



# Rethinking “Data” with Emotion & Materiality

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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.

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

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

data is material

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

data is material

Ebb: fabric-based data display

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

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Hint: social biosensing display

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Ripple: reflection in daily life

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information is a slippery concept

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



# two ways of understanding affect



information model

**`user.emotion = "happy"`**

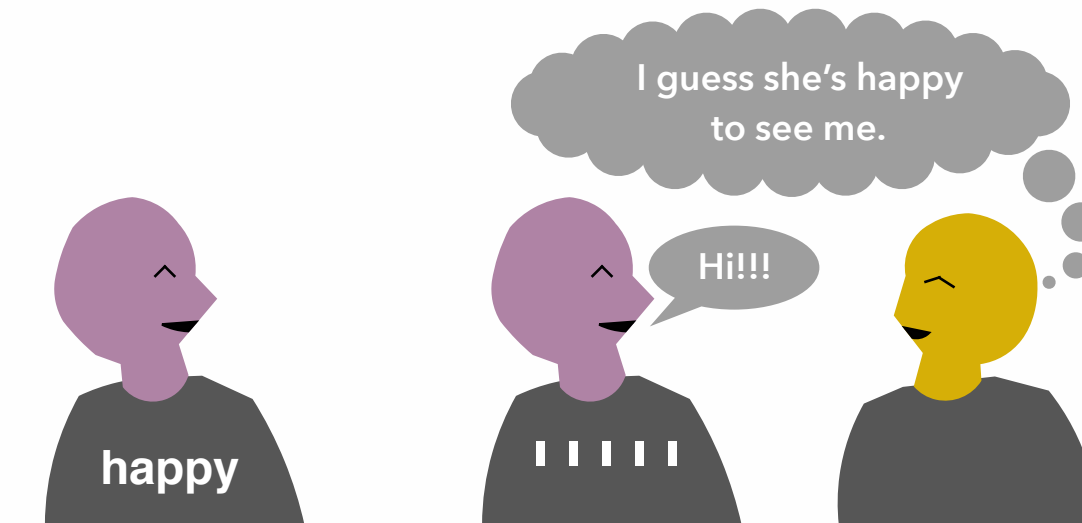
Kirsten Boehner, Rogério DePaula, Paul Dourish, and Phoebe Sengers. 2007. How emotion is made and measured. *International Journal of Human-Computer Studies*.

