Emotion in the Science Center:

Applying Affective Theory, Research, and Technologies in Designed Experiences

Museum of Science.

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

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"

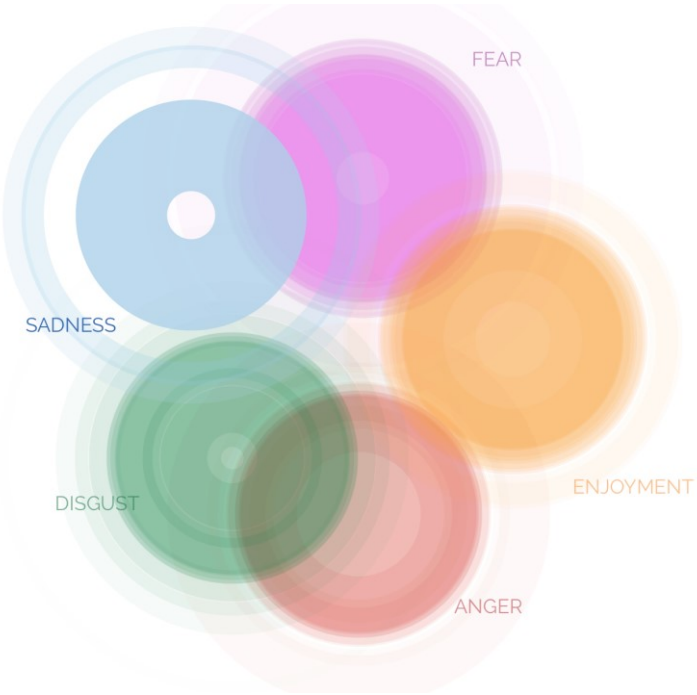
(Immordino-Yang, 2015, pp. 27-28)

What is emotion?

