



# Exploring Laughter Sound Visualizations for Self Reflection

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## ABSTRACT

We present an exploratory design study on visualizing laughter sounds for personal reflection. We experimented with a variety of graphic design elements to visualize temporal, spatial, and social aspects of laughter sounds. In order to experience their own laughter being visualized, our participants collected audio recordings of everyday conversations with their loved ones. We extracted laughter from the participants' audio files using a machine learning algorithm, then visualized selected laughter in five different types of visual representations, and shared the result with each participant. Through the journey of collecting, seeing, listening to, and interacting with their personal laughter visualizations, participants explored what laughter means for them in different contexts. The study reveals that interactive laughter visualizations have the potential to evoke memories, support emotional expressions, and promote relationships.

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## INTRODUCTION

Laughter is an indispensable part of our everyday life. It typically results from a person's pleasant psychological shift [8], indicating a positive mood. Each laughter reveals a certain characteristic that is unique to the speaker and the circumstance [25]. It is a social vocalization usually provoked by others where people experience joyful moments together [23]. Laughter is contagious and contributes to interactional intimacy [23,26]. It contains and conveys rich personal emotion embedded in its social context, yet it is ephemeral for a few seconds. Designing instances of laughter as visual representations makes the transitory enjoyment enduring. This may be particularly pertinent given the current COVID-19 pandemic where we are experiencing an unprecedented length of social distancing. Being able to reflect on positive laughter shared with friends, family, and loved ones via interactive visualizations may serve as an additional venue for us to feel more connected with them in times of isolation.



We explore the role laughter visualization could play in celebrating the uniqueness and expressivity of each individual's laughter, eliciting memories, and promoting relationships between individuals. Laughter is both emotive and personal, so we take a different approach from a traditional sound/music visualization [16,21]. Compared to sound visualization, we believe laughter visualization should put evocative and affective elements more to the foreground so that they can be preserved, shared, and reflected upon [22, 31].

### Author Keywords

Laughter; Sound; Interactive Visualization; Interface Design; Emotional Design; Reflection; Personal Informatics

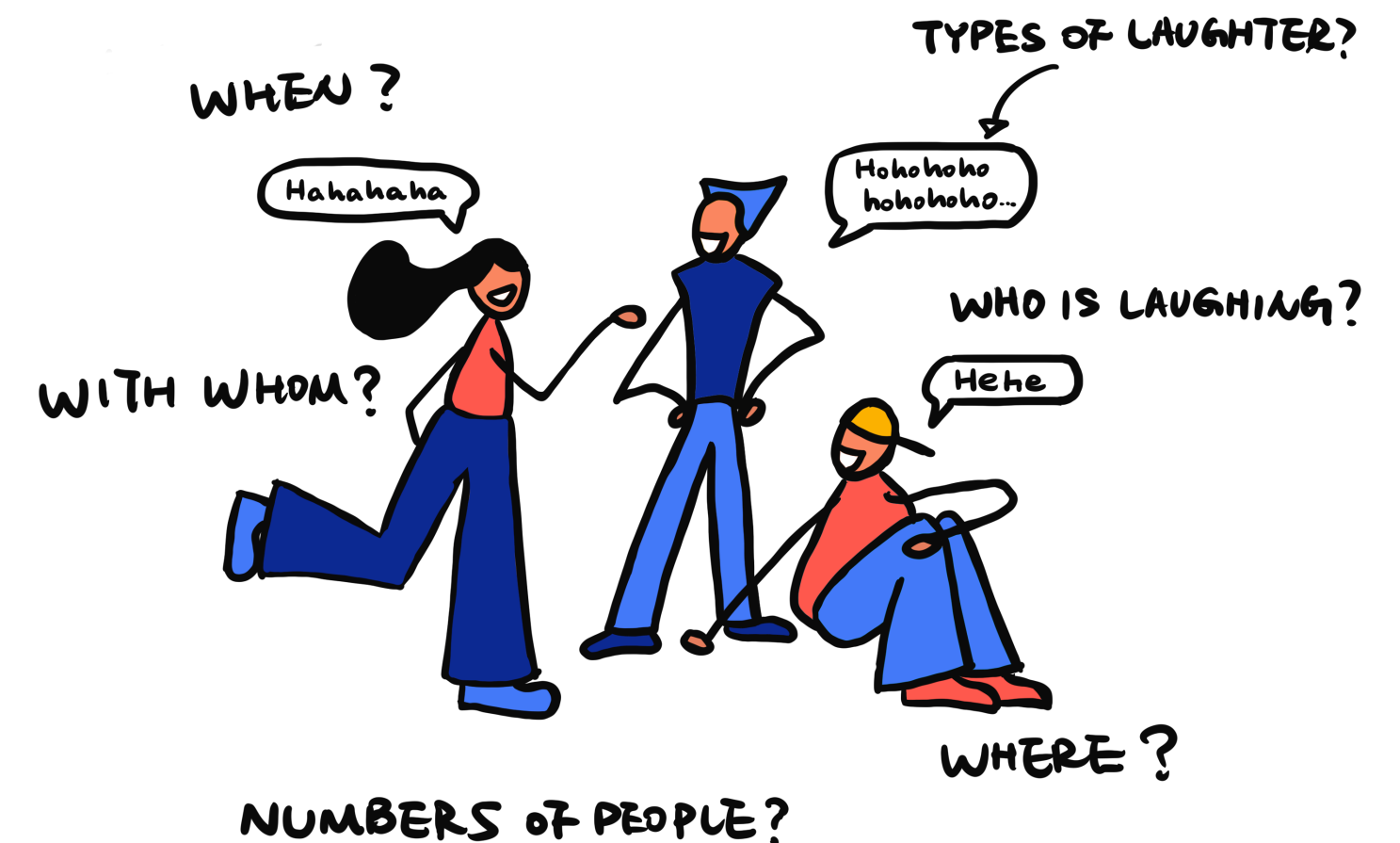
### CSS Concepts

Human-centered computing: Human computer interaction (HCI)

## BACKGROUND & RELATED WORK

Significant efforts have been made to represent sound in different visual forms. Stanford and Schmidt visualized sound by the real-time reflection of soundwaves' physical property on various media [20,30]. Morena, Levin & Lieberman designed with the human voice by creating animations made with strings [7] and virtual costumes [5]. Hurle and Grego visualized each frame of music as 3D morph [12] and moving graphics [24], while George & Jonathan III and Makio135 visualized an entire music piece with fluid moving images [3,19]. Soundviz and Lei have transformed ephemeral sound into preservable visual [27] and tangible art [29]. Suzuki developed a playful system using drawing to create sound [34]. These visualizations creatively visualized commercial music, sound effects, and human voice, yet were not designed for visualizing laughter sound.

Prior research has demonstrated that laughter can be captured, preserved, and reflected through a variety of representations. Ryokai et al. designed individuals' laughter as tangible forms [13,14] and visual representations in mobile augmented reality [15]. Laughter can also be used to release pressure and promote interaction. Deshpande et al. used laughter as the controller of the game mechanics to bust stress [2] and Lee et al. designed wearables using laughter sound to evoke interaction among strangers [28]. Illustrations by Lupi & Posavec, Sadler, and Roberts portrayed a collection of laughter across a temporal scale for self-reflection [4,6,17]. However, these were not interactive prototypes. Previous studies have shown that speech input can be visualized for self-tracking [32, 33]. We have yet to see the range of laughter sound visualizations and their potential applications, which led to the current study.



