Project: Emotions in the Human Body

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1 Introduction

We all know how it feels to have our heart beat fast with fear and cheek warm with embarrassment. Research on the physiological component of human emotions involves measuring processes that occur in the body that are formative to different emotional experiences. Emotional Self-Awareness is the ability to understand your own emotions and their effects on your performance. You know what you are feeling and why—and how it helps or hurts what you are trying to do. People with a high degree of emotional intelligence know what they're feeling, what their emotions mean, and how these emotions can affect other people. One of the key skills of emotional awareness of self-awareness is to be aware of the changes that emotions produce in the body.

Recent research has highlighted the importance of emotional awareness and emotional intelligence particularly in organizations. Knowing how to understand and interpret bodily responses in accordance to different emotions helps contribute to our quality of life, just as how important it is for individuals to name the emotions. On a macro level, understanding the link between bodily sensations and emotions could open the door for treating a whole range of emotional disorders, such as depression and anxiety, which are accompanied by altered emotional processing, autonomic nervous system activity and somatosensation.

For this project, we collaborated with Greater Good Science Center and utilized the data collected through their online course “Empathy and Emotional Intelligence at Work” to produce our visualizations. We wanted to explore different visualization techniques, combined with a compelling narrative, to show our audience the importance and relationship between emotions and bodily sensations.

2 Project Goals

In particular, we designed our visualizations with four goals in mind:

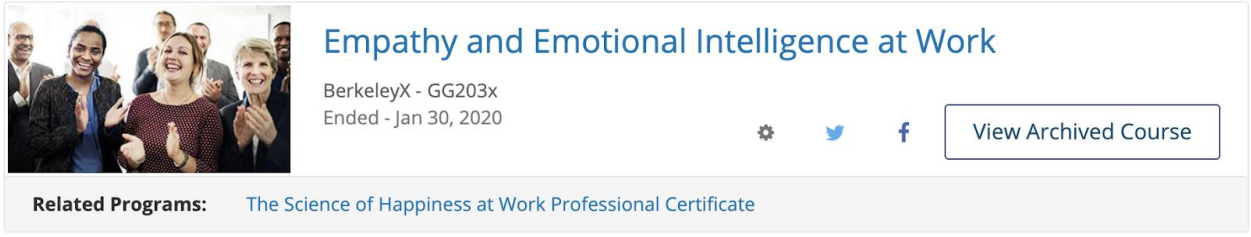
- Visualize where emotions are held in the human body
- Visualize which physical feelings/sensations are most commonly associated with which emotions
- Promote individual awareness and understanding of emotions-body connection
- Provide an interactive learning and engaging learning experience for the users

By employing the following interfaces that allow our targeted users to interact with:

- **Statistical bar charts** that show general distributions of survey responses across different emotions and
- **An interactive body map** that highlights emotional feelings with the associated dominant bodily sensations with different colors
- **An interactive radar chart** that illustrates the sensations felt most commonly
- **Sunburst diagram**

3 Related Work

EdX Empathy and Emotional Intelligence at Work



This is the original online course where the exercise was originally posted and the data collected. The course is open to the global community who enrolled on EdX for free. In the course, students are asked to participate in the exercise named “Emotions in the

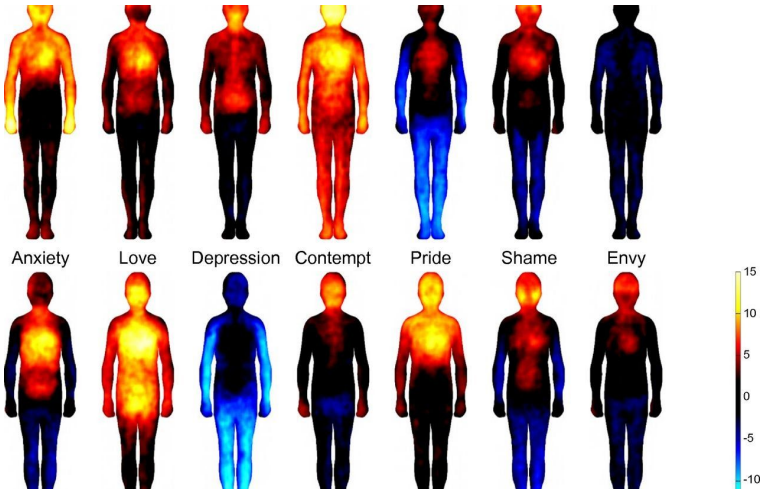
Body: Try it Now” in the “Module 1: Introduction to Empathy and Emotional Intelligence at Work”. The course itself provides a lot of context in empathy and emotional intelligence at work and how the exercise itself could help bring more awareness.

NPR: Mapping Emotions on the Body

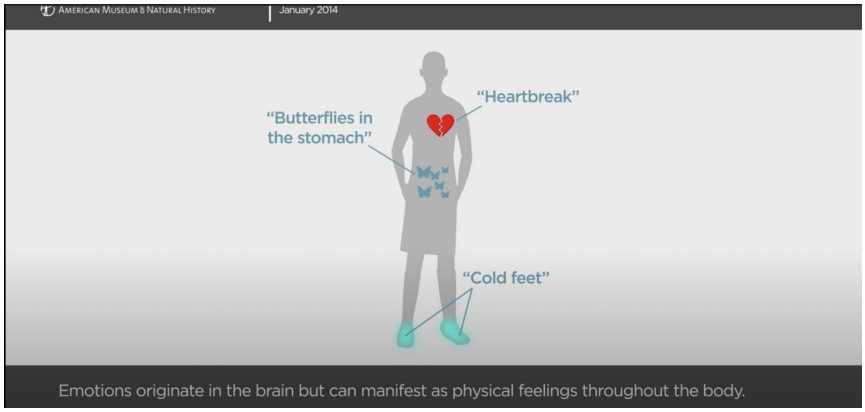
The study discussed in this article asked participants to map where they felt different emotions in the body (linked below). We especially like the way NPR highlighted one prominent finding that arose from this visualization: the brightest colored bodies represented happiness and love, inspiring the title of the article “Love Makes Us Warm All Over”, which demonstrates an excellent way to interpret a scientific research into something engaging to a larger audience.

“Bodily maps of emotions” (Nummenmaa et al., 2014)

The research conducted in this article is very much the inspiration for this project, where the researchers asked participants to map out where they felt different emotions in the body and visualized with statistical software. Because the data collection methods were very similar to the edX data that we are using in this project, it’s very insightful to compare how the resulting data and overall findings compare and contrast to that of our project.