Anatomy of a Scene

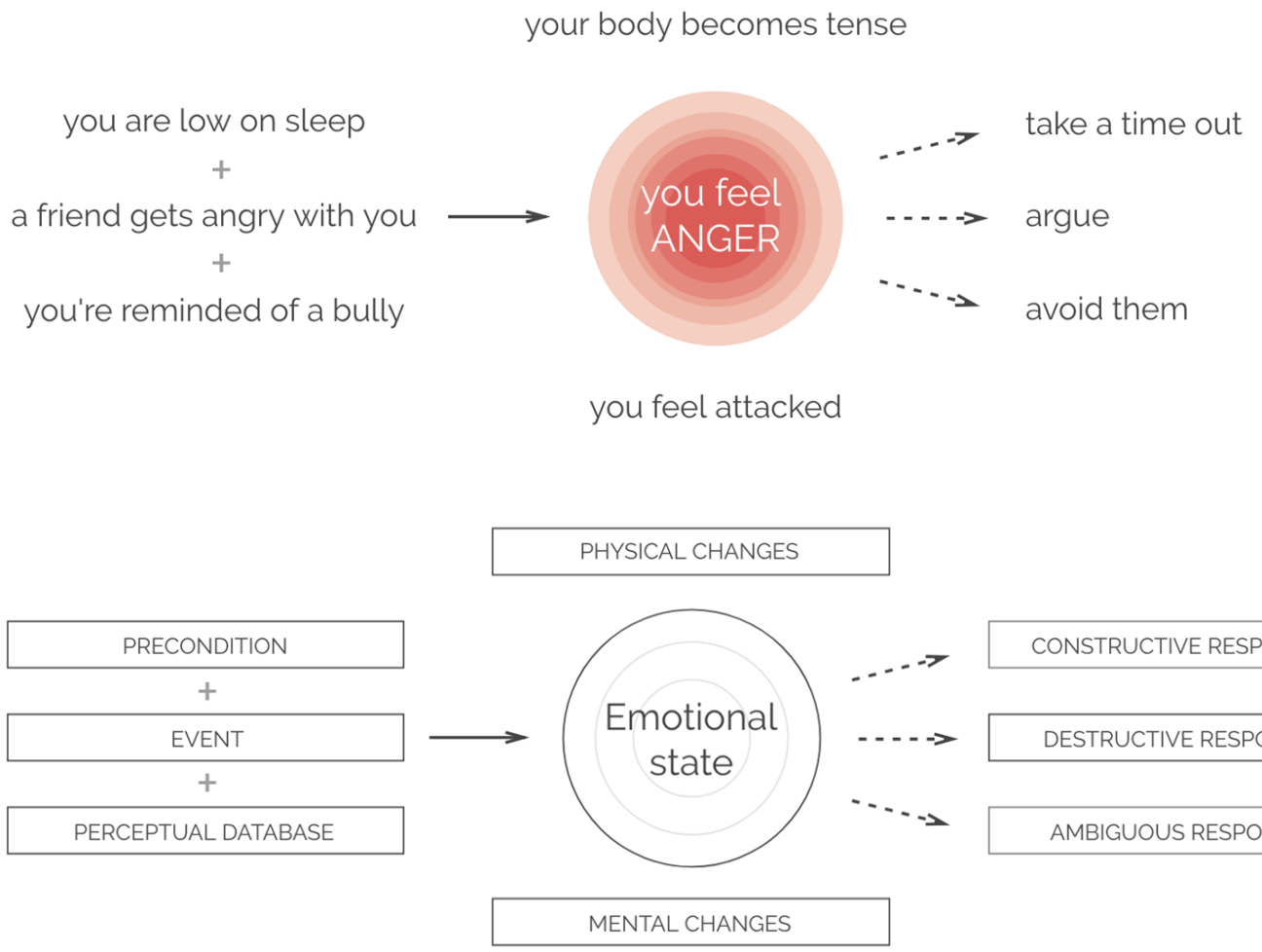
Anatomy of a Scene

- 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

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

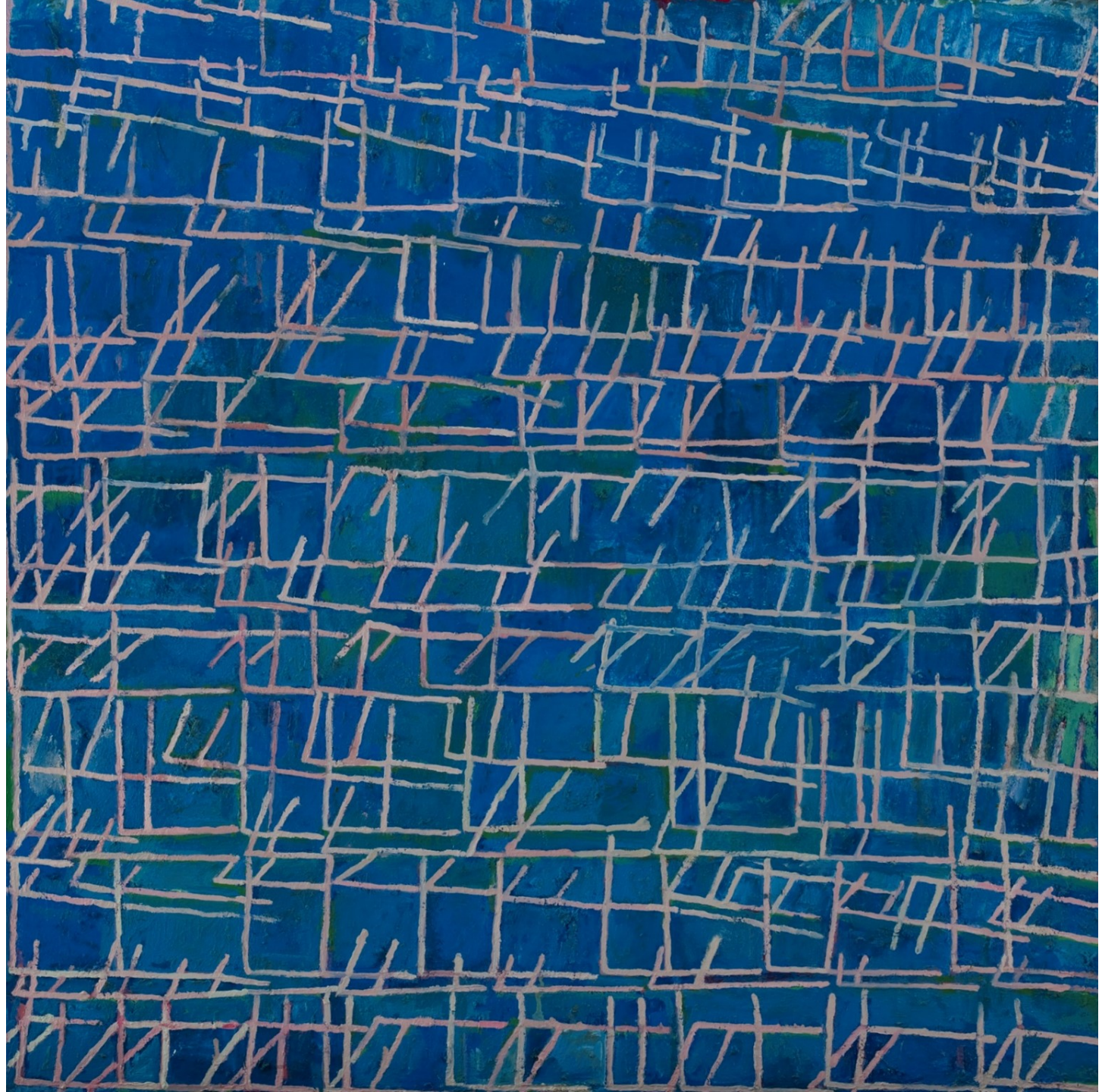
Break

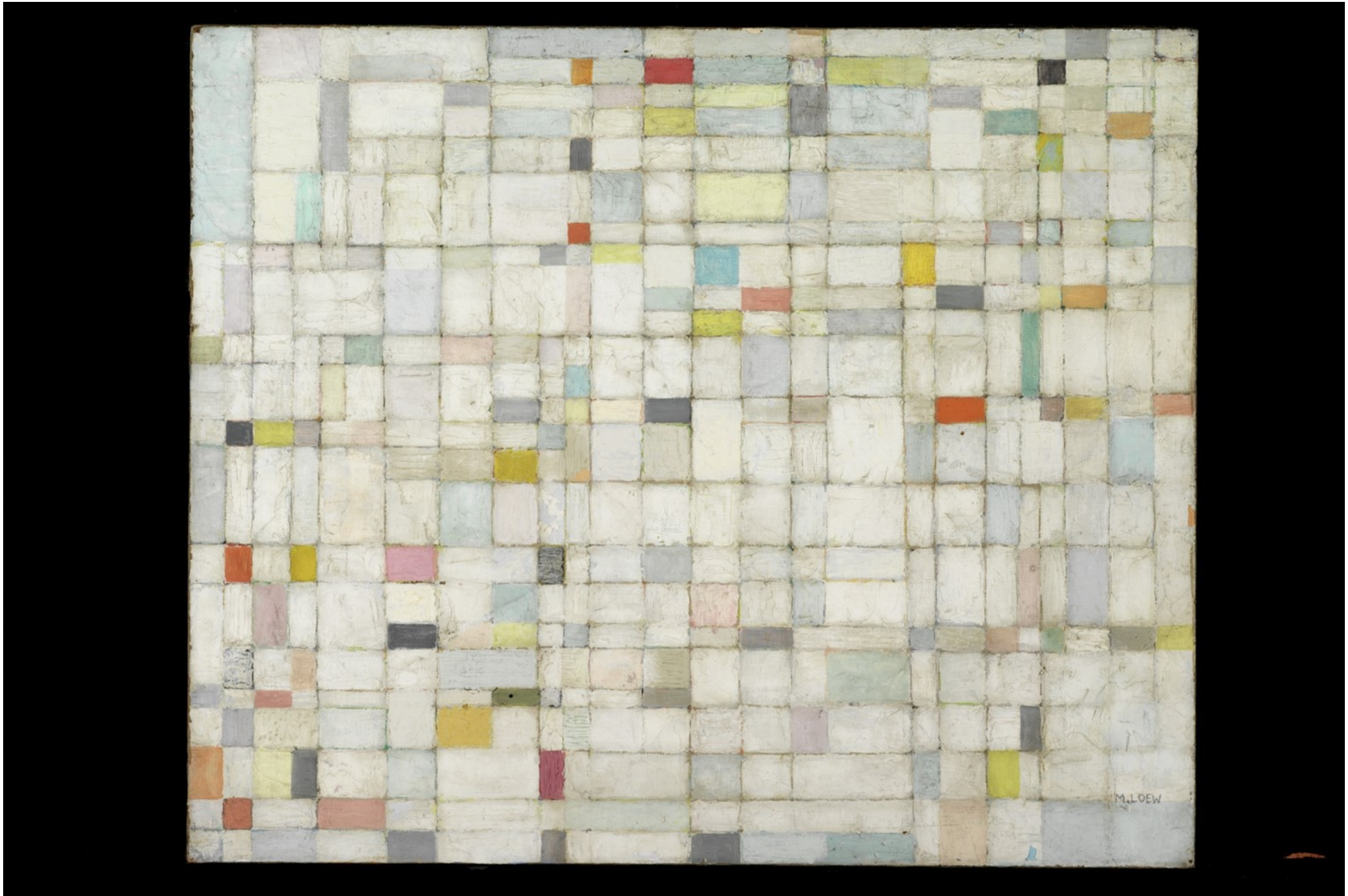
Measurement of Emotions

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/

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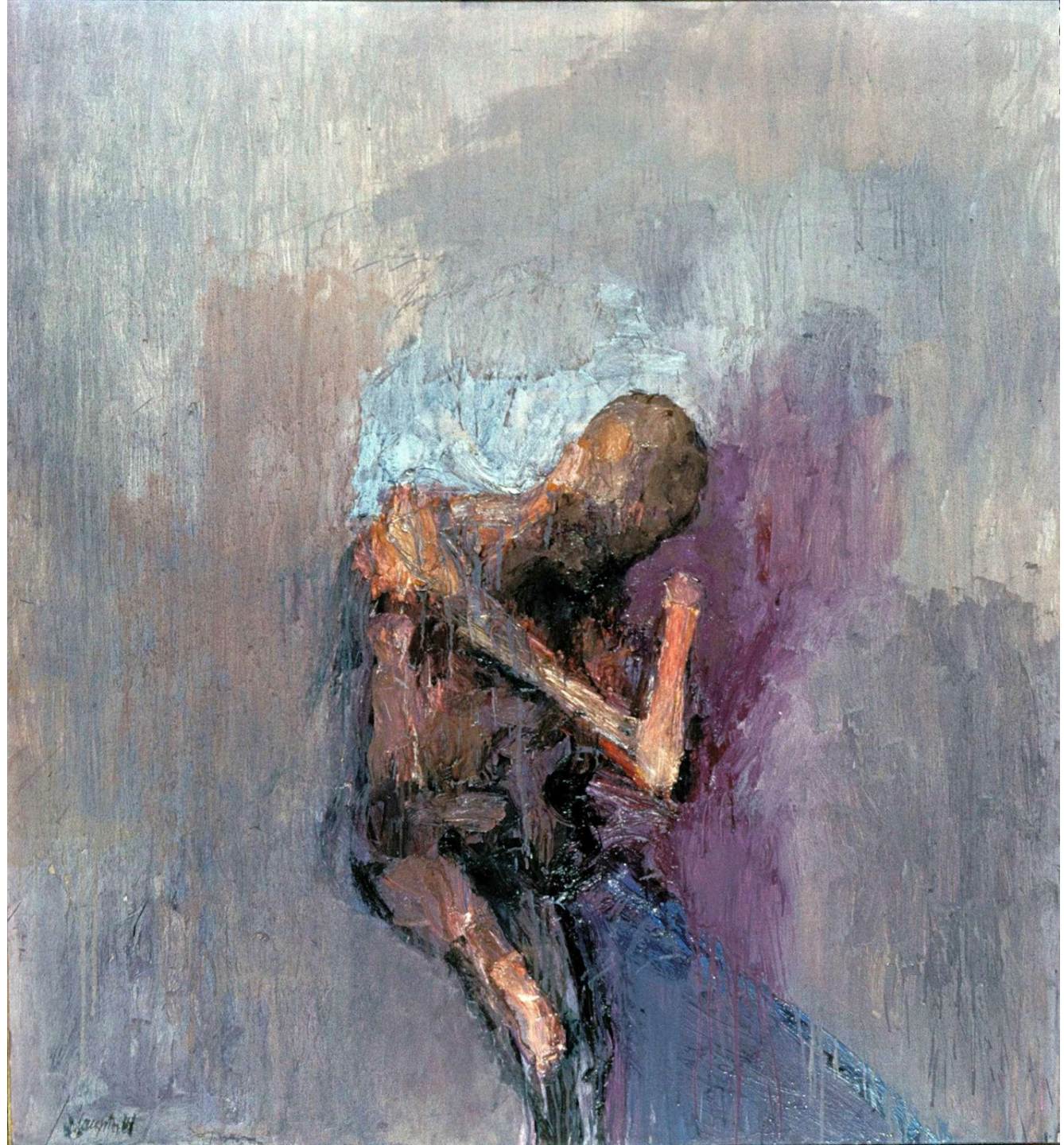
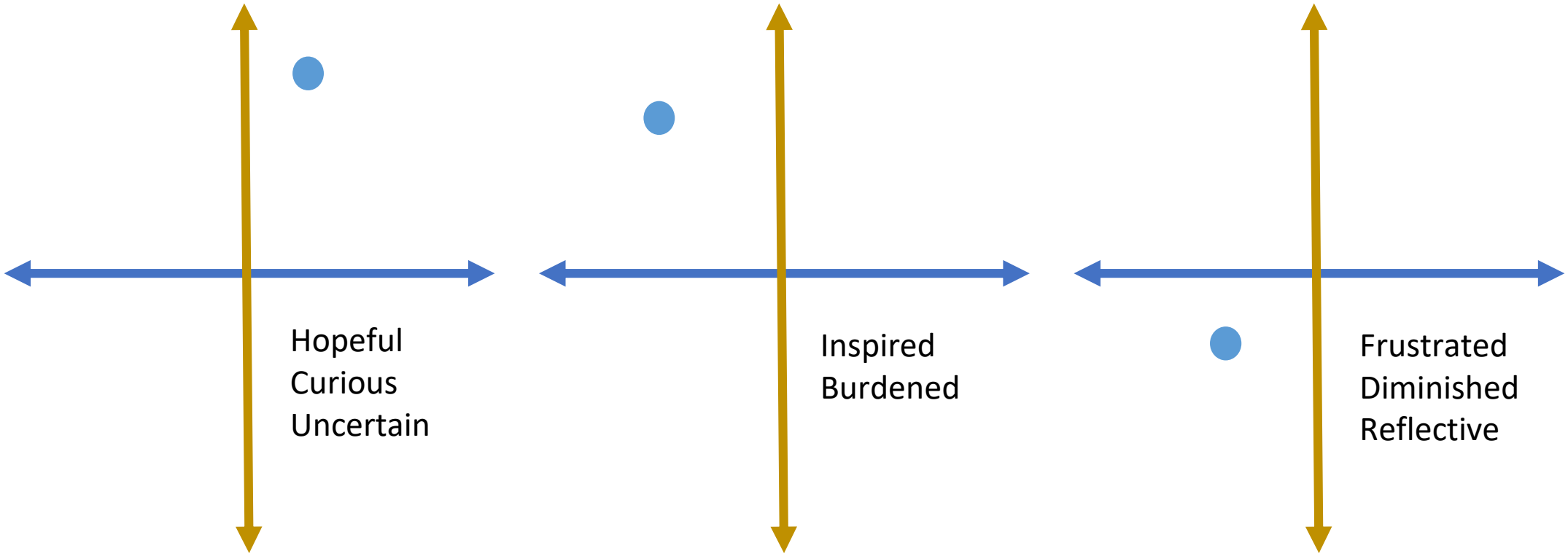
PAPPAS



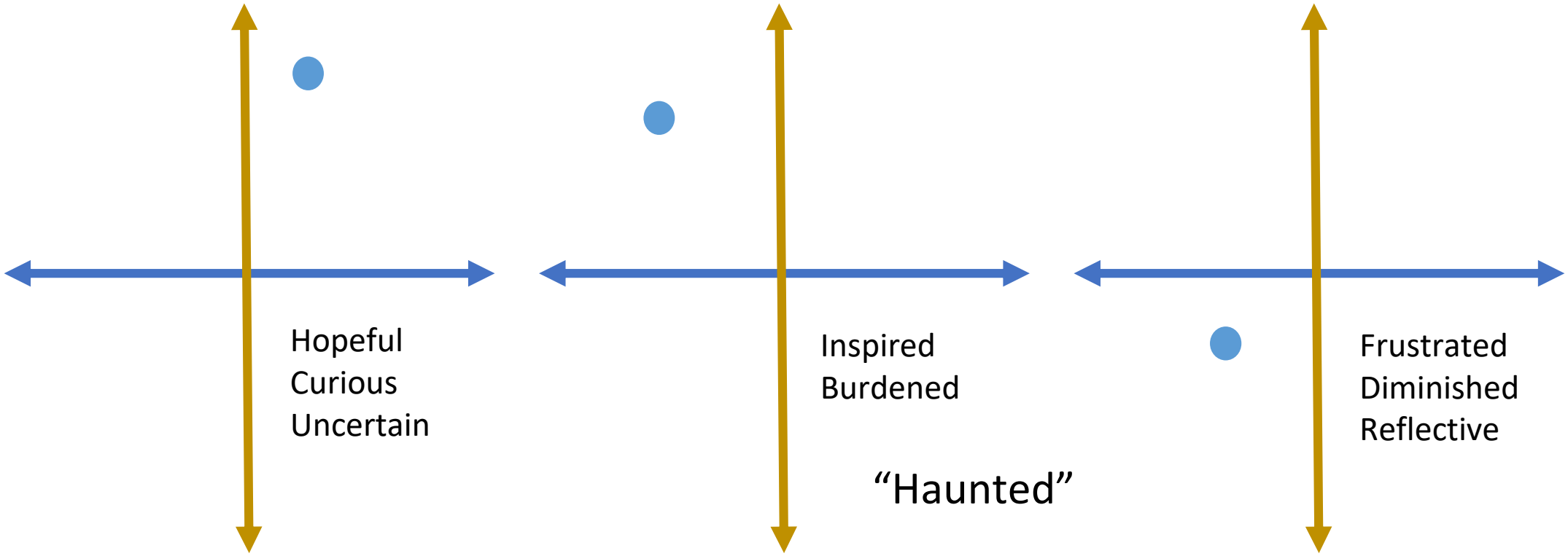
How can we richly and rigorously characterize the emotion experiences of our visitors?

Characterizing an emotion experience



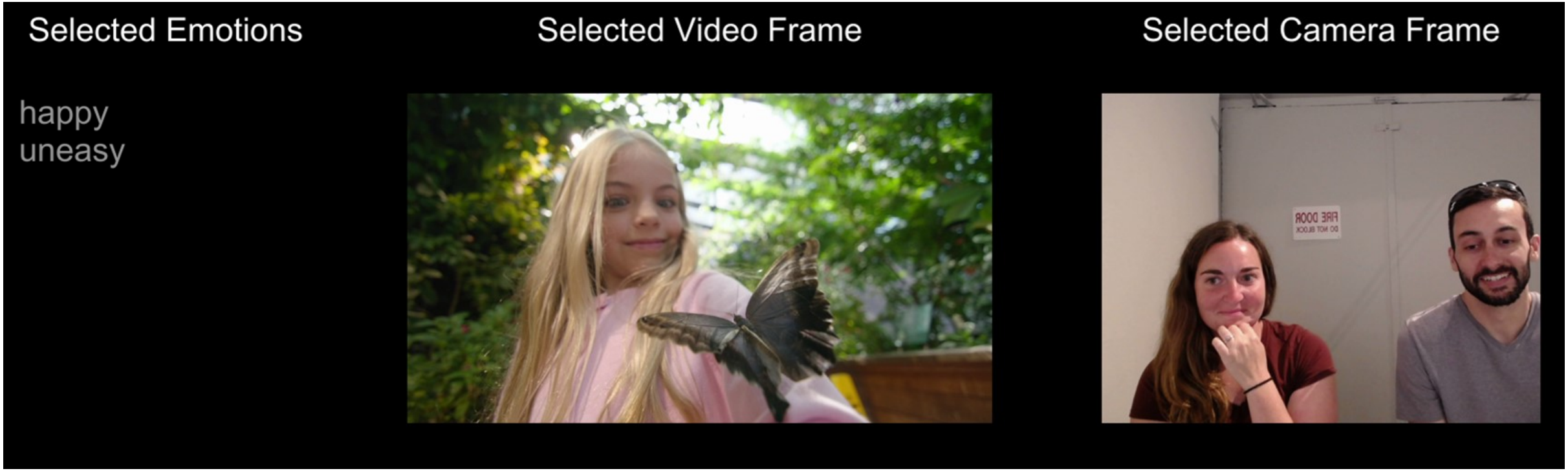
Overall: Stimulated but overwhelmed

Characterizing an emotion experience



Overall: Stimulated but overwhelmed

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



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

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

This visitors' 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…

Heart rate

Eye movements (attention)

Electroencephalograph (Brain waves)

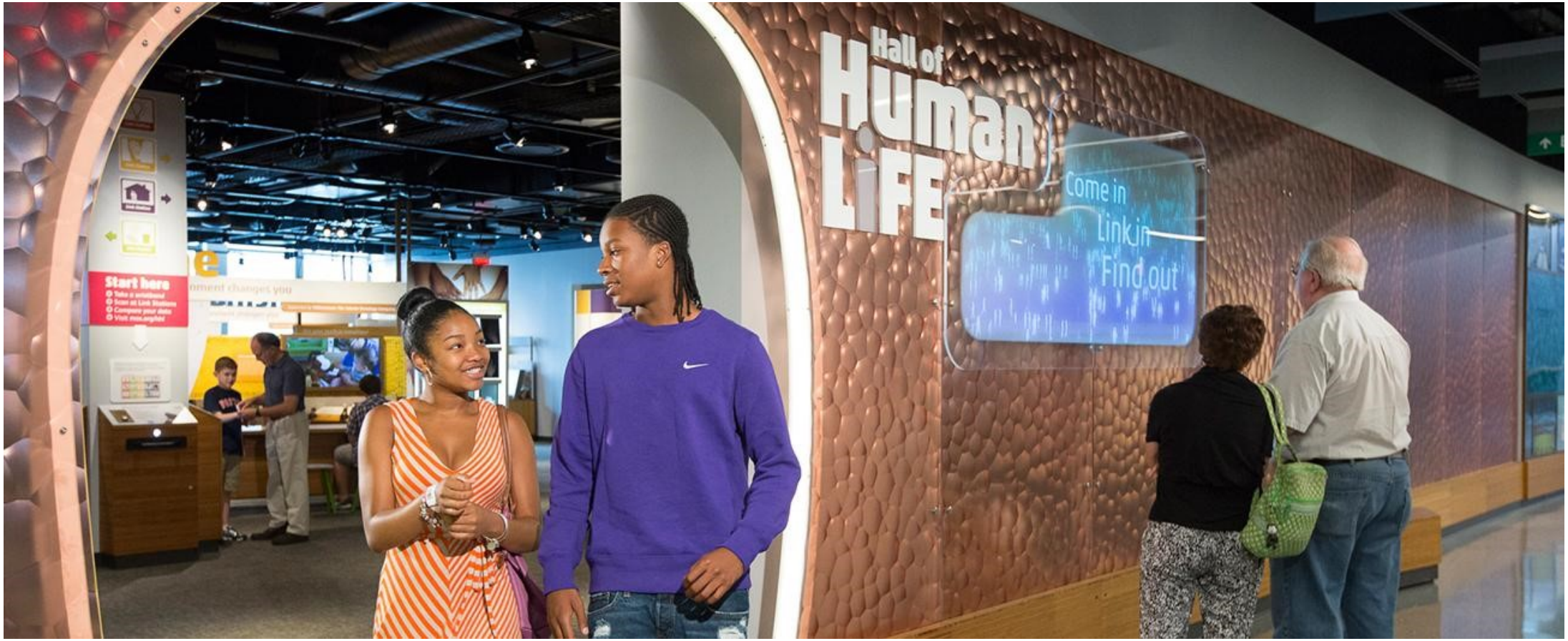
Electrodermal (Sweat!)