## VISUALIZING LAUGHTER

# Understanding Context of Laughter

The context in which laughter visualization may exist is different from commercial sound or music visualization. We have identified several design elements based on previous research and related work. Laughter treated as a soundwave has all of the properties attributed to a wave, such as frequency, amplitude, waveform, and duration. However, there are also unique properties of laughter that make laughter visualization distinct from traditional sound visualization: the **speaker of laughter** - whom the voice belongs to; **number of people** involved - whether it is single-voice laughter or a mix of multiple voices; **types of laughter** - whether it is a giggle, chuckle, or belly laugh; and **purity of laughter** - if there are words or sentences captured along with the laughter. Some of the design elements are beyond the quality of the laughter sound, such as **when** and **where** it was made, on **what occasions**, and **with whom** laughter happened [1,8,11,23,25,26]. Laughter visualization can range in resolution from presenting the detailed quality of each individual laugh to showcasing the overall quantity of laughter occurrences over time. A designer will need to consider many factors in selecting and combining elements to achieve the design goal. We have created numerous sketches of laughter visualizations based on these different properties of laughter. Through a pilot study, we learned that laughter visualization based on a longer time scale and a broader activity range would lead to fruitful results. From our initial sketches, we selected laughter visualizations of five different types that covered the properties mentioned above to explore potential visualization techniques.



# Laughter Visualization Design

We selected and developed five different types of laughter visualization that highlighted different aspects of laughter:

**Laughter Trees:** focused on the quality of individual laughter based on its amplitude;

**Laughter Calendar:** focused on the quantity of laughter over time;

**Laughter Map:** focused on the quantity of laughter over space;

**Laughter Creatures:** treated laughter as anthropomorphic representations;

**Laughter Paintbrush:** used laughter as a medium for drawing/painting.

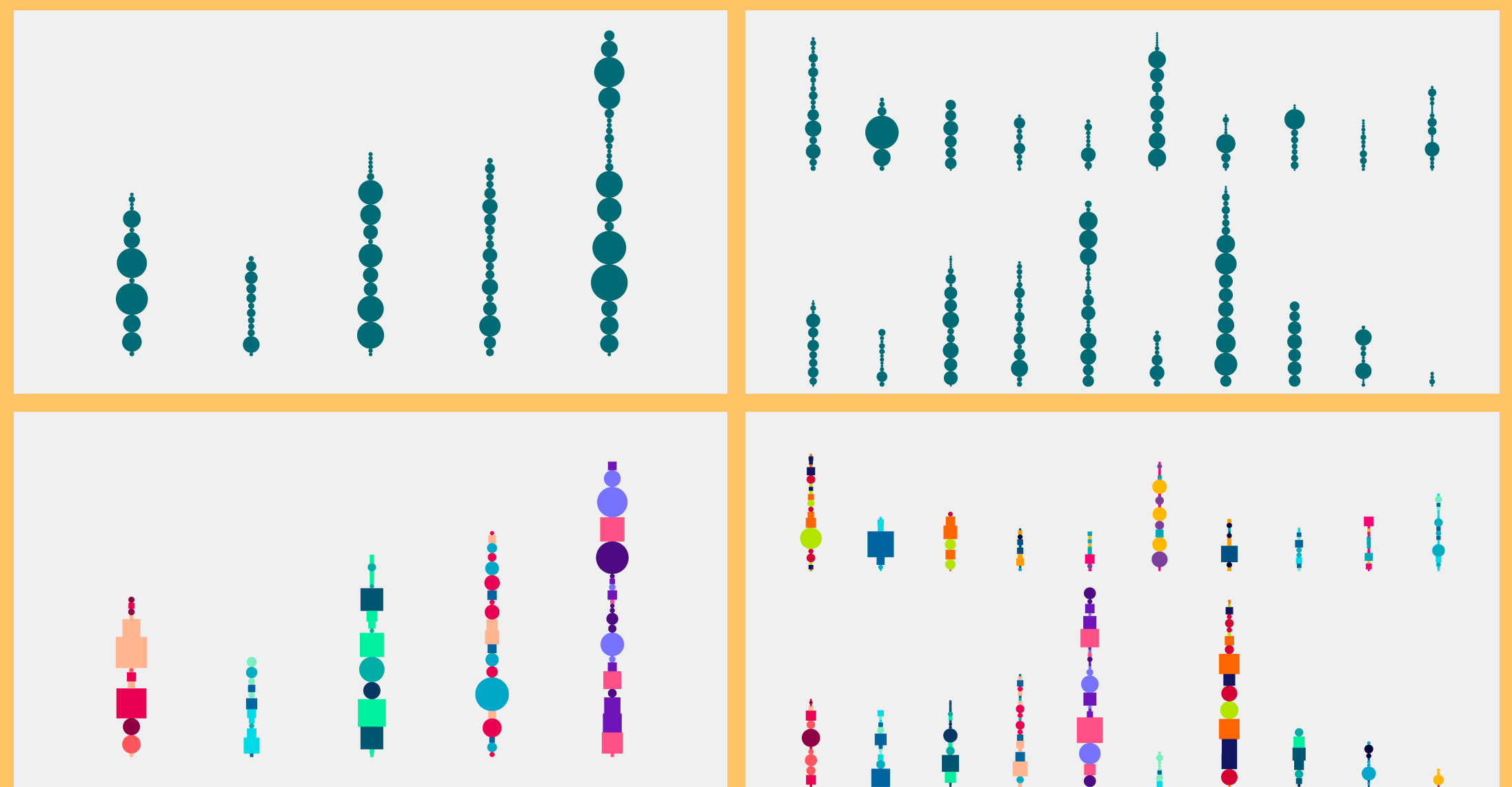
The visualizations ranged from mockups, to interactive animations with laughter sounds, to fully working interactive prototypes. The interactive prototypes can be viewed here: <https://bit.ly/3Efm8N>

## Laughter Tree

The goal of the Laughter Tree design was to visualize the individual quality of laughter instances. This visualization represented each laugh sound as a string of shapes and was fully interactive. We designed the algorithm to read the amplitude of the laughter sample every 0.2 seconds and mapped it to the size of the circle. When clicked, circles gradually appeared on top of each other in sequence synchronized with the laughter sound. One could listen to the laughter while seeing its tree-shaped pattern grow.

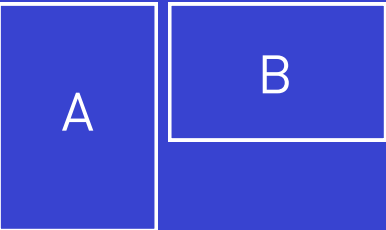
We created two versions of a Laughter Tree: Version A contained five interactive laughter patterns made of monochrome circles. Version B was a variation based on A where different speakers are represented with contrasting color palettes (e.g., a blue palette for speaker 1, a red palette for speaker 2), further adding squares in addition to circles to make the growing shape more varied and interesting. For each variation, we created two views: micro-view (A1 and B1 showing 5 laughter instances) and macro-view (A2 and B2, showing 20+ laughter instances) so that the participants could see the details as well as the whole.

A1	A2
B1	B2

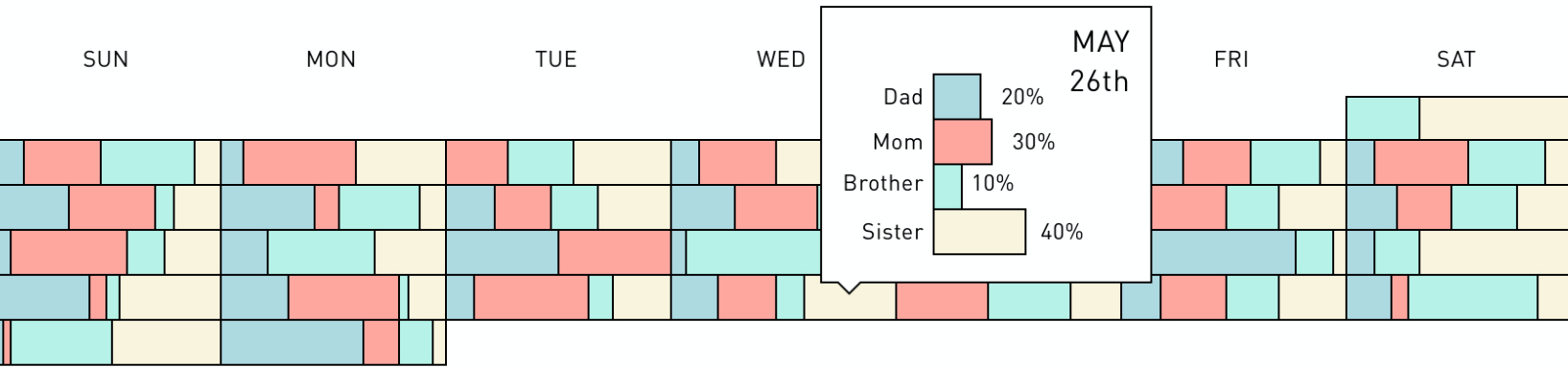


# Laughter Calendar

The goal of the Laughter Calendar was to visualize how much laughter happened over time. We felt that the calendar was a format people could easily relate to. Each member of a group was denoted in one color and every day was colored differently according to how much each member laughed. We created two variations: version A showing an entire year, and version B showing a more detailed view on a scale of a month. The calendar quantified laughter by time. Given the difficulty of acquiring laughter data from participants over a long span (i.e., over a month and a year), we created a mock-up for this design.

