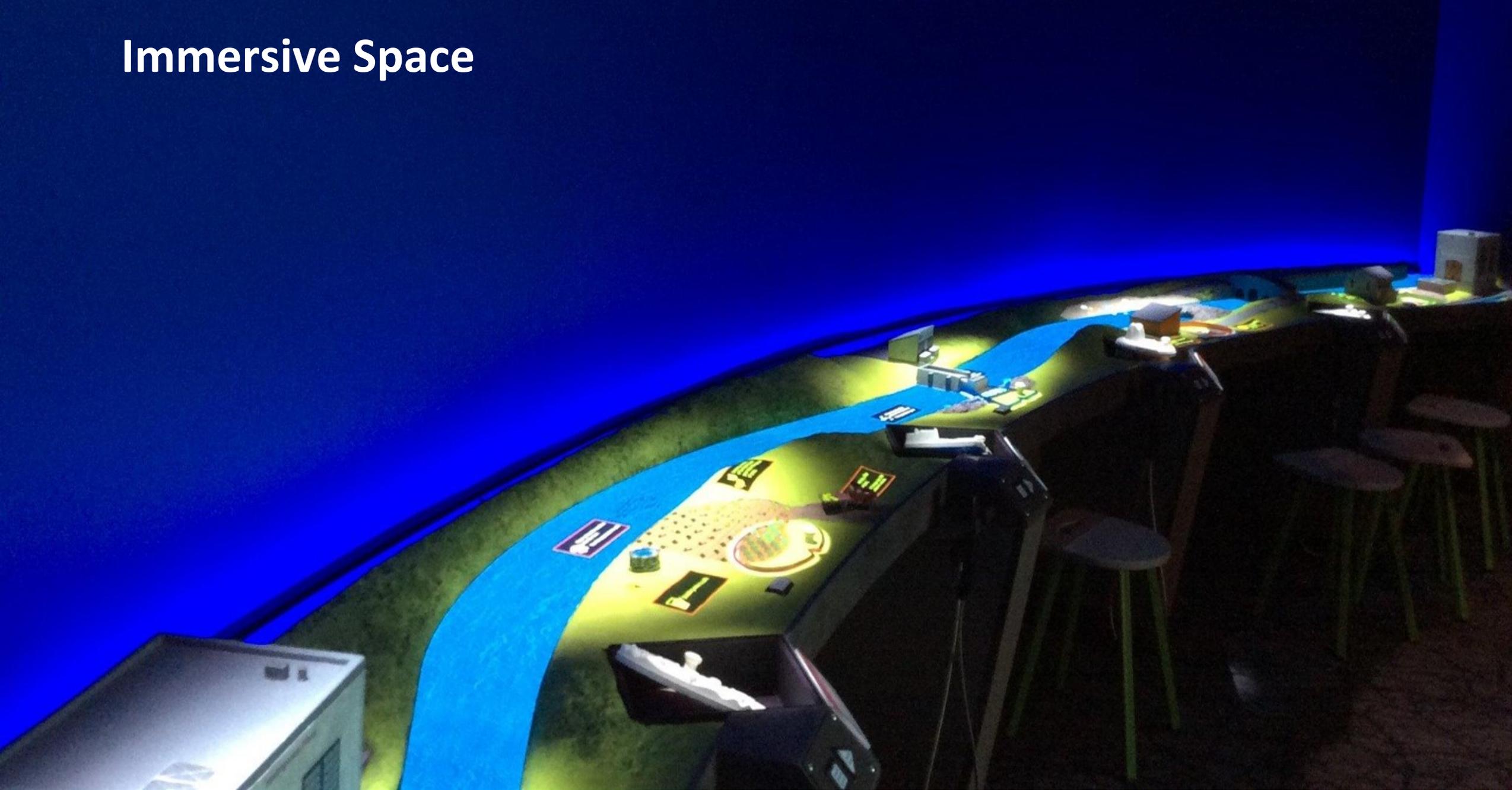


Crawl Through

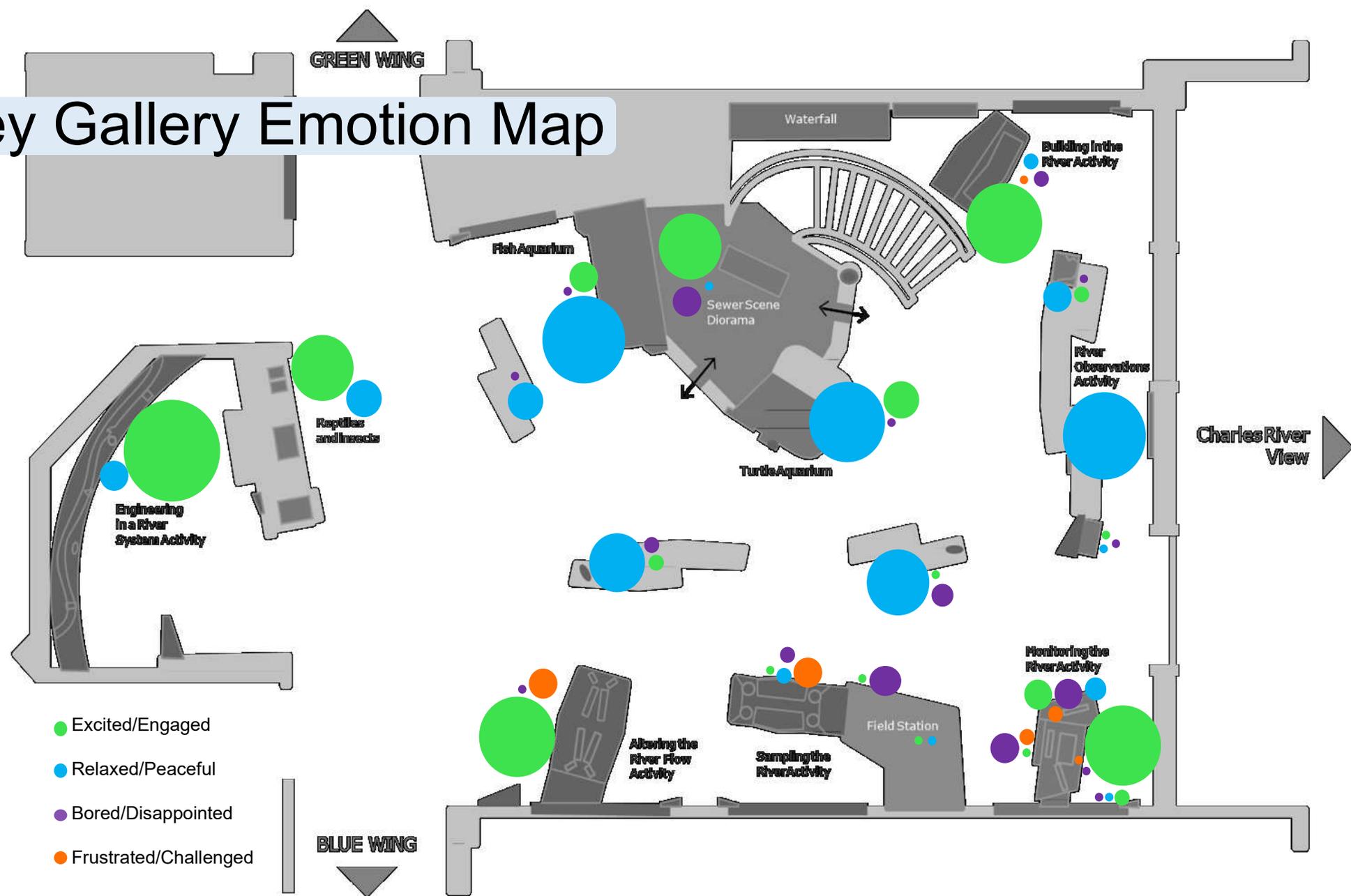


APE (Active Prolonged Engagement) Activities

# Immersive Space



# Yawkey Gallery Emotion Map



# Productive Struggle

An NSF-funded Design-based research project to investigate the emotional state of “productive struggle”