We can relate emotions to events and behaviors…

Epistemic (knowledge construction)

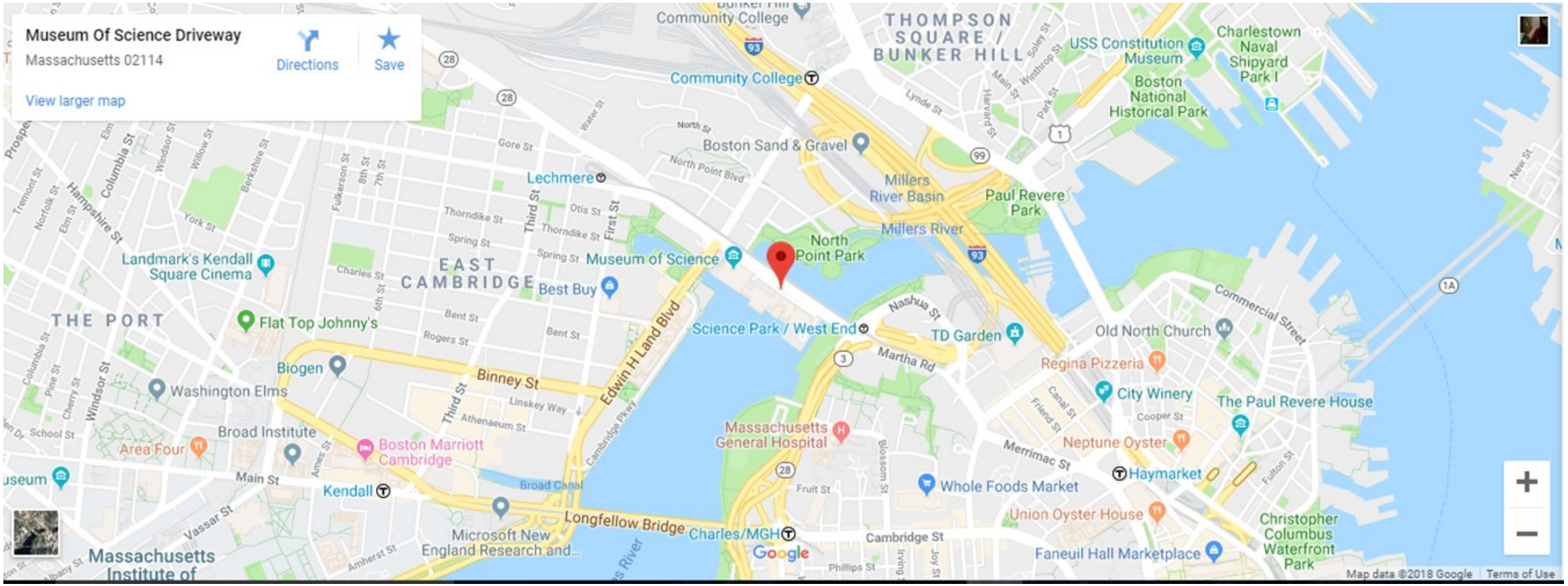
Achievement

Social



Topical – content and experience

Incidental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Directions
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Community College
THOMPSON SQUARE / BUNKER HILL
USS Constitution Museum
Charlestown Naval Shipyard Park I
Boston National Historical Park
Boston Sand & Gravel
Lechmere
Millers River Basin
Paul Revere Park
Millers River
North Point Park
Museum of Science
Landmark's Kendall Square Cinema
EAST CAMBRIDGE
Best Buy
THE PORT
Flat Top Johnny's
Science Park / West End
TD Garden
Old North Church
Regina Pizzeria
Biogen
Binney St
Edwin H Land Blvd
Washington Elms
City Winery
The Paul Revere House
Broad Institute
Area Four
Boston Marriott Cambridge
Massachusetts General Hospital
Neptune Oyster
Kendall
Broad Canal
Whole Foods Market
Haymarket
Union Oyster House
Longfellow Bridge
Charles/MGH
Microsoft New England Research and...
Google
Faneuil Hall Marketplace
Christopher Columbus Waterfront Park
Massachusetts Institute of
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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.”

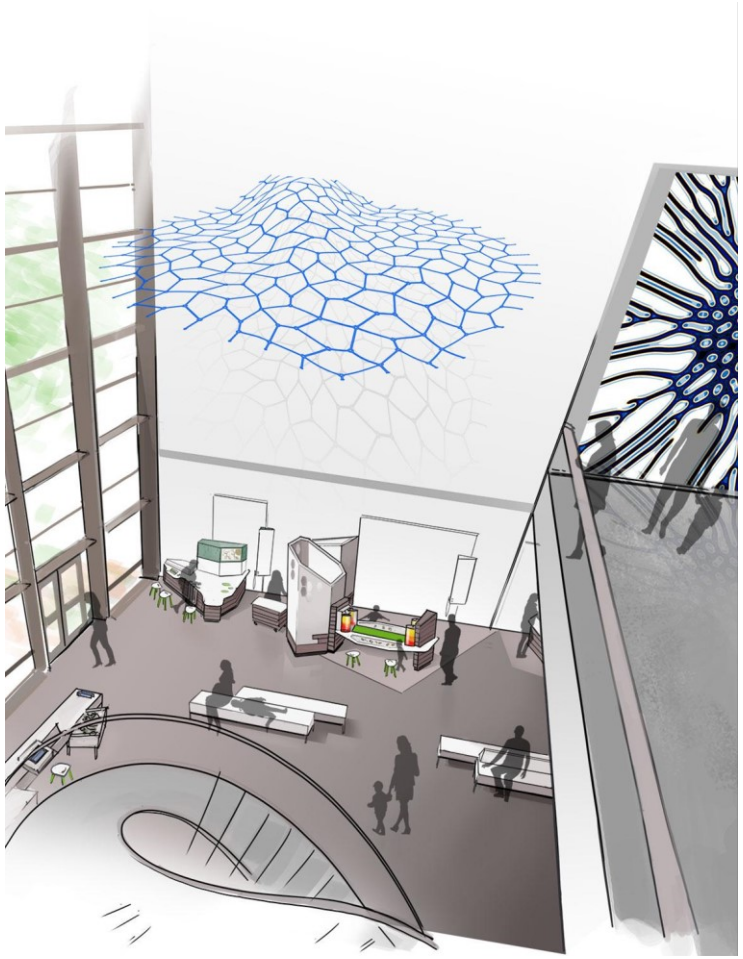
P2: “For me, what I would have thought about after the activity is thinking about stopping more, actually taking in stuff instead of just like rushing through. But also … like how people use their emotions to express what they’re feeling to people in general…”

