Emotional Biosensing: Possibilities, Problematics, & Critical Alternatives

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Hi, I’m Noura Howell, I’m a PhD student here advised by Kimiko Ryokai. Today I’d like to invite you all to rethink “data” with data around emotion and by considering the material, physical properties of data.

emotional biosensing

data is material

Ebb: different data display

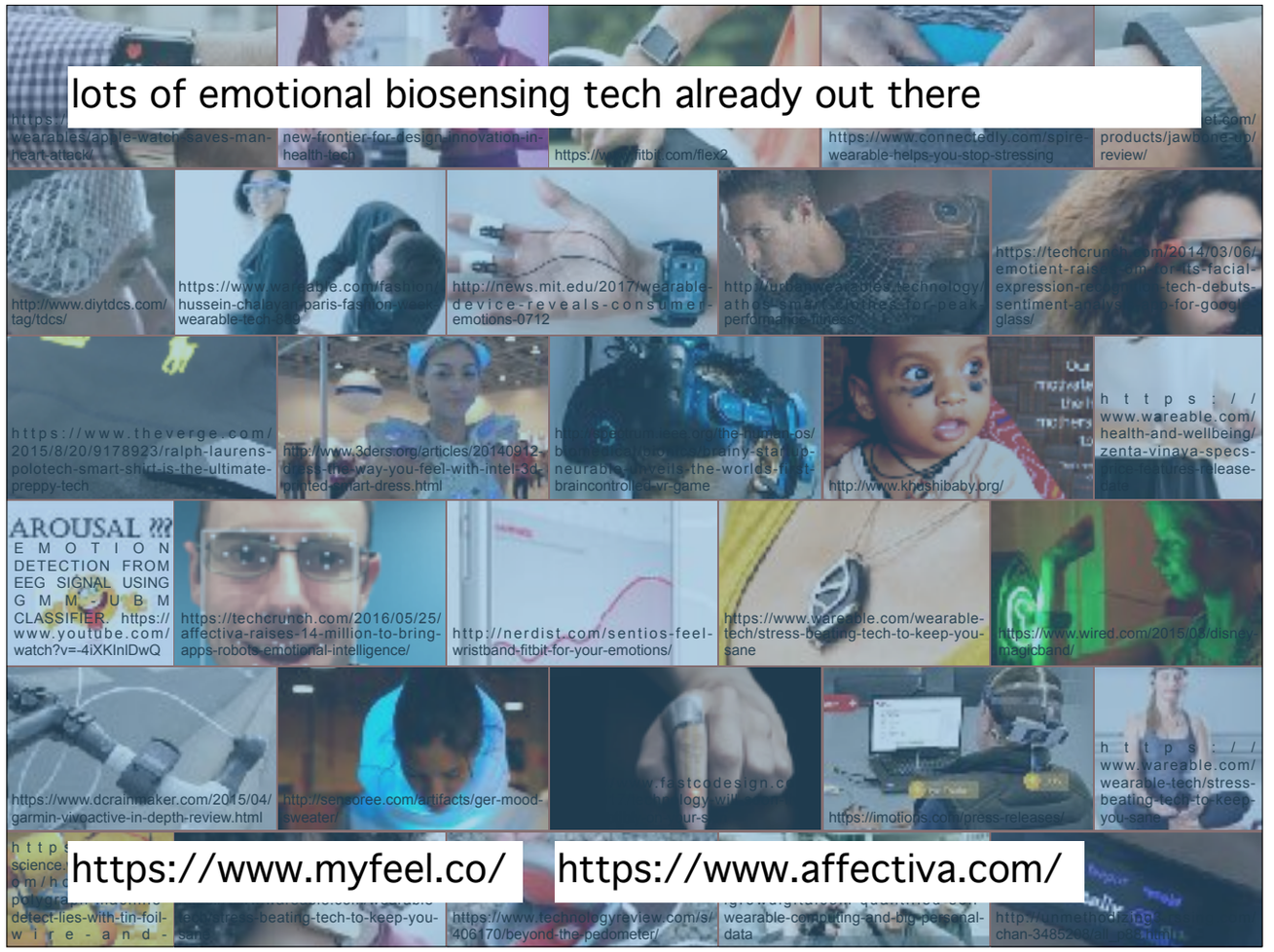
affect-as-*information* vs. affect-as-*interaction*

Hint & Ripple: different concepts of emotion

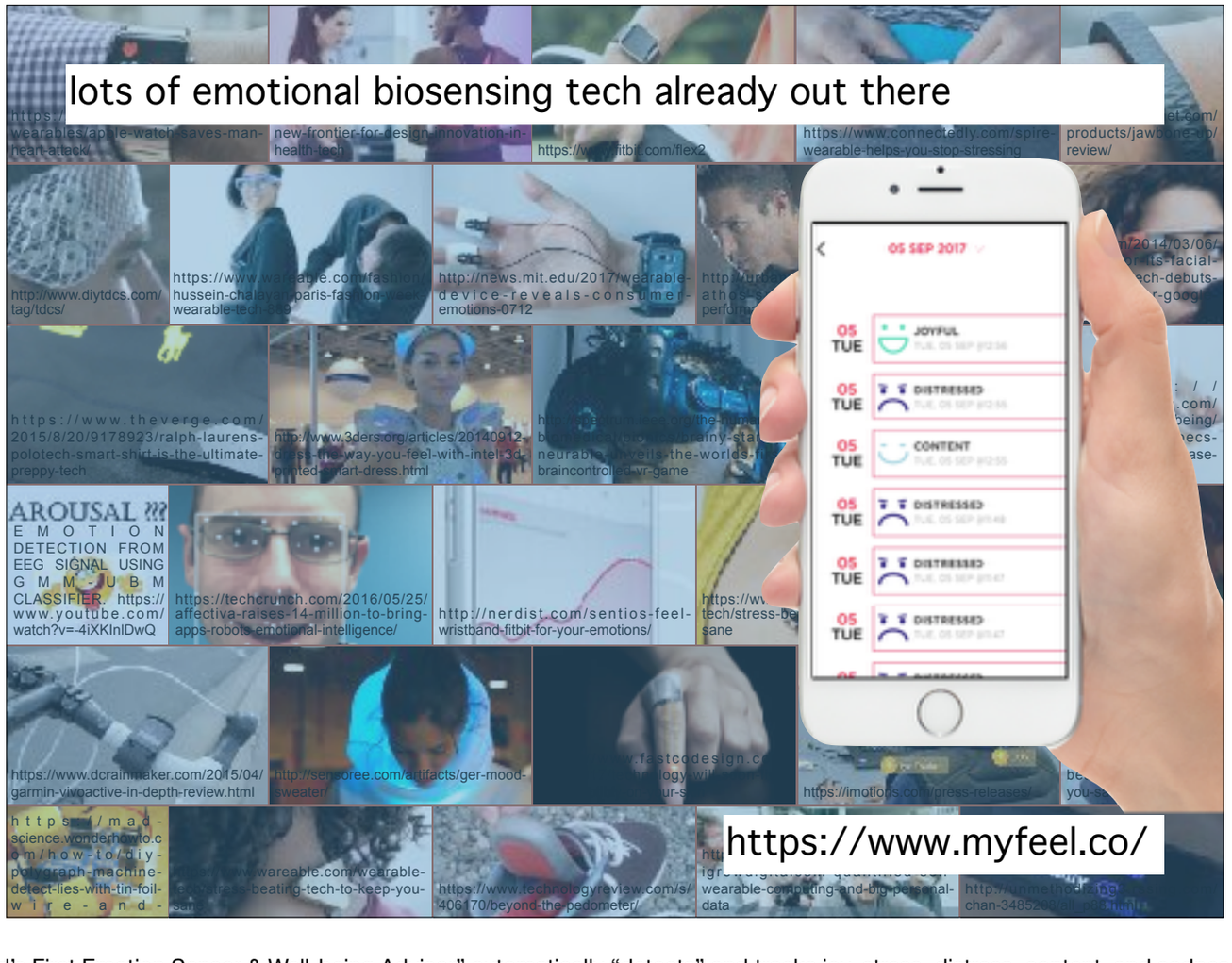
Laughter: different data

tangible interactions with data

emotional biosensing

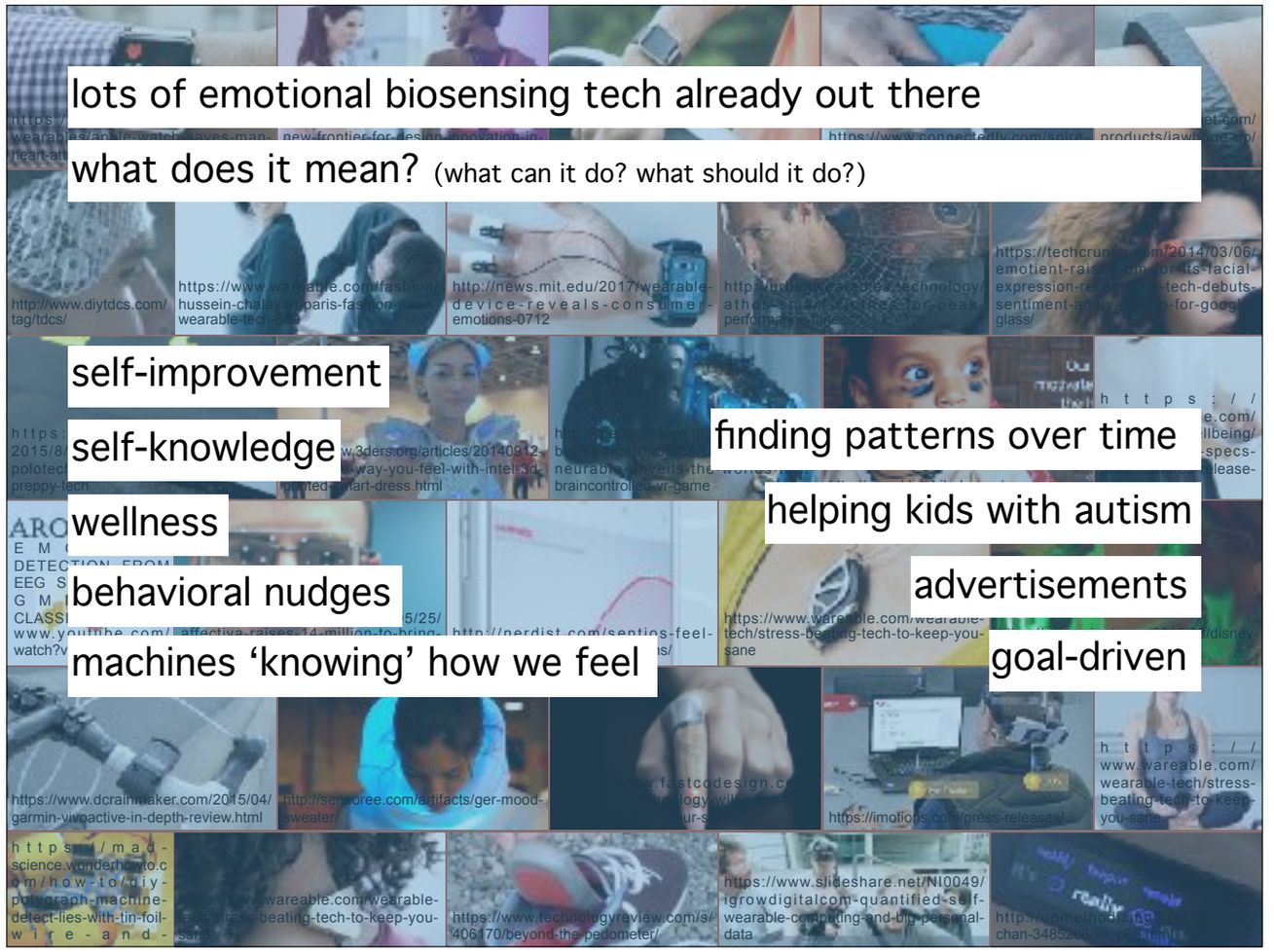


There are a lot of biosensing technologies already out there, some of them are emotional biosensing.