# Productive Struggle

## Project tasks:

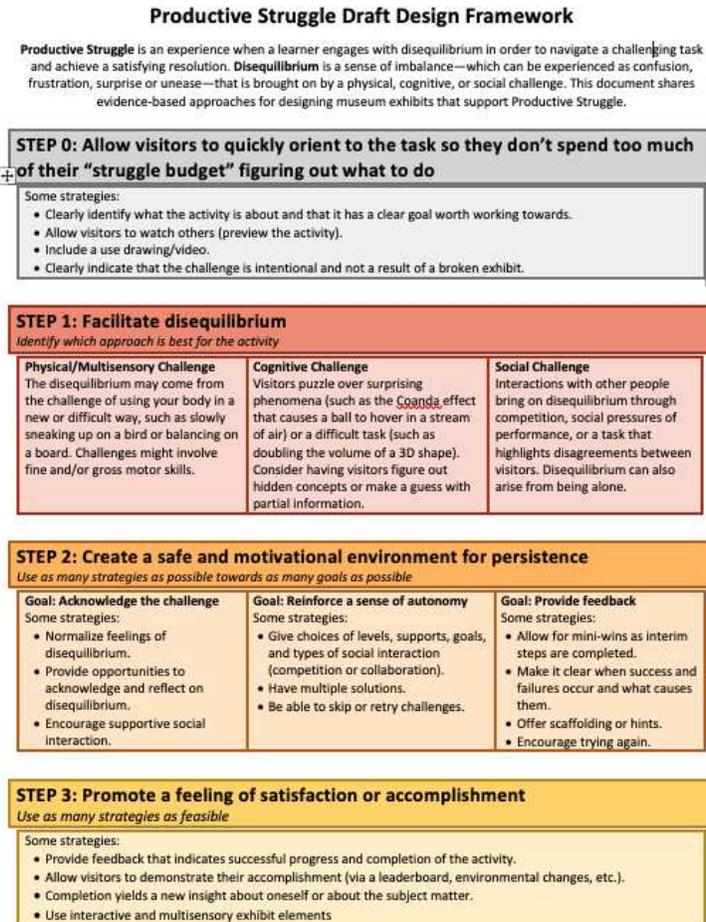
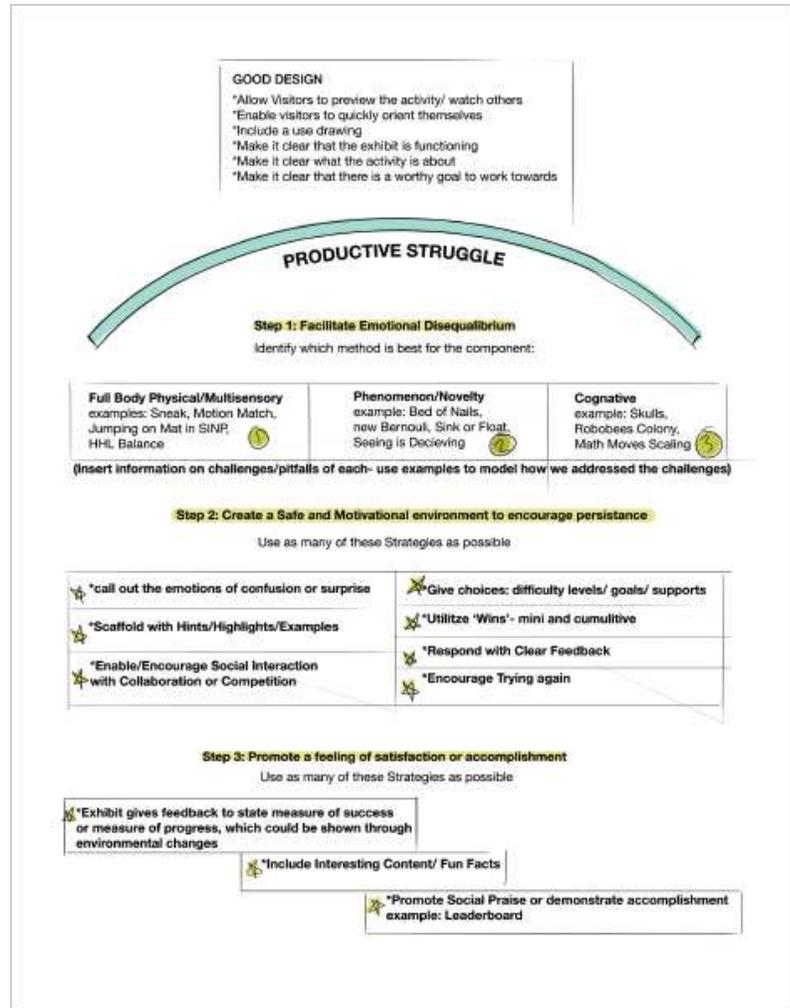
- Develop a theoretical model for productive struggle
- Revise two existing activities and create one new one to support productive struggle
- Develop a set of design guidelines and strategies

# Productive Struggle

## Elements of Productive Struggle:

- High activation
- Self-reported productivity
- Self-reported struggle
- Progress towards a goal

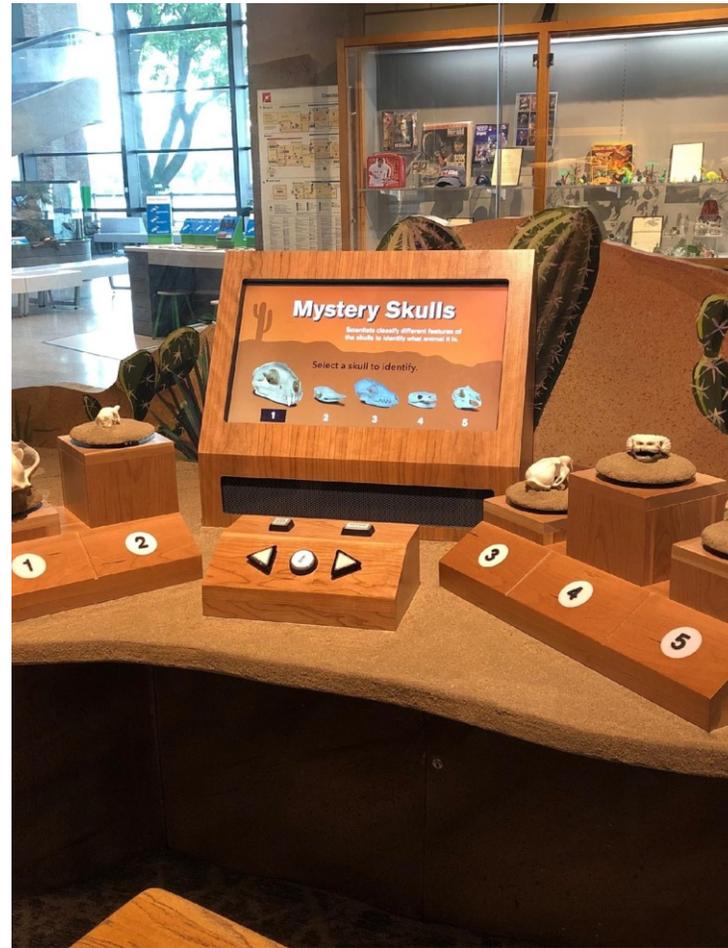
# Working on the design framework



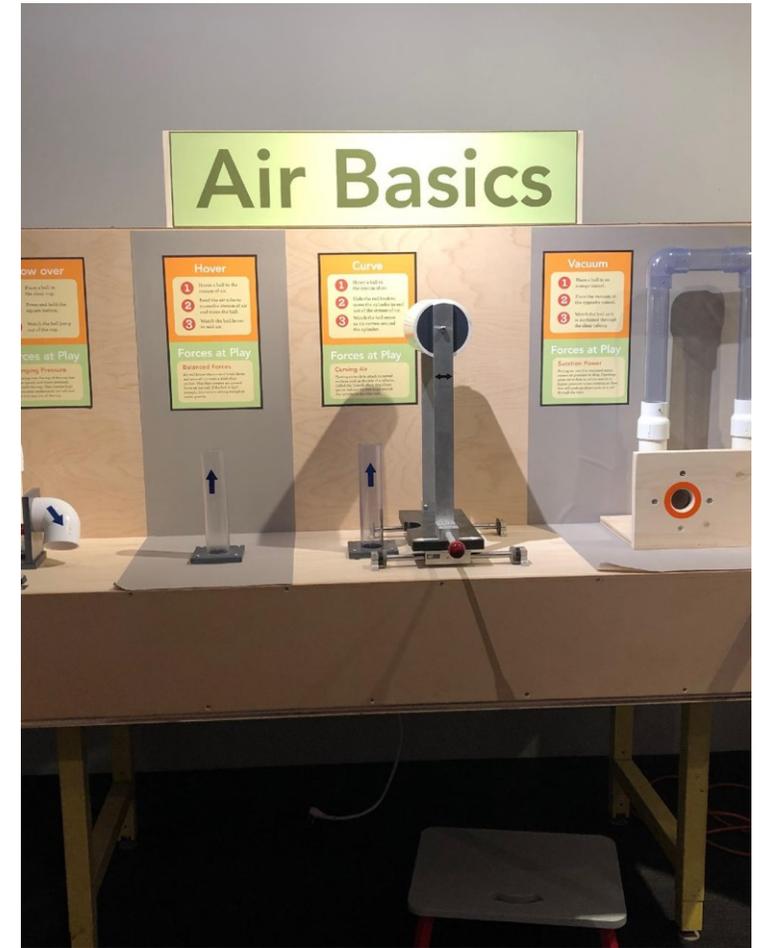
# Exhibits featuring productive struggle



Sneak



Mystery Skulls



Air Prototype

# Emotional Engagement during Live Presentations

What would a museum visit look like if educators could “tune in” to the needs, interests, and engagement levels of each visitor?

What if educators already are, but we just haven't figured out how to see it?





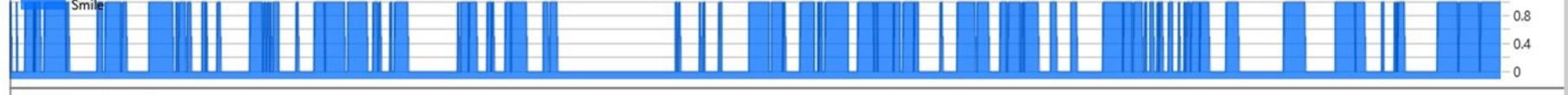
# Affective data collected...