YouTube: Science Bulletins: Mapping Emotions in the Body



While doing research for this project, we also came across a YouTube video that was made as a complementary visualization by American Museum of Natural History. The video walked the viewers through a journey of different conclusions derived through the research about emotions in the body. The video gave us an insight into how a compelling storyline would allow all kinds of viewers to engage with the visualization and explains a complex scientific research very well.

"The Experience of Emotions" (Barrett et al., 2007)

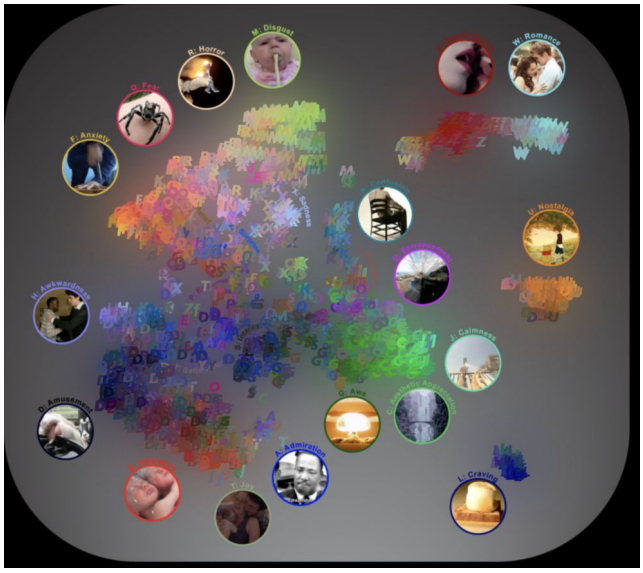
This article is unique from the others in that it analyzes the neurobiological processes of emotion and physiological experiences. It analyzes and explains different theories of emotion and discusses the idea that emotions may in fact arise from physiological reactions that occur in the body.

"Self-report captures 27 distinct categories of emotion bridged by continuous gradients" (Cowen, Keltner, 2017)

This article focuses on the organization of emotion and overall found that 27 different categories of emotion exist. However, one important distinction made is that emotion is not discrete but rather is continuous, as all emotions found within this study are connected by gradients. These findings have gotten us wondering how the different emotions within the edX study could interact with each other and we are certainly curious to see if we find any similarities of reported physical reactions and/or parts of the body stimulated between different emotions.

The Emotions Invoked by Video

This is an interactive map where 2185 of the most emotionally evocative videos that have ever been studied are plotted along the 27 dimensions of self-reported emotional experience they can reliably evoke. The map reveals gradients among distinct varieties of reported emotional experiences, such as the gradients from anxiety to fear to horror to disgust. This interactive visualization of the emotional responses videos provided us with ideas to color-code different emotions.



Body Awareness: a phenomenological inquiry into the common ground of mind-body therapies (Mehling et al., 2011)

We came across this article while researching to articulate the motivations and objectives we have for this project. The article provides a useful insight in proving that enhancing body awareness has been described as a key element or a mechanism of action for therapeutic approaches. Through clinical researches, we had a more empirical understanding of the therapeutic benefits developing bodily awareness of the emotions.

Refugee Crisis

We referred to one of the student projects from previous years' Info Viz final showcase, where we particularly liked the website layout and engaging storytelling methods. At

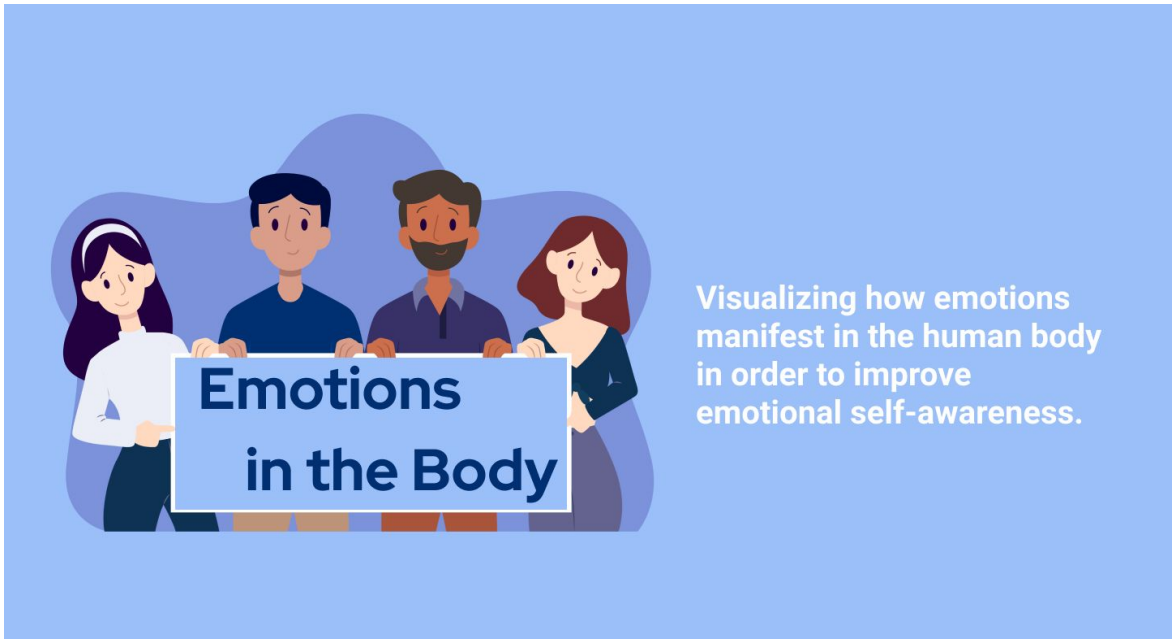
the end of the day, the project is about implementing visualization techniques but also makes sense of the visualizations and texts to tell a compelling story.

4 Visualization

Overall, we wanted to create a visualization that tells a good story, while allowing the users to interact with the visualization for a more intuitive learning. We

Background

We started the visualization by creating an introductory screen and a background section. The purpose of this section is to engage the users and evoke curiosity.



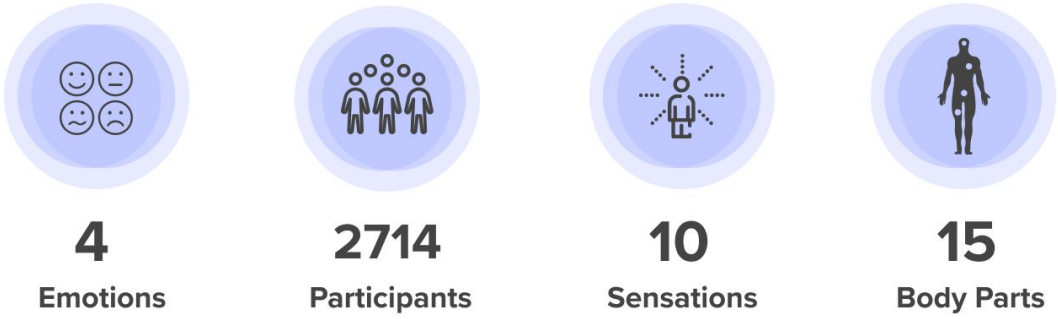
Quotes are generally helpful to piquing curiosity.