For example, the Feel wristband claims to be the “World’s First Emotion Sensor & Well-being Advisor” automatically “detects” and tracks joy, stress, distress, content, and sadness to help you “monitor your weekly and monthly progress” and “discover key emotional patterns”. The mobile app provides automated behavior nudges to help “keep you on track towards meeting emotional well-being goals.” I’m just quoting from their home page here.

Affectiva uses video of faces to detect emotions like smile, joy, contempt, anger, to help you “unfiltered consumer emotional responses,” their founder started out trying to help kids with autism learn to recognize others’ emotions, but one of their earliest technical demos up on their website tracked emotional responses to advertisements.



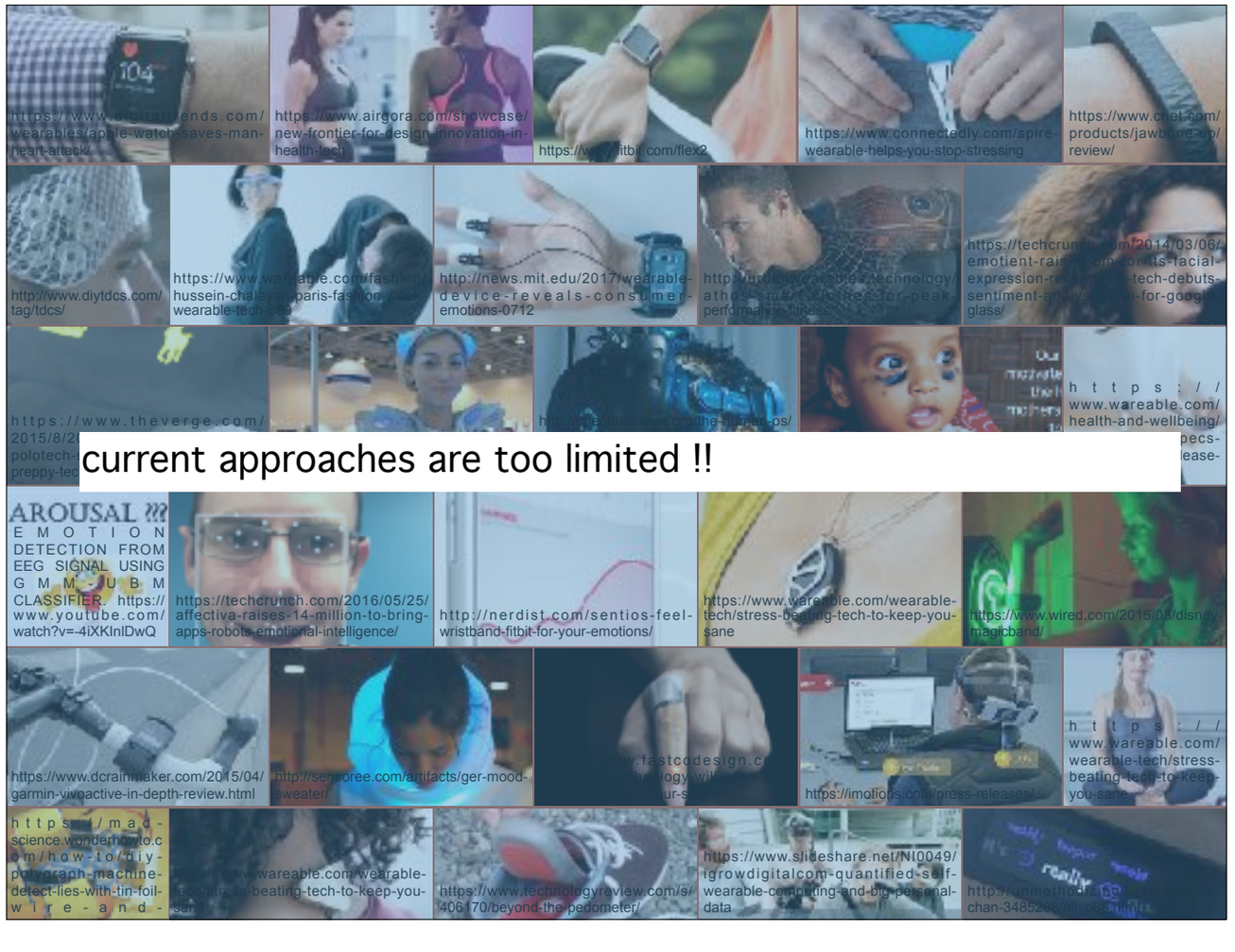
So what kind of insight or meaning are these claiming to support? What can these emotional biosensing technologies do? What are they implying we should be doing?

Many of them are focused on supporting self-improvement, gaining self-knowledge through data analysis and finding patterns over time, wellness or emotional wellness or mindfulness… in a goal-driven way guided by these automated behavioral nudges that tell us what to do… all of it kind of undergirded by this notion that machines can ‘know’ how we feel.

There is positive potential here, like helping people feel less stressed out, or helping kids with autism with socializing, but there’s also problematic stuff happening here, like making advertisements more emotionally manipulative…

or another kind of creepy thing, suggesting that we should be engaging in some kind of goal-driven emotional self-improvement regime. Maybe this is just me, but I’m not like tracking towards my emotional self-improvement goals, I’m just tryna be a nice person and feel OK at the end of the day so I can do it all over again tomorrow.

Also, the emphasis on individual stress management can over-emphasize that it’s the individual’s responsibility to deal with that stress, instead of acknowledging that actually there are a lot of problems in broader society like structural racism and poverty that might be stressing people out, and having your mobile app prompt you to take a few deep breaths is not gonna take away that stress.



OK, so all that is to say, there’s some interesting potential and some issues with emotional biosensing, but current approaches are way too limited! I want to explore other ways of engaging with emotional biosensing in daily life.

data is material

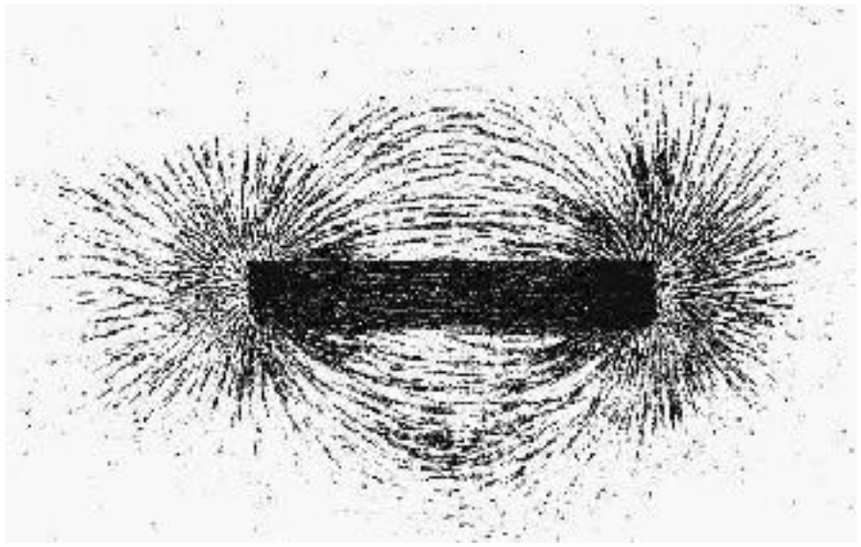
an anecdote

Paul Dourish and Melissa Mazmanian. 2011. Media as material: Information representations as material foundations for organizational practice. In *Third International Symposium on Process Organization Studies.*

data is material

So, this anecdote helps illustrate how data is material. Back in the days when data was encoded on tapes, a researcher Paul Dourish was working in the UK. He got sent a tape of data from the U.S. and wanted to read what was on it. So he tried it in all the different computers he could find, but none of them could read the tape. Finally someone suggested he take the tape to Harry who could “eyeball” it. He was kind of skeptical about this but was out of options.

an anecdote



Paul Dourish and Melissa Mazmanian. 2011. Media as material: Information representations as material foundations for organizational practice. In *Third International Symposium on Process Organization Studies.*

data is material

Harry took the tape, unwound some of the tape and laid it out on the table, and then put some iron filings around it. As you know, iron filings will align themselves with magnetic fields. So here the iron filings were responding to the magnetic tape.

Harry found the “empty spots” on the tape that marked the space between data records. By measuring the physical distance between two of these spots, he was able to determine how the data was encoded, and which computer needed to be used to read the tape.

Even though this is with an older technology, even with digital data, digital is still ultimately based in electrical circuits which are material. It all comes down to 0s and 1s, but then those really just represent high or low voltages on the hardware level… this physical structure has consequences for how we store data and query data.