*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

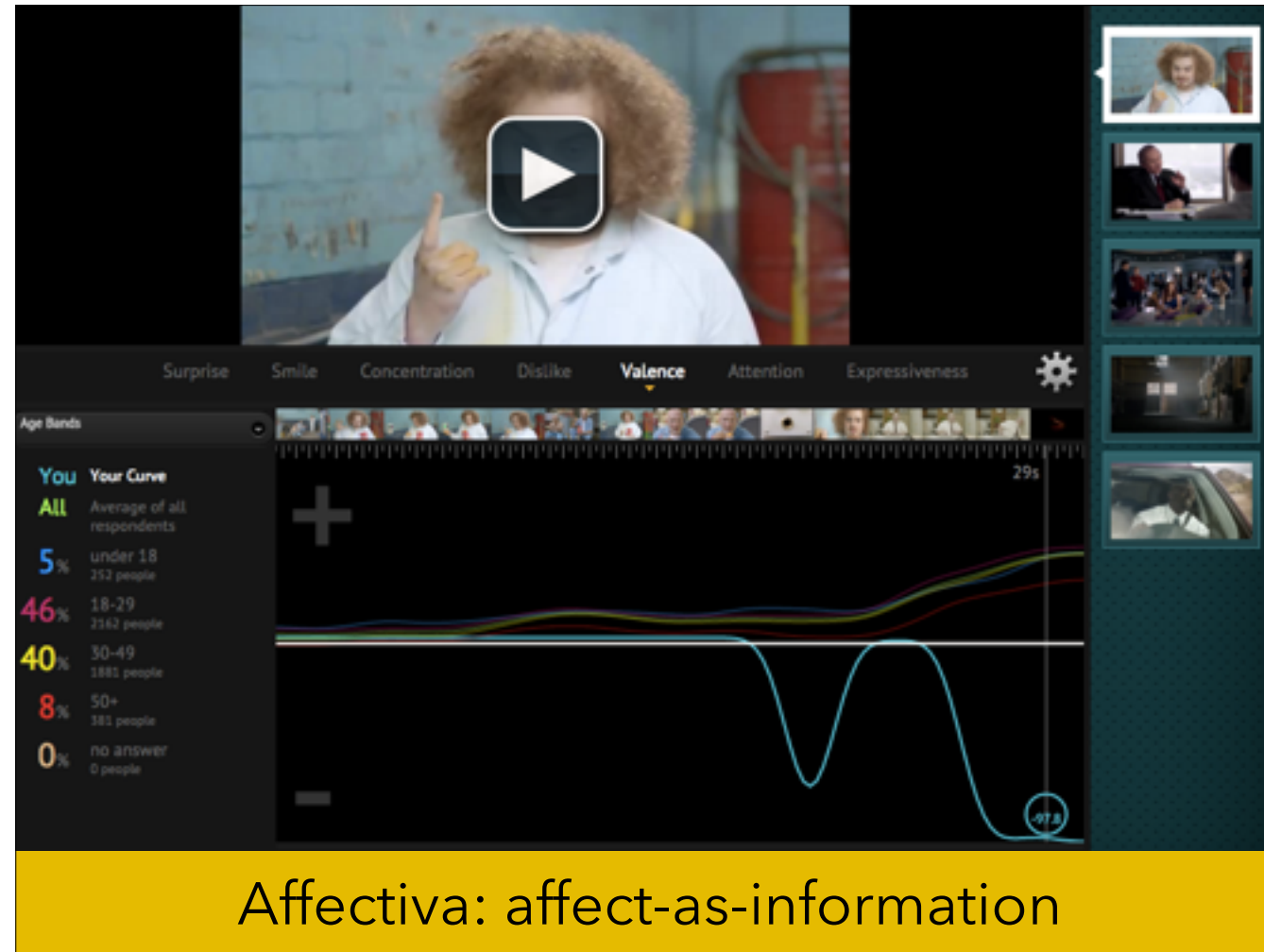
`user.emotion = "happy"`

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.