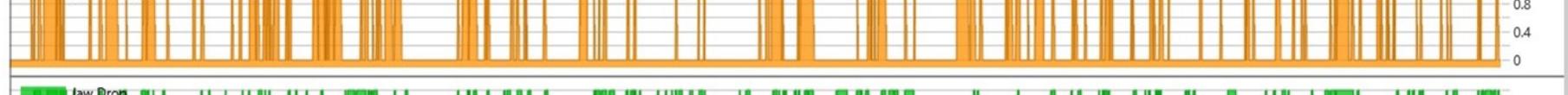
**Brow Raise**



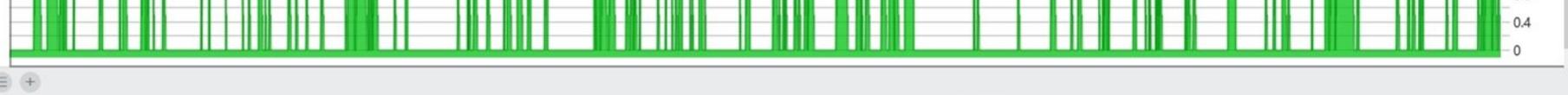
**Smile**



**Inner Brow Raise**



**Jaw Drop**



Stimulus: FaceRecording-1

Exposure time: 21:08

Ed2 P2 Skeleton\_Vis Face

00:00:752 Speed 1x

# Affective data collected...



**Visitor's Arousal**



**Educator's Arousal**



# Affective data collected...

“How in tune did you feel?”

“Tell me about emotions you felt along the way.”

“How do you think the educator played a role in what you were feeling?”

# What did we learn?

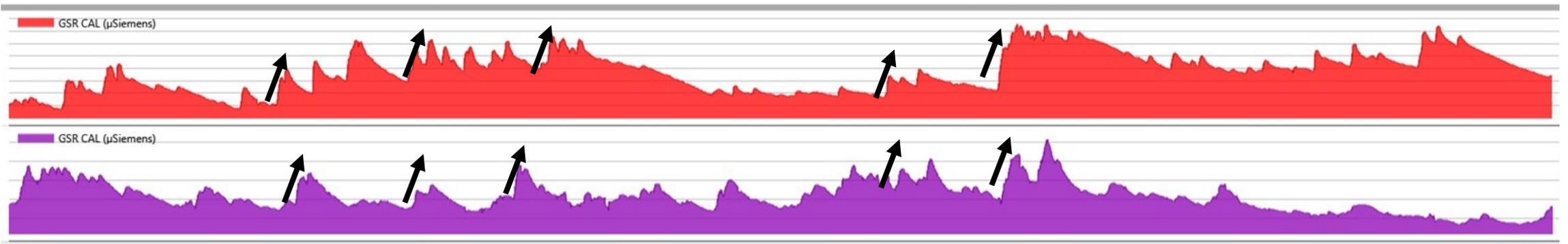
**Visitor:** “I felt very connected... the educator went with what we were going with... the flexible structure helped.”

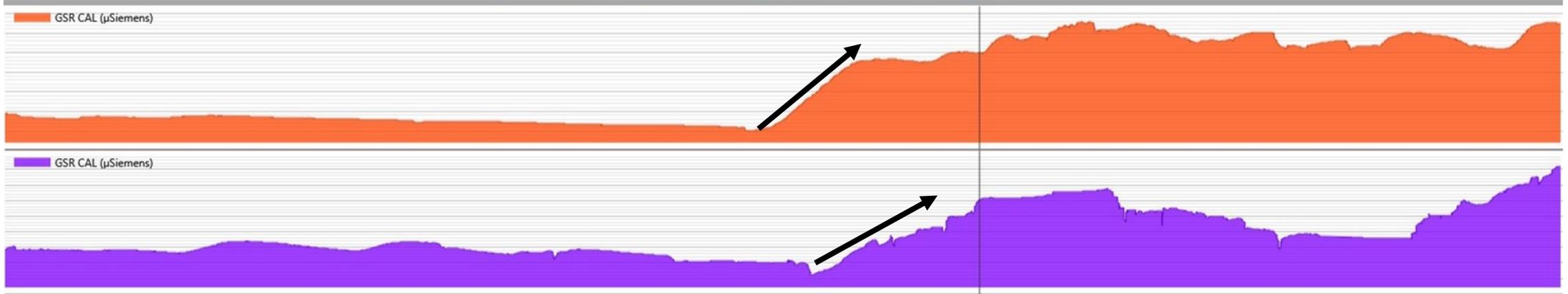
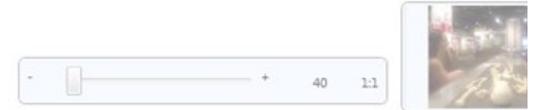
**Educator:** “It was one of my best programs... the visitor had a goal in mind, they were curious, and were very excited.”

# What did we learn?

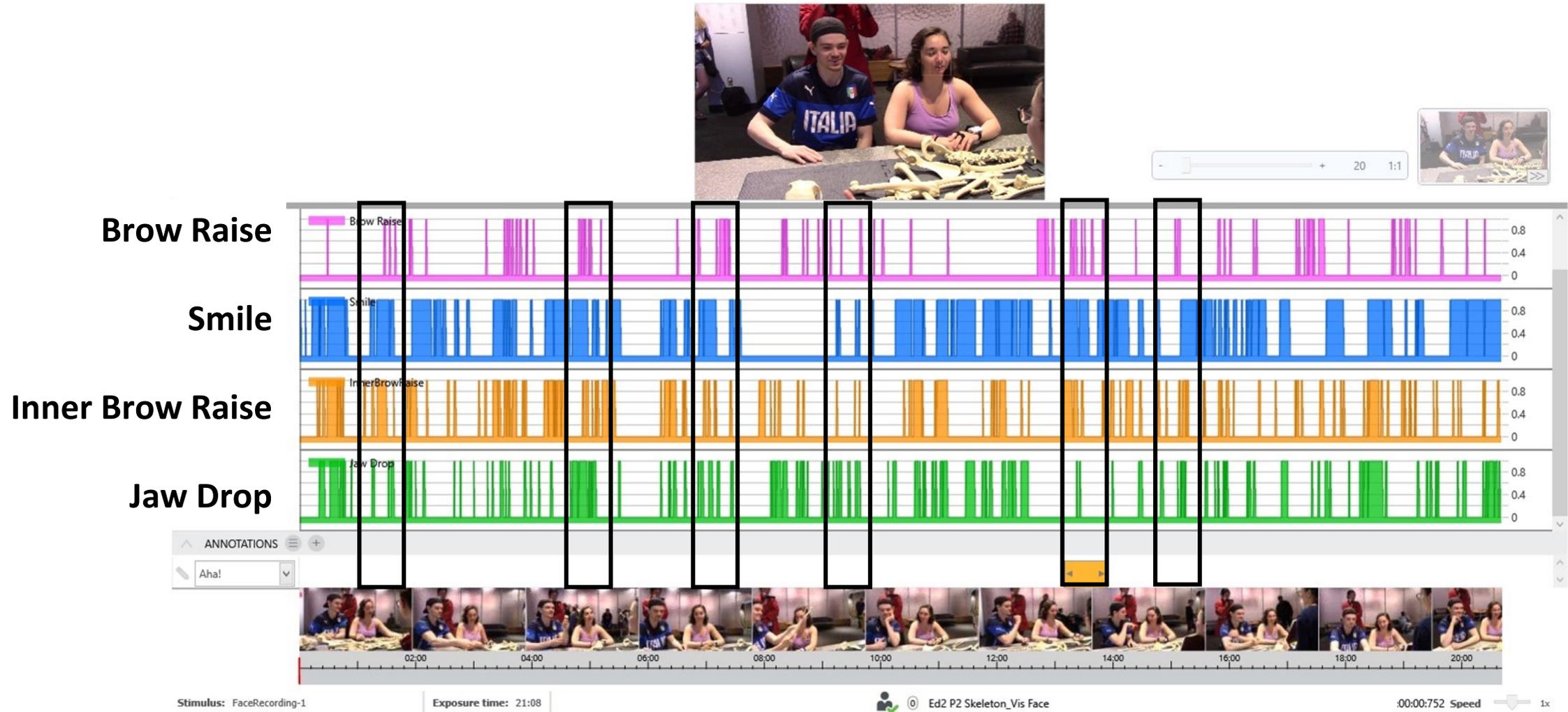
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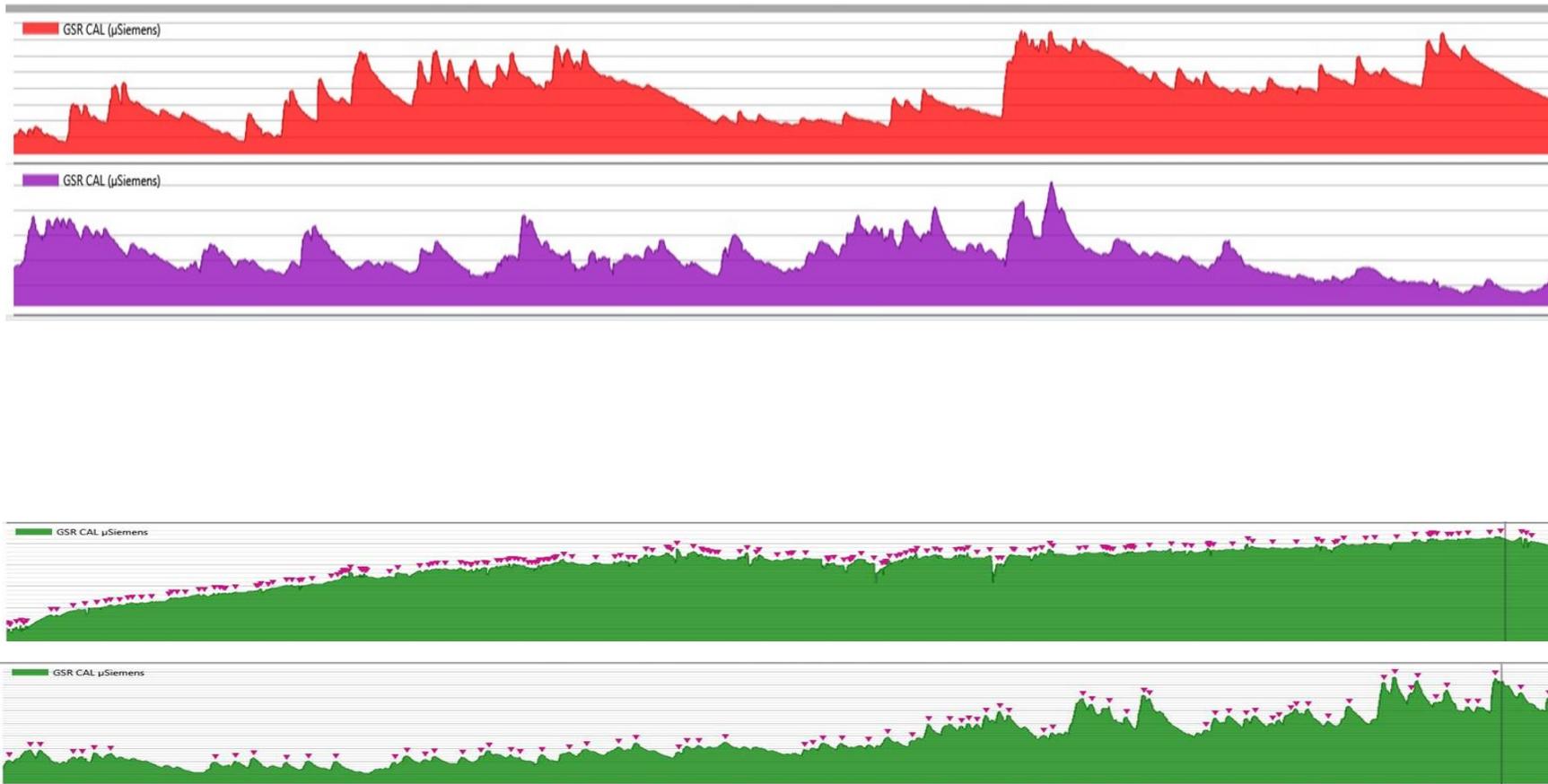