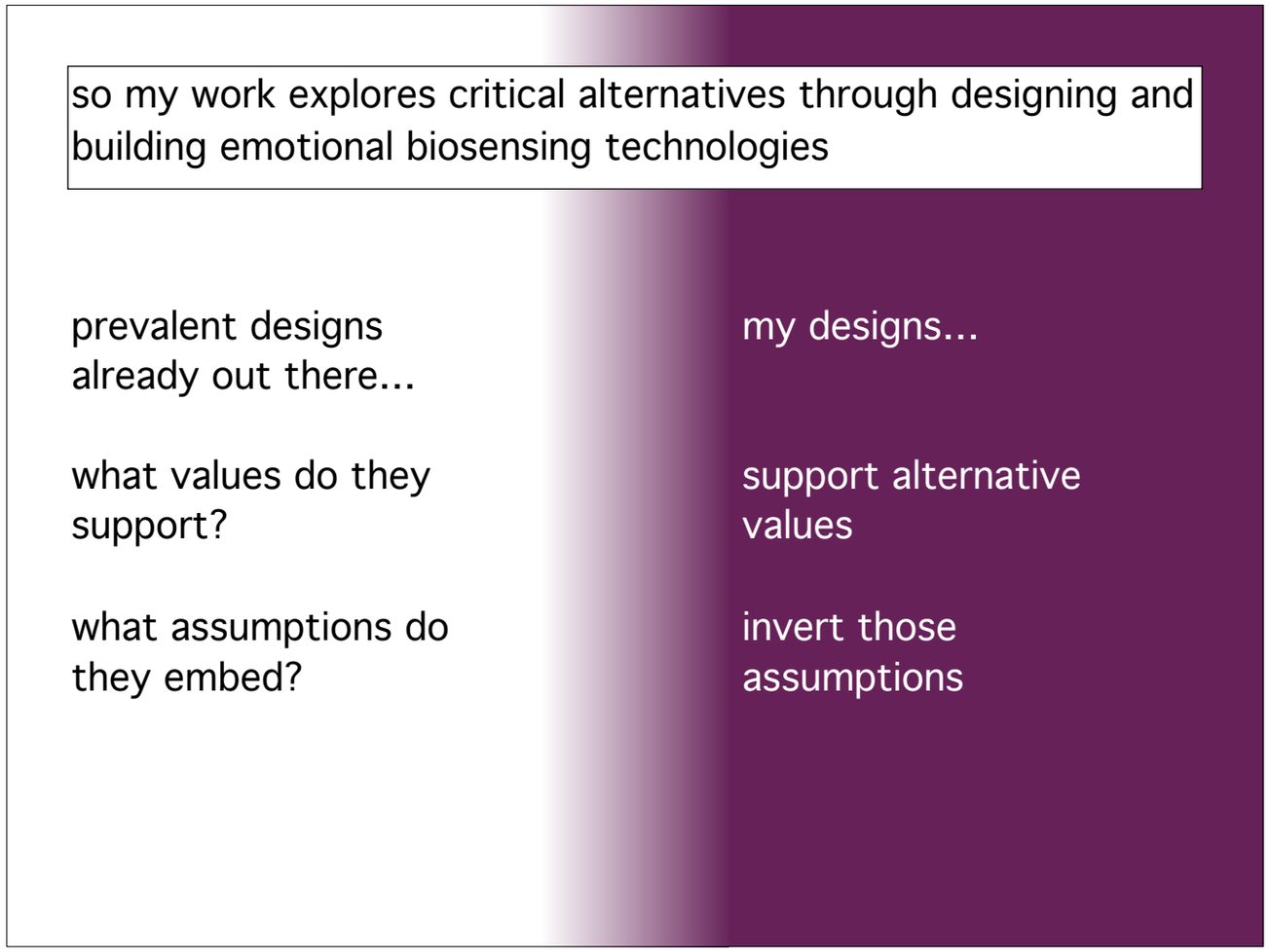
other examples

- different practices in film vs. digital photography
- a graph on paper you can annotate vs. a website graph you can't
- One Wilshire street hosts physical servers for Version, AT&T, AWS, Netflix…
- geographic location of DNS servers
- ease of querying data depends on its structure (e.g., array vs. dictionary)

… other examples?

data is material

Ebb: different data display



So, my work explores critical alternatives through designing and building emotional biosensing technologies, and asking people to use them and then interviewing them about their experiences.

drawing from approaches in critical design, speculative design, reflective design, … it's kind of like a study in contrasts.

Looking at what designs in emotional biosensing are already out there, I ask, what values do they support? what assumptions do they embed?

Then, in my designs, I try to support alternative values and invert those assumptions.

my designs are not meant to be products that people will want to use and buy, instead

they are meant to explore alternatives, prompt critical reflection upon what technologies we already have and help re-imagine what technologies we might want to have in the future

slowness and ambiguity as assets

Laura Devendorf, Joanne Lo, Noura Howell, Lin Lee Jung, Nan-Wei Gong, M. Emre Karagozler, Shiho Fukuhara, Ivan Poupyrev, Eric Paulos, Kimiko Ryokai. 2016. "I don't want to wear a screen": Probing perceptions of and possibilities for dynamic displays on clothing. *CHI'16*.

Ebb: fabric-based data display

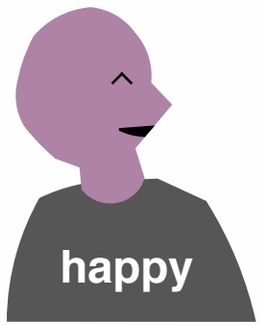
We made color-changing fabric swatches and asked fashion designers and everyday wearers to envision possible interactions with color-changing fabric in clothing in everyday life. Participants saw the slowness and ambiguity of this fabric as assets. They suggested ways that these color-changing fabrics could provide a very different experience as information displays than, say, screens.

Ebb: fabric-based data display

talk over the video about the different swatches…

affect-as-*information* vs. affect-as-*interaction*

two ways of understanding affect



information model

`user.emotion = "happy"`

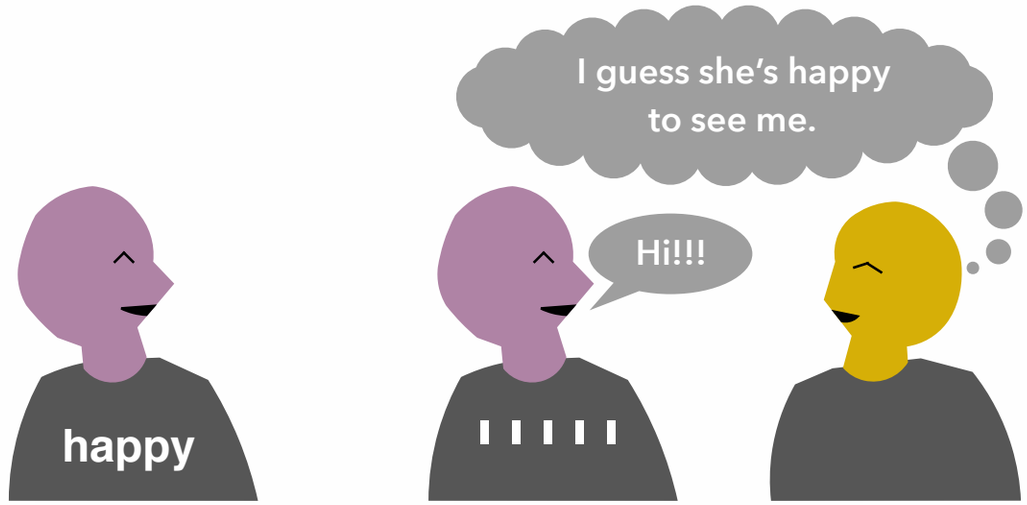
Kirsten Boehner, Rogério DePaula, Paul Dourish, and Phoebe Sengers. 2007. How emotion is made and measured. *International Journal of Human-Computer Studies.*

affect-as-*information* vs. affect-as-*interaction*

Drawn from the reading for today. There are different approaches to understanding affect.

At one end of the spectrum is the information model. computers treat emotion like any other kind of variable or state. Sensors and algorithms are used to detect emotions and categorize them into things like “happy,” “angry,” “sad,” etc. These kind of models measure emotion on the level of the individual and put these emotions into distinct categories. Context sort of gets flattened out here, “happy” in one context is assumed to be equivalent to “happy” in any other context.

two ways of understanding affect



information model

`user.emotion = "happy"`

interaction model

Kirsten Boehner, Rogério DePaula, Paul Dourish, and Phoebe Sengers. 2007. How emotion is made and measured. *International Journal of Human-Computer Studies.*

affect-as-*information* vs. affect-as-*interaction*

On the other hand, the Interaction Model, treats emotions as emergent from interactions between people, socially experienced, and highly contextual and situated in interaction. Rather than trying to get machines to detect and categorize feelings, the focus is more on supporting reflection and interpretation by humans.

Lucian Leahu and Phoebe Sengers. 2014. Freaky: performing hybrid human-machine emotion. *DIS'14*

Freaky: affect-as-interaction

machine learning to detect fear
computer performing fear by
"freaking out"
hybrid human-machine emotion

One example that gets away from purely detecting emotions in the user is Freaky. Freaky is an alien larvae like creature worn in a baby carrier. It uses machine learning to detect fear in its person. When it detects fear, it "freaks out" by making noises and vibrating. Its person has to pet and rock Freaky to get it to calm down.

I mean, the form factor is obviously weird, but I think that serves to show that this is an "alien" machine interpretation rather than claiming that this is the "true value" for the human's current emotions. So the system accommodates both machine interpretation and human interpretation, rather than claiming they are the same.

So, I think it could be argued that Freaky is a hybrid approach. The information-centric part is that the alien larvae does make its own judgment about "fear" based on its informational measurements of the wearer's heart rate. But, rather than assigning that label of "fear" to the wearer, Freaky enacts that fear itself. Much of the meaning and interpretation comes out in the wearer's interaction with Freaky, and with other people who are around at the time.

What are some advantages or disadvantages of the different approaches to understanding emotion?

affect-as-*information* vs. affect-as-*interaction*

- comparisons across time are easier with discrete categories of emotion, to look for long term trends?
- but those comparisons mean you have to treat all instances of “happy” as the same in order to really compare them like that
- what about computing systems that are more responsive to human emotion? what about if they get it wrong?

Hint & Ripple: different concepts of emotion

skin conductance (SC)
electrodermal activity (EDA)
galvanic skin response (GSR)

Hint: social biosensing display

One kind of information we thought it could be interesting to display is skin conductance, also known as GSR or EDA. Skin conductance is essentially how sweaty you are, but micro-fluctuations in this are associated with emotional arousal such as being stressed or happily excited. Skin conductance has been used in lie detectors, stress detectors, and so on, but we wanted to try something where we embrace the inherent ambiguity of skin conductance. See, skin conductance gives an indication of arousal, but no indication of valence - it could be a positive or negative kind of excitement - and I find that ambiguity interesting.