"Take care of your body with steadfast fidelity. The soul must see through these eyes alone, and if they are dim, the whole world is clouded."

- Johann Wolgan Goethe -

Here we used iconographs and numbers using techniques learned when creating infographics to provide users an overview of the scope of our project.

We worked to understand how these pieces fit together



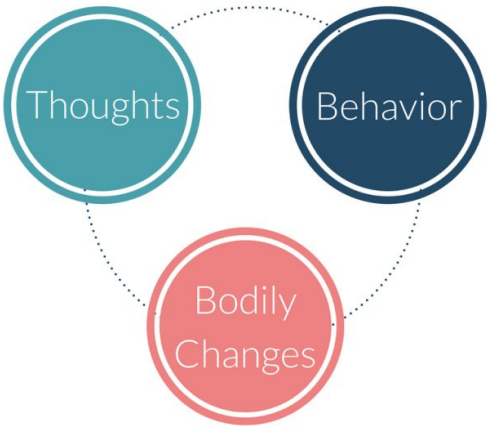
Most emotions have **both a mental and physical** component.

For example,

when we are **nervous**, we may feel a *twisting in our stomach.*

Or when we are **angry**, we may feel *our heart rate increase.*

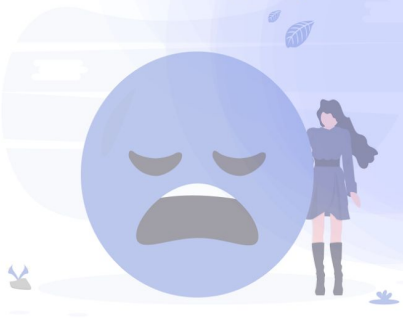
Or when we are **embarrassed**, we *may feel our face blush.*



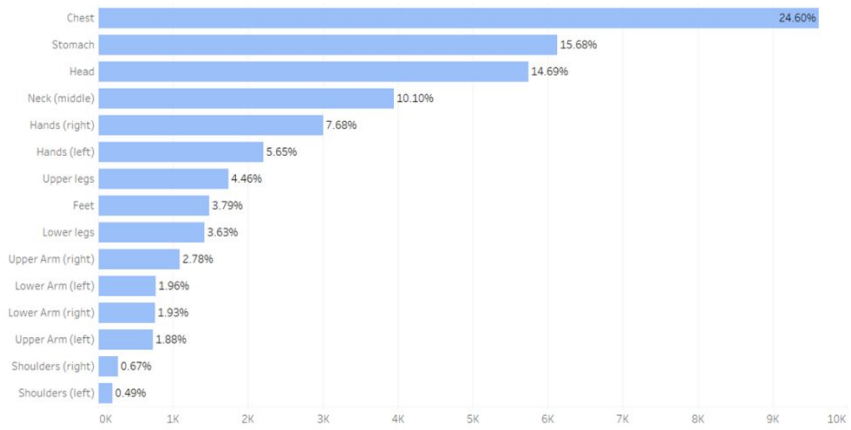
Data Overview

Greater Good Science Center collected data from **2714 participants** in an online course **"Empathy and Emotional Intelligence at Work"** as a course exercise.

The visualizations are created based on these observational data from self-selected samples.



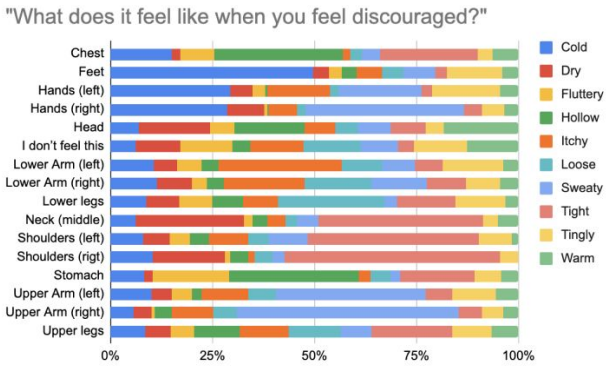
For this sectio, we used statistical charts generated through Google Sheets and Tableau to show the distribution of our data.

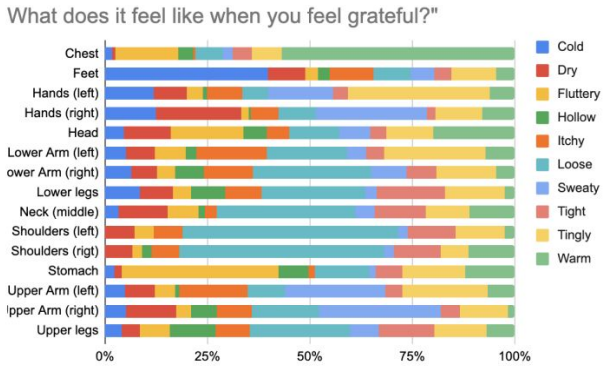


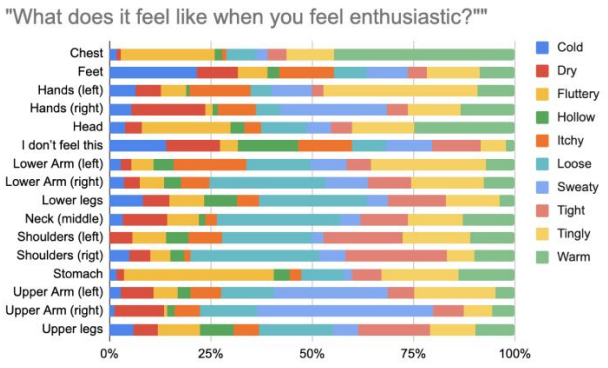
Some parts of the body are more likely to expericene a physiological reaction than others, with the top 3 being the chest, stomach and head.

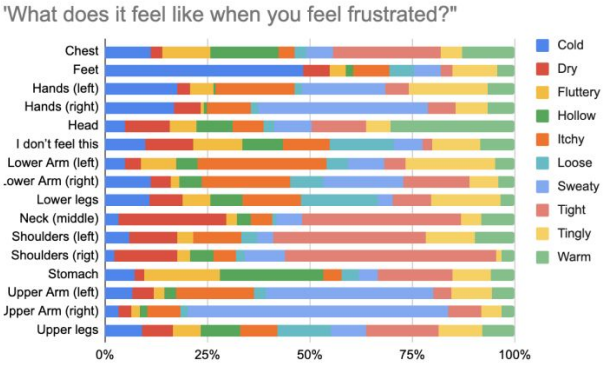
Do you commonly experince sensations in these top reported areas?