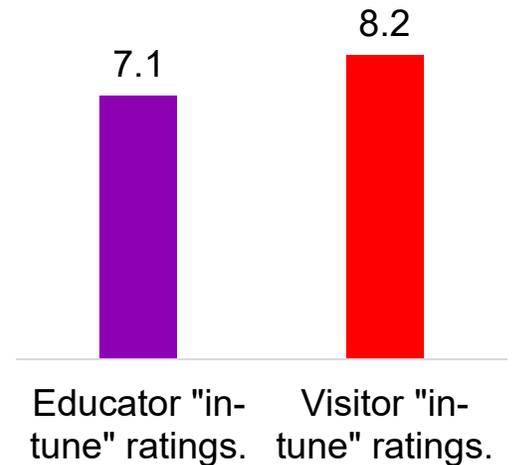
# What else did we learn?



# What else did we learn?



Average ratings of feeling "in tune."  
(n = 14 pairs)



# What else did ~~we~~ the educator learn?

“I do think seeing this data helps me confirm that I have a good read on how things are going, ... and I can be harsh on myself ... but that overall people tend to have a really positive experience ... And that the emotions do play off of each other. That’s something I thought of, but looking at the plots and sequences it’s more obvious than I would have thought.”

“This is more information than I’d get from a typical interaction... It confirms what I was thinking, but gives more context, like [another visitor said] ‘I was a bit confused’ ... but I thought he was just bored. ... Maybe I could stop and ask more questions. ... **What are ways I can be supportive?**”

# Design Challenge: Bees



# Bees Topics

1. Bees: Bio-inspired design
  - Possible topics: robotic bees for surveillance, robotic bees for pollination, honeycomb structure strength
2. Bees: Indicators of environmental health
  - Possible topics: Colony collapse disorder, bee's role in ecosystems, pesticide interactions
3. Bee-human interfaces
  - Possible topics: bee sting allergies, arthritis treatments, benefits of local honey
4. Bee society as a model for human politics
  - Possible topics: gender, hierarchy, caste, worker roles



# Acknowledgments

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This work would not have been possible without collaboration with the following organizations and technical partners:

iMotions  
Affectiva

We'd also like to acknowledge contributions to this work from colleagues who could not present with us today, but whose input was valuable to our planning for this workshop:

Liz Kong  
Katie Todd



:) Affectiva



# Emotion 101

## Glossary of Terms

### Emotion

biological and psychological processes that result in the experience of feeling, with impacts on thought and behavior

### Core Affect

The basic sense of how your body feels that can be described by valence and arousal. It is distinct from emotion which is a complex mental construction.

### Valence

The sense of how positive or negative a feeling is, from unpleasant to pleasant.

### Activation/ Arousal

The amount of energy associated with a feeling. For example, heightened physiological activity might be described as agitation, lower activity as calm.

### Gestalt

A sense of how you feel taken a whole.

### Productive Struggle

An experience when a learner engages with disequilibrium in order to navigate a challenging task and achieve a satisfying resolution.

### Disequilibrium

A sense of imbalance, which can be experienced as confusion, frustration, surprise, or unease.

Emotions...	So we can characterize emotions by...	"Cheat Sheet" Notes:	e.g.
<b>(A)</b> ...are continuously experienced	<p>...asking people how they feel at different points <b>during</b> an experience.</p> <p>...asking people how they felt at different points in an experience <b>afterward</b> (preferably soon after).</p> <p>...asking people how they felt about an experience as an <b>overall assessment</b> (gestalt experience).</p>		[1, 2, 3, 4]
<b>(B)</b> ...emerging from appraisals (evaluations) and interoception (bodily feelings)	<p>...asking people how <b>good or bad</b> they feel.</p> <p>...asking people how <b>excited or calm</b> they feel.</p>		[5, 6, 7, 8]
<b>(C)</b> ...are socially learned and culturally sensitive	<p>...letting people <b>use their own language</b> and words to describe how they feel.</p>		[9, 10]
<b>(D)</b> ...are shared across human beings with some universal components	<p>...asking people to <b>use predetermined labels</b> to describe how they feel.</p> <p>...making <u>some</u> assumptions about how to <b>categorize different emotion experiences into common buckets.</b></p>		[11, 12]
<b>(E)</b> ...are observable (physiological, facial, body movement and gesture, voice)	<p>...observing <b>behavior and social signals.</b></p> <p>...using technology to <b>automate detection and labeling</b> of <u>some</u> social signals.</p> <p>...making <u>some</u> assumptions about how to <b>categorize emotion experiences based on what we observe.</b></p>		[13, 14, 15, 16]
<b>(F)</b> ...are experienced consciously and subconsciously	<p>...using technology to <b>measure <u>some</u> subconscious physiological changes</b> (brain wave activation, heart rate, electrodermal changes, eye movement).</p>		[17]
<b>(G)</b> ...mediate our relationship to the world	<p>...categorizing how an emotion <b>experiences relates to context or environment</b> (epistemic, achievement, topical, social, incidental).</p>		[18, 19]
<b>(H)</b> ...form the basis of other more complex social and emotional phenomena	<p>...<b>connecting them with other processes</b>, such as decision-making, perspective-taking, empathy, motivation, self-regulation, collaboration, etc.</p>		[20]

## Emotion Measurement Reference Starter Pack

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## Characterizing an Emotion Experience – Data Collection Protocol

I'm interested in learning about the emotions you felt as you were doing the Scaling Shapes activity. One way to think about emotion is that it has two parts. One part is how much energy you feel, shown on this line [*point to energy scale*], and that can range from low (or calm) to high (or energized). The other part is how negative (or bad) to positive (or good) you feel [*point to valence scale*].

Think about how you felt when you **first started** the Scaling Shapes activity. How would you rate your feelings, from negative (0) to positive (10)? **Response:** \_\_\_\_\_

And how would you rate your feelings, from low energy (0) to high energy (10)? **Response:** \_\_\_\_\_

Another way to describe emotions is through labels. These could include simple emotion words like happy or angry, more complex words like confused or reflective, or words that describe your feelings that might not be considered stereotypical emotion words, like when you have a sinking feeling in your stomach. Think about the emotions you felt **throughout the experience**. Use these stickers to outline the emotions you felt over time, or write-in your own:

First I felt...