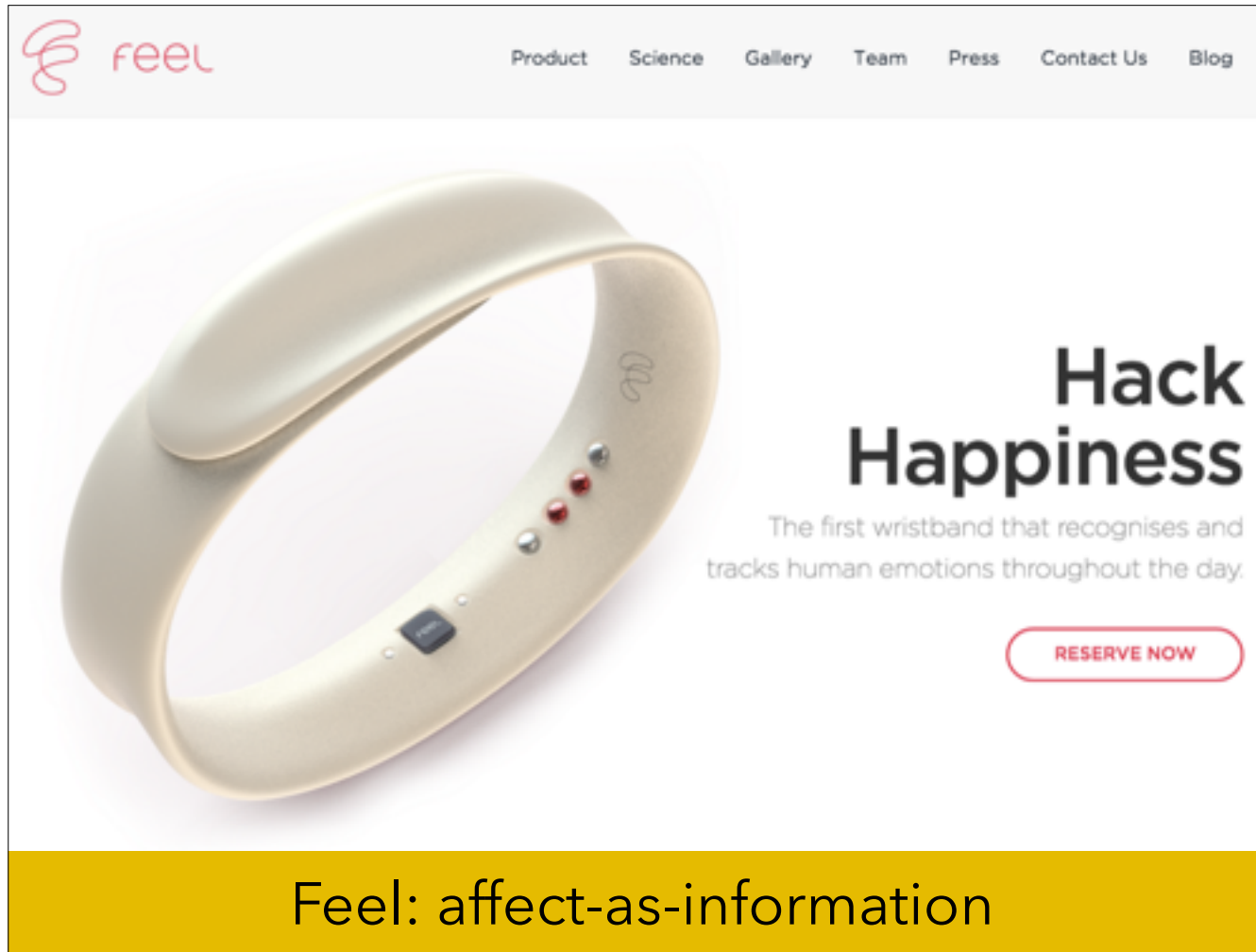


## Affectiva: affect-as-information

Affectiva is a company that spun out of research at the MIT Media lab, founded by Rana el Kaliouby. It takes in video of a person's face and detects different parts of their facial expression, such as the shape of their mouth or their eyes, and uses machine learning to map combinations of those to different aspects related to emotion such as valence (positive or negative feelings), surprise, smiling, etc.

I went onto their website and tried out their demo, where they tracked my face while I watched an ad. You can see my "valence" graph in the bright blue. Apparently I really didn't like this ad because the valence went super negative. Evidently most people had a more positive valence toward the end of the ad.

So, you can see how advertisers would love this kind of information to help better sell to consumers. There are a lot of other possible applications too. I think Kaliouby initially wanted to help children with autism understand how others around them were feeling to help them socialize. You could also imagine online courses that offer special help when a student appears to be frustrated.



Another example is the Feel wristband, that tracks the wearers' emotions throughout the day in order to help them "Hack Happiness".

They track galvanic skin response, pulse, and skin temperature. Galvanic skin response, also known as skin conductance, is a measure of how electrically conductive one's skin is. or basically how sweaty you are. but, like, micro-fluctuations in that. a sudden increase in skin conductance is associated with excitement of various kinds. for example feeling nervous and having sweaty palms.

heart rate is also associated with emotions, perhaps we have more intuition about that. for example feeling afraid and your heart is pounding



**Feel the wristband**

4 integrated sensors on the wristband measure and track biosignals from users throughout the day, including galvanic skin response, blood volume pulse and skin temperature. The buckle on the top of the wristband hides a flexible connection which ensures that the bracelet stays stable on the wrist.