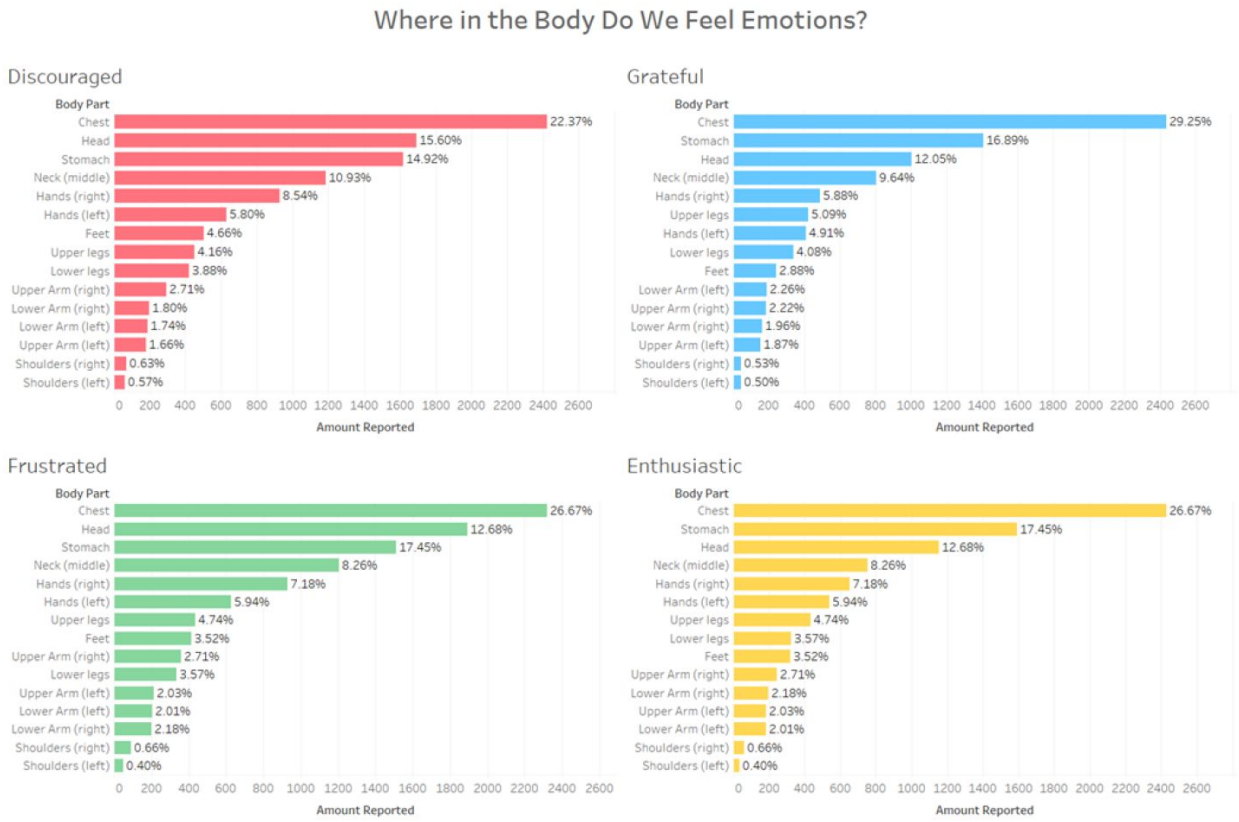
Notice that more people report reactions in their right hand compared to that of their left hand. Perhaps people are more likely to feel sensatins in their dominent hand.











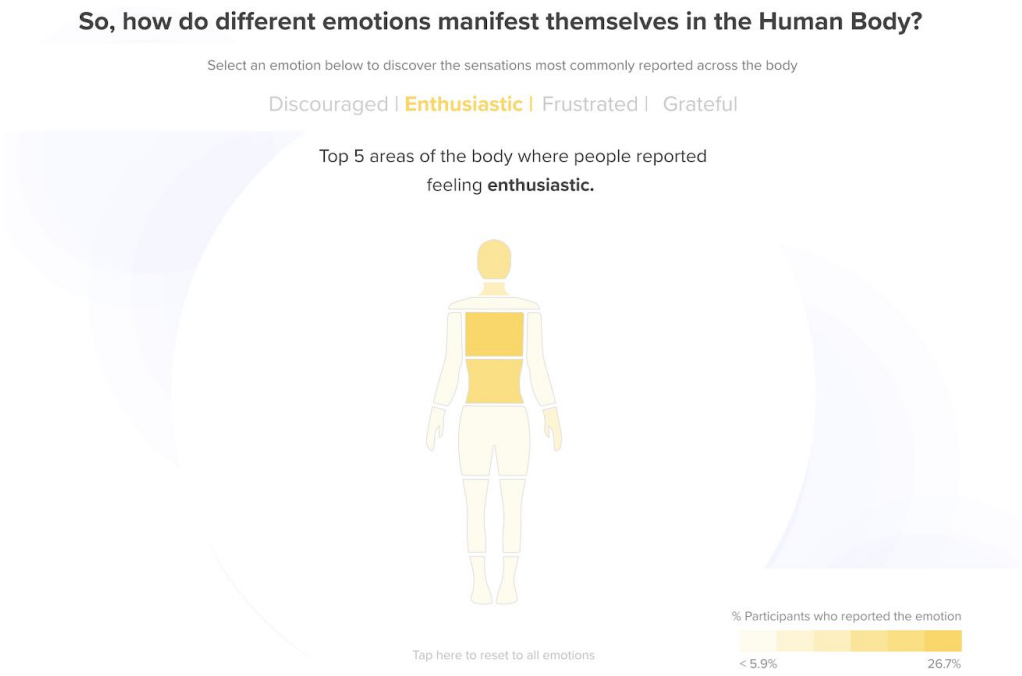
Body Maps

Nothing says emotions and their relationship to the body than mapping them on a body map. We created an interactive body map for each emotion so that users can click through and intuitively see which parts of the body are mostly associated with each emotion and the percentage of participants who mutually felt that way.