Throughout I felt...

Finally I felt...



Now think about how you felt **at the end** of the experience, how would you rate your feelings, from negative (0) to positive (10)? **Response:** \_\_\_\_\_

And how would you rate your feelings, from low energy (0) to high energy (10)? **Response:** \_\_\_\_\_

[Look at the words your partner used to describe how they felt at the **BEGINNING** and the **END**, and use them to fill in the blanks]: You said you felt emotions like [**BEGINNING words**] at the beginning of the activity, and emotions like [**END words**] at the end. What do you think played a role in that [**shift / stability**] in your feelings over time?

Finally, which of the following statements best represents your experience at this activity overall?

- It felt **easy**, and it was **boring** to keep trying.
- It felt **easy**, but it was **satisfying** to keep trying.
- It felt **challenging**, but it was **satisfying** to keep trying.
- It felt **challenging**, and it was **frustrating** to keep trying.

**Characterizing an Emotion Experience – Annotated Connections to “Measures Cheat Sheet”**

I'm interested in learning about the emotions you felt as you were doing the Scaling Shapes activity. One way to think about emotion is that it has a **core affect**, a combination of appraisals and descriptions of bodily feelings, shown on this line [point to energy scale], and that can range from negative (or bad) to positive (or good) (energized). The other part is how you felt when you were doing the activity. How would you rate your feelings, from negative (0) to positive (10)? Response: \_\_\_\_\_

**(B)** These questions gauge “core affect,” a combination of appraisals and descriptions of bodily feelings.

And how would you rate your feelings, from low energy (0) to high energy (10)? Response: \_\_\_\_\_

Another way to describe emotions is through labels. These could include simple emotion words like happy or angry, more complex words like confused or reflective, or words that describe your feelings that might not be considered stereotypical emotion words, like when you have a sinking feeling in your stomach. Think about the emotions you felt throughout the activity, and the emotions you felt over time, or write-in your own:

First I felt...



**(A)** This portion captures the temporal nature of emotions.  
**(C & D)** It also provides a common language to efficiently communicate emotion feelings, while leaving the option for personal descriptions.

Finally I felt...



Now think about how you felt at the end of the experience, how would you rate your feelings, from negative (0) to positive (10)? Response: \_\_\_\_\_

And how would you rate your feelings, from low energy (0) to high energy (10)? Response: \_\_\_\_\_

[Look at the words your partner used to describe how they felt at the BEGINNING and the END, and use them to fill in the blanks]: You said you felt emotion during the activity, and emotions like [END words] at the end. What [ ] in your feelings over time?

**(G & H)** This question might capture evidence about what elements in the environment led to certain emotions. It might also capture something about participant’s meaning-making.

Finally, which of the following best describes your overall experience overall?

- It felt easy, and
- It felt easy, but
- It felt challenging
- It felt challenging

**(D & H)** This final question provides a more targeted common language to efficiently communicate emotion feelings, in conjunction with details about whether the activity was motivating.

How would you rate your feelings, from **NEGATIVE (0)** to **POSITIVE (10)**?

0	1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	---	----

**NEGATIVE**

**Neutral**

**POSITIVE**

How would you rate your feelings, from **LOW ENERGY (0)** to **HIGH ENERGY (10)**?

0	1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	---	----

**LOW ENERGY**

**Neutral**

**HIGH ENERGY**

Confused

Conflicted

Enraged

Angry

Sad

Frustrated

Powerless

Defeated

Hostile

Upset

Provoked

Uncertain

Hesitant

Skeptical

Diminished

Proud

Satisfied

Overjoyed

Reflective

Happy

Excited

Energized

Motivated

Empowered

Optimistic

Encouraged

Reassured

Enthusiastic

Challenged

Intrigued

Confused

Conflicted

Enraged

Angry

Sad

Frustrated

Powerless

Defeated

Hostile

Upset

Provoked

Uncertain

Hesitant

Skeptical

Diminished

Proud

Satisfied

Overjoyed

Reflective

Happy

Excited

Energized

Motivated

Empowered

Optimistic

Encouraged

Reassured

Enthusiastic

Challenged

Intrigued

**Enraged**

**Furious**

**Anxious**

**Angry**

**Worried**

**Concerned**

**Repulsed**

**Sad**

**Disappointed**

**Pessimistic**

**Lonely**

**Despondent**

**Hopeless**

**Despairing**

Adapted from  
the Yale...

**Shocked**

**Tense**

**Angry**

**Restless**

**Annoyed**

**Irritated**

**Uneasy**

**Apathetic**

**Bored**

**Discouraged**

**Tired**

**Sullen**

**Disheartened**

**Drained**

...Center for  
Emotional  
Intelligence...

**Exhilarated**

**Surprised**

**Enthusiastic**

**Motivated**

**Happy**

**Pleasant**

**Joyful**

**At ease**

**Satisfied**

**Calm**

**Relaxed**

**Mellow**

**Thoughtful**

**Complacent**

...RULER Mood  
Meter

**Ecstatic**

**Elated**

**Inspired**

**Excited**

**Proud**

**Thrilled**

**Hopeful**

**Fulfilled**

**Touched**

**Grateful**

**Balanced**

**Peaceful**

**Carefree**

**Serene**

[ei.yale.edu/ruler](http://ei.yale.edu/ruler)

Finally I...	...and I felt...
--------------	------------------

Next I...	...and I felt...
-----------	------------------

First I...	...and I felt...
------------	------------------

# Design a museum experience for emotion

What is your big content idea? What is the emotion aspect?

- Exhibition
- Component
- Program

Who is your audience?

What emotions might they come with?

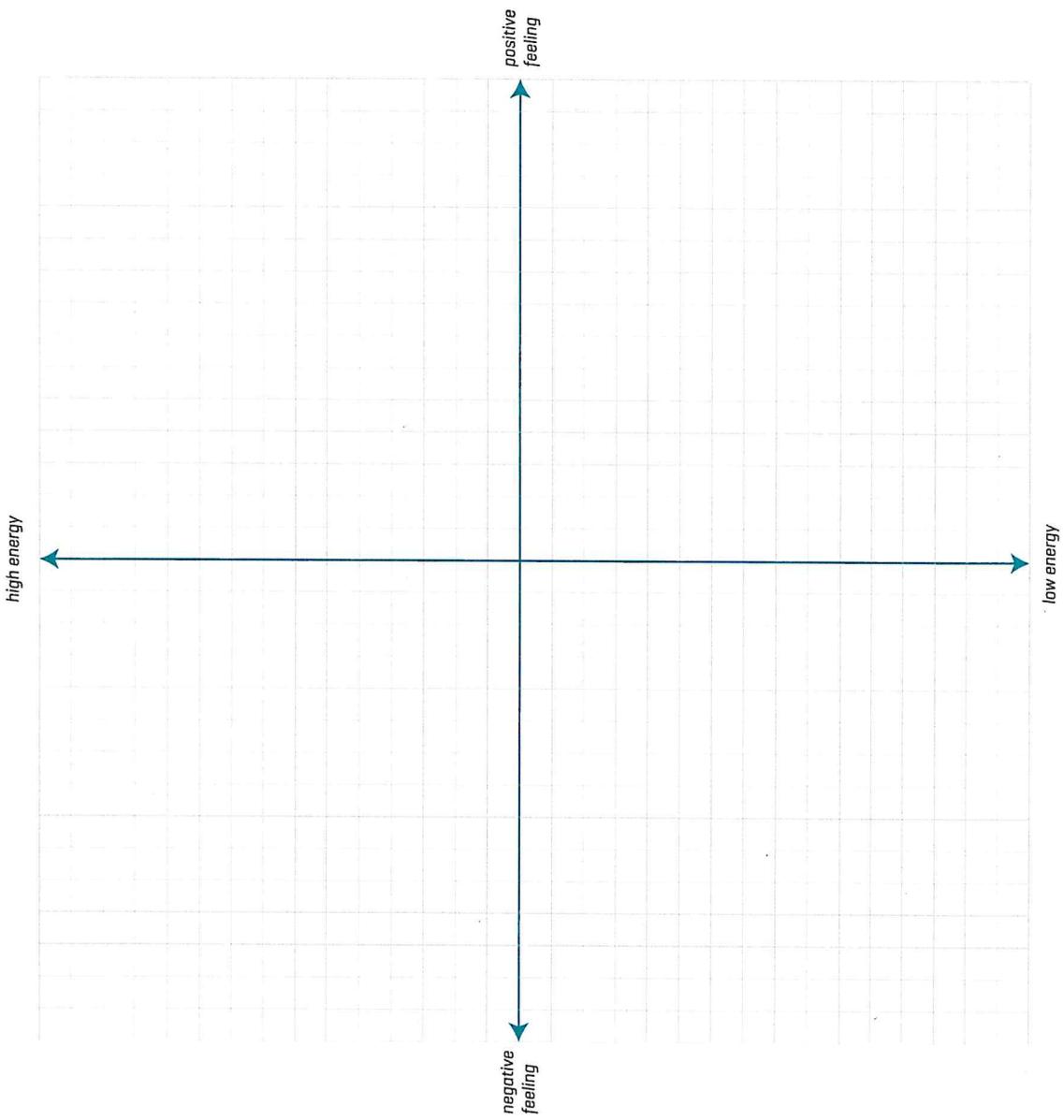
What will visitors do and feel?