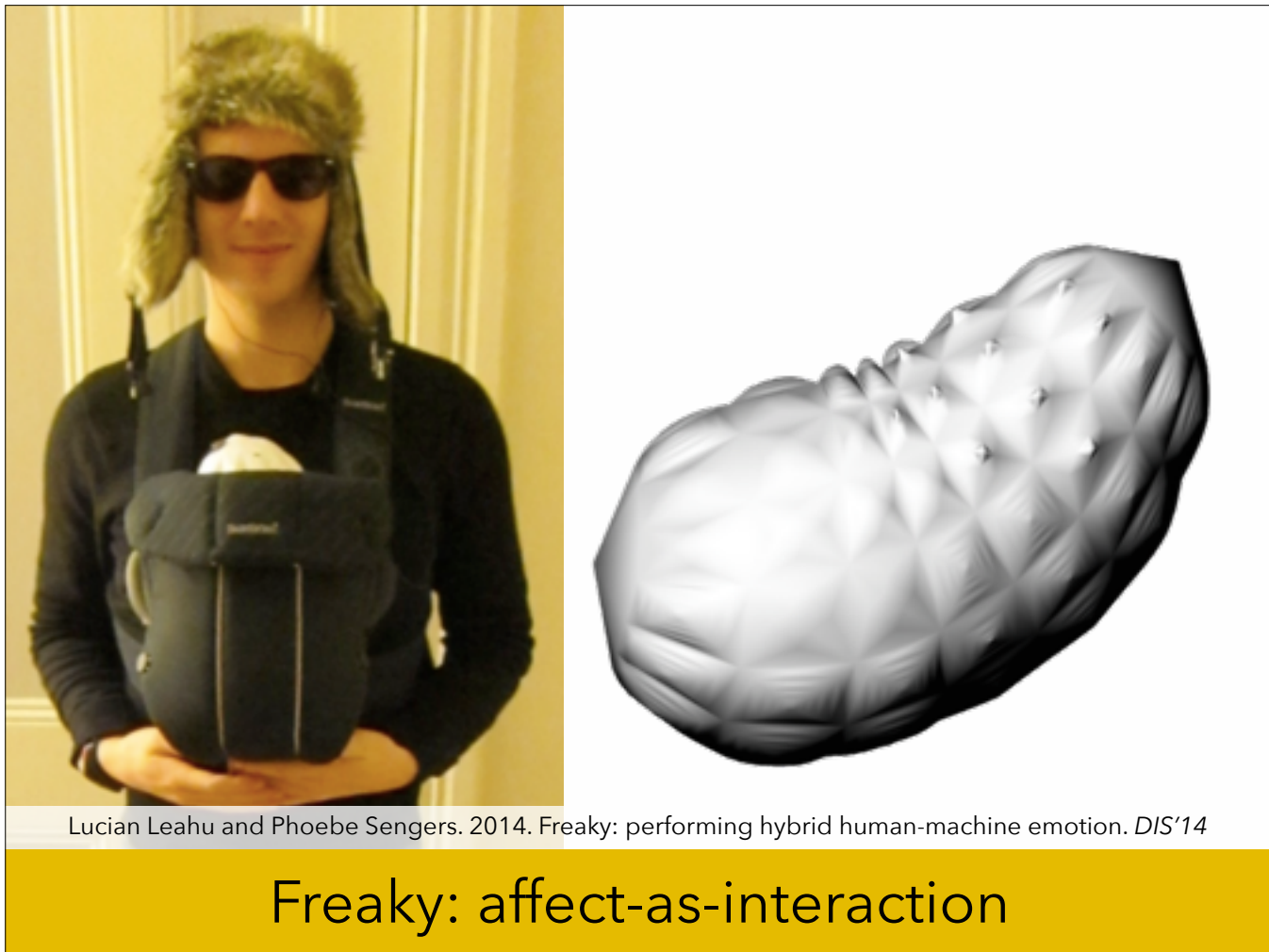
**Feel the app**

The modern wristband communicates directly with the user's mobile phone using Bluetooth. The mobile application visualizes the results to show users how they feel during the day and how their mood is affected by factors such as their activity, the people they meet, as well as the environmental conditions. The app also provides personalized

## Feel: affect-as-information

It comes with a mobile app to show you graphs of your “happiness”, “stress”, and “pleasure” over time.

So, it's taking a quantified self approach to helping people be happy.