Design with Emotion in Mind

Evolution of Emotion Thinking

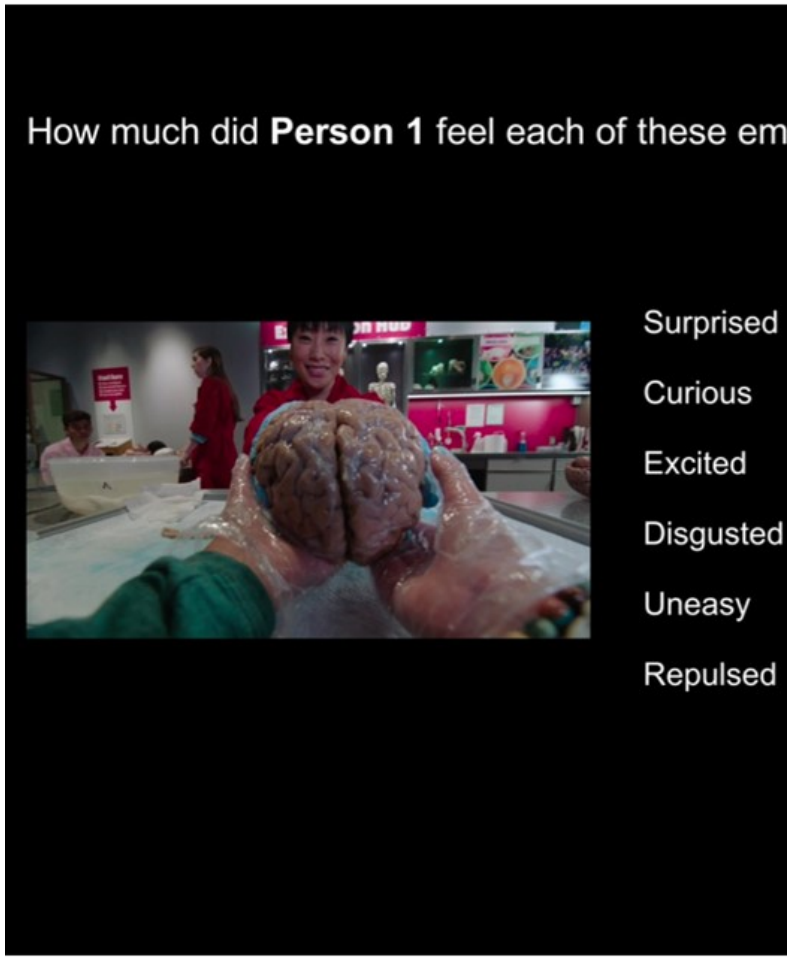
at the Museum of Science, Boston

Designing for Emotion



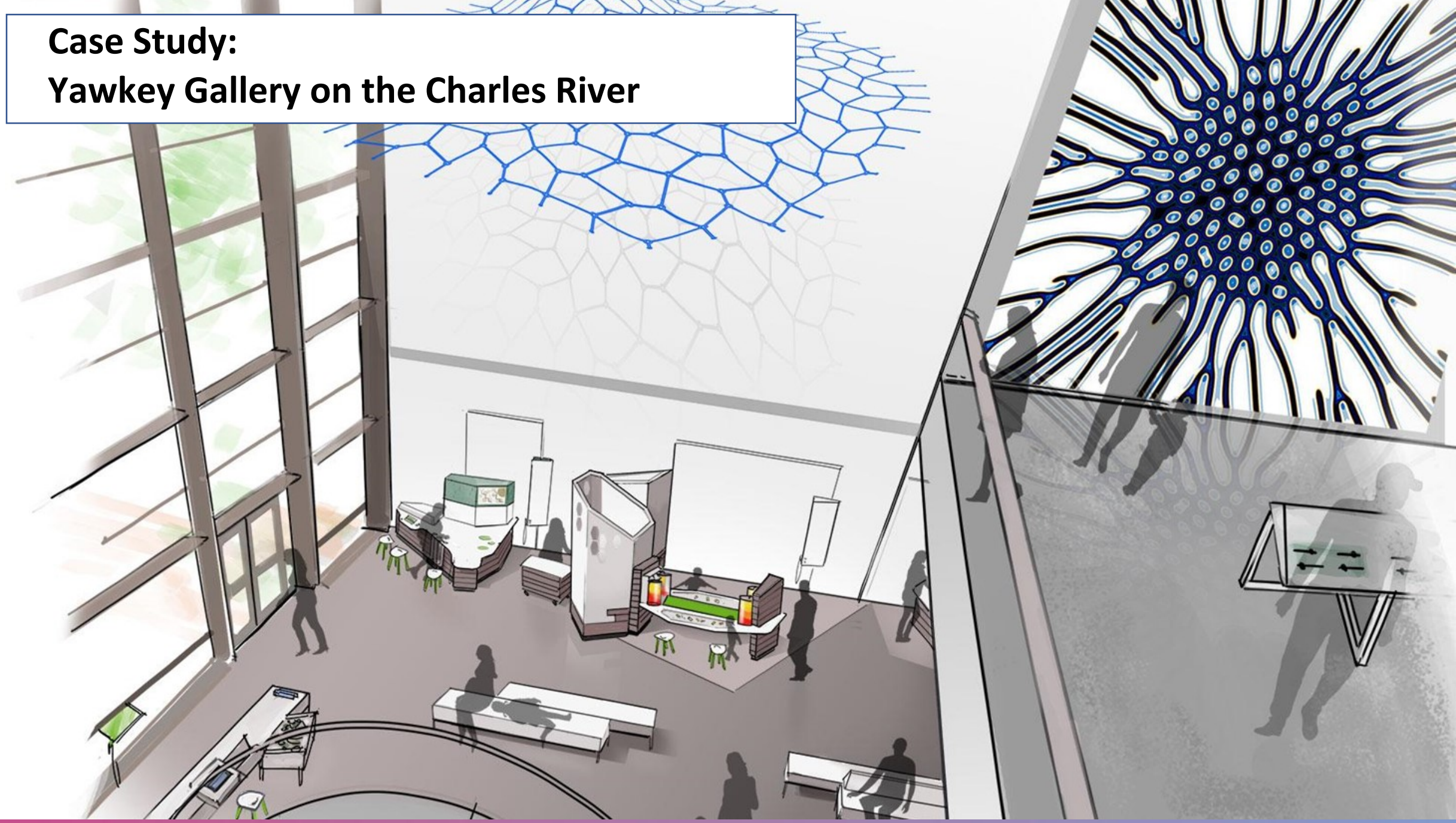
Gallery

Component



Educator/Program

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

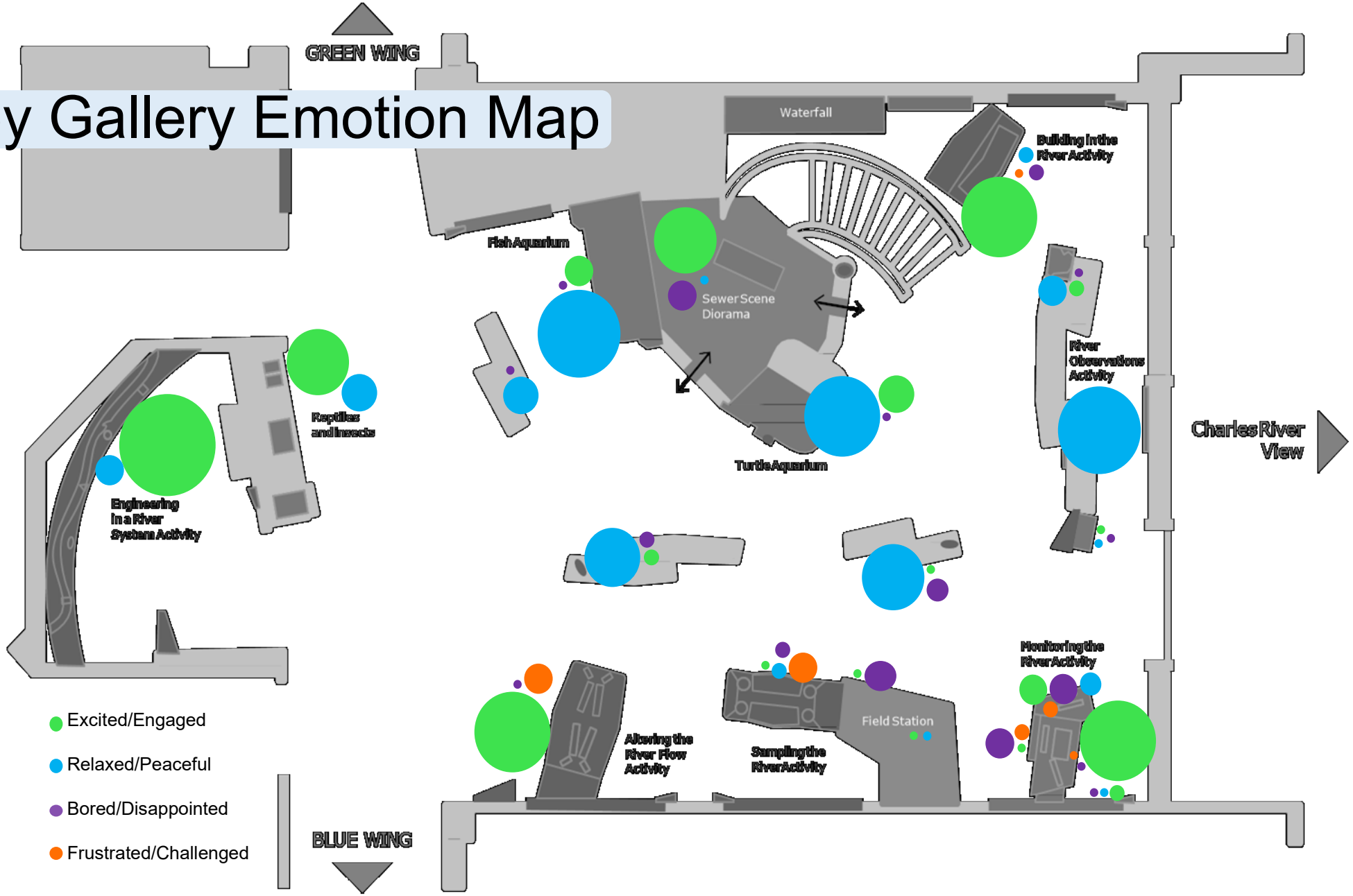
Active Spaces

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:

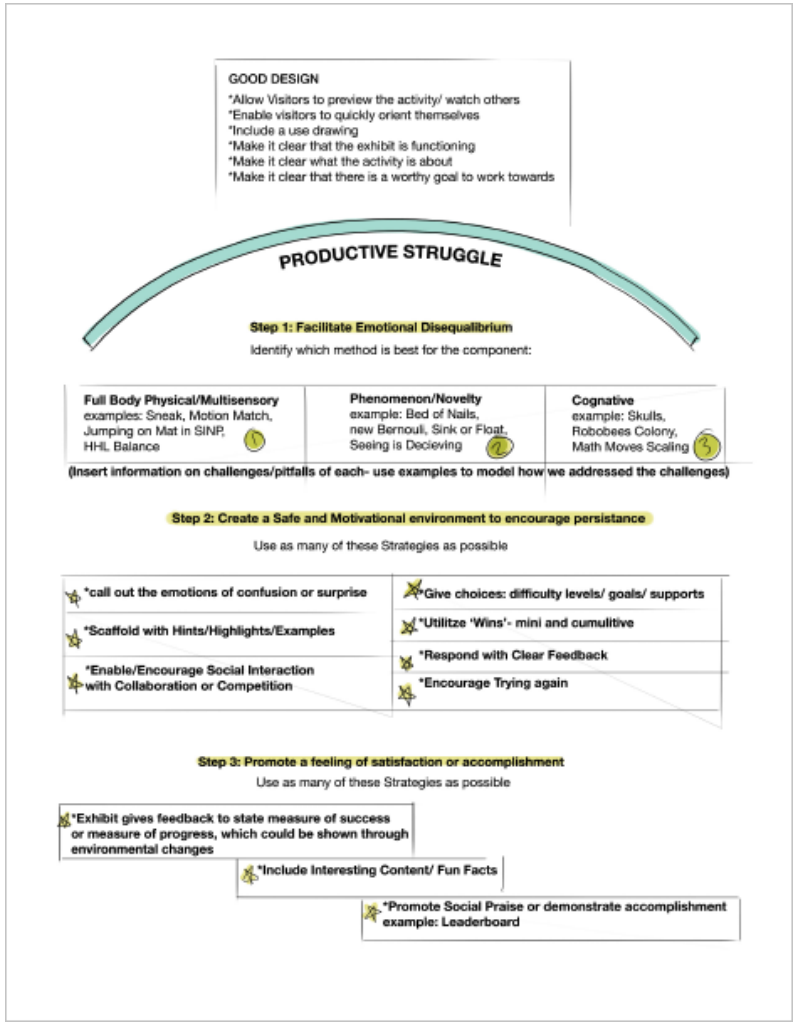
- Develop a theoretical model for productive struggle
- Revise two existing activities and create one new one to support productive struggle
- Develop a set of design guidelines and strategies

Productive Struggle

Elements of Productive Struggle:

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

Working on the design framework



GOOD DESIGN

*Allow Visitors to preview the activity/ watch others
*Enable visitors to quickly orient themselves
*Include a use drawing
*Make it clear that the exhibit is functioning
*Make it clear what the activity is about
*Make it clear that there is a worthy goal to work towards

PRODUCTIVE STRUGGLE

Step 1: Facilitate Emotional Disequalibrium

Identify which method is best for the component:

Full Body Physical/Multisensory	Phenomenon/Novelty	Cognative
examples: Sneak, Motion Match, Jumping on Mat in SINP, HHL Balance (1)	example: Bed of Nails, new Bernouli, Sink or Float, Seeing is Decieving (2)	example: Skulls, Robobees Colony, Math Moves Scaling (3)

(Insert information on challenges/pitfalls of each- use examples to model how we addressed the challenges)

Step 2: Create a Safe and Motivational environment to encourage persistance

Use as many of these Strategies as possible

*call out the emotions of confusion or surprise
*Scaffold with Hints/Highlights/Examples
*Enable/Encourage Social Interaction with Collaboration or Competition
*Give choices: difficulty levels/ goals/ supports
*Utilitze 'Wins'- mini and cumulitive
*Respond with Clear Feedback
*Encourage Trying again

Step 3: Promote a feeling of satisfaction or accomplishment

Use as many of these Strategies as possible

*Exhibit gives feedback to state measure of success or measure of progress, which could be shown through environmental changes
*Include Interesting Content/ Fun Facts
*Promote Social Praise or demonstrate accomplishment example: Leaderboard

→

Productive Struggle Draft Design Framework

Productive Struggle is an experience when a learner engages with disequilibrium in order to navigate a challenging task and achieve a satisfying resolution. **Disequilibrium** is a sense of imbalance—which can be experienced as confusion, frustration, surprise or unease—that is brought on by a physical, cognitive, or social challenge. This document shares evidence-based approaches for designing museum exhibits that support Productive Struggle.

STEP 0: Allow visitors to quickly orient to the task so they don't spend too much of their "struggle budget" figuring out what to do

Some strategies:
- Clearly identify what the activity is about and that it has a clear goal worth working towards.
- Allow visitors to watch others (preview the activity).
- Include a use drawing/video.
- Clearly indicate that the challenge is intentional and not a result of a broken exhibit.

STEP 1: Facilitate disequilibrium

Identify which approach is best for the activity

Physical/Multisensory Challenge	Cognitive Challenge	Social Challenge
The disequilibrium may come from the challenge of using your body in a new or difficult way, such as slowly sneaking up on a bird or balancing on a board. Challenges might involve fine and/or gross motor skills.	Visitors puzzle over surprising phenomena (such as the Coanda effect that causes a ball to hover in a stream of air) or a difficult task (such as doubling the volume of a 3D shape). Consider having visitors figure out hidden concepts or make a guess with partial information.	Interactions with other people bring on disequilibrium through competition, social pressures of performance, or a task that highlights disagreements between visitors. Disequilibrium can also arise from being alone.

STEP 2: Create a safe and motivational environment for persistence

Use as many strategies as possible towards as many goals as possible

Goal: Acknowledge the challenge	Goal: Reinforce a sense of autonomy	Goal: Provide feedback
Some strategies: • Normalize feelings of disequilibrium. • Provide opportunities to acknowledge and reflect on disequilibrium. • Encourage supportive social interaction.	Some strategies: • Give choices of levels, supports, goals, and types of social interaction (competition or collaboration). • Have multiple solutions. • Be able to skip or retry challenges.	Some strategies: • Allow for mini-wins as interim steps are completed. • Make it clear when success and failures occur and what causes them. • Offer scaffolding or hints. • Encourage trying again.

STEP 3: Promote a feeling of satisfaction or accomplishment

Use as many strategies as feasible

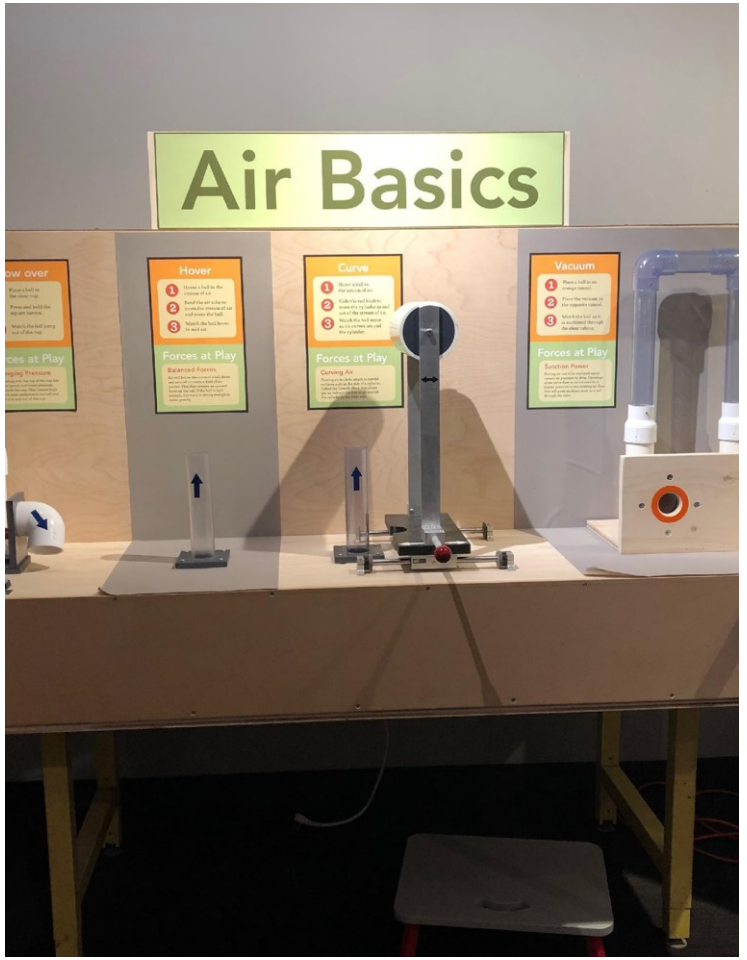
Some strategies:
- Provide feedback that indicates successful progress and completion of the activity.
- Allow visitors to demonstrate their accomplishment (via a leaderboard, environmental changes, etc.).
- Completion yields a new insight about oneself or about the subject matter.
- Use interactive and multisensory exhibit elements

→ ?