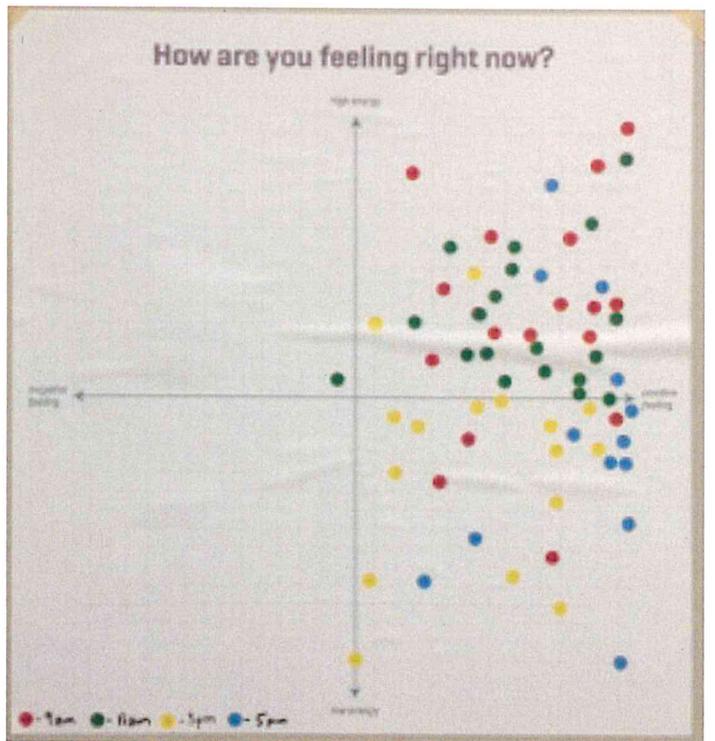
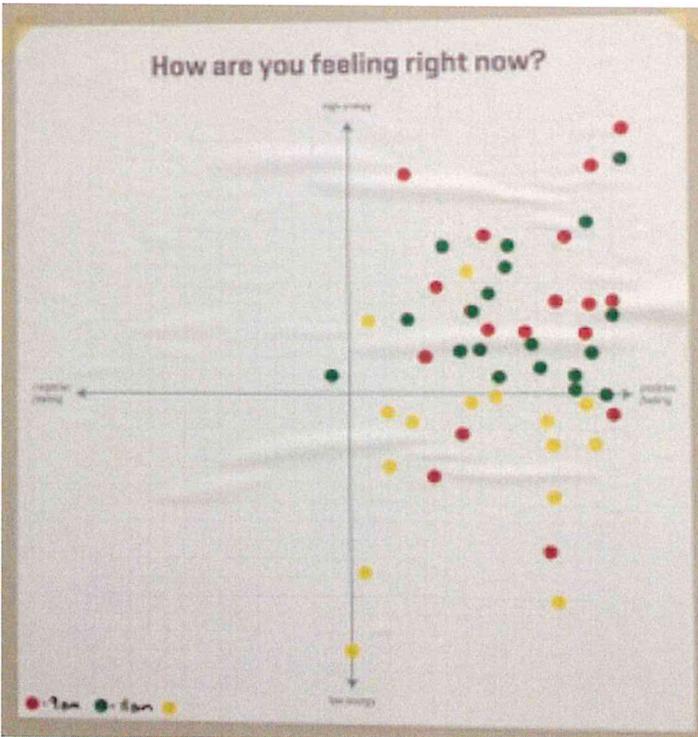
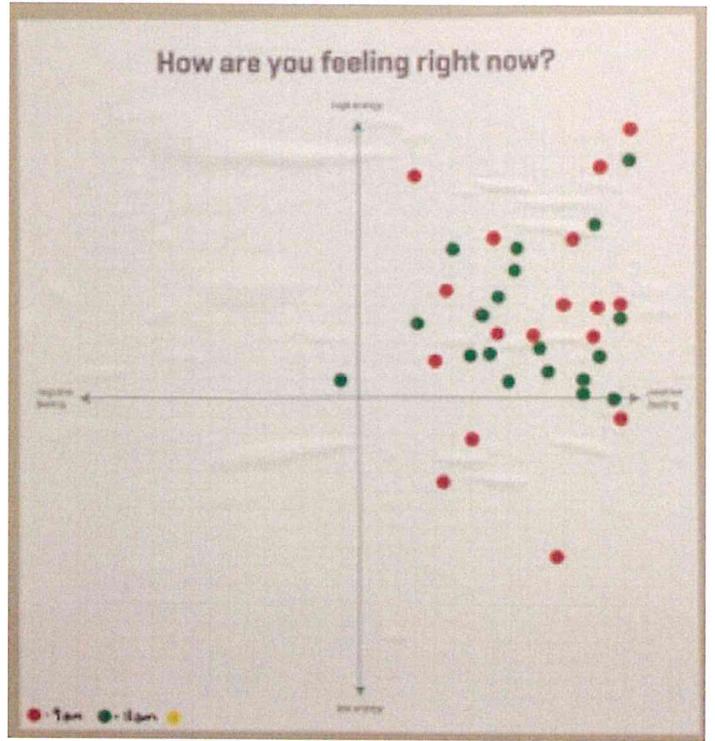
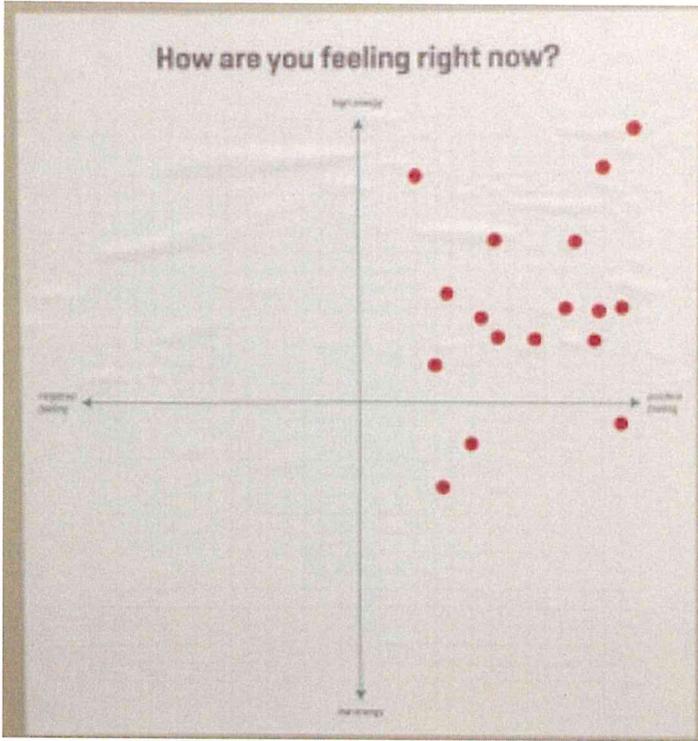
What design strategies support that outcome?

Describe the relationship between the emotion and cognition in this experience.

How might you measure your success?

# How are you feeling right now?

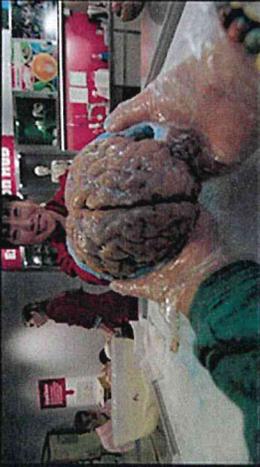




# Emotion Video Prototype

Visitors watch a short video clip chosen to elicit emotion (e.g., a demo with a human brain) while a camera records their face. Afterwards, they identify the emotions they felt and an image of themselves while they were feeling those emotions.

How much did **Person 1** feel each of these emotions at this point in the video?



Very strongly

Not at all

Surprised

Curious

Excited

Disgusted

Uneasy

Repulsed

Continue

Someone asked the subject to watch your face expressed the emotion you felt. How do you think your expressions compare with what you were feeling in the video?

Surprised

Curious

Excited

Disgusted

Uneasy

Repulsed

None at all

Very strongly

Continue

Exit

This frame shows Person 1 watching the video. Pick the frame where Person 1 was feeling **Surprised** and **Curious**.



Continue

This frame shows you watching the video. Pick the frame where you were feeling **Surprised**, **Curious**, and **Excited**.



Continue

How much did you feel each of these emotions at this point in the video?

Very strongly

Not at all

Surprised

Curious

Excited

Disgusted

Uneasy

Repulsed

Continue

# Sneak

Visitors move towards an animated bird without being noticed. If they move too quickly, the bird looks at them and sounds an alarm, which causes a deer hidden in the bushes to run away.



# Mammal Skull Mystery

A computer program walks visitors through the steps of identifying a physical skull by classifying specific traits (teeth, eye orbitals, and rostrum).