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*

data is material



an anecdote

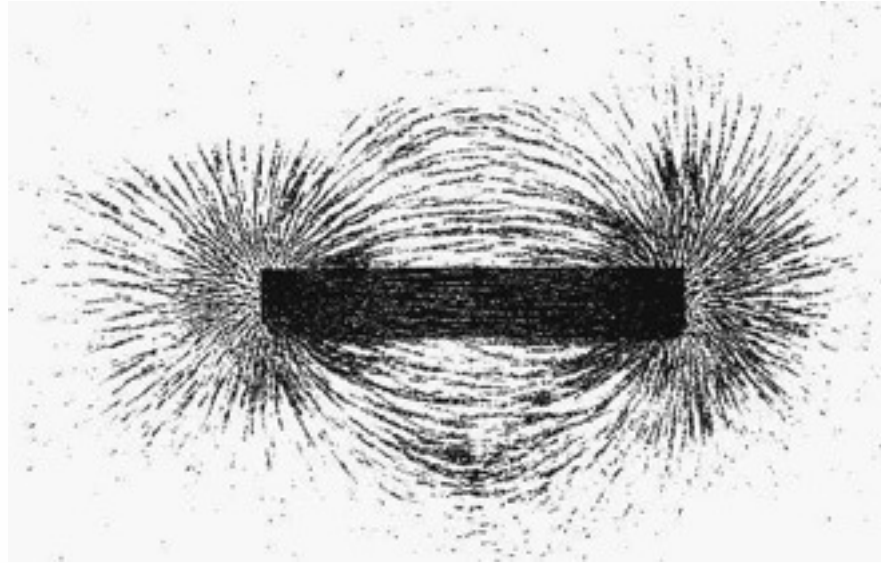


Paul Dourish and Melissa Mazmanian. 2011. Media as material: Information representations as material foundations for organizational practice. In *Third International Symposium on Process Organization Studies*.

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 Verizon, 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

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

data is material

OK, so those are two big concepts that have influenced my work:

First, conceiving of affect through interactions and interpretations situated in social and cultural context, rather than as symbolically encoded information.

Second, taking into account the material properties and affordances of information.

## Ebb: fabric-based data display

To explore these concepts, I've done some design research projects which I'd like to share with you. The earliest piece is Ebb...