We also decided to depict these only through a specific combination of bright & pale colors for positive & negative emotions respectively:

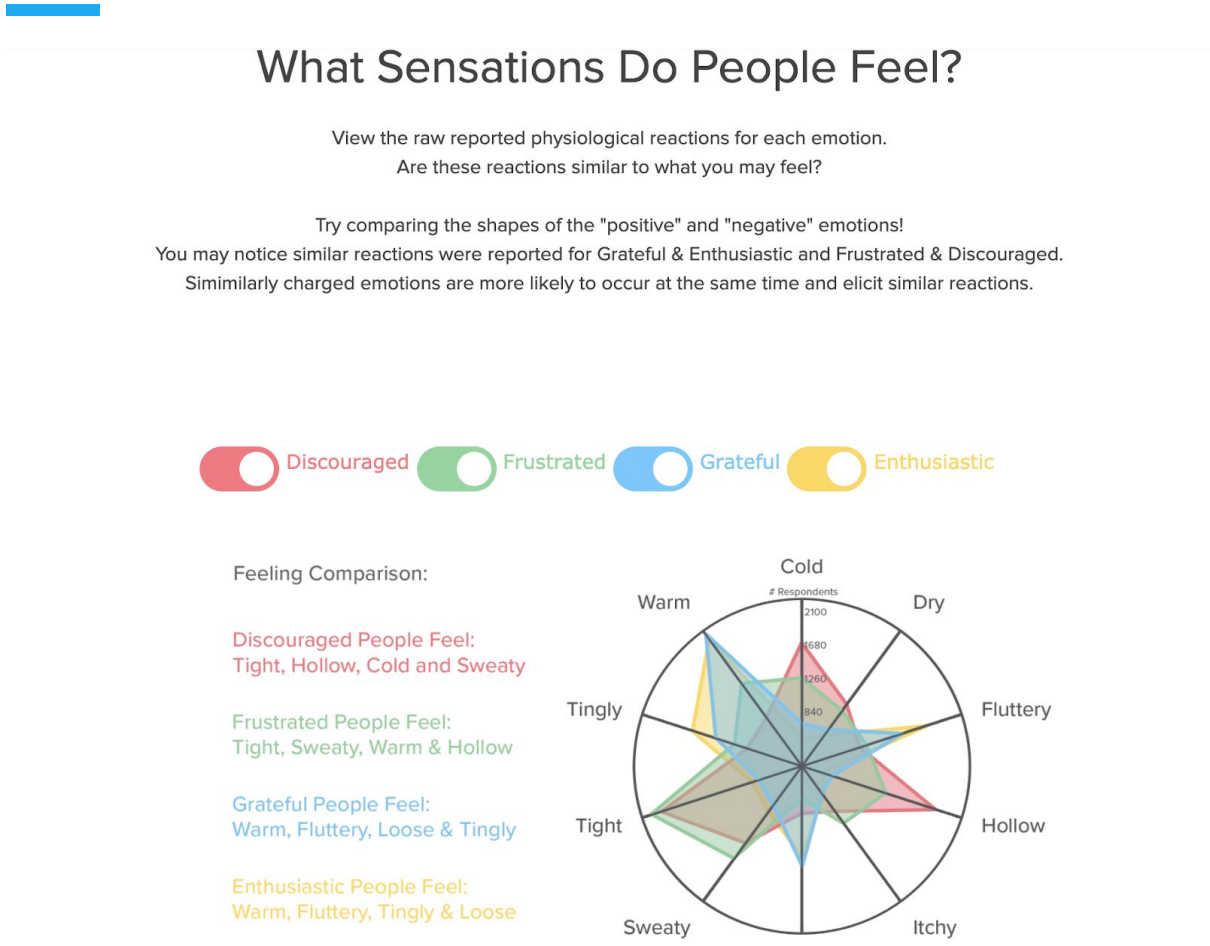
- Discouraged: Pale red, as a mildly warm color considered a shade associated with negative and disappointing feelings
- Enthusiastic: Bright yellow, considered a 'happy color' it's known to uplift your mood and be an energizer and induce optimistic feelings which is what we were going for to depict this emotion across the body

- Frustrated: Pale green, we wanted to go with a muted color with a tinge of grey to relate to this emotion as
- Grateful: Bright baby blue, considered a cool calming color which is what we wanted to go with when talking about this emotion

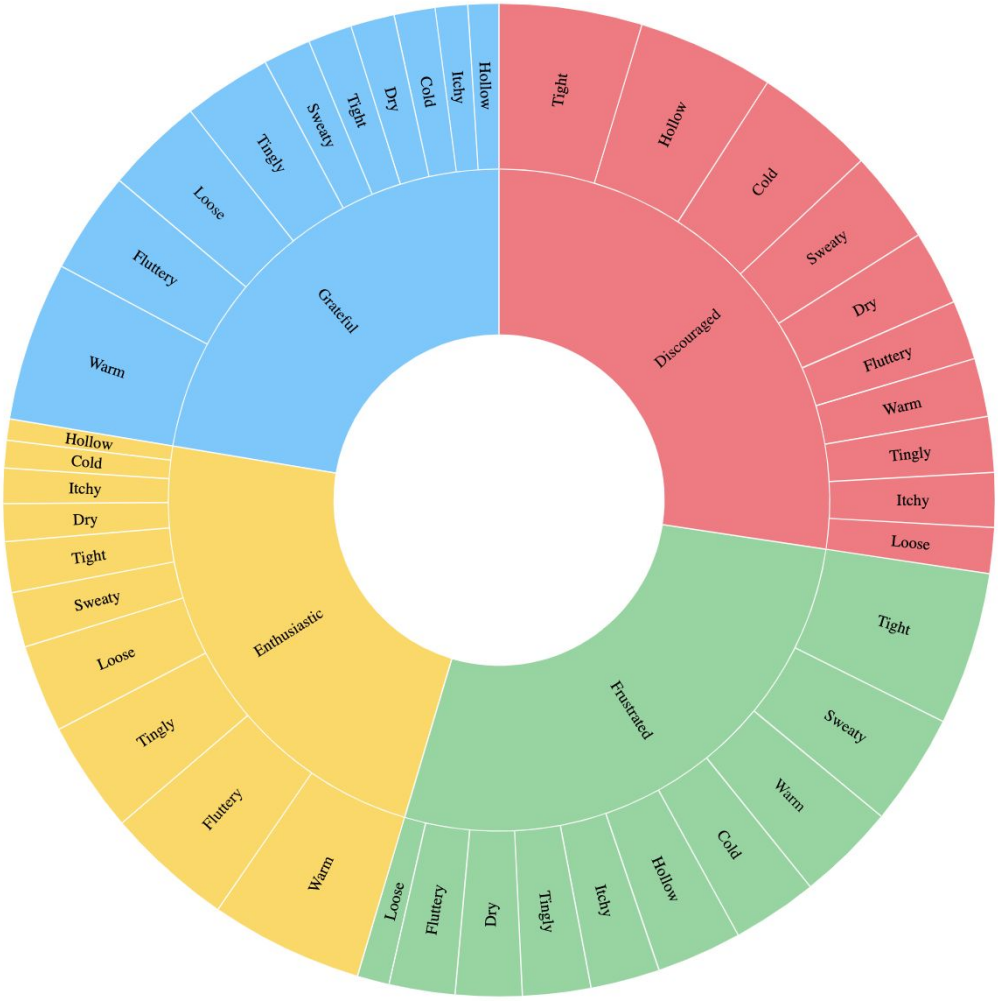


Overall for the background theme of the body chart we went with concentric radiating circles of purple, another calm color to induce the pleasure even across the website as the viewer absorbed all the content and visualizations.