clothing skin conductance display

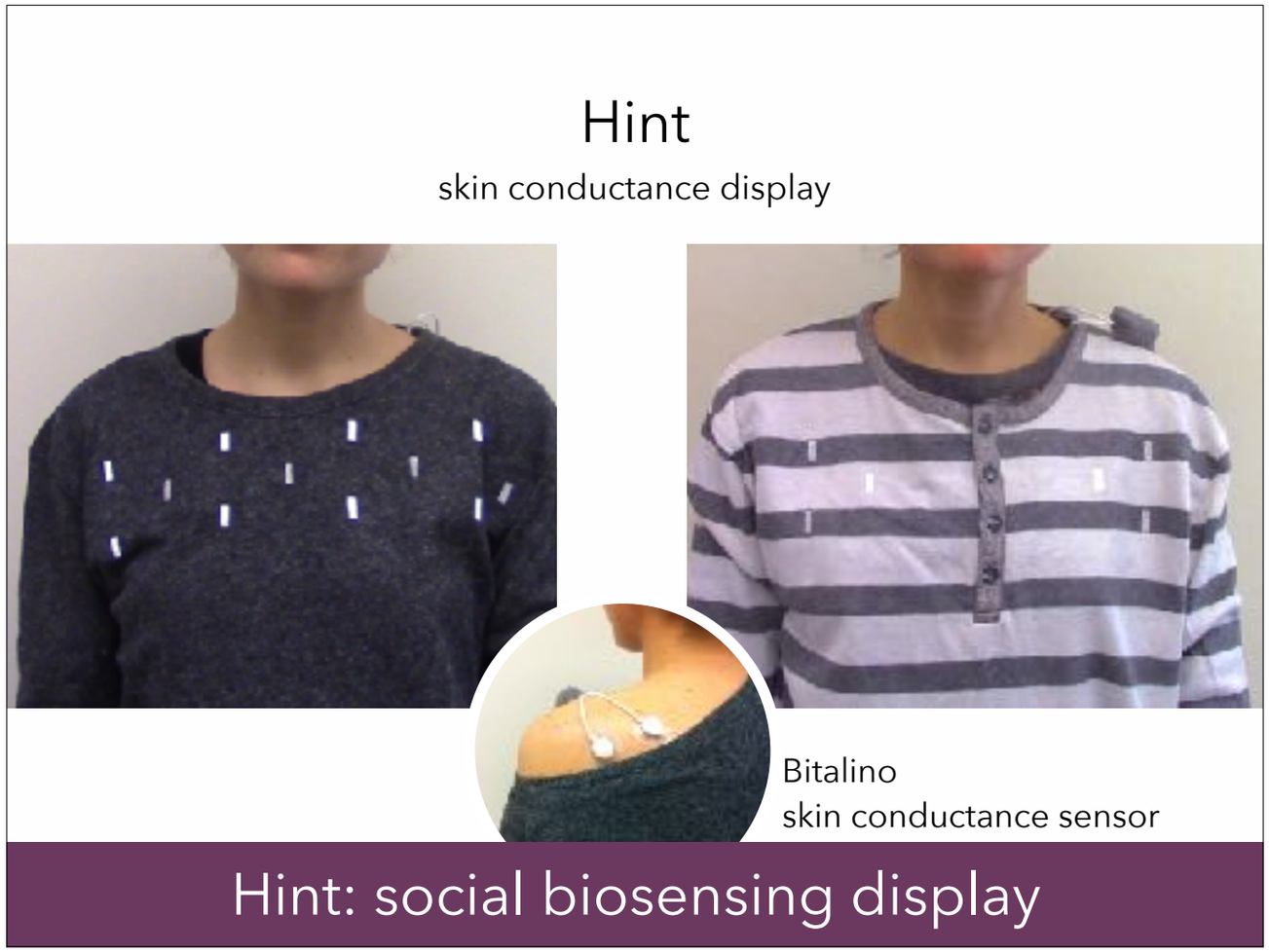
speed up 20x

Hint: social biosensing display

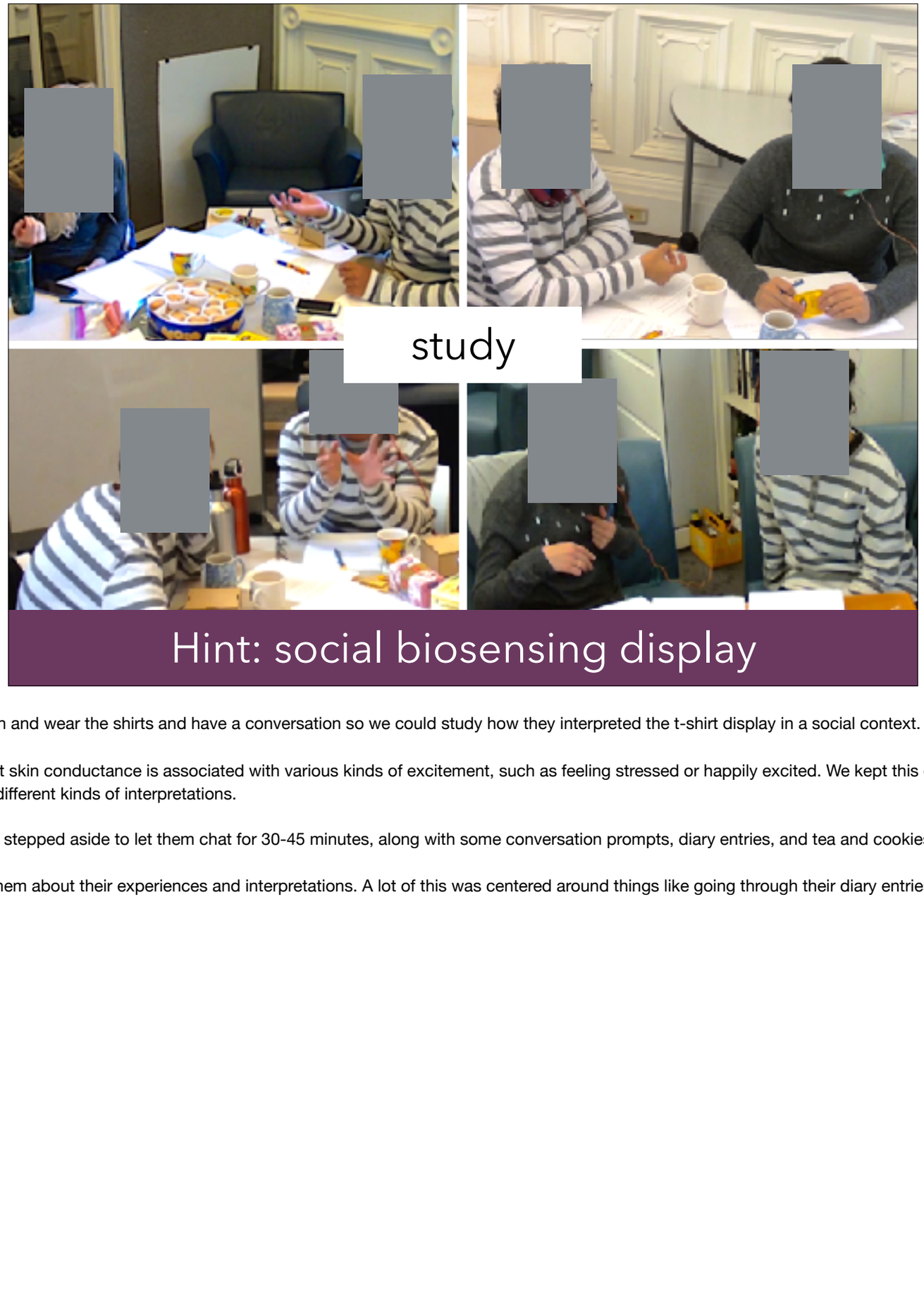
We developed Hint, a t-shirt that changes color in response to the wearer's skin conductance. When the wearer's skin conductance spikes, small white rectangles gradually appear.

The display is abstract. Its color change indicates that something emotional *might* have changed in the wearer, but it doesn't give any clues as to what. It's up to the people in the context of the situation to interpret it.

For the purposes of this study, we wanted the shirts to look fairly ordinary, so we adapted store-bought t-shirts and used screen printing as it is a common technique for t-shirts. We placed the display up around the collarbones so that the display would be easily visible to those around the wearer, not something that it would be easy to hide.



We used a Bitalino skin conductance sensor worn on the back of the shoulder.



For the user study, we asked pairs of friends to come in and wear the shirts and have a conversation so we could study how they interpreted the t-shirt display in a social context. We had 5 pairs come in for a total of 10 participants.

The researcher introduced the shirts and explained that skin conductance is associated with various kinds of excitement, such as feeling stressed or happily excited. We kept this explanation short and consistent with everyone because we didn't want to prime them too much with different kinds of interpretations.

Then the participants put on a shirt and a sensor, and I stepped aside to let them chat for 30-45 minutes, along with some conversation prompts, diary entries, and tea and cookies.

After their conversation I came back and interviewed them about their experiences and interpretations. A lot of this was centered around things like going through their diary entries to talk about what they had noticed, as well as what they liked and didn't like about the shirts, etc.

participant interpretations

Researcher said…	Participants said…
stressed	“empathy”
happily excited	“fear”
	“embarrassed”
	“passionate” (while debating)

Hint: social biosensing display

On the left is how I introduced the system to participants. I said that the white rectangles appearing on their shirts could be associated with an increase in excitement such as feeling stressed or happily excited. I kept that explanation short and consistent across participants because I didn’t want to prime them too much.

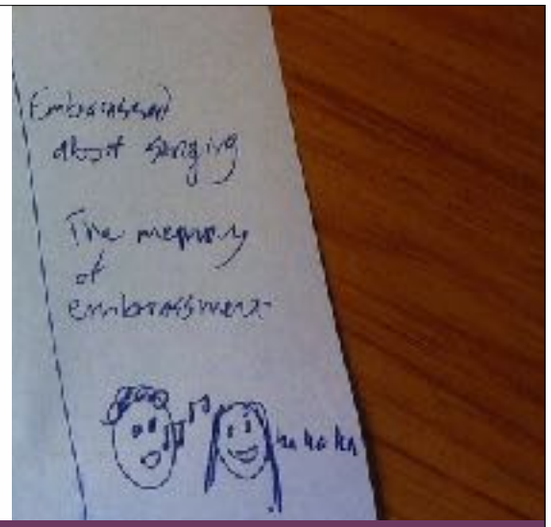
Participants associated a change in their t-shirt display with feeling empathy, fear, embarrassed, or passionate while debating.

“pure joy”

Hint: social biosensing display

One pair noticed their shirts changing at the same time, and attributed it to the “pure joy” they were sharing while laughing together about cat memes.

validation



"I just wanted some **confirmation** that what I was feeling was **real**."

—Ryan

Hint: social biosensing display

Some participants seemed to want the system to help validate their feelings. Ryan told a story about singing to his ex girlfriend and how she laughed at him in response. He said that while he was telling that story he felt deeply embarrassed, and wanted to observe a change in his t-shirt display because
"I just wanted some confirmation that what I was feeling was real"

showing emotional engagement

"**I'm worried [my friend] will think I don't care about her stories,** which I do, but, because I have this **baseline anxiety** [my shirt isn't changing]… It's not that I don't have a change in emotion to some extent, it's just that there's something else that's also there."

–Mary

Hint: social biosensing display

Other participants seemed to want the system to help them show emotional engagement in their conversation.

I want to sort of zoom in on this one quote, and this one user's experience, which I think illustrates the kinds of interactions users had with the system.

During the post interview, Mary said,

[read the quote]

Mary associated her t-shirt display with her "baseline anxiety". During their conversation Mary and her friend talked about how Mary was feeling stressed about the end of the semester, and during their post interview with me Mary identified herself as "a person with anxiety" and said it's something she struggles with.

During their conversation her friend told a lot of personal and entertaining stories about her life. Mary was worried that her t-shirt might convey a lack of care by displaying only her anxiety and not showing her engagement with her friend's stories.

Whereas a lot of work that designs for affect with the information model tries to get at one feeling that a user has at a particular moment, I think in social contexts we often have a variety of feelings - even conflicting feelings - at any given moment, and part of what we do in socializing is controlling which emotions we want to show and which ones we want to hide. It's not like Mary was completely hiding her anxiety from her friend - they talked about it earlier - but then later Mary wanted to show that she was engaged with her friend's stories.

social cues

Hint: social biosensing display

In trying to design for affect while employing the interaction model, I think social cues could be a good source of inspiration. Social cues are public-facing communication about ourselves that we might “give off” unintentionally or “give” intentionally if we are being really self aware. They do communicate something about how we are feeling, within the context of the current social interaction.

biosignals

www.myfeel.co

social cues

Hint: social biosensing display

On the other hand, a lot of work with biosignals tries to extract these “signals” of our “true state”. For example the Feel wristband and mobile app gives real time numerical estimates of one’s happiness, stress, and sadness.

biosignals

www.myfeel.co

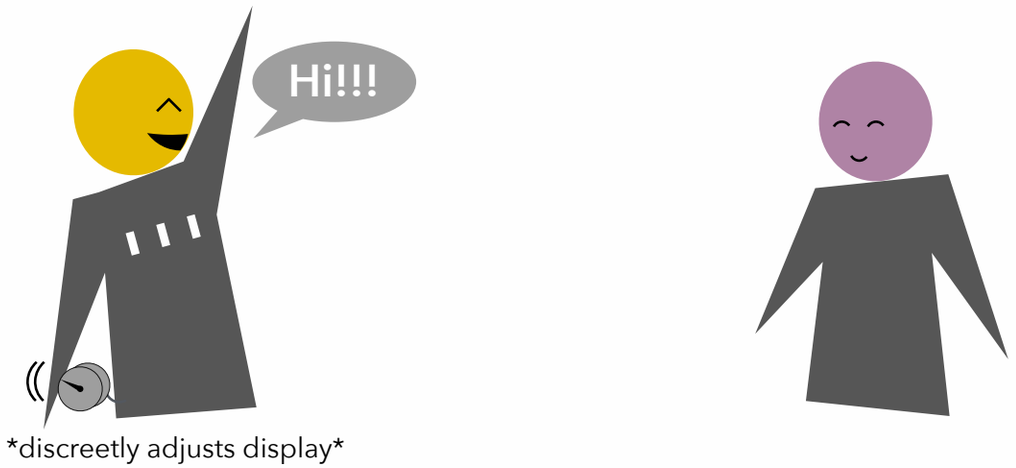
bio-cues

social
contextual
multiple meanings
human-interpreted

Hint: social biosensing display

But, in contrast to that, I think Hint provides something more like a bio-cue. It's seen socially, the meaning is emergent in context, it can have multiple meanings, and above all the meaning is interpreted by humans.

designing for bio-cues



What if users could mediate their bio-cues display?