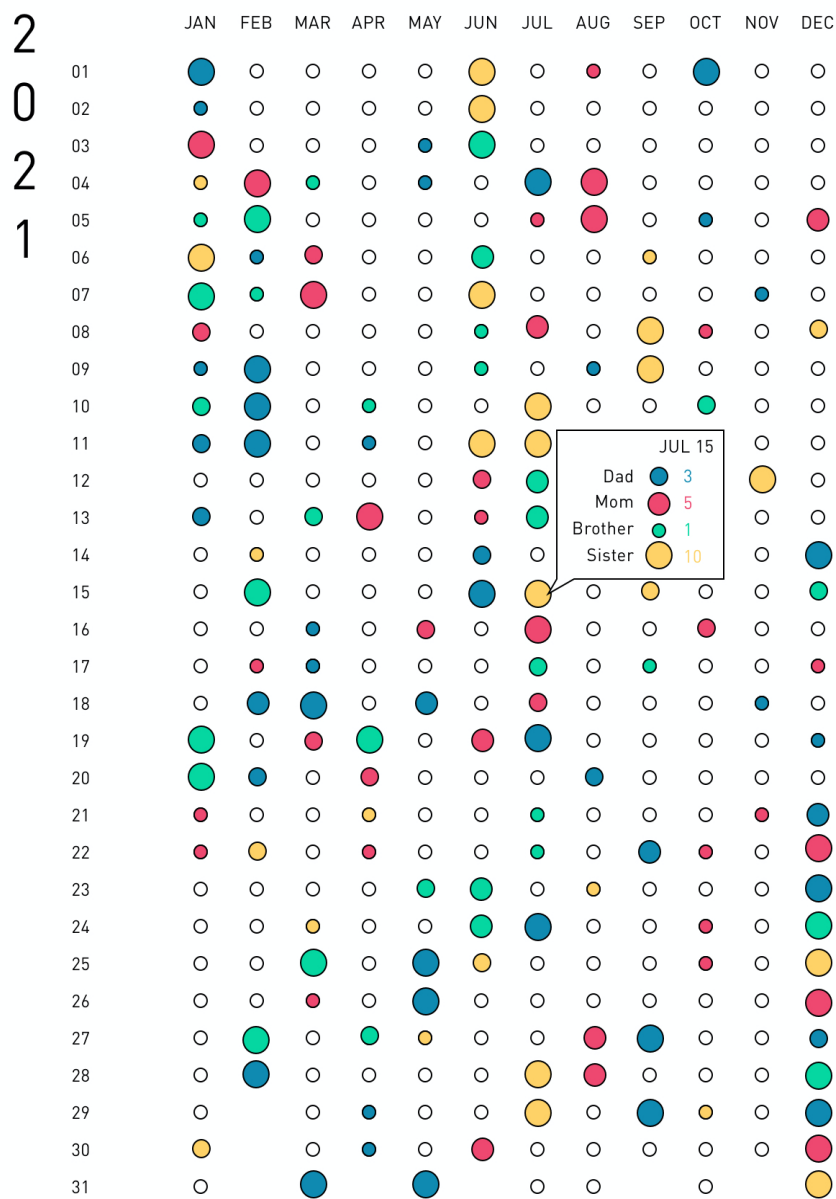
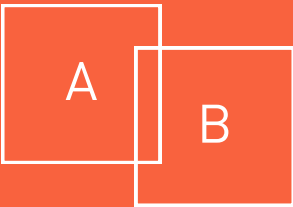


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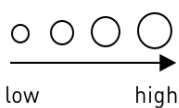


# Laughter Map

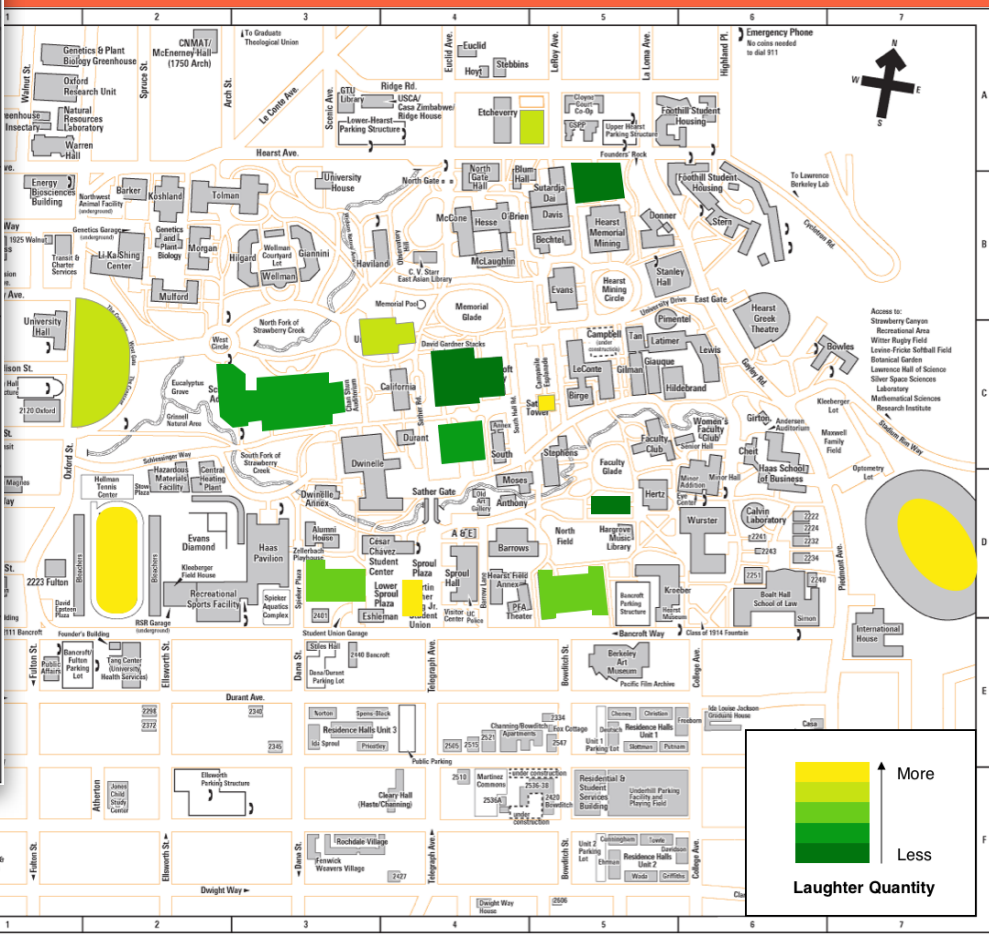
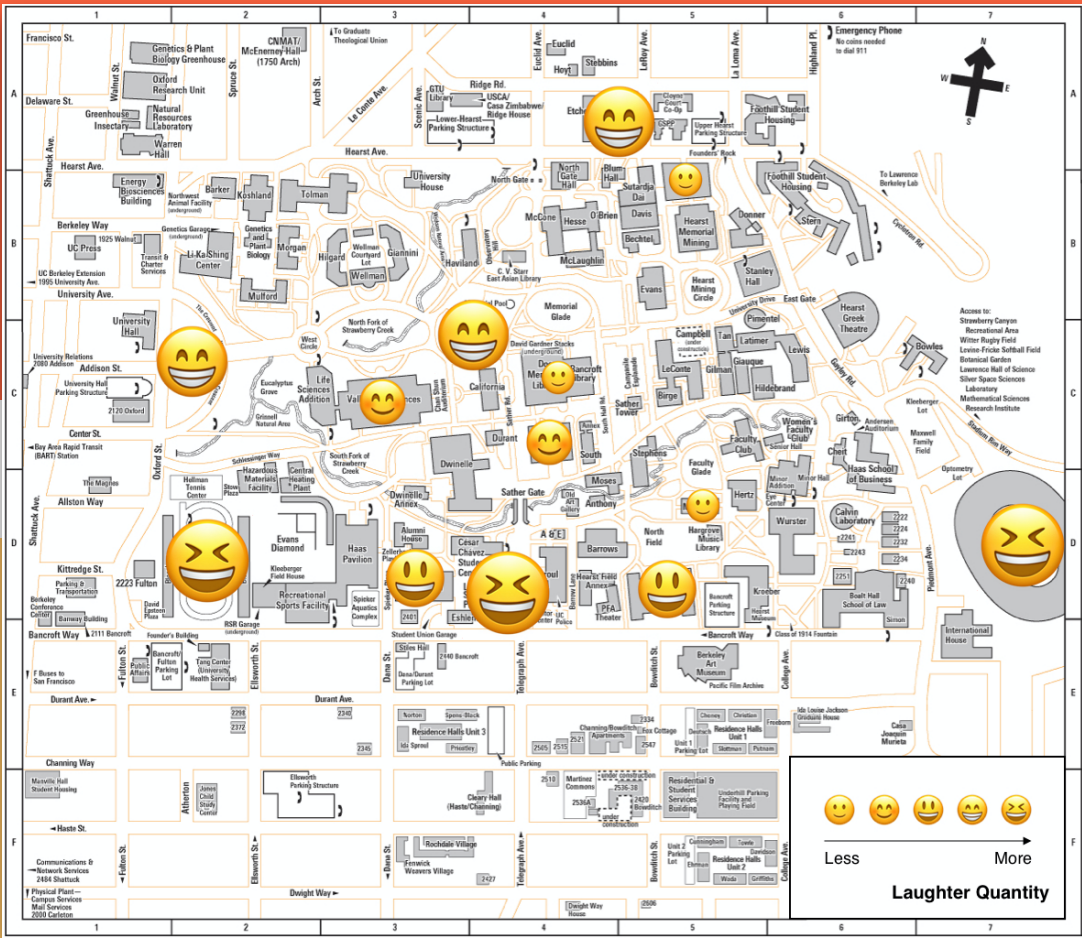
The goal of the Laughter Map was to emphasize where the laughter took place. This design presented the quantity of laughter occurrences on a spatial dimension. We designed two versions for comparison. Version A used emojis of varying happiness levels and sizes to indicate the amount of laughter. Version B used color scales. The map visualized laughter according to locations. Similar to the Laughter Calendar, there was difficulty in acquiring laughter and spatial data from participants over a long span. Therefore, we created a mock-up for this design.