Exhibits featuring productive struggle

Sneak

Mystery Skulls



Air Prototype

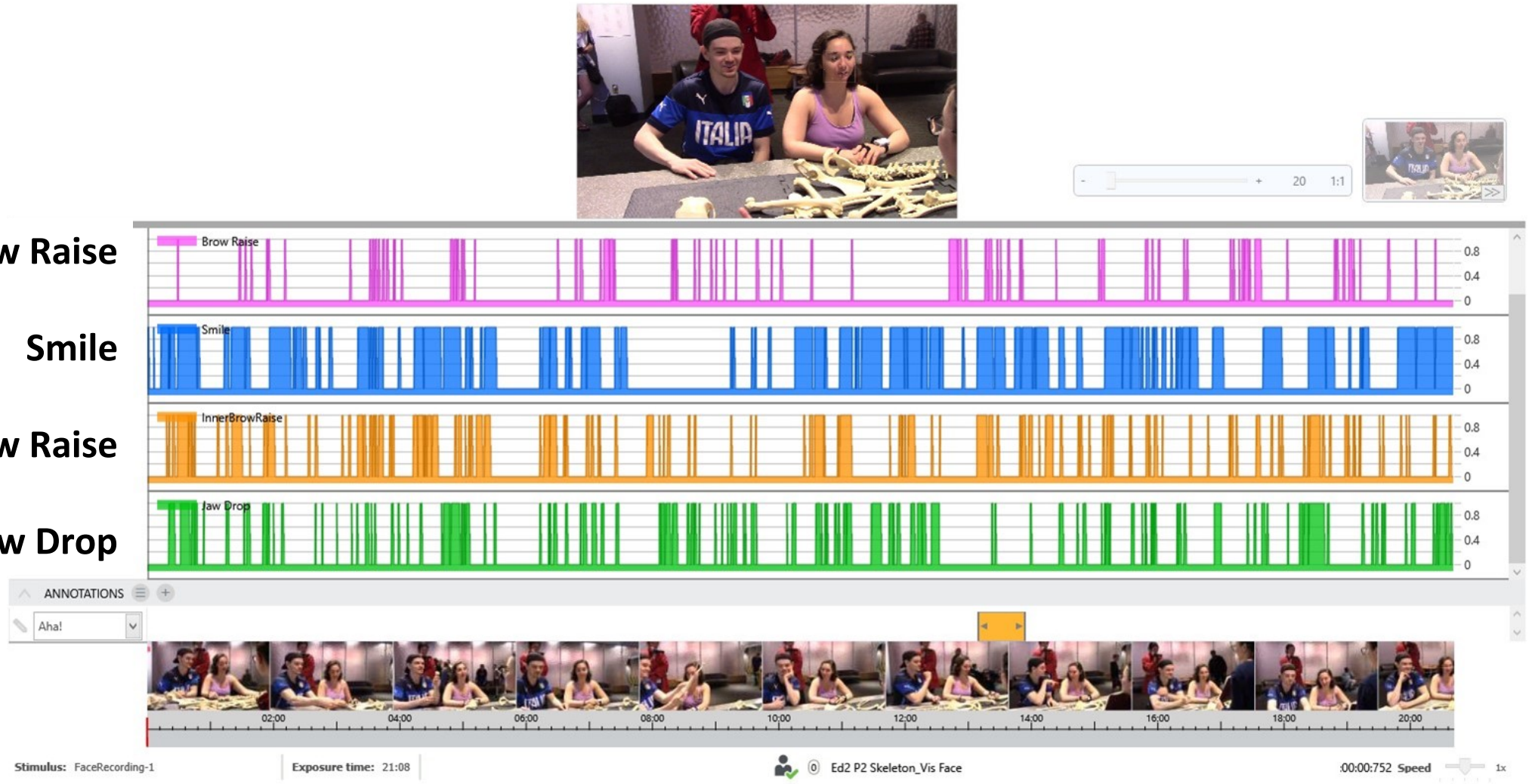
Emotional Engagement during Live Presentations

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?

MUSEUM OF SCIENCE
OF SCIENCE H.O.S.T.

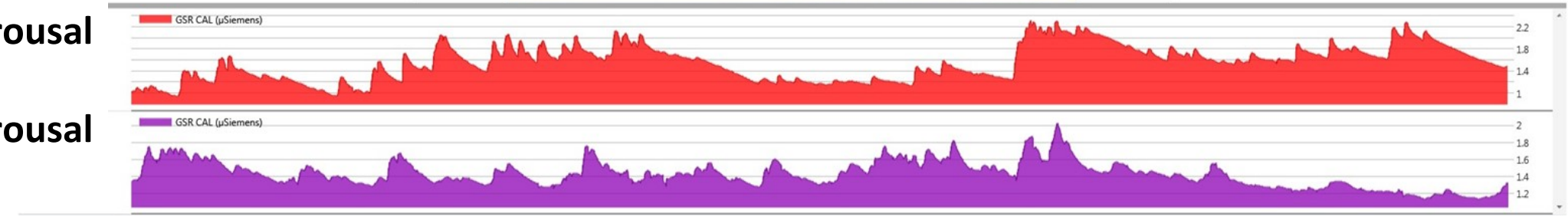
Affective data collected…



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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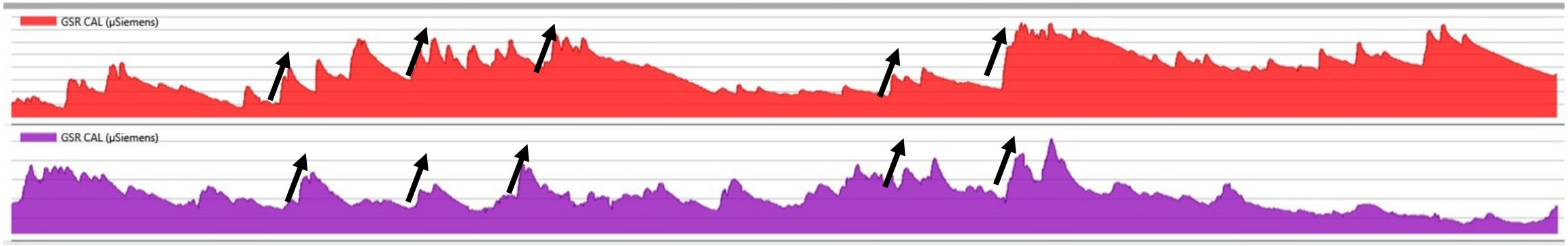
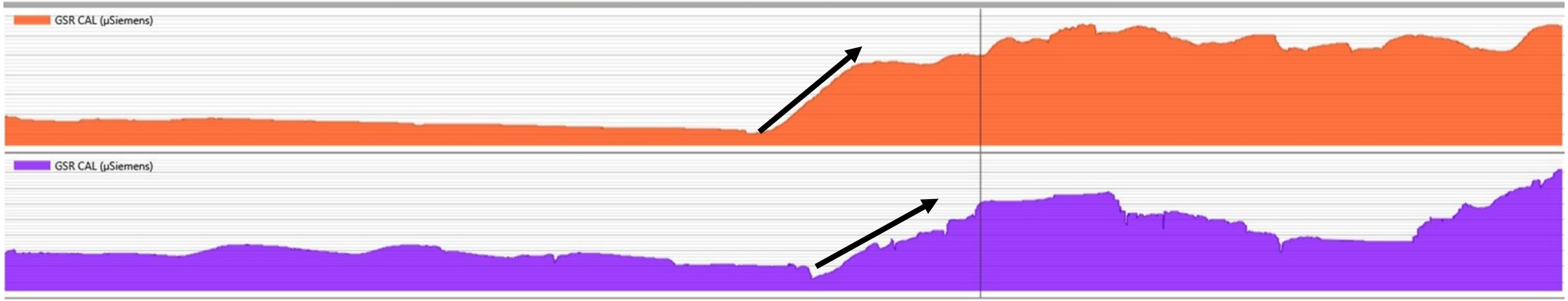
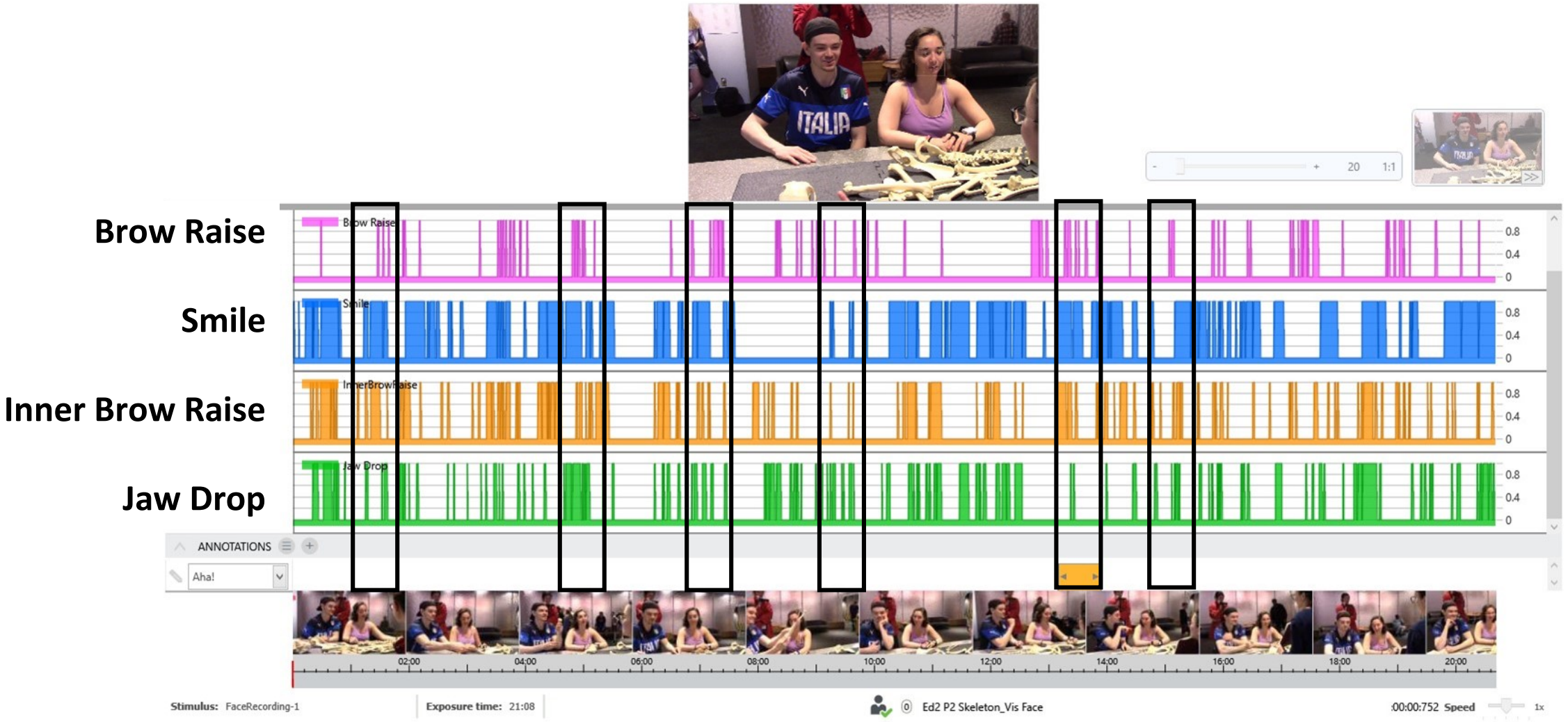


Start here
Food


GSR CAL (µSiemens)
GSR CAL (µSiemens)

What else did we learn?