What about exploring a loss of control?

Hint: social biosensing display

So, what might it look like to design for bio-cues? Well, one interesting possibility could be letting users mediate their biosignals display to help them enact social performances. Here the user is discreetly adjusting their t-shirt display to help show that they are excited to see their friend.

On the other hand, I think it could be interesting to explore that loss of control in these kinds of displays to call social performances in question. So, I think it could go both ways, but this idea of designing for bio-cues rather than bio-signals is an interesting framing for design.

Hint & Ripple: different concepts of emotion

Hint was interesting, but I still felt that it was too limiting to just study participants' interactions in a lab-based social setting, even if the lab was just our casual student space in South Hall, and even if tea and cookies were involved.

So with Ripple, we adapted the core technology of Hint to be much more robust, strong enough to be worn as a regular garment throughout daily life.

different concepts for biosensing of emotion - Ripple project

So, combining these ideas, I made shirts “Ripple” with a small pattern that changes color in response to emotional biosensory data of the wearer.

These shirts respond to sudden increases in skin conductance, which is associated with various kinds of excitement. Skin conductance is essentially how sweaty the skin is, but micro fluctuations in that are associated with various kinds of excitement. For example, if you are really nervous you might have sweaty palms, but skin conductance could also respond to more positive forms of excitement like just being really happy about something.

different concepts for biosensing of emotion - Ripple project

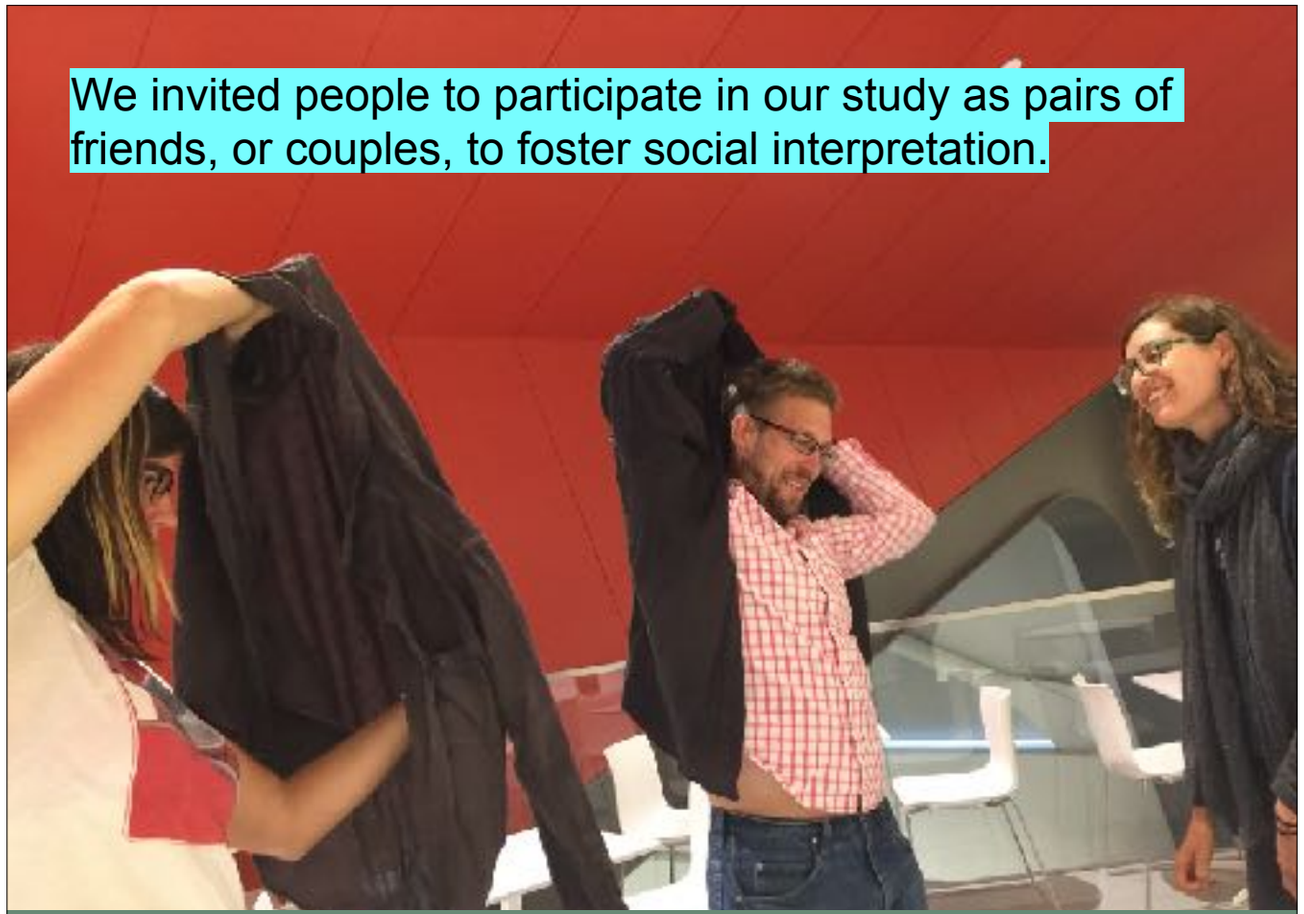
Three pinstripes on the sleeve slowly change color over the course of about ten minutes.

different concepts for biosensing of emotion - Ripple project

different concepts for biosensing of emotion - Ripple project

So, rather than displaying a particular category of emotion, the shirt just suggests that the wearer might be experiencing some kind of excitement, keeping it intentionally super vague what kind of excitement that might be and leaving it up to the people to interpret it.

I asked participants to wear these shirts throughout two days of their daily lives, and then interviewed them about moments when they noticed the shirts responding. I asked them to participate as pairs of friends so they could not only interpret their own shirt but also their friend's.



study procedure

We invited people to participate in our study as pairs of friends, or couples, to foster social interpretation.

After an introductory meeting, participants went about their daily lives wearing Ripple. For that period, they were given diary prompts asking them to document their experiences with text and photos.

The next day, they met again with a researcher for a semi-structured post-interview asking about their experiences with and interpretations of the display, which they had worn for about 8-20 hours.

findings

Ripple: reflection in daily life

Participants had a broad range of experiences with Ripple throughout their daily lives.

For example, when one pair of friends was climbing on the yellow blocks, one of them almost fell and then noticed that her shirt's display had changed color then. She attributed it to her fear of almost falling.

Another person received a job offer over the phone while wearing Ripple, and attributed the display change at that point to his excitement.

One pair of participants, Alva and Brant, was a married couple who were about to move. They were walking and discussing their upcoming move when they noticed Alva's shirt changing, but not on Brant's shirt. She attributed it to her stress about their upcoming move, and it prompted them to talk about that.

One participant stepped outside the sushi bar for a smoke, and wondered if the display changing at that moment was due to the nicotine entering his body.

embodied reflection

*"**It made me reflect on how situations are clearly transmitted into my body**, you know, 'cause usually I think about emotion as something that is not physical or non-tangible, it's just like, 'oh, yeah, emotions,' but this was like 'No, dude! These are emotions! They impact your body!' ... I think [the angry phone call] made me self aware of my body, I would say in a positive way... I'm not just thinking from my body to the outside, but actually going back to my body and **connecting mind and body and emotions**. I think that was super cool; that was, like, this philosophical moment, you know?"*

—Agustin

Ripple: reflection in daily life

I want to dive into this one quote because I think it highlights the kind of embodied reflection participants engaged in with Ripple.

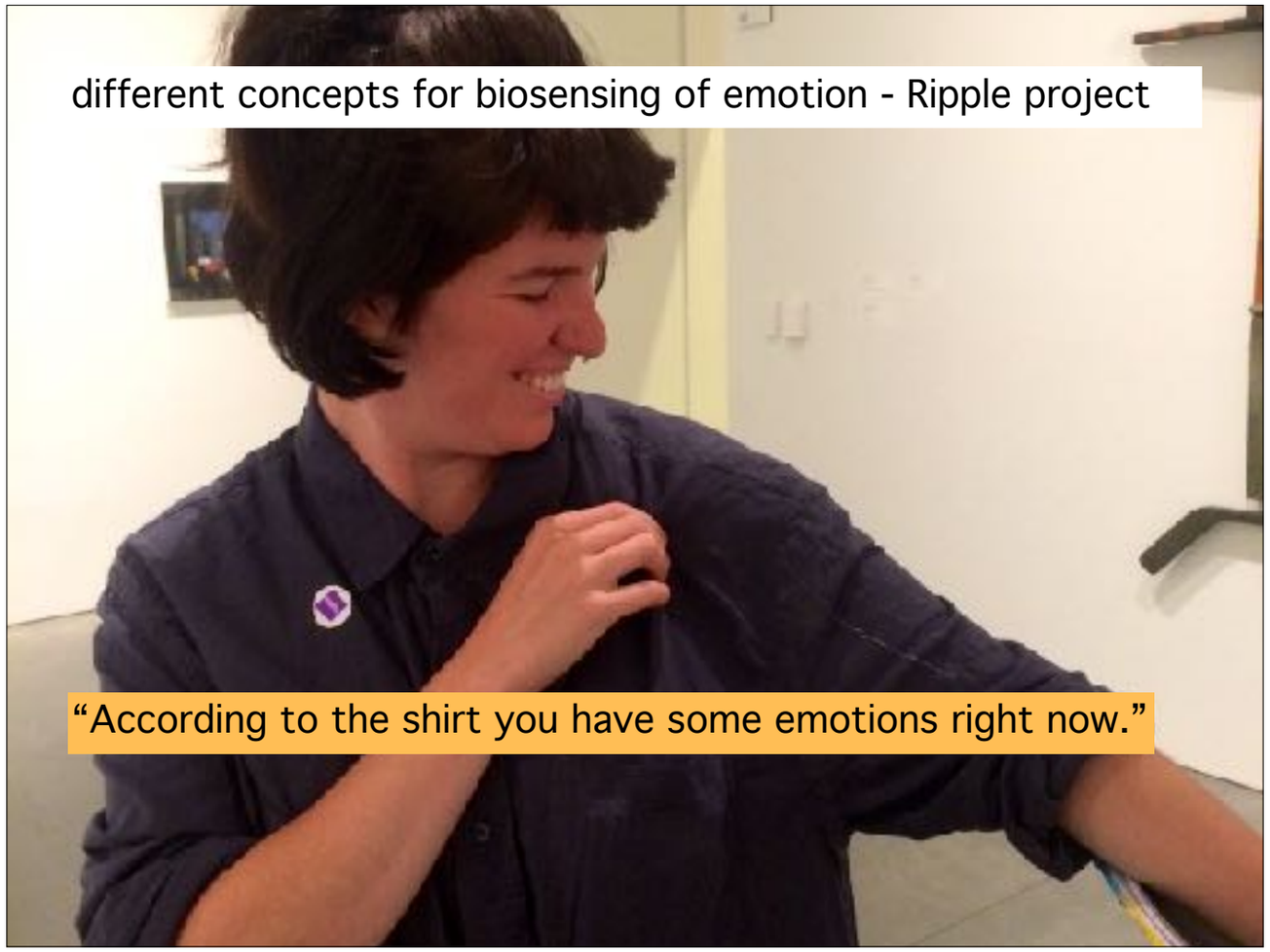
Agustin was having an angry phone call with his internet service provider when he noticed his shirt display was responding. He attributed it to his anger about the call.