The Amount of Laughter



King of the Day

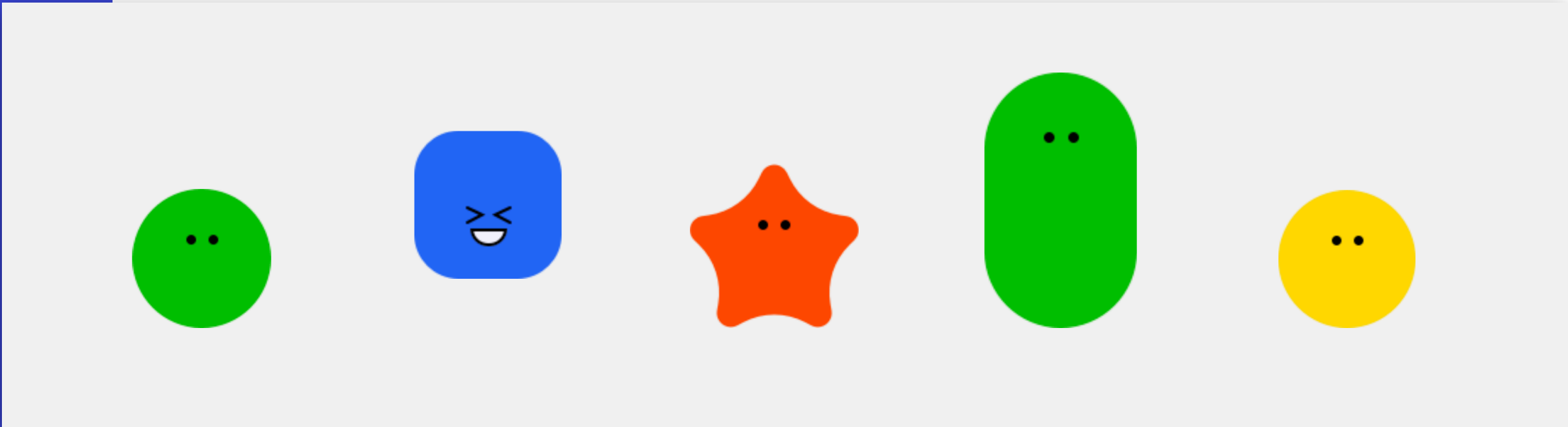
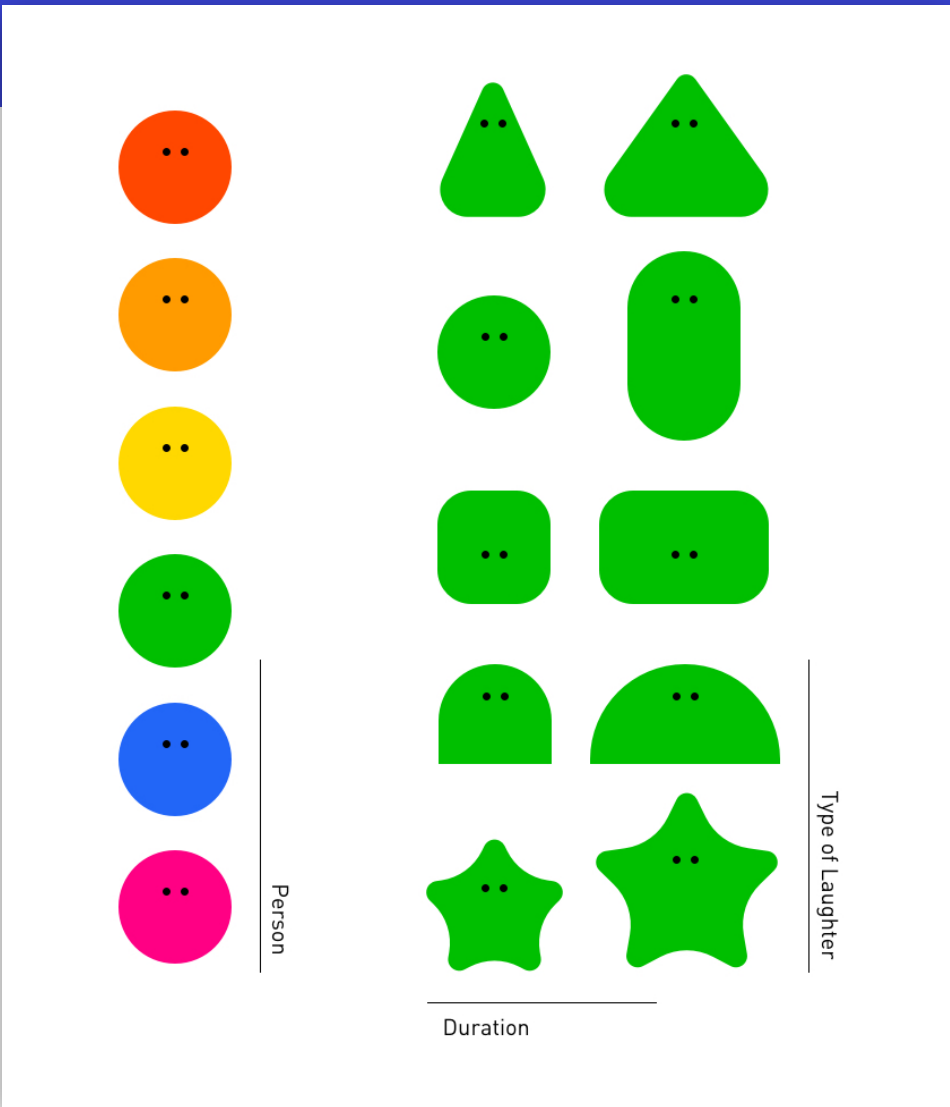




# Laughter Creatures

This visualization took a different approach and treated individual laughter as if it were a little creature of its own. This was partially inspired by the story of *Tinker Bell* [18], a fairy in the famous Peter Pan story. According to the tale, Tinker Bell was born from a baby's first laugh. We created this visualization to explore whether we could use anthropomorphic representations for individual laughter sound.