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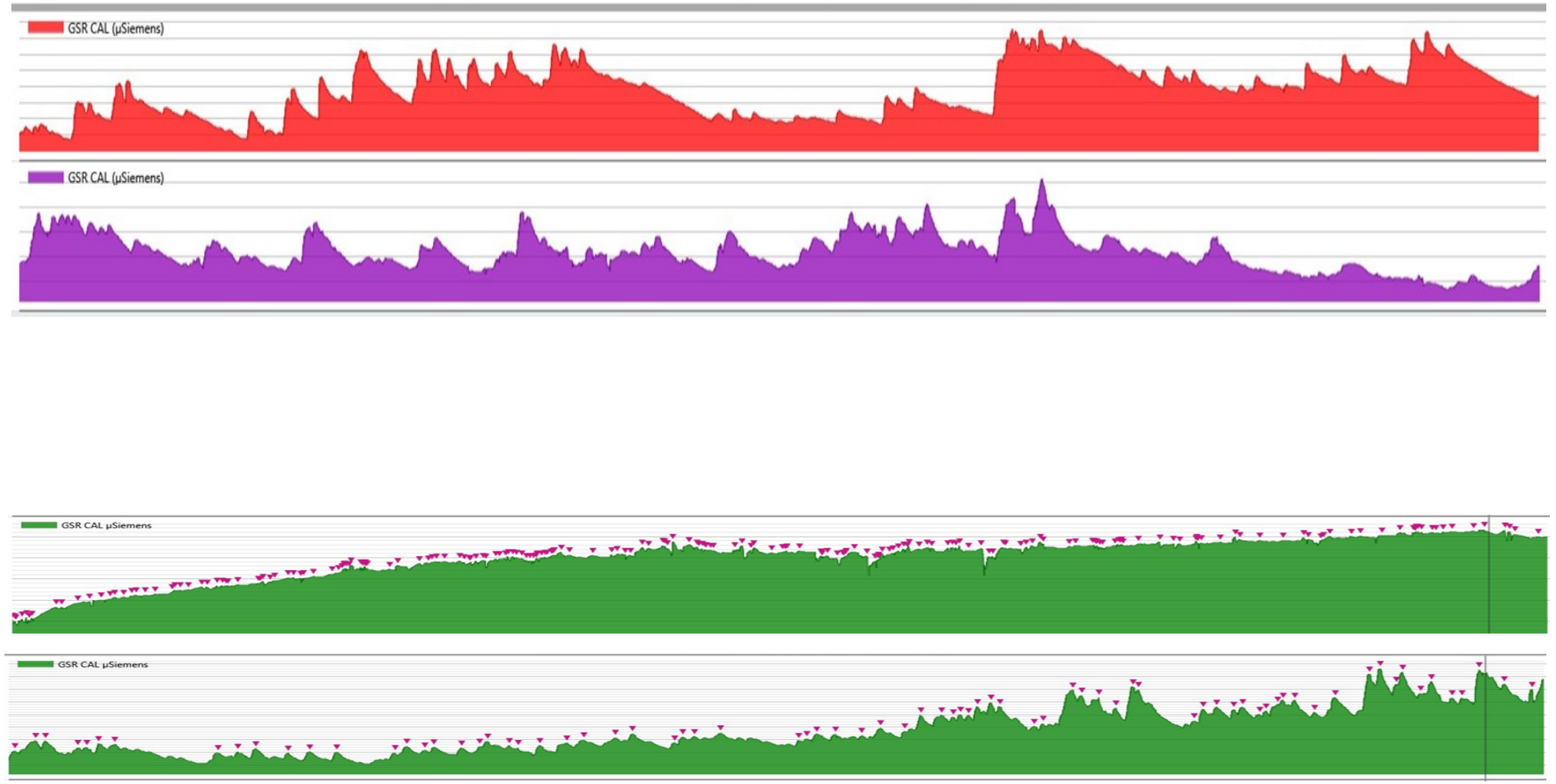

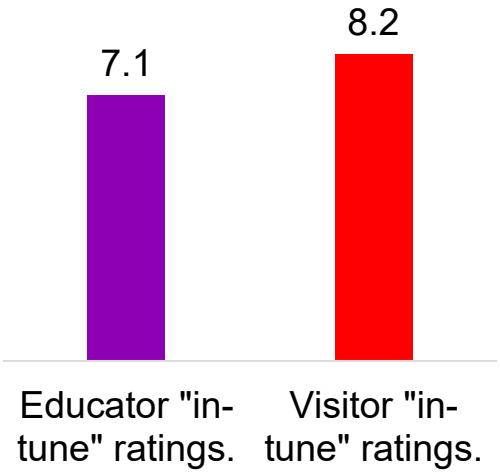

What else did ~~we~~ the educator learn?

"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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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

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.

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

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

Think about how you felt when you ... 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 emotions you felt over time, or write-in your own:

(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.

First 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 emoti... he 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 fol... ty overall?

- ☐ It felt **easy**, and
- ☐ It felt **easy**, but
- ☐ It felt **challengin**
- ☐ It felt **challengin**

(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**

Valence and Energy Rating Scale Reference Sheet

Confused	Proud	Confused	Proud
Conflicted	Satisfied	Conflicted	Satisfied
Enraged	Overjoyed	Enraged	Overjoyed
Angry	Reflective	Angry	Reflective
Sad	Happy	Sad	Happy
Frustrated	Excited	Frustrated	Excited
Powerless	Energized	Powerless	Energized
Defeated	Motivated	Defeated	Motivated
Hostile	Empowered	Hostile	Empowered
Upset	Optimistic	Upset	Optimistic
Provoked	Encouraged	Provoked	Encouraged
Uncertain	Reassured	Uncertain	Reassured
Hesitant	Enthusiastic	Hesitant	Enthusiastic
Skeptical	Challenged	Skeptical	Challenged
Diminished	Intrigued	Diminished	Intrigued

Enraged	Shocked	Exhilarated	Ecstatic
Furious	Tense	Surprised	Elated
Anxious	Angry	Enthusiastic	Inspired
Angry	Restless	Motivated	Excited
Worried	Annoyed	Happy	Proud
Concerned	Irritated	Pleasant	Thrilled
Repulsed	Uneasy	Joyful	Hopeful
Sad	Apathetic	At ease	Fulfilled
Disappointed	Bored	Satisfied	Touched
Pessimistic	Discouraged	Calm	Grateful
Lonely	Tired	Relaxed	Balanced
Despondent	Sullen	Mellow	Peaceful
Hopeless	Disheartened	Thoughtful	Carefree
Despairing	Drained	Complacent	Serene
Adapted from the Yale...	...Center for Emotional Intelligence...	...RULER Mood Meter	ei.yale.edu/ruler

First I...	Next I...	Finally I...
...and I felt...	...and I felt...	...and I felt...

Sample Story Board Cards

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?

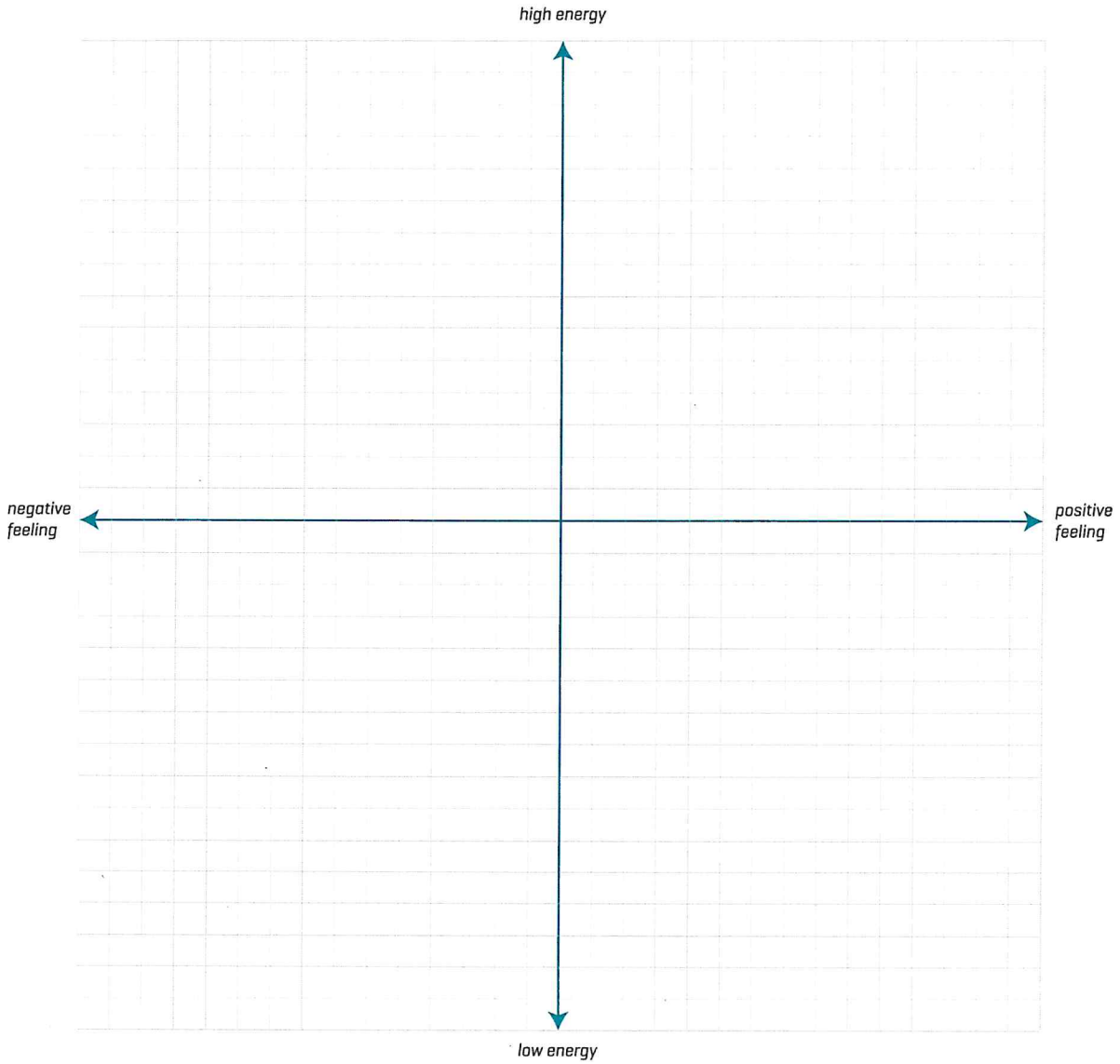
What will visitors do and feel?

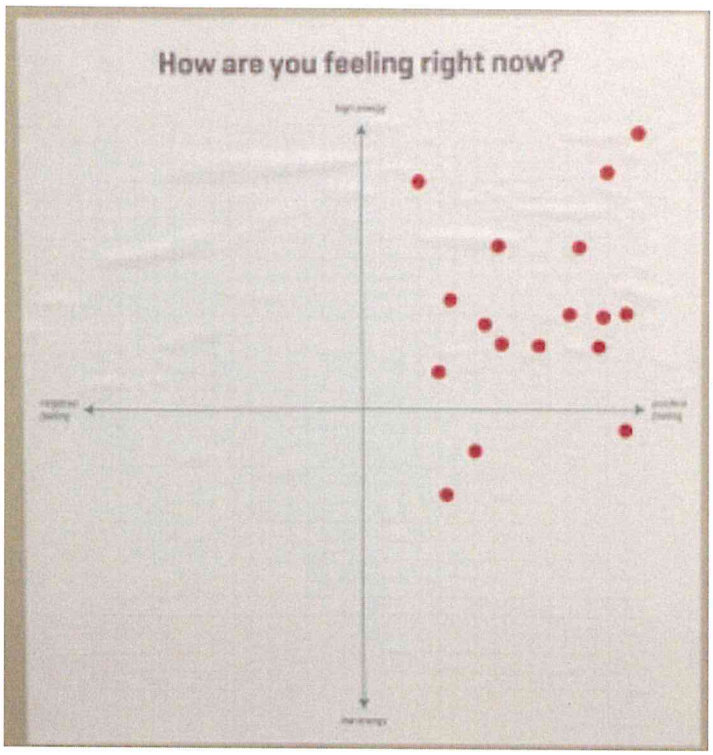
What design strategies support that outcome?

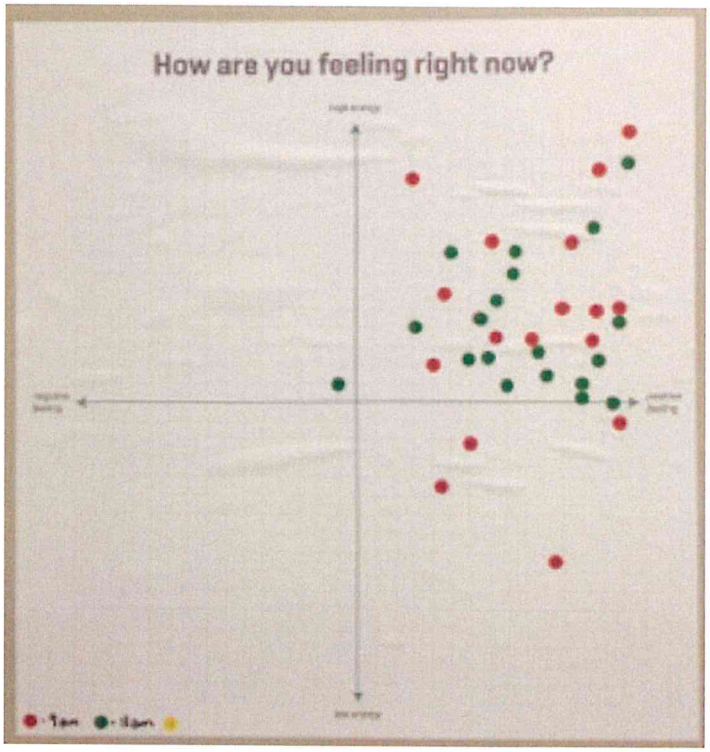
Describe the relationship between the emotion and cognition in this experience.