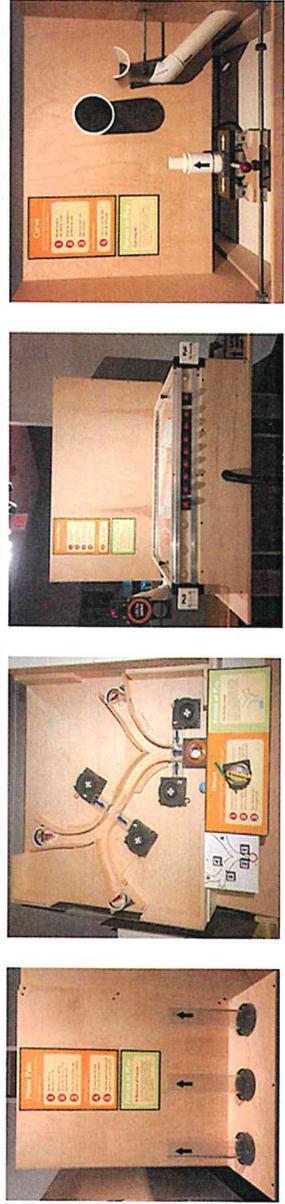
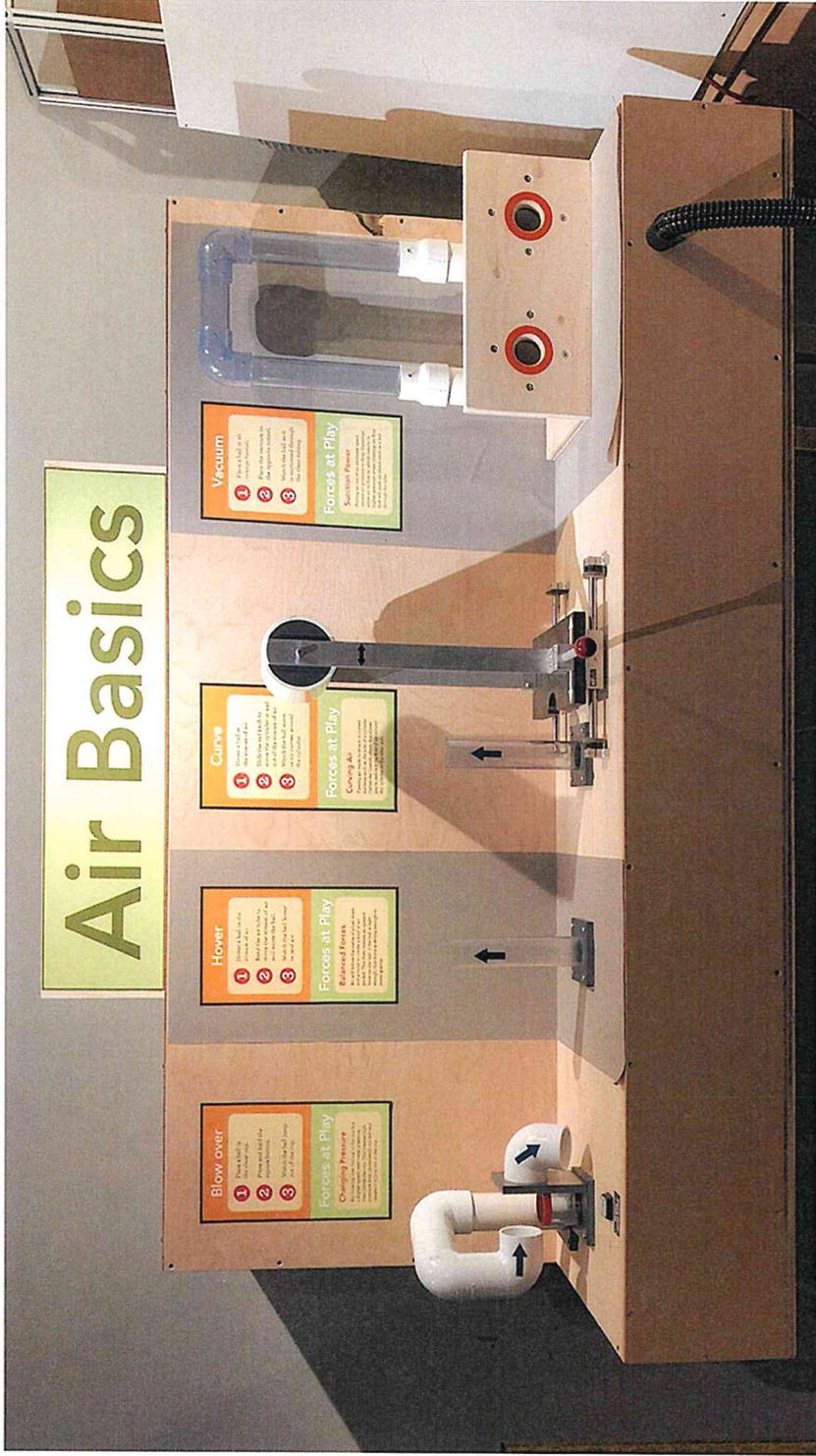
# Mystery Skulls

This updated version of Mammal Skull Mystery also guides visitors through identifying physical skulls (using teeth, eyes, and sagittal crest). In addition, visitors are asked to guess which of three animals they think it might be before they start.

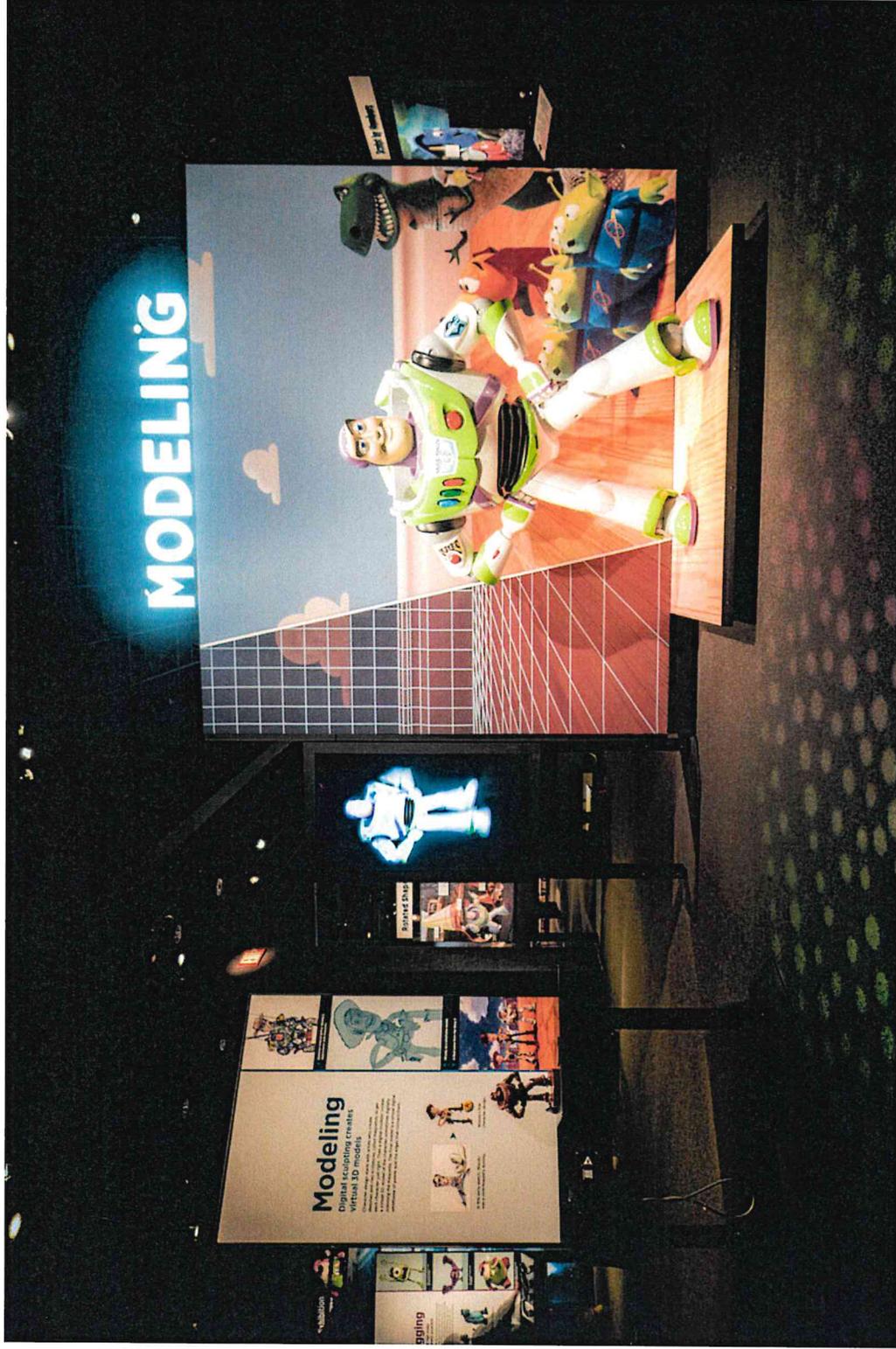


# Air Prototype

Seven activities allow visitors to explore air-related phenomena (e.g., Coanda effect and vacuum) and use them to solve challenges (e.g., hover a ball in a stream of air and pass it to another stream of air).



## When should music be used to “set a mood” in a learning experience?



The Science Behind Pixar, Museum of Science, Boston

- What kind of soundscape would you propose for this exhibition?
- What mood would you want to create?