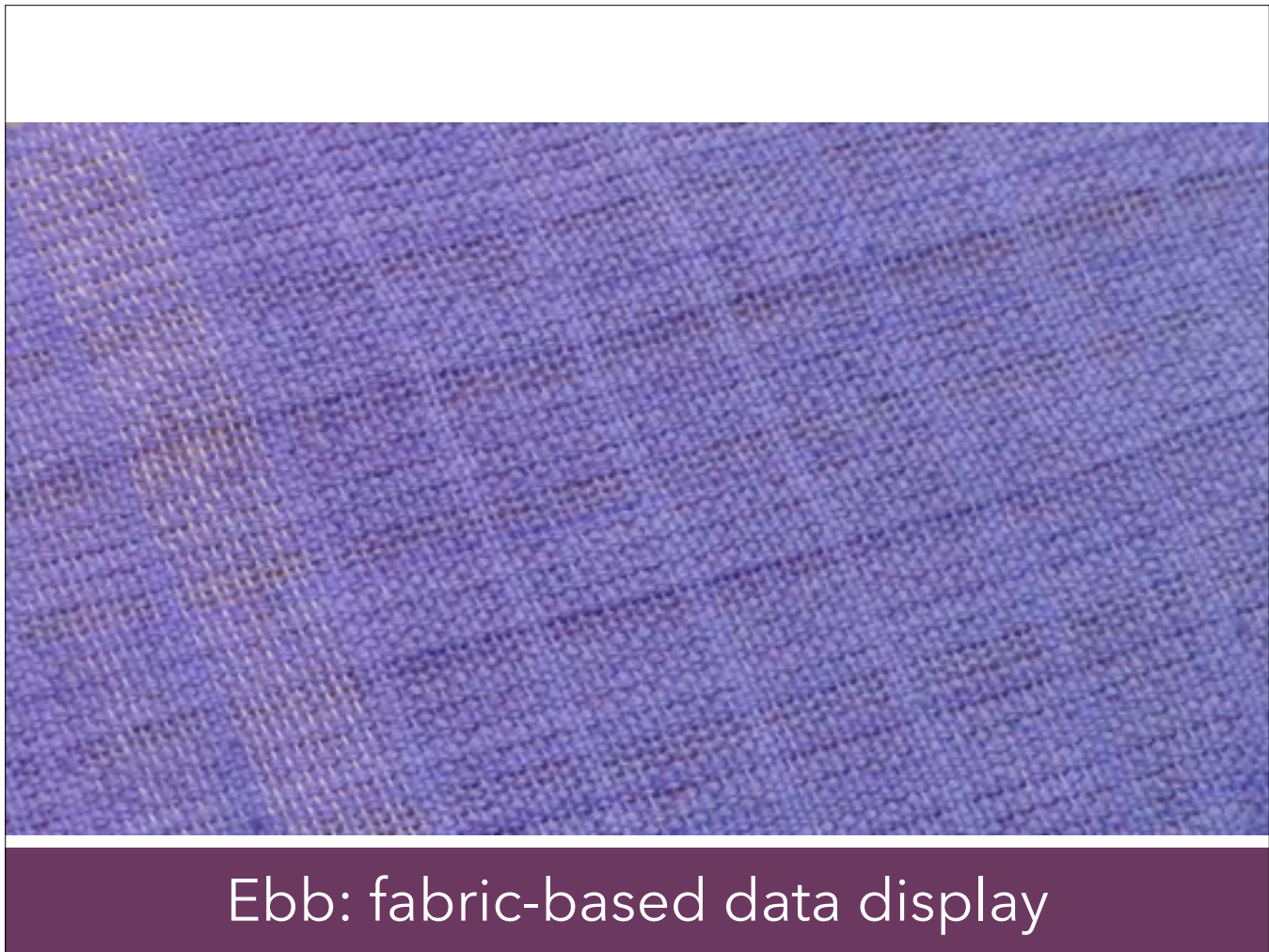
## slowness and ambiguity as assets



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

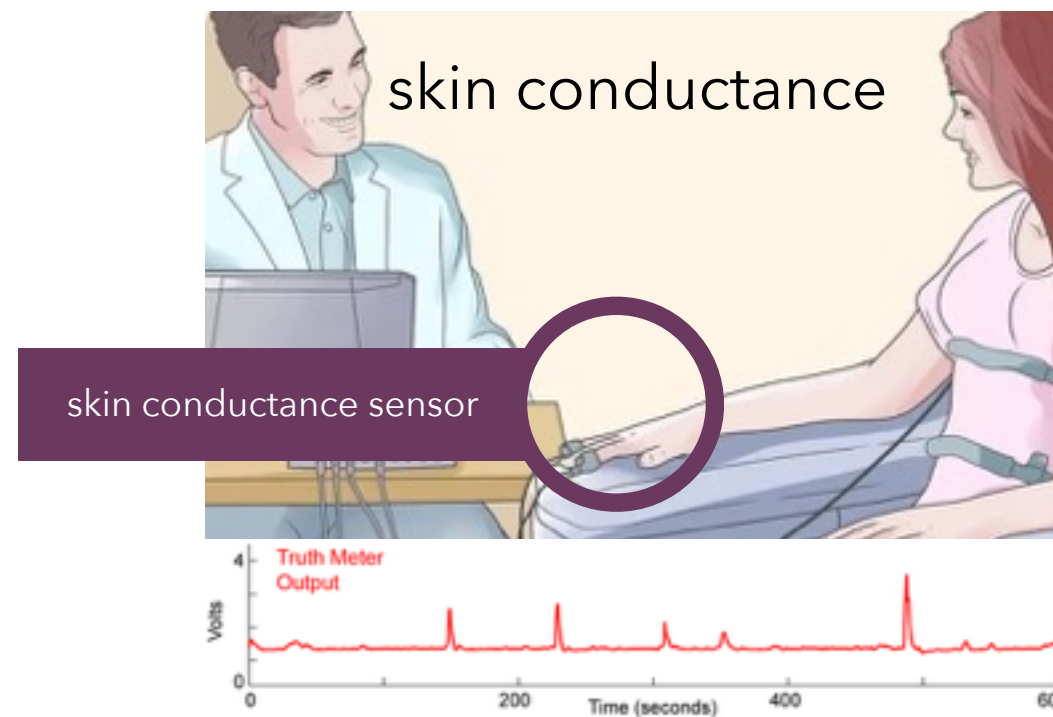
talk over the video about the different swatches...



Hint: social biosensing display

Hint is a social, clothing-based biosensing display. Building off of the same color-changing fabrics used in Ebb, with Hint I was curious to study interpretations around biosensing in a social context, with this drastically different form of data display.





How to Cheat a Polygraph Test, Method 1.2: Don't Admit Anything Relevant. Retrieved from [http://www.wikihow.com/Cheat-a-Polygraph-Test-\(Lie-Detector\)](http://www.wikihow.com/Cheat-a-Polygraph-Test-(Lie-Detector)) on June 1, 2016.

Truth Wristband. Retrieved from <http://www.produceconsumerobot.com/truth/> on June 1, 2016.