read the quote

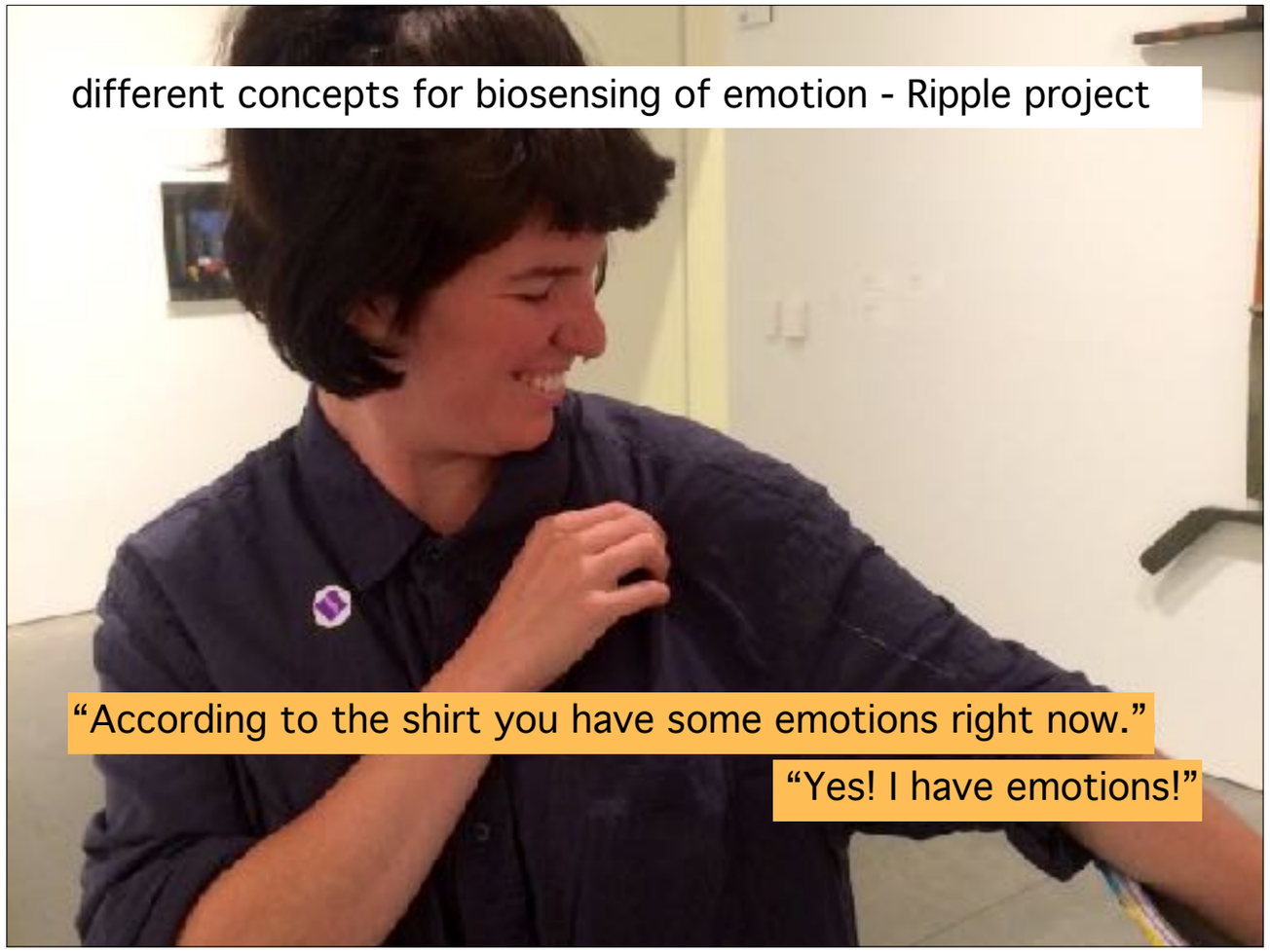
I can't know this for sure, but it seems like since clothes are literally the interface between our bodies and the world, so situating the sensor and display on clothing may have encouraged this kind of reflection connecting the environment, body, and emotions.


different concepts for biosensing of emotion - Ripple project

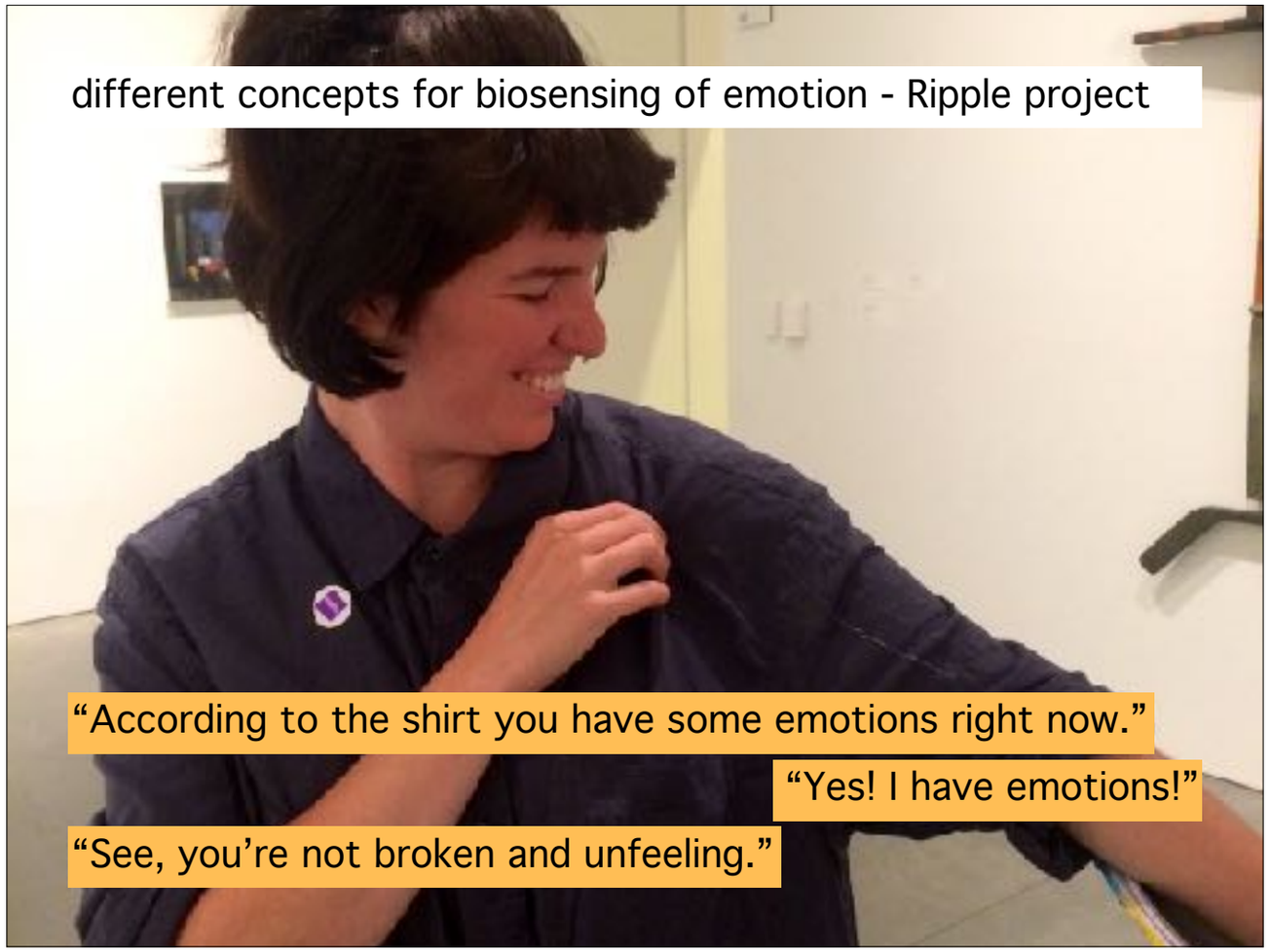
Yet, we also observed tensions emerging. Some participants seemed to map a lack of display response to a lack of emotion. One participant expressed concern that the shirt not responding might indicate that she was not a very emotional person.



When her display changed at the end of the first meeting, her husband pointed it out by saying, “According to the shirt you have some emotions right now.”



In response she broke into a huge smile and exclaimed, “Yes! I have emotions!”