To do so, we set three parameters to control the appearance of creatures. Colors indicated the speakers of laughter. Size represented the duration of the laughter. Shapes visualized the types of laughter (e.g., soft chuckles as triangles, giggles as circles, belly laughs, or deep voices boomer as squares, deep voice chortles as arches, and high-pitched, rapid laughs as stars). Up to five creatures could be shown on the interface. During the idle stage, creatures would hang out by slightly swaying to show their liveliness. When a user touched one of them, the creature would jump and smile, while the associated laughter sound played. The design explored the quality of each laughter as a lively anthropomorphic form.



## Laughter Paintbrush

This design was aimed at inviting people to use captured laughter sounds as a medium for art creation. It presented a white canvas with a palette of five colors at the bottom. Each color represented one laughter sound. As a user selected a color and drew on the canvas, its corresponding laughter sound played. The width of the paint stroke varied in real-time according to the amplitude of the laughter sound being played. We developed this design as a fully working prototype so that we could explore how people may use laughter for audio-visual creation.



In summary, we selected and developed these five types of laughter visualizations in order to investigate the potential of these laughter visual representations for personal reflection. The goal of this research was not to evaluate the details of each user interface design, but rather to use them to start conversations with participants about exploring the design space of laughter visualizations.

METHOD

We recruited seven participants (four males and three females) for this study. All participants were asked to collect audio files that contained naturally occurring laughter from their lives such as informal gatherings with friends and family for about three hours in total (each file could be any length as long as the total time was about three hours). We informed participants that the researchers would not listen to the recordings, and only the laughter sounds detected by the algorithm from the recordings would be used for research.

We employed an automatic laughter detection algorithm that uses modern convolutional neural network architectures to identify and extract naturally occurring human laughter instances from any audio source [9,10].

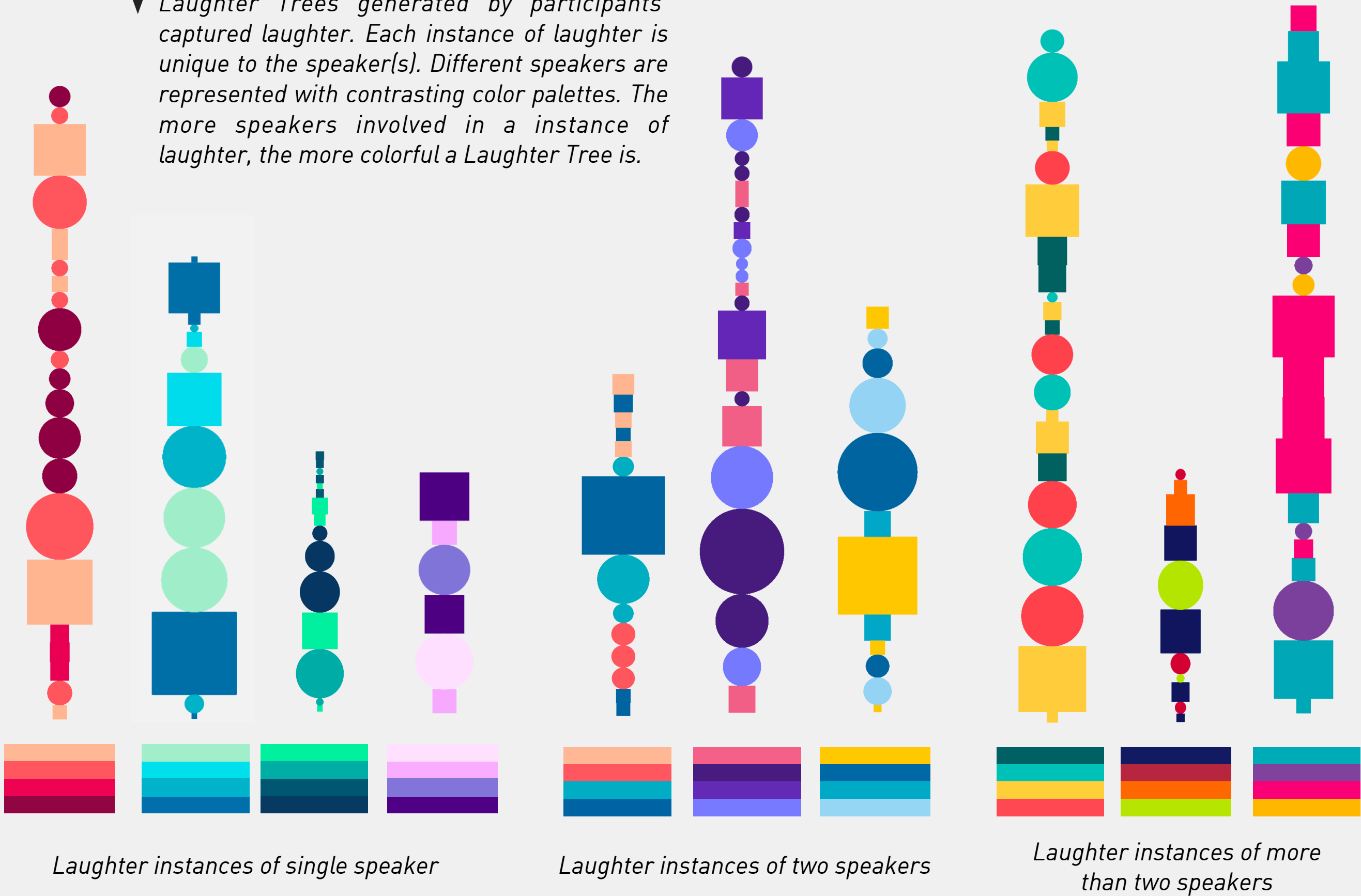
We implemented each participant’s unique laughter visualizations based on their captured laughter sounds. We invited each participant for an interview, where we shared each interface on a laptop. We let participants interact with the design first without much explanation so that they could form their own interpretations of the design, and followed that by asking open-ended exploratory questions. We asked heuristic questions to learn participants’ attitudes towards each visual form, such as their impressions, preferences, their thoughts on possible applications of the design, as well as occasions to use these applications and willingness to accept such designs. After the study, each participant received a \$100 gift card as compensation.