We also created a radar chart that serves a similar purpose that allows users to learn the top sensations participants felt in relation to the emotion experienced.



The sunburst diagram allows the users to explore the relationship between emotions and the bodily sensations by further categorizing 4 emotions that we discussed throughout the visualizations.


Grateful
Warm
Fluttery
Loose
Tingly
Sweaty
Tight
Dry
Cold
Itchy
Hollow
Discouraged
Tight
Hollow
Cold
Sweaty
Dry
Fluttery
Warm
Tingly
Itchy
Loose
Enthusiastic
Hollow
Cold
Itchy
Dry
Tight
Sweaty
Loose
Tingly
Fluttery
Warm
Frustrated
Loose
Fluttery
Dry
Tingly
Itchy
Hollow
Cold
Warm
Sweaty
Tight

Conclusions

Implications

Observe your body
it has an emotional message for you.

Every emotion is related to
physical sensations
in the body.

Your body is wise
and knows what you need.

Visualizing the data can help bring more awareness.

This website was created by Carissa Yao, Kimberly Hirsch and Sneha Chowdhary as a final project for Information Visualization a course at the UC Berkeley School of Information.

The visualizations were created with Tableau, Illustrator, Figma and D3 and are based on data originally accessed through the edX course *"Empathy and Emotional Intelligence at Work"* in collaboration with Greater Good Science Center.

Berkeley SCHOOL OF INFORMATION

Greater Good Science Center

Berkeley UNIVERSITY OF CALIFORNIA

5 Data

The dataset we're working with is collected from the responses of 2714 participants who have completed the 'Emotions in the Human Body' exercise in the "Empathy and Emotional Intelligence at Work" course on edX. We're working with a dataset of 9798 entries (some of the users responded twice and some of the users only filled out part of the 4 emotions, which we will handle during the data cleaning process).