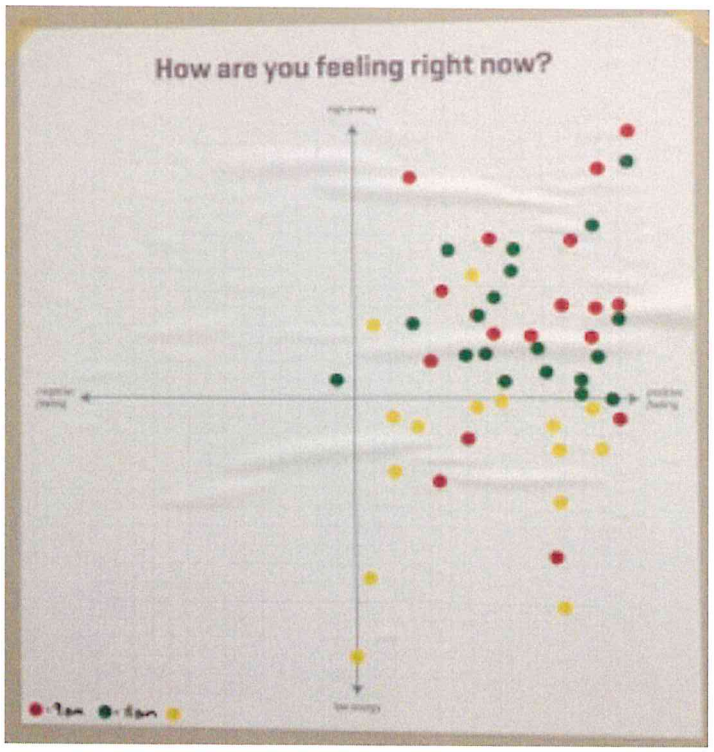
How might you measure your success?

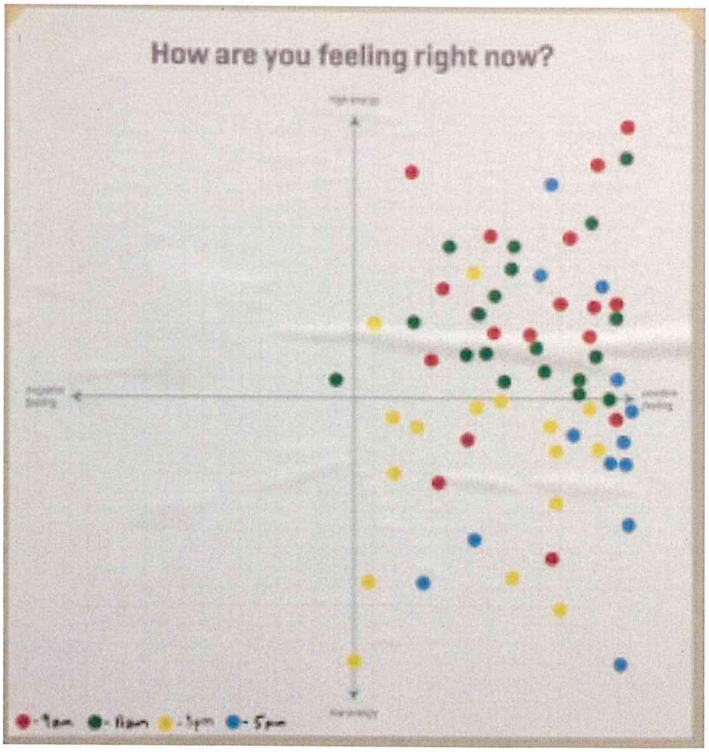
How are you feeling right now?




How are you feeling right now?

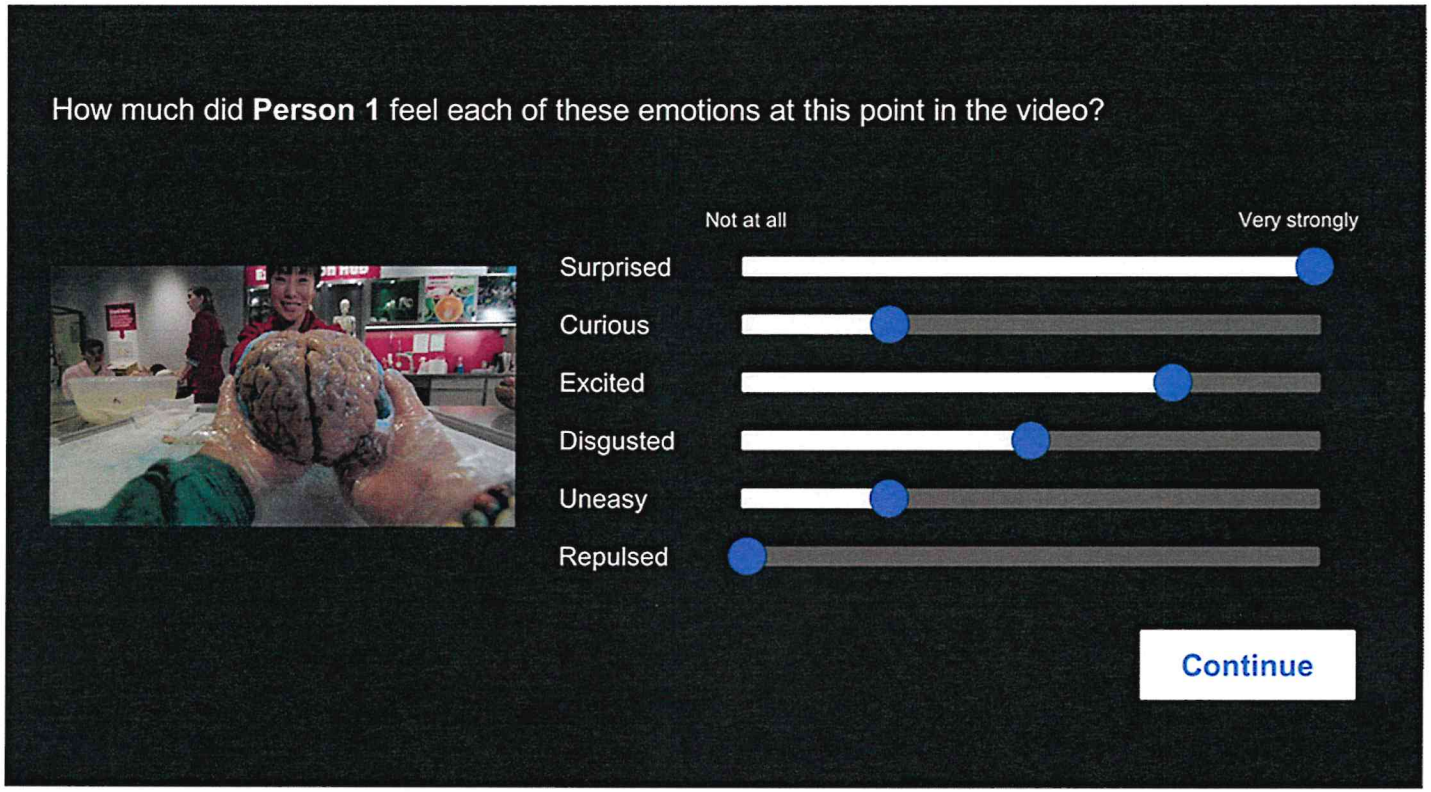

How are you feeling right now?

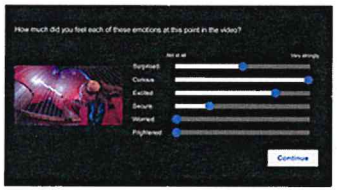

How are you feeling right now?

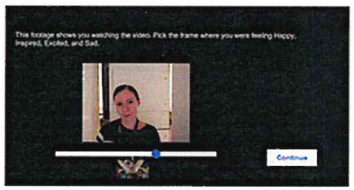

How are you feeling right now?

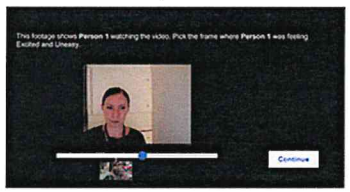
Emotion Video Prototype

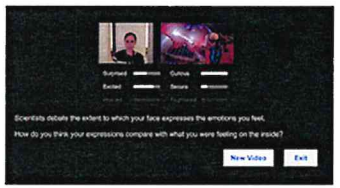
Visitors watch a short video clip chosen to elicit emotion (e.g., a demo with a human brain) while a camera records their face. Afterwards, they identify the emotions they felt and an image of themselves while they were feeling those emotions.





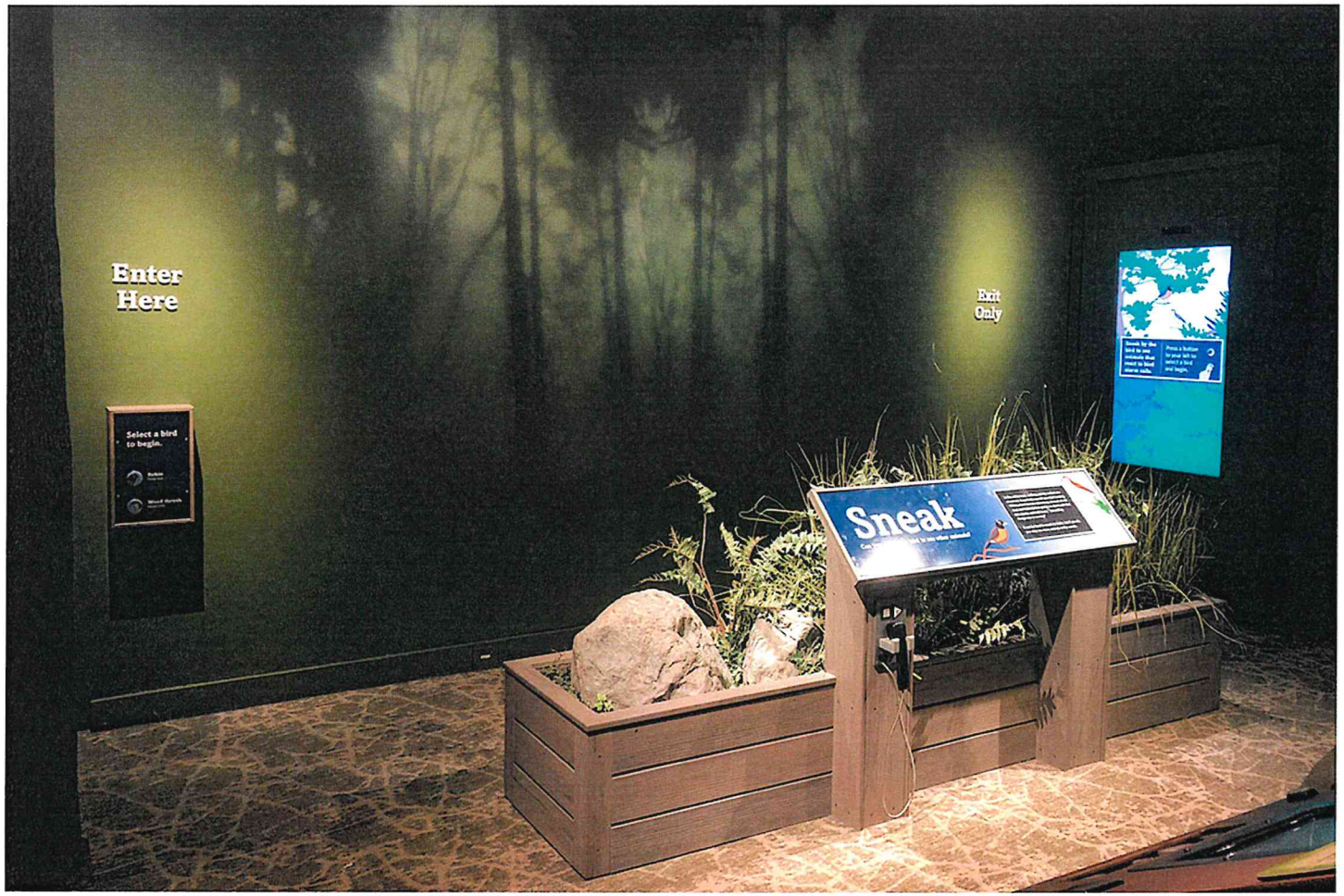






Sneak

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).