FINDINGS

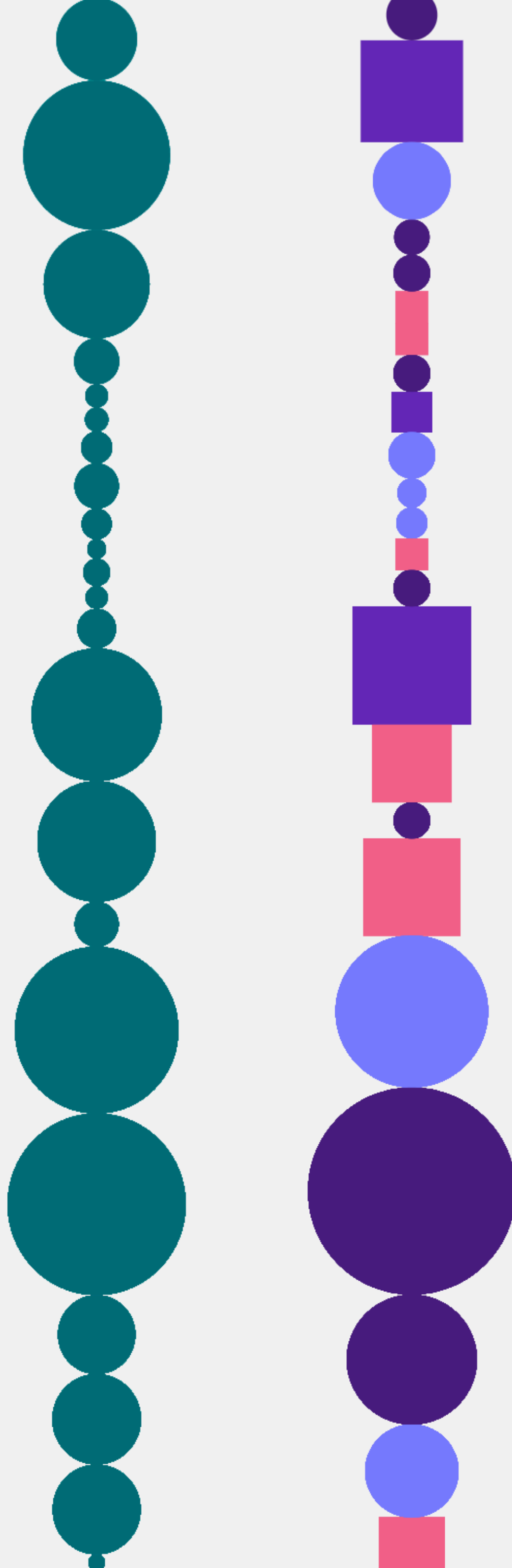
Laughter Tree

The Laughter Tree visualization elicited participants to celebrate the unique quality of each individual laugh. One participant, Hank, described each unique pattern as “similar to a fingerprint.” Another, Dennis indicated the Laughter Tree might be used as a personalized visual signature on social media to “replace dull written text.” Meghan saw each tree as representing a person, and the collection of twenty patterns as “a cool version of the family tree.” Participants enjoyed watching the laughter trees grow while listening to the corresponding laughter sound. The animated visualization seemed to bring together the sound of laughter and the quality of each speaker behind the laugh.

▼ Laughter Trees generated by participants’ captured laughter. Each instance of laughter is unique to the speaker(s). Different speakers are represented with contrasting color palettes. The more speakers involved in a instance of laughter, the more colorful a Laughter Tree is.







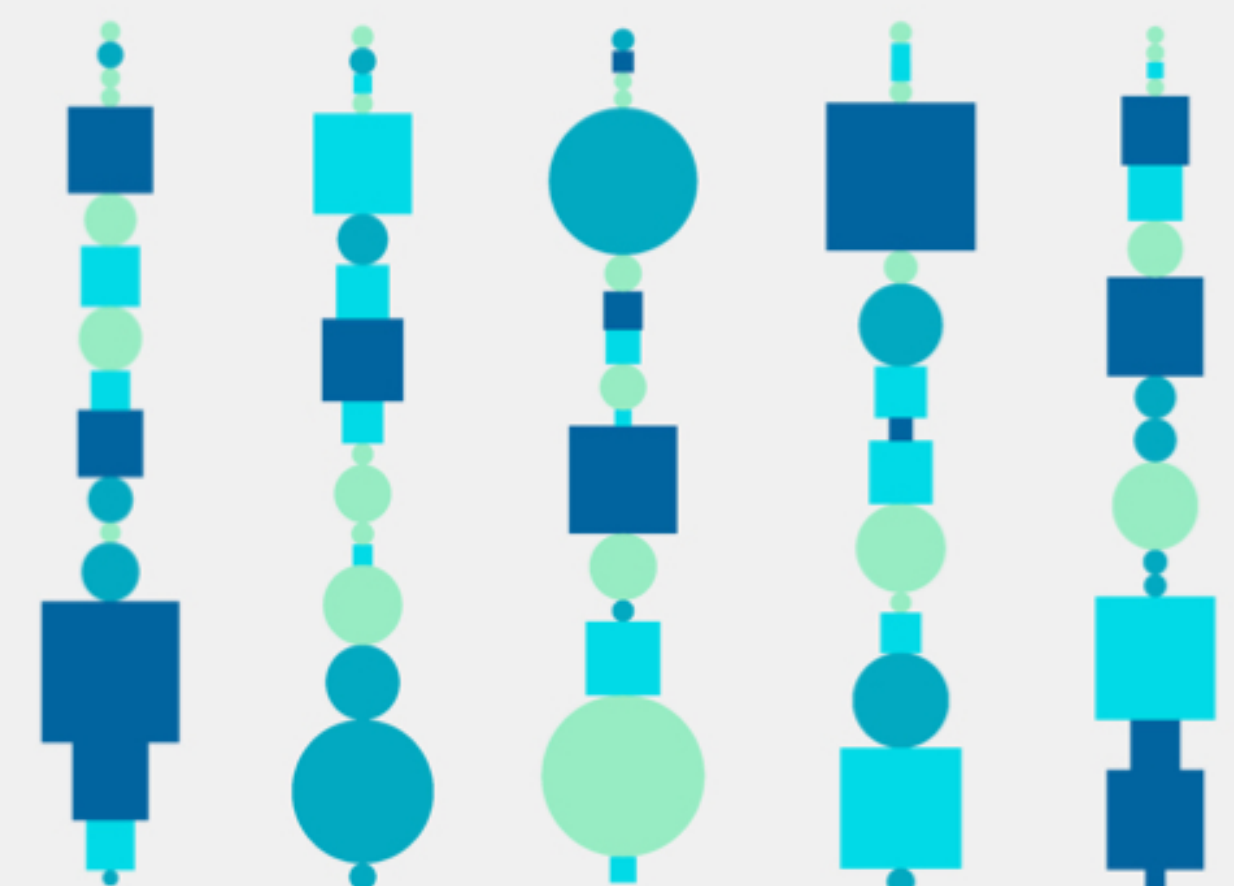
Participants reacted differently to the two versions of the Laughter Tree. The true-to-data graph-like version A led people to think of the visualization more like a professional diagram, while version B led people to imagine its application for personal uses. Participants suggested uses for version A such as visual transcripts for interviews, references for psychotherapy, biometric identification, or quantification of product user testing. In version B, many participants liked the colors and could interpret different color schemes as representations of different people, while they could not explain the mix of shapes at first glance. After our explanation, most people preferred version B over version A and indicated their interest in using version B for playful occasions. They offered examples such as printing out framed art, screensavers, tattoos, stickers, and even making 3D beads out of the patterns for accessories like a necklace, bracelet, earrings, or a keychain, for private collections or for giving as presents. Meghan, in describing how she would 3D print the pattern as a keychain, said "When I use my key[chain], people might ask what's this? I'll say this is my laughter!" While version B, with its colorful mixed shapes, was not as straightforward as version A, it inspired more creative use and invited people to share their personal interpretation behind the designs.

► The algorithm generated unique Laughter Trees based on the laughter sound. The result looks different each time when pressing the same button.

◀ An instance of laughter presented in two versions: true-to-data design vs. playful design

The collection of laughter trees (Laughter Tree A2 and B2) inspired people to use visual forms of laughter for personal documentation and reflection. For example, Meghan said she would keep gratitude journals everyday, attaching each laughter pattern to its corresponding gratitude entry so that she could vividly document her life. Another participant, Emily, said she would love to mark the details of each laughter tree with notes about whose laughter it is, when and where the laughter happened, and with whom to help her recall and review these happy moments.

The interactivity of the Laughter Tree inspired two participants to incorporate it into a game they would play with family or close friends. For example, Hank imagined people could click on each pattern, listen to the laughter while seeing it grow, and invite other people to guess whom the laughter belongs to or match the laughs that belong to the same person. In summary, the Laughter Trees elicited people to appreciate and celebrate the uniqueness of each individual by viewing and interacting with their personal laughter.