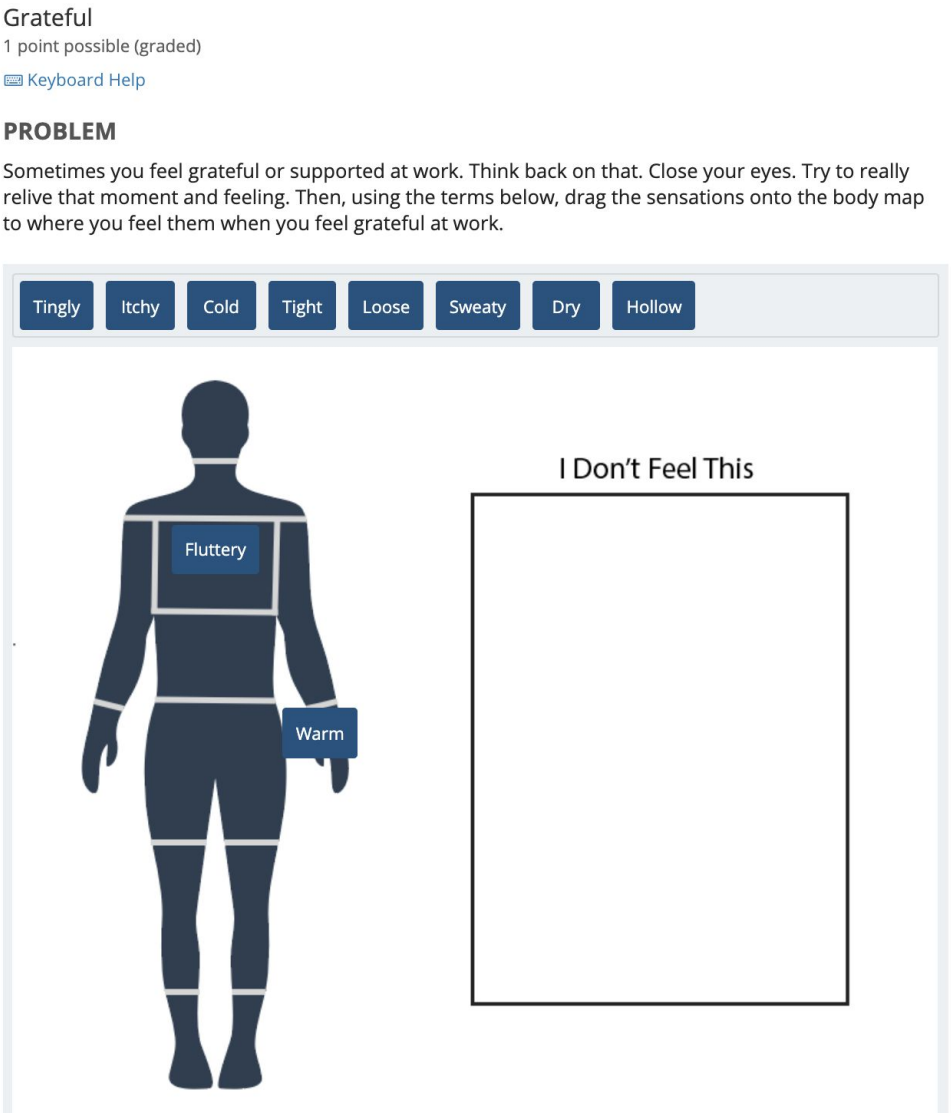


Figure 1 screenshot of the exercise page

	username	Coded_ID	title	location	block_key	state
2	_curiosus_	1	Grateful	Grateful	block-v1:Berkele	{"completed": true, "attempts": 1, "item_state": {"1": {"correct": true, "zone": "zone-6"}, "0": {"correct": true, "zone": "zone-6"}, "3": {"c
3	_curiosus_	1	Enthusiastic	Enthusiastic	block-v1:Berkele	{"completed": true, "attempts": 1, "item_state": {"1": {"correct": true, "zone": "zone-9"}, "0": {"correct": true, "zone": "middle"}, "3": {"c
4	_curiosus_	1	Frustrated	Frustrated	block-v1:Berkele	{"completed": true, "attempts": 1, "item_state": {"1": {"correct": true, "zone": "zone-6"}, "0": {"correct": true, "zone": "bottom"}, "3": {"c
5	_curiosus_	1	Discouraged	Discouraged	block-v1:Berkele	{"completed": true, "attempts": 1, "item_state": {"1": {"correct": true, "zone": "zone-6"}, "0": {"correct": true, "zone": "zone-6"}, "3": {"c
6	-Lynn-	2	Grateful	Grateful	block-v1:Berkele	{"completed": true, "attempts": 1, "item_state": {"1": {"correct": true, "zone": "top"}, "0": {"correct": true, "zone": "top"}, "3": {"correct":
7	-Lynn-	2	Enthusiastic	Enthusiastic	block-v1:Berkele	{"completed": true, "attempts": 1, "item_state": {"1": {"correct": true, "zone": "zone-6"}, "0": {"correct": true, "zone": "zone-6"}, "3": {"c
8	-Lynn-	2	Frustrated	Frustrated	block-v1:Berkele	{"completed": true, "attempts": 1, "item_state": {"1": {"correct": true, "zone": "zone-8"}, "0": {"correct": true, "zone": "zone-6"}, "3": {"c
9	-Lynn-	2	Discouraged	Discouraged	block-v1:Berkele	{"completed": true, "attempts": 1, "item_state": {"1": {"correct": true, "zone": "zone-4"}, "0": {"correct": true, "zone": "zone-6"}, "3": {"c
10	-Suzanne-	3	Grateful	Grateful	block-v1:Berkele	{"completed": true, "attempts": 1, "item_state": {"1": {"correct": true, "zone": "top"}, "0": {"correct": true, "zone": "bottom"}, "3": {"corre
11	-Suzanne-	3	Enthusiastic	Enthusiastic	block-v1:Berkele	{"completed": true, "attempts": 1, "item_state": {"1": {"correct": true, "zone": "top"}, "0": {"correct": true, "zone": "bottom"}, "3": {"corre

Figure 2 screenshot of the first few rows of the dataset

Figure 2 is a screenshot of the raw dataset downloaded via edX, which includes

- edX username: which we will de-identify once we start our project
- Coded_ID: participants' unique ID on the course
- title/location: emotion (grateful, enthusiastic, frustrated, discouraged)
- State: data in json that contains user's answers to sensations (coded by numerical number) in parts of bodies (coded by zone-x) when experiencing different emotions

Data cleaning

The original dataset we acquired consisted of responses from 2714 Participants, with a total of 9798 records. Where some of the users responded twice and some of the users only filled out part of the 4 emotions, this was one of the challenges we tackled with our data cleaning. Another challenge lay in the format of our data. As 'feelings' (self-reported sensations) that respondents felt for each 'emotion' were captured in a zone which corresponded to a body part, this data was captured in the dataset in a nested JSON format, which was not readable or usable for the purpose of our EDA.

In order to account for unique participants who expressed bodily emotions i.e. 'feelings' in zones or body parts for any of 4 emotions (Gratitude, Discouragement, Enthusiasm and Frustration) and convert this information from its natural JSON format to one more usable. We chose to clean our data according to the following criteria:

- Retaining 'Emotions' for participants for every completed state

    - Retaining records of participants who have 4 or less than 4 distinct emotions for every unique code (even if it's just 1 emotion per person), provided they have completed 'states'

- Entirely eliminating duplicate entries
    - Any records of participants having double entries per user ('coded ID') were eliminated entirely as there wasn't a parameter to retain only 1 entire set of their emotions

- Eliminate the data without any responses or partial responses for 'states' (eg. row 9087 9779)
    - Records with empty states were eliminated to prevent incorrectly skewing the resultant dataset and produce meaningless outliers
    - Allowing us to account for true participants, those who correctly mapped feelings to body parts, contributing to the successful completion of this module

- Processing the 'state' column into 'Feelings' & 'Body parts' from their given zones
    - To ensure a readable dataset for viewers eventually, give the JSON format represented in 'codes' for the feelings ranging from 0-9 and 'zones' for body parts, we actualized these properties to their corresponding real values for presentable data analysis

Code - Feelings	Zone - Body Parts
0 = Fluttery 1 = Tingly 2 = Itchy 3 = Cold 4 = Warm 5 = Tight 6 = Loose 7 = Sweaty 8 = Dry 9 = Hollow	Top = Head Middle = Chest Bottom = Stomach Zone 1 = Upper legs Zone 2 = Lower legs Zone 3 = Feet Zone 4 = Lower Arm (left) Zone 5 = Lower Arm (right) Zone 6 = I don't feel this Zone 7 = Shoulders (left) Zone 8 = Hands (left) Zone 9 = Hands (right) Zone 10 = Upper Arm (left) Zone 11 = Upper Arm (right) Zone 12 = Neck (middle) Zone 13 = Shoulders (right)

- Thus, creating new columns in our data set where - column titles corresponded to a physical reaction (feeling) and cell block values contained the zones (body parts)

All of the above manipulation & data cleaning was carried out with the help of a python script we wrote from scratch to meet our requirements. The resulting dataset from this process was further modified to exclude columns - state & block_key, which played no role in our analysis. The final dataset we proceeded with consisted of 2433 participants, represented in 9064 records.

6 Tools

Requirement	Tool

Data cleaning & EDA	Python Google Sheets Excel
Data Visualization	Tableau Illustrator Observable d3.js
Design	Figma Illustrator
Demo	HTML/CSS GitHub Pages

7 Results

We conducted a usability test with 3 perspective users to understand what our targeted users are able to identify from the visualizations of a body chart, an interactive zoomable circle unpacking and its comparison to radar charts. We also assessed what users find more comprehensible and are easily able to relate to a better story as they scroll. We hope to understand the possible affordances and interactions that would be required to integrate during the implementation phase of our project.

Our target user base is rather broad but given the situation and time constraints, we're looking to test our sketches and designs with audiences based on certain age, behavioural & technology criteria. We plan to select participants who meet the screening criteria mentioned below by having them fill out a pre-test survey. The participants who participated in the test are all individuals aged 18+, who showed curiosity in emotions but not very familiar with the relations between emotions and body. Given this project will be hosted & used on the web, we chose participants who are comfortable using the internet and familiar with a web landscape & navigation layout.

Methods: We tested & measured digital versions of our designs since they capture how participants could interact with it on a website, with our 5 second test & click tests. We collected this feedback via exposing them to visual stimulus and analysing their assessment on prolonged exposure. We also recorded the time spent on each task, which could indicate which visualizations are the most complex as well as the number of questions that they asked while completing the task to gauge confusion.

Results: Overall our usability studies were very insightful and even validated some initial hypotheses during our discussions on how viewers might interpret associations between emotions and reported physiological reactions or how they prefer interacting with different visualizations (body chart vs zoomable circle unpacking vs. radar charts).