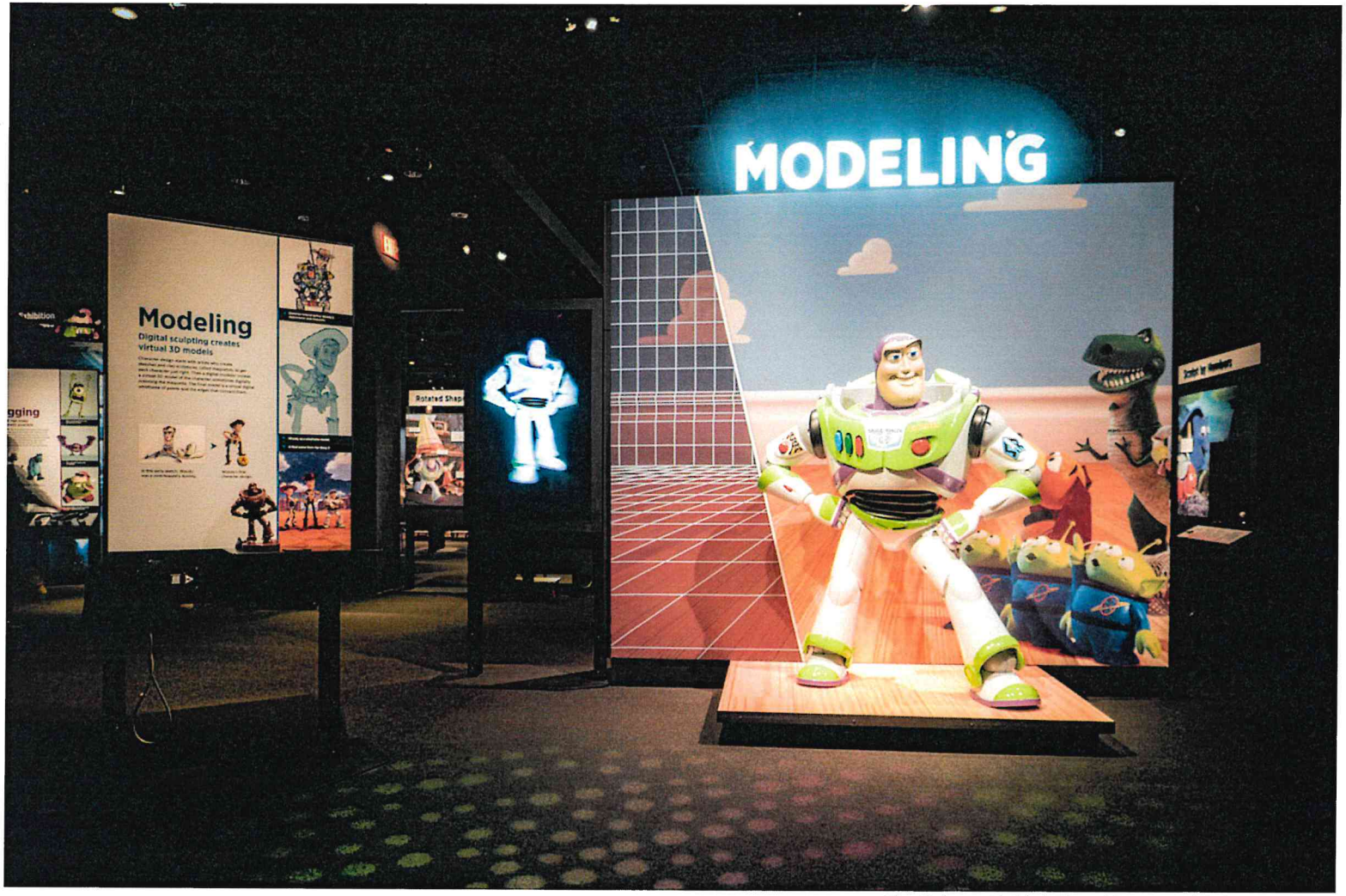
Mystery Skulls

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?

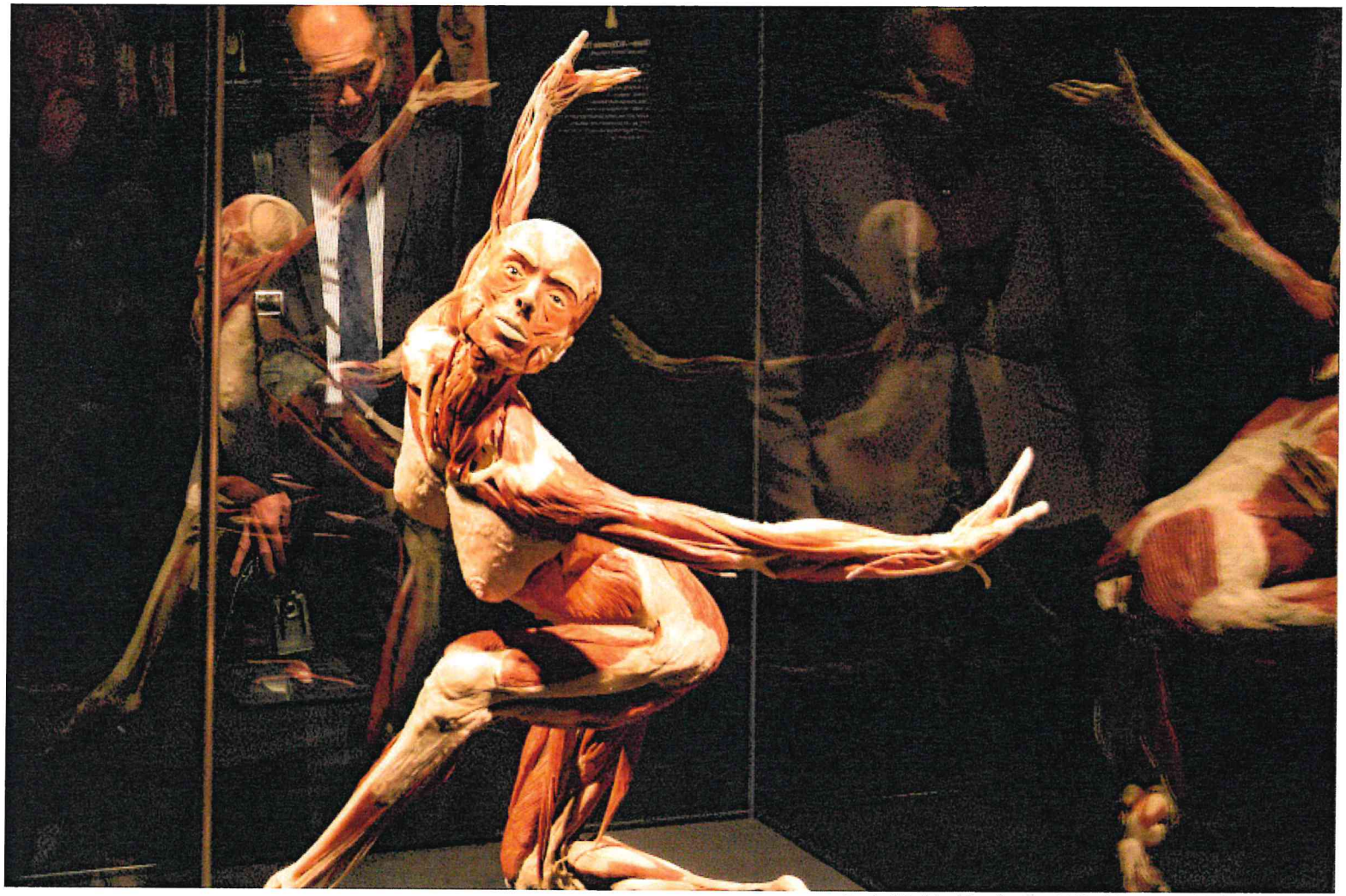


The Science Behind Pixar, Museum of Science, Boston

- 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?

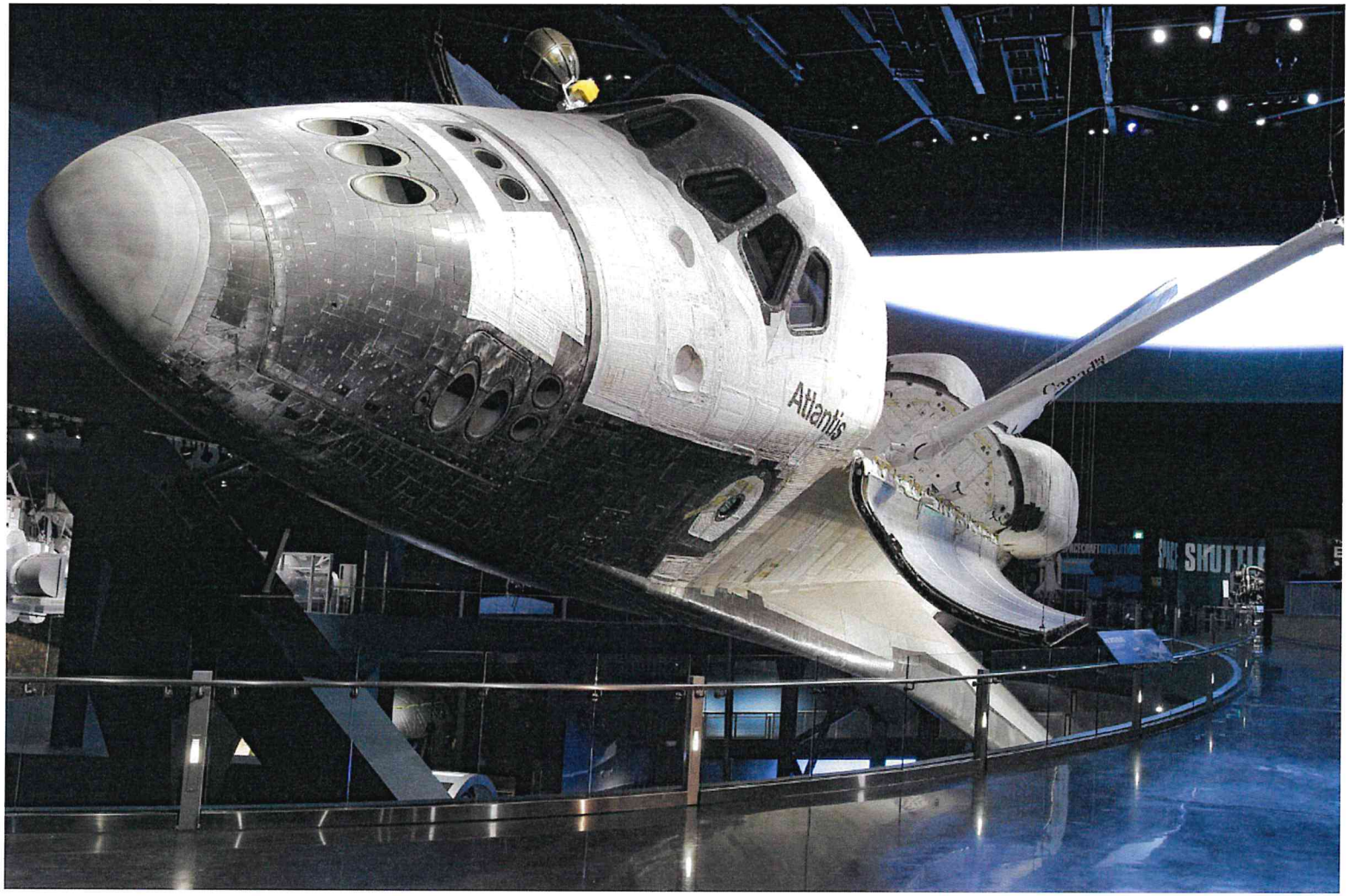
(Turn page over)

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?

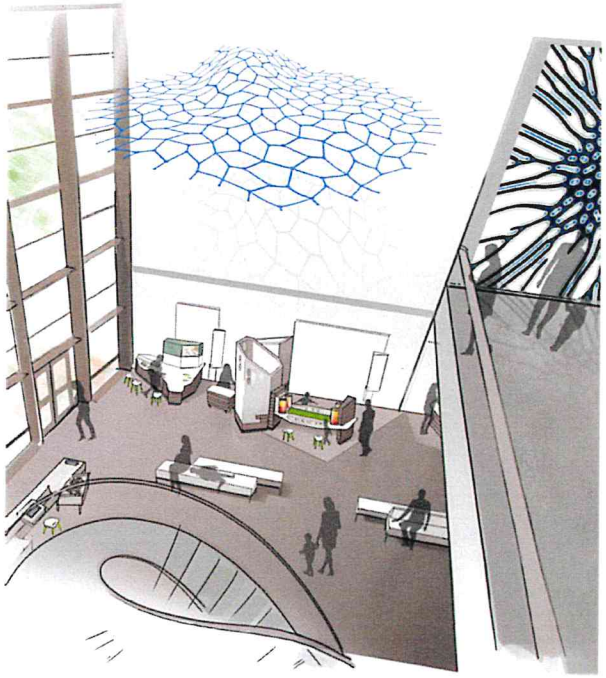


NASA Space Shuttle *Atlantis*, Kennedy Space Center

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

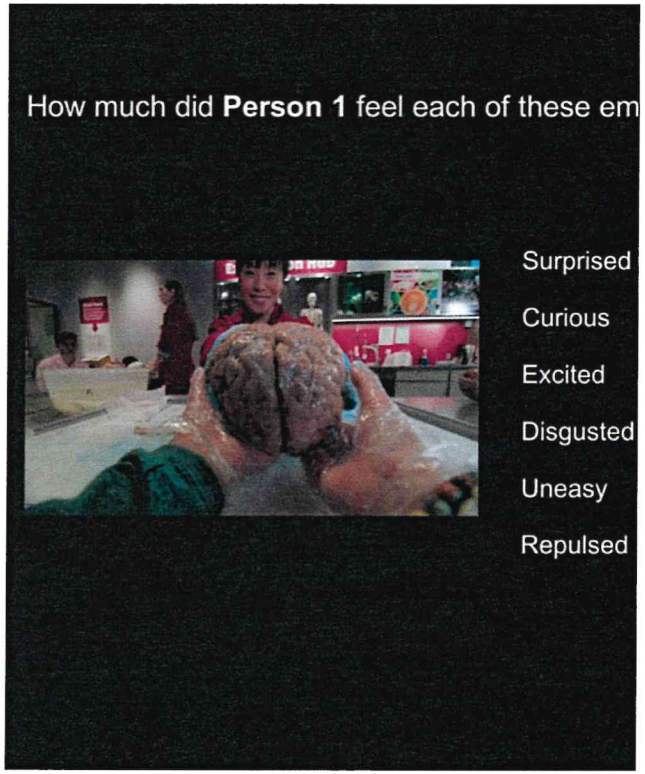
youtube.com/watch?v=B7ZCkgjcXischch

Designing for Emotion



Gallery

Component



Educator/Program