# Laughter Calendar

Participants regarded the Laughter Calendar as a personal summary or shared record of laughter. Despite being a mockup, the calendar representation elicited a variety of emotions and encouraged people to reflect on their past. The participants imagined using the calendar to reflect, “When was my happiest or unhappiest week?” “What did I do during that week?” and “Who did I spend time with?” As they explored the pattern of laughter on a calendar format, they imagined it being inspirational for future activities or spending more time with those who brought them joyful experiences.

The Laughter calendar was also viewed as a possible shared record, which may promote intimate connection and benefit family members’ well-being. For example, Meghan imagined reflecting on the calendar such as, “Dad had pretty good days during February 9th to 12th” and “Mom was not happy for a while.” Most people indicated that the shared laughter calendar would only be used with a group of people in intimate or stable relationships, like family, and it did not matter whether or not the group was physically together. Dennis indicated the calendar as his favorite design as he imagined that the shared calendar could reunite his family virtually while he was studying abroad, especially during the COVID-19 pandemic. Dennis explained, “Having each member’s phone to document laughter and upload to the same calendar can help us share and update our lives. Unlike a phone call which lasts for only one hour, the documentation of laughter on the calendar will last for a year.” The calendar was perceived by the participants as a concrete and enduring emotional sharing platform that could connect their loved ones.

Comparing the calendar design versions A and B, most participants ranked version A as their top preference but version B as the least favorite of all visualizations. This implied their endorsement of visualizing laughter over time, but the interface design mattered. Participants referred to the “Memories” features in Photos on iPhone and on Facebook and saw Laughter Calendar as a potential new alternative. Emily explained that she would be interested in seeing the highlighted events with laughter on a calendar but not a “datafied” style, as the latter made her feel “not personal.” Some participants noticed that there were too many blank spaces with no laughter, which made them feel uneasy. These findings suggest that a Laughter Calendar design needs to emphasize significant events related to laughter to remind people of happy memories and reinforce those enjoyments rather than simply quantify the presence or absence of laughter.





# Laughter Map

The participants saw uses for the Laughter Map in both personal and social contexts. Dennis imagined using the Laughter Map to reflect on places where he was happy. "If the record shows I have most of the laughs at church, that means I was happy with my church friends. I should go there more often in the future," said Dennis. Emily saw visualizing laughter on a map as analogous to "adding pins on a travel map," and that setting goals to conquer more places with laughter might reinforce positive emotion. For another participant, Teresa, the Laughter Map felt similar to "crowd-sourced review websites." She described that knowing the number of laughs at different locations may help her decide where to hold her future events or spend her leisure time.

Some participants found the size or facial expression of emojis on the Map obscure, and felt that Map B was more precise. Yet, six out of seven participants preferred Map A over Map B. Overall, participants reacted to Map B as "professional," "scientific," and "remind me of an exam," which seems to move away from positive experiences. Participants also pointed out the difference between public and private places. Hank, for example, said, "If I know my office is not a happy place, there is nothing we can do. Marking only the public areas will be useful." In summary, the Laughter Map seemed to serve as a space to reflect on locations with joyful memories, as well as to envision where users may want to spend their time in the future.

"This is my aunt's laughter!"

# Laughter Creatures

The Laughter Creatures evoked a mix of reactions from the participants. Half of the participants reacted positively and could associate each creature with its speaker. For example, Meghan explained, "I recognize who everyone is. The blue square is my dad. It's almost like my dad in an emoji form, so this is how he looks like." Emily felt that the representation should be more like animals or cartoon figures. The Laughter Creatures reminded participants of "emoji," "memoji," "meme," and "avatar in games" in a personalized style. They imagined sending the laughter creatures in chat apps or using it as an interactive social media profile photo. "People can click on your profile photo and listen to your laughter at the same time," said Meghan.

The other half of the participants found the Laughter Creatures "cute" but felt that the representations seemed rather "random" and they could not make the association between shapes, colors, and sounds.

"It's almost like my dad in an emoji form!"



"That's my aunt again, that makes sense. She is not big, but she has a 'big personality.'"

▲ Laughter Creatures made of Meghan's captured laughter.

From a design perspective, mapping different types of laughter (e.g., belly laugh vs. giggle) with different shapes (e.g., triangle, circle, star) did not work well, as there was no clear boundary between different types of laughter, and many laughter samples fell somewhere in between. The small audio samples some participants collected were homogeneous and did not yield diverse laughter types. Many of the extracted single-voice laughter samples were less than three seconds. By listening to short laughter audios without context, participants were not always able to recognize its original speaker. All these ambiguities made the Laughter Creatures not always relatable or understandable.

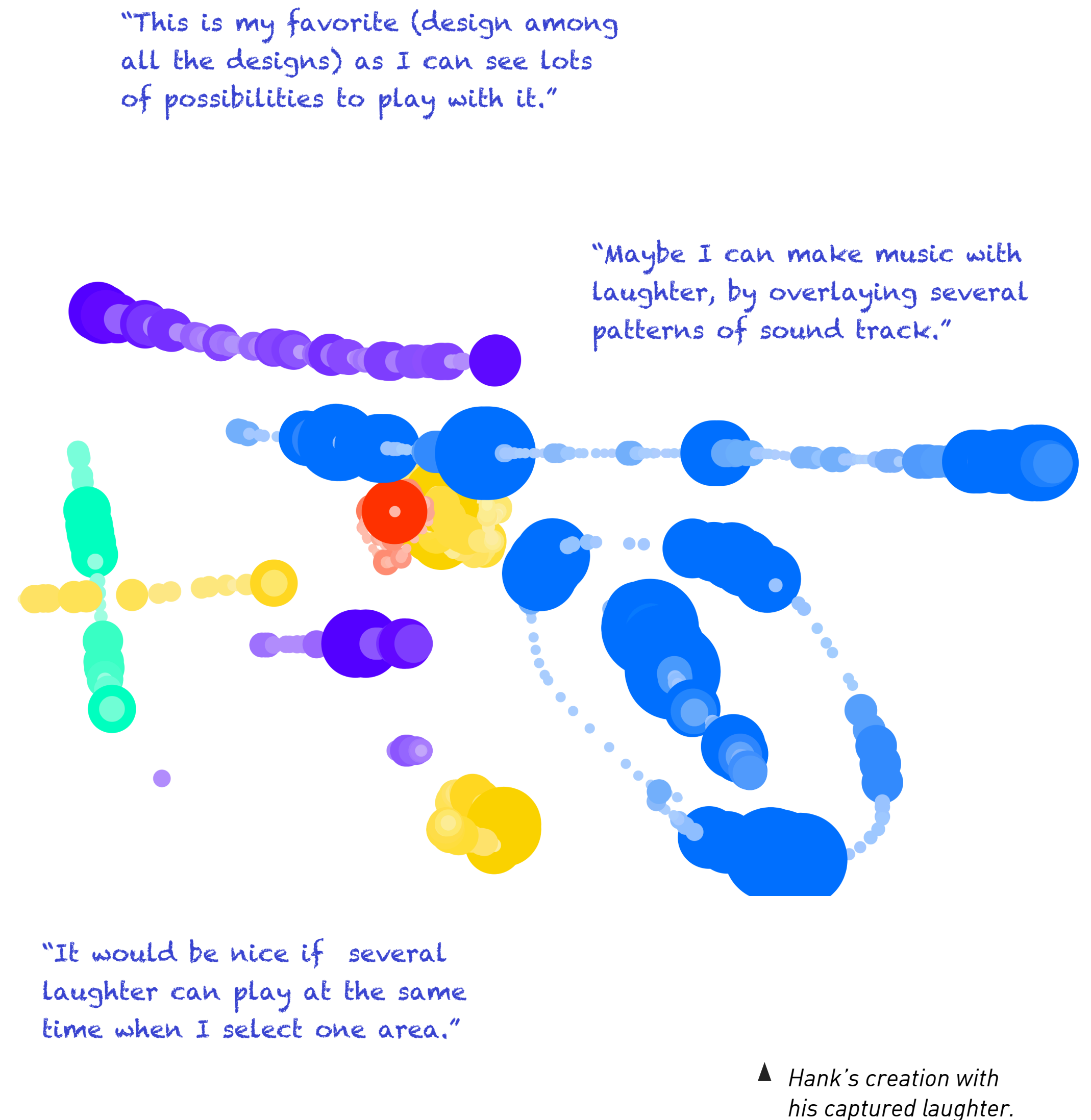
Our design intention was to use various shapes to represent different types of laughter. However, people tended to attribute different shapes to different speakers, similar to how we currently use avatars in the virtual world. Therefore, it would be confusing to represent different types of laughter from one speaker with different shapes. From this, we learned that in order to anthropomorphize laughter, the laughter from the same speaker would need to have consistent visual elements.