Learnings from our study:

1. Studies tend to take longer than anticipated, practicing ahead in time would help
2. Users reactions are powerful in indicating how they feel, which was an essential feedback on its own especially when comparing it to what they said
3. Timing tasks & quantifying confusion via ‘Number of questions users asked’ is tricky and hard to keep track if not diligently followed through on
4. Surveys are multifaceted and can be used for note taking, easily drawing comparisons between responses while collecting users inputs as well.
5. Context & descriptions are greatly appreciated and must be incorporated throughout, even for the purpose of usability testing
6. While we conducted the tests on targeted audience, the diversity of the participants also mattered (e.g. knowledge in data and visualization, emotions and body connection), which helps generate valuable insights
7. Conducting the 5 second tests before the click tests did not result in biasing participants ‘aesthetically’ or skewing results, as we initially were concerned about

Changes we incorporated from our findings:

Body Chart Visualizations

1. When zooming in on an emotion, it is helpful to retain the other emotions to continue acting as a means of navigation
2. On hover cues of the body parts could be a big help to indicate that the different parts are clickable
3. Though the body itself grabbed attention, its surrounding halo/circular orb grabbed even more attention acting as a distractor, which needs to be toned down/removed
4. Viewers preferred comparisons of all body parts depicted in the chart and would prefer seeing the distribution of responses in remaining body parts as well
5. Interactivity with body parts was engaging and much appreciated
6. Metrics can be confusing if not paired with the right terminology of legends, can even we be secondary and placed in the call outs to appear only when body parts are clicked

As we played with the data to create this chart and conducted our tests we also realised that participants who reported these feelings, commonly reported:

1. Emotions only in 5 parts of the body - majorly (which varied for different emotions)
2. Feeling more in their right hand than the left, which could be because the population is dominantly ‘right-handed’ than left handed
3. Additionally, when speaking with the greater good team we also discovered that they had participants report feelings in both hands separately due to a technical infeasibility of their ‘drag-drop’ functionality on the website/course, which led to this skewed depiction

Circle Packing to an interactive Sunburst Chart

1. From the results shown in the likert scale for this visualization, it's apparent that more context and descriptive language is required. For the final website design, a header, along with descriptive text to the side of the visualization, should be added in, as a thorough walkthrough to discover the circles on the website would be helpful.
2. It also could be helpful if labels were added in so that the viewer can read which reactions correspond to each circle from the primary view of all 4 emotions.
3. Participants tended to click directly into the third level of circles from the primary view rather than going into the second level first. This often confused participants because skipping the second level removed a great deal of necessary context, being that they had no idea which sensation the bodily reactions correspond to. With this said, it would be ideal if the visualization did not allow the viewer to skip this middle step. If we are unable to make this change for the current visualization we may transfer it to a treemap, as the JSON data will translate well to this type of visualization.
4. Additionally, it is difficult to compare the different circles. With this said, a menu of sensations may be added in off to the side that the user could click on and it would highlight the sensation's circle within all 4 emotions.
5. Participants were also confused by the meaning of the percentages, especially for the primary level. We will most likely remove the percentage from this level and have to figure out how to add in further description for the other levels.

Interactive Radar Chart

1. This chart is strong at depicting comparisons of extrema and the simplicity of it was appreciated by participants. Compared to the circle packing, this visualization

was easier to take in & understand what was happening between the different emotions and feelings.

2. Interactive functionality is being considered such as highlighting feelings or stacking emotions and then have participants discover them through highlighting
3. The numbers on the scale were found to be inconsistent for all four radar charts. This will be adjusted immediately.
4. The number labels may not even be necessary for this visualization as their context is unclear (as they describe the total number of respondents that reported feeling each sensation). With this said, they may either be removed or changed to percentages.

Overall Website

1. Because our goal is to build a static website with all the background information and the visualizations, the usability test was primarily testing the overall flow, aesthetics as well as the effectiveness of storytelling. We found that the participants generally liked the flow and the aesthetics of the website. In particular, participants enjoyed the calming blue color of the website and the illustrations throughout.
2. The only 2 hyperlinks created in the website are shortcuts to “visualizations” and “about” pages, which were appreciated by the participants.
3. For storytelling’s purpose, we will reshuffle the layout of the visualizations so that they start from simple charts like radar charts and stacked bar charts to interactive circle packing bubble gram. We will also implement the color coding and font to the bar charts for easier comparison.

Overall Feedback (User Quotes):

“I had no idea that there were direct relations between my emotions and the feelings in the body. It’s really cool to see that!”

“I liked the blue color tone and the illustrations of the website - very calming. The radar chart is also very straightforward and understandable”

“I think the interactive component helps with my understanding and attention.”

8 Links

Type	Link to access
Project Demo	https://kimberlyhirsch88.github.io/BodilyEmotions/
Figma Body Map	https://www.figma.com/proto/x9d7y7P7peg78rBajTxOzj/BodyMap-AllConnected?node-id=1%3A2&scaling=scale-down
Sun-Burst Observable	https://observablehq.com/@khirsch/zoomable-sunburst
Github Repository:	https://github.com/kimberlyhirsch88/BodilyEmotions
Usability Guide	https://docs.google.com/document/d/1c8LA8YTKD4_bWpJ6jxtEHZJKnr6YcO1-4HPvUDdl8n0/edit#heading=h.n202zfe956ki
Web Design - Figma	https://www.figma.com/file/1gdqKMGpYVCf0iB9fqSwfR/Emotions-in-the-Body
Other references	https://www.creativebloq.com/web-design/12-colours-and-emotions-they-evoke-61515112 https://fivesecondtest.com/

	https://www.creativebloq.com/web-design/12-colours-and-emotions-they-evoke-61515112 https://www.verywellmind.com/theories-of-emotion-2795717 Science Bulletins: Mapping Emotions in the Body

9 Individual Contribution

Project Component	Sub Component	Carissa	Kimberly	Sneha
Data Preparation	Data Sourcing	100%	-	-
	Literature Review	50%	30%	20%
	Data Cleaning	-	50%	50%
Visualizations	EDA/Statistical Charts	30%	50%	20%
	Body Map	-	-	100%
	Radar Charts	-	100%	-
	Sun burst	-	100%	-
Design	Website Layout	60%	20%	20%

	High Fidelity	40%	-	60%
	Website Writeup	80%	10%	10%
	HTML/CSS	-	100%	-
User Testing	Guide Writing	30%	-	70%
	User Testing	33.3%	33.3%	33.3%
	Report Writing	30%	10%	60%
Final Writeup	Report Writing	60%	20%	20%