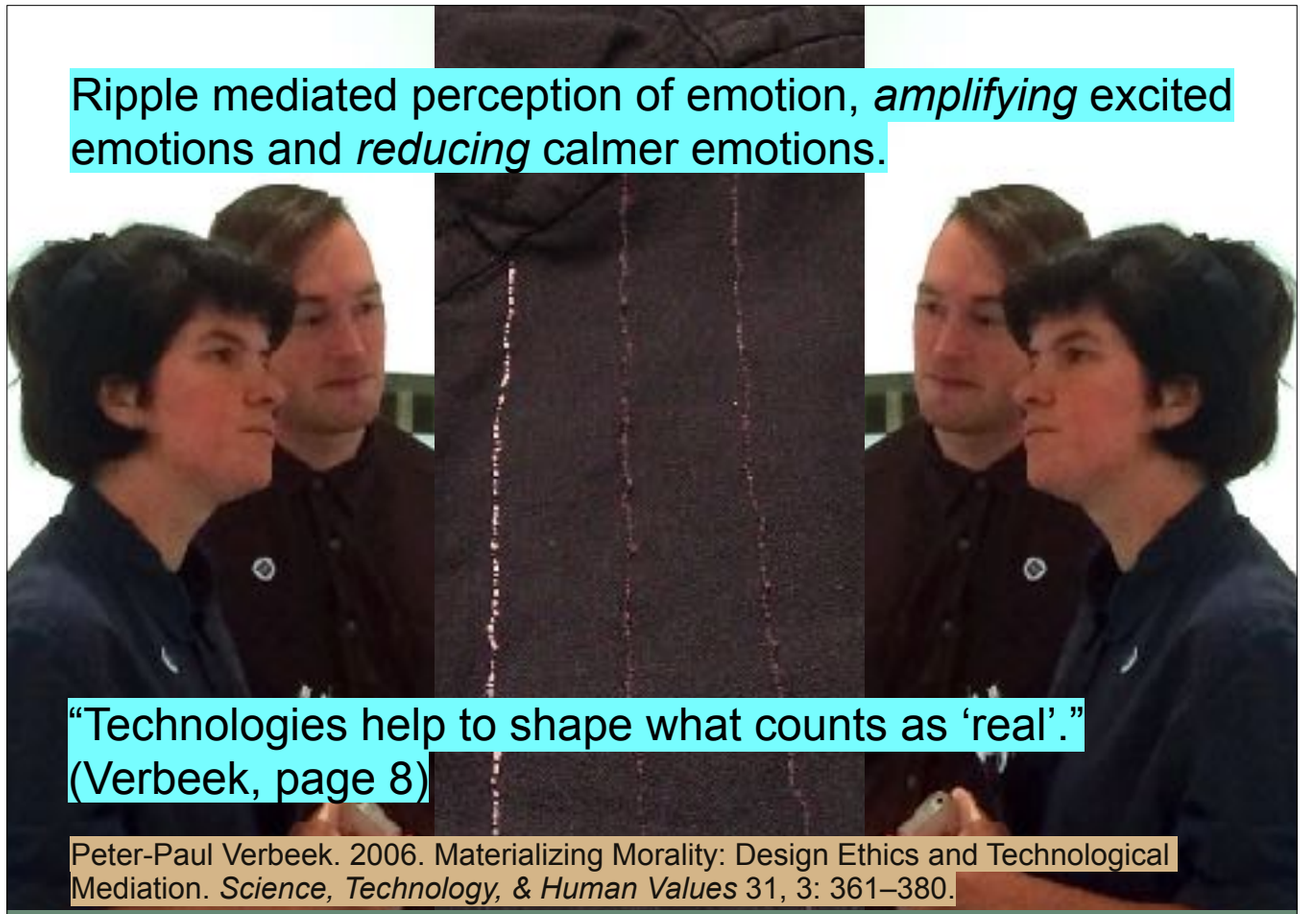


Her husband replied, “See, you’re not broken and unfeeling.” And like, I got the sense that he was quoting back to her a phrase she had used, in order to reassure that she was not in fact broken and unfeeling.

Erika seemed to interpret a lack of responsiveness in the display as suggesting that she did not have feelings. She may have been having calm emotions the whole time, but Ripple didn’t respond to that - Even though the shirts was intentionally super ambiguous about what it was displaying, it still seemed to have shifted what counts as “emotion” for some participants by only responding to some kinds of emotions and not others.

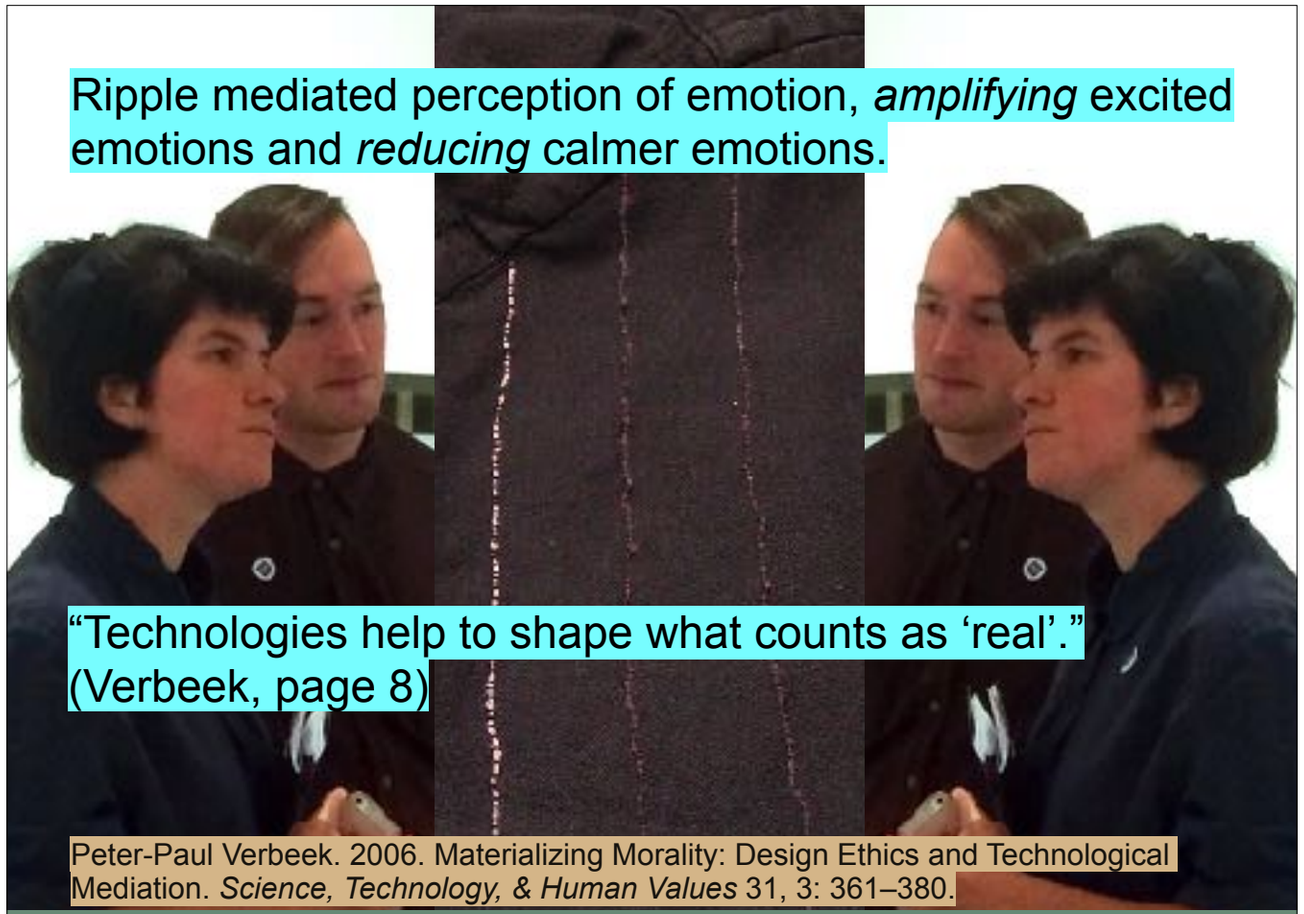
While for some people Ripple prompted a kind of reflection they found valuable, for other people it seemed to have the potential to foster or aggravate insecurities.

So, I was pretty surprised at what happened with this study, and I definitely did not intend to foster this kind of upsetting interaction. Still kind of unpacking this. But at the same time, it’s this unexpectedness which is why I love studying how these designs play out in the real world! A lot to chew on there but to keep moving right along…

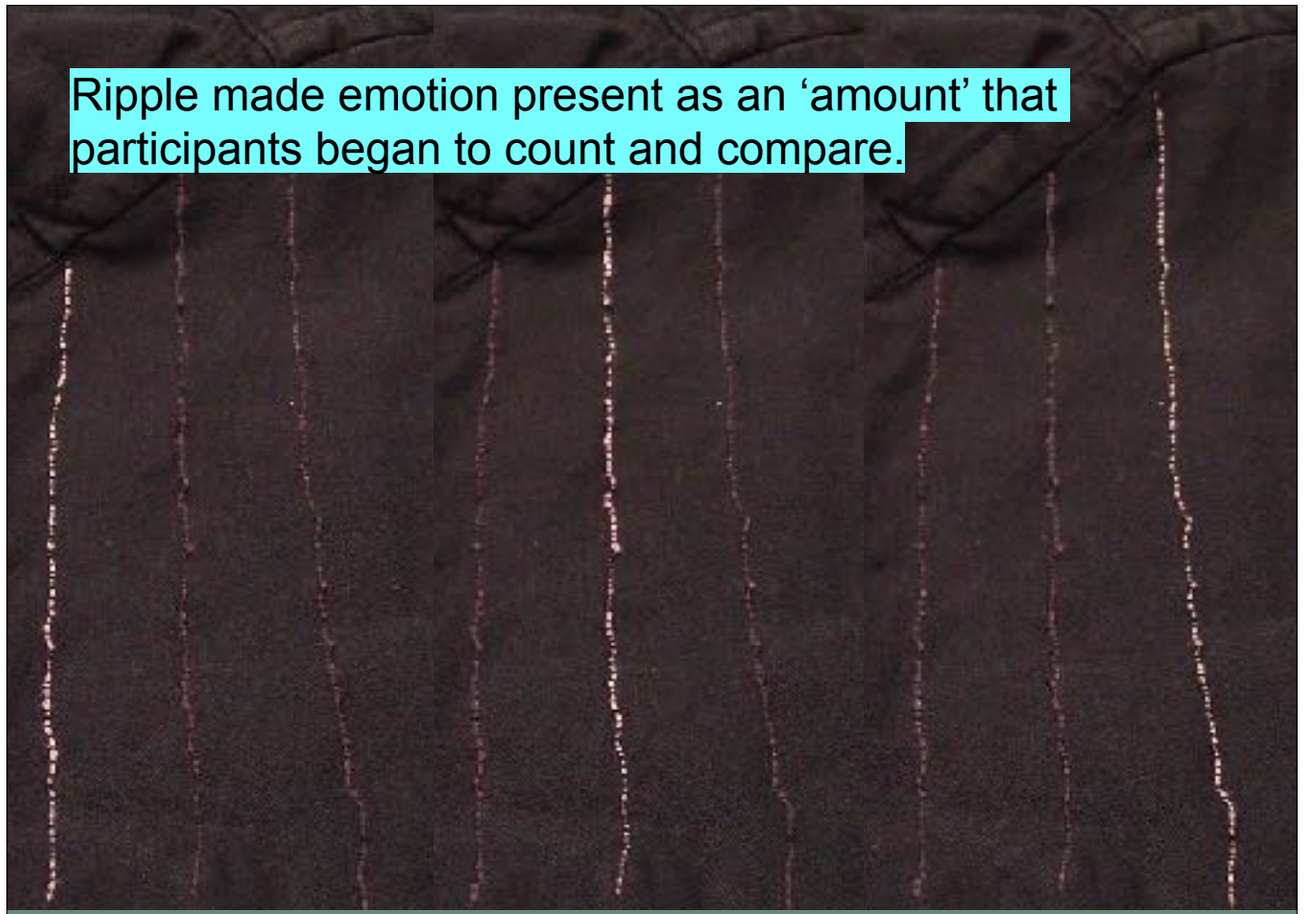


Ripple mediated perception of emotion, amplifying excited emotions and diminishing calmer emotions. In a sense, people were looking through the display back at themselves as they sought to enroll the display in emotional reflection.

Ripple made excited emotions more present for some participants by amplifying those moments with a display change. Ripple made calmer emotions less present by not responding in those moments. Further, for some participants it seems Ripple shifted their conception of emotion itself to be defined according to the display changes. Ripple’s display response was seen to indicate the presence of emotion, while a lack of response by Ripple was seen to indicate a lack of emotion.



Like other mediating technologies, Ripple “helps to shape was counts as ‘real’” for participants with regard to their emotions.