# Laughter Paintbrush

The fully functional Laughter Paintbrush prototype invited the participants to try out and create drawings with their personal laughter sounds, as well as to imagine how they might share their creations. In addition to the painting they did during the interview, the participants came up with innovative ideas for future art creation with the Laughter Paintbrush. For example, Hank and Meghan imagined painting visual-audio art by mixing the colors of paint and sounds of laughter. Similarly, several participants wanted the ability to play several laughs together when one area of the painting was selected. Emily saw the Laughter Paintbrush as offering a customized version of Laughter Tree and wished to paint artworks that could be framed on her wall. One participant suggested that the artwork may be auto-generated from the laughter on the Laughter Calendar to be used as a cover image or a gift for their family members.

The art creation process also inspired people to imagine sharing their joy of creation with each other. Meghan said she would paint and print her painting as a sticker for her friend as a tangible memento of the event they spent together where their laughter was recorded. On the other hand, a participant Calvin said, he would use the Laughter Paintbrush for creating an apology message when he made his girlfriend angry: "I can imagine using laughter from both of us to paint a drawing and give it to her, saying 'I'm so sorry.' These are the happy moments we've spent together."

Some participants preferred not to draw by themselves but to invite their younger and older family members to draw with the Laughter Paintbrush. Dennis said, "They (my aunt's kids and grandparents) should be very interested in this one... Because they (grandparents) can listen to their grandson's voice recorded in this tool, or listen to the whole family's laughter by drawing." James said he would let his nephew who is in a different country draw and send the painting back to him so that he could be surprised by his nephew's audio-visual creation. The Laughter Paintbrush evoked possibilities to turn laughter sounds into a visual artistic medium to socially create and share with their loved ones.





## DISCUSSION

We identified several emerging themes for laughter visualization, which were: 1) Laughter Visualization as Memento, 2) Laughter Visualization for Emotional Expression, 3) Laughter Visualization as Relationship Catalyst, 4) Different from Data Visualization, 5) The Contexts Matter. In addition, we discuss participants' concerns about privacy for using laughter sounds in personal reflection design.

### Laughter Visualization as Memento

As laughter is a person's voice, reviewing the laughter in visual form accompanied with the voice triggers one's memory of the speaker. The visual representation of the laughter seemed to stand in as a symbol of the person the laughter came from, as one participant said, "wearing jewelry made of my grandma's laughter visualization was just like wearing my grandma's watch." Laughter visualization could stand in as a concrete memento to commemorate and carry on the person's spirits. Participants frequently mentioned that attaching laughter visualizations to gratitude journals or marking the event in a collection of laughter turned the personal memory into vivid forms. Laughter visualization has the potential to make those positive moments concrete and spark new forms and materializations for personal reflection.

### Different from Data Visualization

We have learned from our study that laughter visualization is unlike traditional sound visualization because the latter often requires high accuracy so that people can analyze, edit, and inform, while the former is meant to be evocative and preservable. The comparison between versions A and B of the Laughter Tree and the Laughter Map suggests that laughter visualization's aesthetics may be prioritized over its accuracy.

### Laughter Visualization for Emotional Expression

During a conversation, a burst of laughter can support one's expression, lighten the atmosphere, generate goodwill, and promote relationships. Transforming such laughter into visual representations may expand its potential for emotional expression. It may serve as a supplement to expression by spoken language or written message. For example, a person may make a collection of laughter from themselves and their partner into an art piece and gift it to their partner as a special bespoke piece to express love across time and space. Similarly, an anthropomorphic laughter visualization may serve as a personalized emoji or meme that could be sent to others via chat message to augment emotional expression that text alone may not achieve. Laughter visualizations could provide new ways to express feelings that are different from current forms of communication.

### Laughter Visualization as Relationship Catalyst

Laughter has innate social attributes as it is often a result of joyful interaction with people [26]. Reproducing laughter as visual forms may promote relationships within an intimate group. For instance, participants reacted that the Laughter Calendar shared amongst long-distance family members may enhance their communication by knowing each other's moods in a shared virtual space. Playing games made of laughter visualizations and sounds among close friends or family at a party could trigger happy moments via contagious laughter and further lead to joyful and intimate conversations. As the sharing of laughter with others indicates an alignment of perspectives and celebration [23], laughter visualization may serve as a catalyst for relationship promotion.

## The Contexts Matter

Laughter rarely exists out of context. The context associated with laughter makes the experience of re-encountering the laughter meaningful, including whom the laughter belongs to, whom we spent the time with, where and when the conversation happened, and what the conversation was about. Visualizing laughter ideally presents the information behind the laugh or allows for recall of the context associated with it. A single-voice laugh sound may stand in for its speaker. Its visualization ideally reflects the speaker's personality. On the other hand, putting multiple single-voice laughs together may symbolically bring the speakers together. Such a design may transcend time and space and reunite the group of people in a visible fashion, especially in the current pandemic we live in. The visualization of laughter should move away from the feeling of data and rather highlight the event and context associated with laughter to honor the person and the moment behind the laughter.

## Laughter Sound and Privacy

The possibility of laughter sound being personal data collected by the system provoked participants' discussion about privacy. Three out of seven people indicated their concerns about being surveilled and commodified if such services are available in the future. Others considered laughter recording less sensitive than photo taking or video shooting and did not encounter resistance when asking people's permission to record their laughter. If sounds of laughter will be automatically captured by an algorithm in the future, we need to ensure that speeches and conversations will not be recorded in the process, as well as offering the users an option to turn off the laughter sound recording entirely for privacy needs.

## LIMITATIONS AND FUTURE WORK

While it is possible to visualize laughter based on its properties such as frequency, amplitude, waveform, and duration, we prioritized alternative visual aesthetics, interactivity, and memory-evoking elements. For the designs such as Laughter Tree and Laughter Paintbrush, we selected amplitude as the soundwave feature in the visualization. We hope to explore other wave properties in future versions.

Due to the small number of the participants, we were unable to cover perspectives from a broader audience such as youth, seniors, or families with children. We hope to further develop some of the designs into higher fidelity interactive systems and evaluate them with more diverse users. One possible direction is to build a fully functional laughter drawing tool and work with children to engage in multimodal storytelling that involves positive affect. Another interesting direction may be to develop a platform with AI that can transform laughter sounds into various generative arts for personal collection or gifts. Reflecting on laughter for therapeutic uses may also be further explored.

## CONCLUSION

We developed and evaluated a variety of ways laughter sounds could be visualized for personal reflection, including laughter visualizations that can span over time and space (Laughter Calendar, Laughter Map), visualizations that treat laughter as having a life of its own (Laughter Tree, Laughter Creature), and laughter as a medium for audio-visual creation (Laughter Paintbrush). Through our exploratory study, we demonstrated that laughter could be represented as various enduring visual forms that honor both personal and social contexts. We studied people's interactions with the designs and speculated future applications of laughter visualization for memory-evoking, emotional expression, and relationship promotion. We contribute laughter visualizations as evocative forms that highlight the emotional as well as aesthetic potential for preserving, sharing, and reflecting what laughter means to us.

## ACKNOWLEDGMENTS

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