(Turn page over)

**When should music be used to “set a mood”  
in a learning experience?**



*Body Worlds: The Cycle of Life, Museum of Science, Boston*

- What kind of soundscape would you propose for this exhibition?
- What mood would you want to create?

(Turn page over)

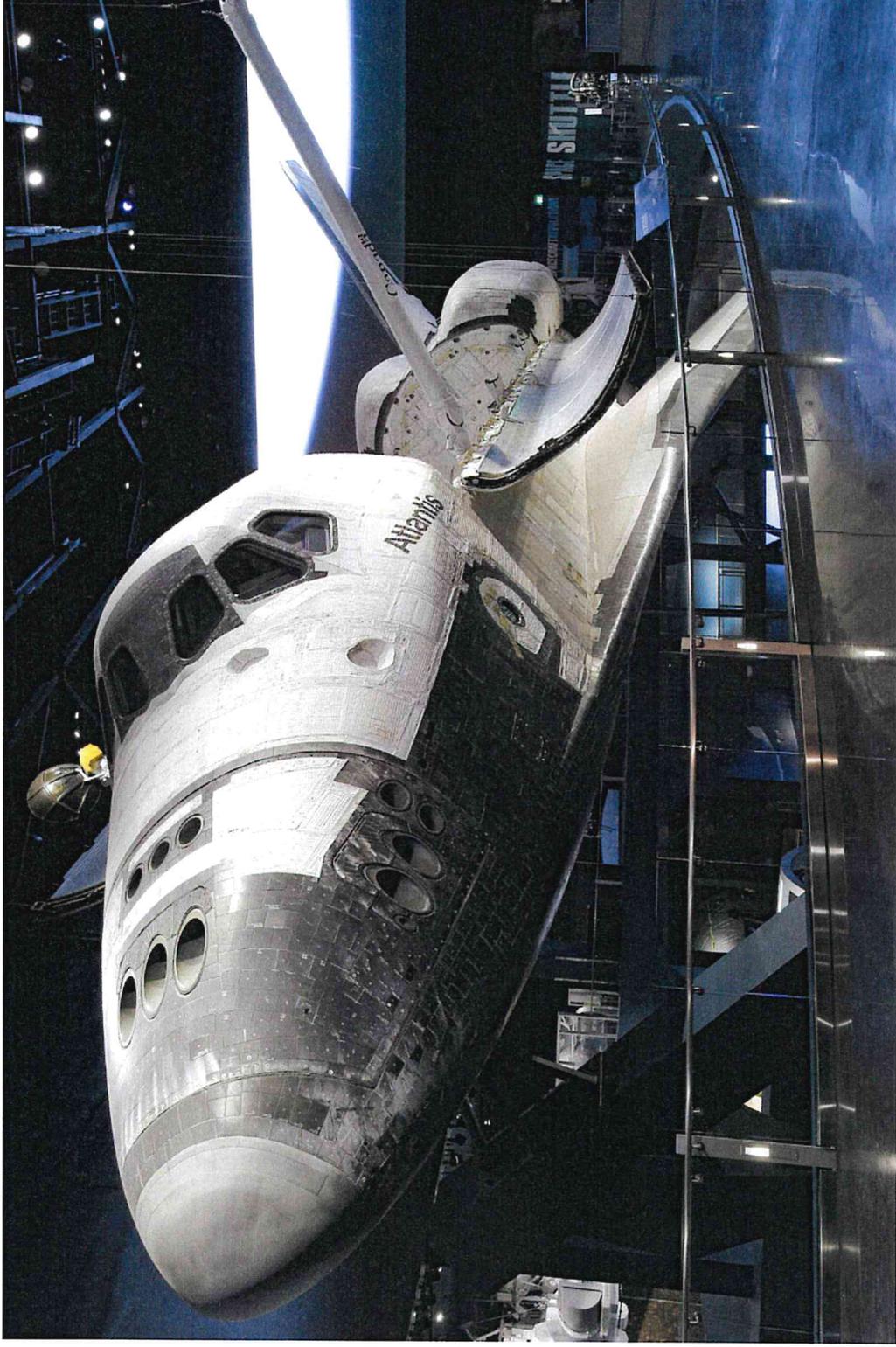
**What expectations do we set if we lead with emotion?**



*Diorama: Climate Change: The Threat to Life and a New Energy Future, AMNH*

- What is the impact of evoking a particular emotion in the introduction to an exhibition?
- How would you think about designing for an emotion journey that begins with evoking emotion in this way?

**Can immersive experiences be designed to support a variety of potential emotional reactions to content?**

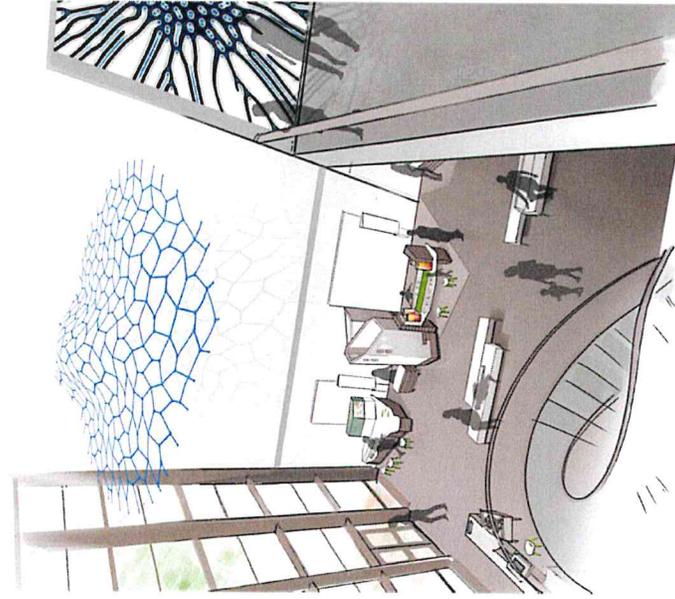


NASA Space Shuttle Atlantis, Kennedy Space Center

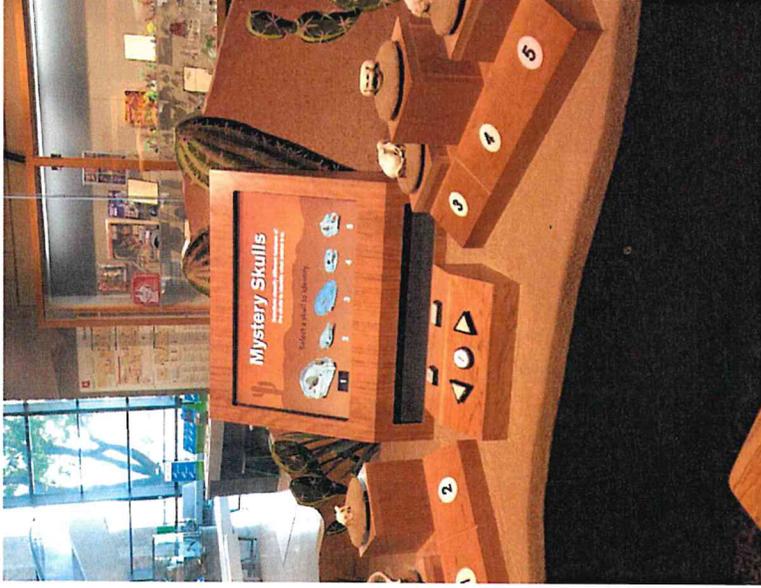
- What elements help an immersive experience evoke an emotional reaction?
- What emotions would you expect a visitor to experience?

[youtube.com/watch?v=B7ZCkgjcXisch](https://youtube.com/watch?v=B7ZCkgjcXisch)

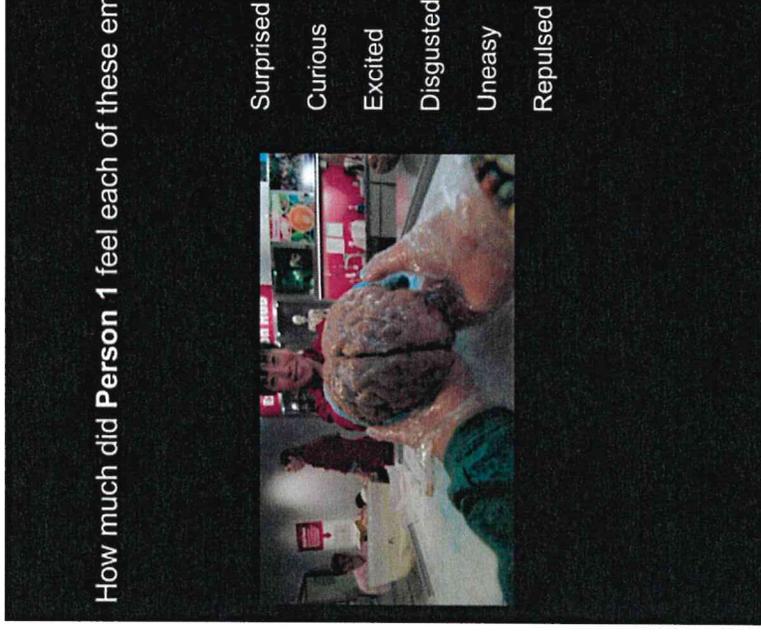
# Designing for Emotion



Gallery



Component



Educator/Program