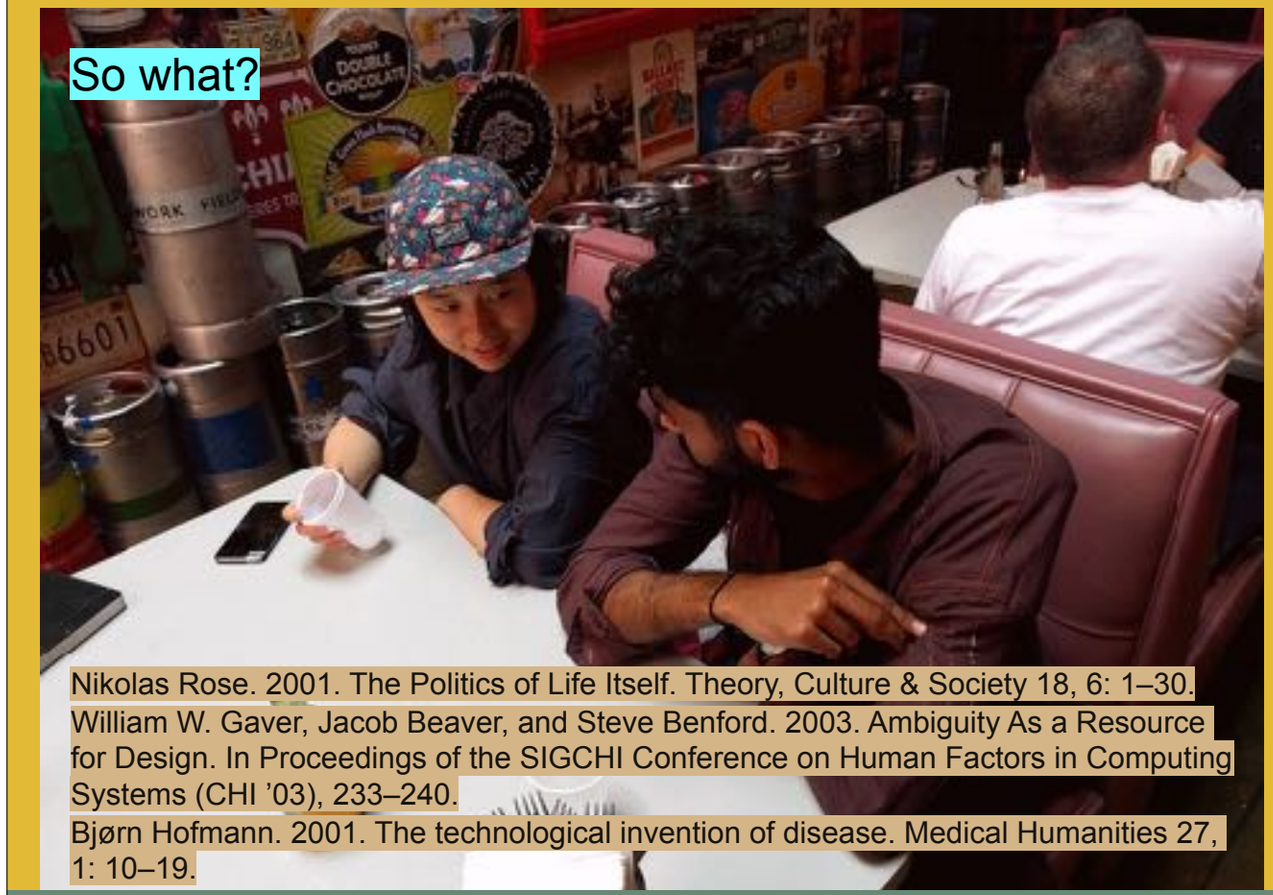
discussion: counting emotions

Ripple made emotion present as an ‘amount’ that participants began to count and compare.

Participants also seem to have begun ‘counting’ the number of instances of display changes, or duration of display change. Erika, wanting to observe a display change, saw the difference between zero display changes and more than one display change as significant, indicating whether they were “a very emotional person” or “broken and unfeeling.” Alva and Brant compared whose display was changing more, and sought to make their displays change about the same amount.

This calls out multiple meanings of ‘count’, where it means
- something that falls into a category
- something good or valuable in a moral sense
- the idea of counting as assigning quantities or ‘values’

Thus, Ripple not only shifted some participants’ conception of emotion, it made emotion present as an ordinal variable. By ordinal we mean participants made comparisons about more or less, but they did not specifically count numerically the number of display changes.



conclusion: some tentative thoughts…

So, what?… well, I was pretty surprised how it turned out… I'm still thinking through all this, so I'm very grateful for the opportunity to share these early stage thoughts with you all in the hopes of getting feedback…

So, we really sought to get away from issues like this, issues of defining our own categories of emotion, issues of thinking about quantities of emotion, but they were still present in the experiences some participants had with our design.

On the one hand, maybe we just designed it wrong… could have some "implications for design" on how to avoid these mistakes in the future, … on the other hand, maybe there is something a bit more here that could be interesting.

Kind of one line of speculation I have is, My hunch is that participants felt insecure about their feelings, and so they wanted to invest a kind of benevolent authority in Ripple so that for them Ripple and its data and display could provide "insights" or "truth," which could provide a sense of security…

We designed Ripple to support open-ended reflection. We hoped that this would foster human-driven interpretation by participants. But I think what it did was open the door for some prevalent (and I think problematic) societal discourse around emotions to come through in participants' reflections.

Specifically, I'm thinking about Rose's ideas around biopolitics, how health is increasingly seen as the responsibility of the individual, and health is increasingly seen as constantly under threat of disease or proclivity toward getting a disease in the future. Where health includes physical, mental, emotional… and not only is health constantly at risk, but one is also taught to "optimize" for health, or fitness, or happiness, for "living one's best life"…

So, with this biomedicalization of emotion comes insecurities around our own lived experience of emotion - How am I feeling right now, and how *should* I be feeling right now? And how will other people around me react to the way that they think I'm feeling?

And, as was discussed in the Techno-Optimism Panel on Friday afternoon, there is this desire to be optimistic about technology's ability to solve our problems and improve our lives… technology makes healthcare seem more legitimate…

OK so that's kind of one line of speculation, also another line of thought, … drawing on Gaver, thinking about Ambiguity as a Resource for Design, I think ambiguity can be a way to encourage critical reflection… but maybe we went overboard and made Ripple too ambiguous? So in the face of so much uncertainty, people feel back on the very societal narratives we were trying to contest…

different kinds of biosensory data - laughter project

Kimiko Ryokai, Elena Duran, Dina Bseiso, Noura Howell, and Ji Won Jun. 2017. Celebrating Laughter: Capturing and Sharing Tangible Representations of Laughter. DIS '17 Companion.

So, the last example I have is of exploring different *kinds* of biosensory data.

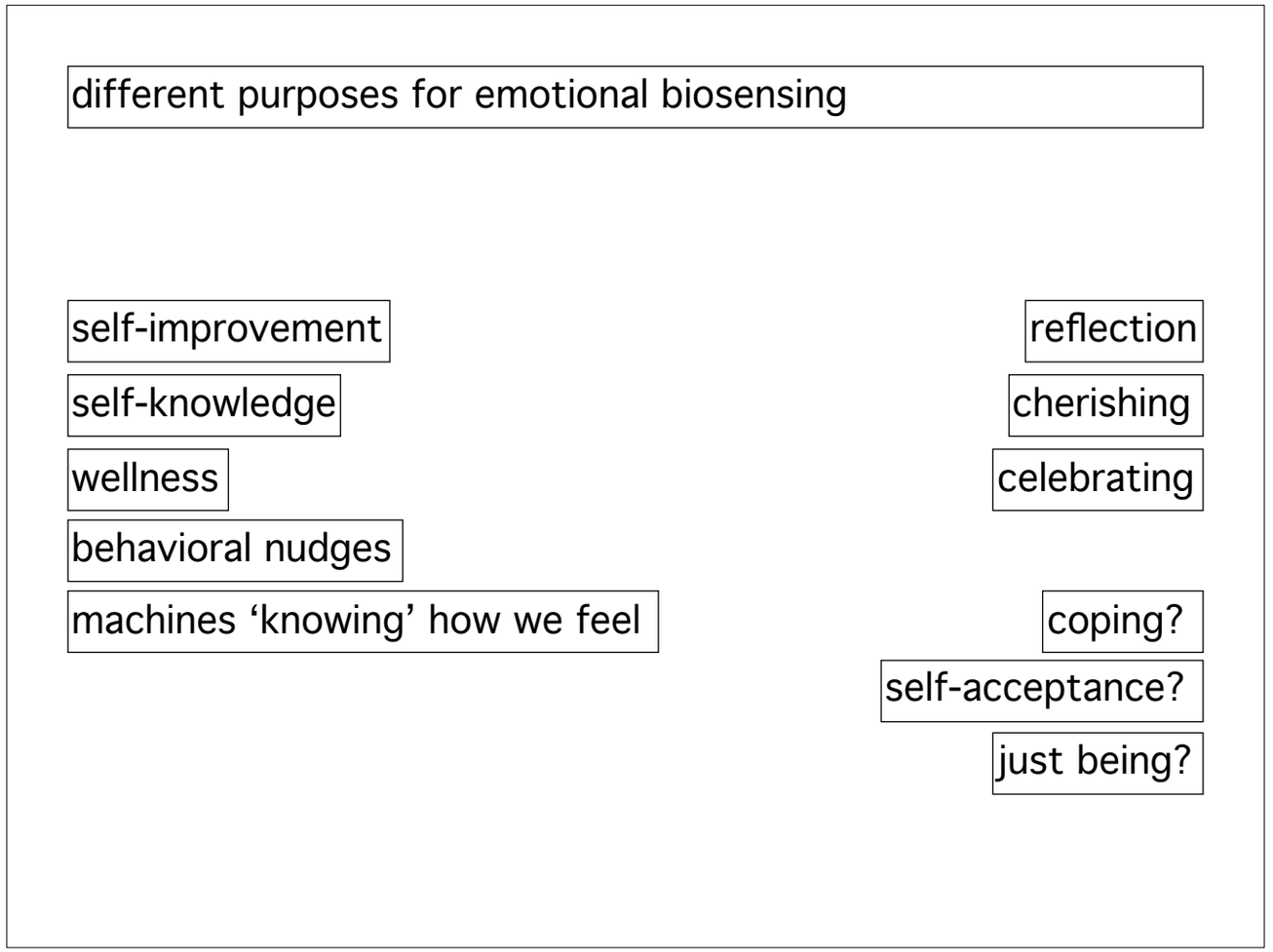
In the previous project I used a pre-made skin conductance sensor, but here we explored what it might be like to "sense" or "detect" and then represent laughter of ourselves and loved ones.

Different laughs could be represented as lights in a jar that twinkle on and off according to the quantity or quality of the laughter.

Chocolate "bar graphs" could represent the number of laughs from particular days or for particular members of the family, and could be given as gifts or casually eaten.

A delicate bottle could preserve the sound of the laughter and play it back when opened.

Instead of self-improvement or personal reflection, here the goal is more about cherishing and celebrating good moments with loved ones.



So, we’ve looked at many different kinds of purposes of what we might do with emotional biosensing.

I’ve argued that prevalent approaches already out there are too limiting. This stuff about self-improvement or self-knowledge, or emotional wellness, guided by behavioral nudges telling us what we should do, based on the idea that machines can ‘know’ how we feel…

I’ve explored some alternative design possibilities around reflecting on emotions in the moment, cherishing or celebrating good moments with loved ones, …

Going forward I’m still curious about other ways that emotional biosensing might be part of our daily lives, like instead of self-improvement how about just coping, or instead of self-knowledge what about just self-acceptance, or just enjoying being the way we are?

Well, I haven’t really provided any good answers or solutions, but I hope I’ve been able to share some of the questions I’ve been grappling about with you.