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

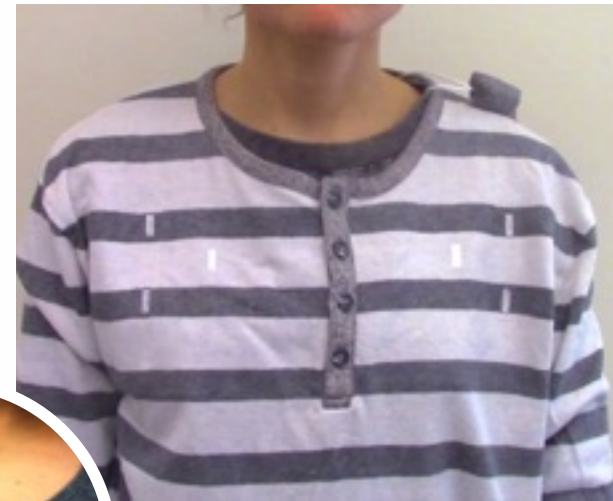
We developed Hint, a t-shirt that changes color in response to the wearer's skin conductance. When the wearer's skin conductance spikes, small white rectangles gradually appear.

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.

# Hint

skin conductance display



Bitalino  
skin conductance sensor

Hint: social biosensing display

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...

stressed

happily excited

Participants said...

"empathy"

"fear"

"embarrassed"

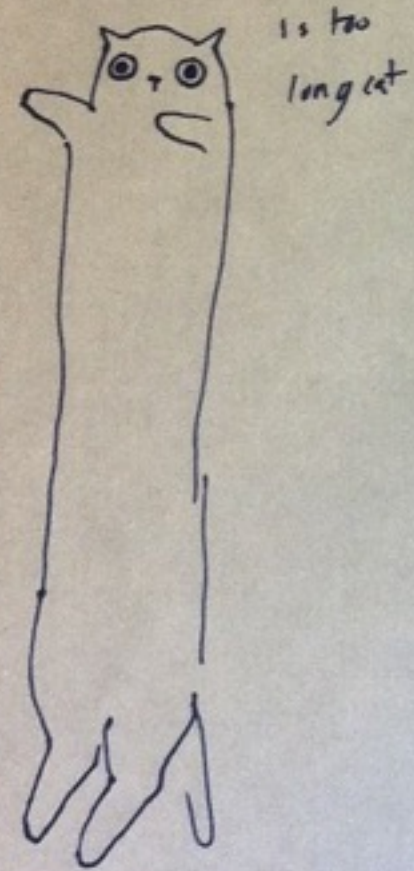
"passionate" (while debating)

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

TORSO	ARMS	HANDS AND FINGERS	FEET AND LEGS
<p>LEAVING SEAT FROM SIDEWAYS: Means no desire to engage with them.</p>  <p>ARMED THREAT GESTURE: Means no yes or agree with them.</p>  <p>CROSSED ARMS: Shows a sign of refusal because a face hard to perceive display when there are several "no" being displayed.</p> 	<p>FINGERS ARE SPREAD AWAY IN A SURPRISE:</p>  <p>A display of confidence and authority.</p>  <p>ARMS AWAY:</p>  <p>Shows that someone is uncomfortable they have the "closed" state.</p>	<p>THUMB UP:</p>  <p>A good intention of positive thought.</p> <p>THUMB DOWN:</p>  <p>A gesture of confidence.</p> <p>THUMB UP:</p>  <p>A gesture of confidence.</p>	<p>POUNCE/STOMP FOOT:</p>  <p>Indicates discomfort.</p> <p>CROSSING LEGS:</p>  <p>Indicates we are comfortable.</p> <p>LEG SHAKING:</p>  <p>Indicates mutual discomfort, doubt or uncertainty.</p> <p>LEG SHAKING:</p>  <p>Shows a good mood.</p>

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



social cues

TORSO	ARMS	HANDS AND FINGERS	FEET AND LEGS
<p>LEAVING SEAT FROM SIDE(S): Means he or she is disengaged with you.</p> <p>ARMED THREAT GESTURE: Means he or she is angry with you.</p>	<p>FINGERS ARE SPREAD AWAY IN A SURVEY:</p> <p>A display of confidence and authority.</p>	<p>THUMB UP:</p> <p>A good indicator of positive thoughts.</p>	<p>POUNCE/SHAKE FOOT:</p> <p>Indicates discomfort.</p>
<p>SPURTING OUT:</p> <p>A sign of anger or someone displaying when there are serious issues being discussed.</p>	<p>ARMS APART:</p> <p>Indicates dominance or someone they think are "bigger".</p>	<p>SHOULDER:</p> <p>(movement to the side)</p> <p>A powerful display of confidence.</p>	<p>CROSSING LEGS:</p> <p>Indicates one is uncomfortable.</p>
<p>CROSSED ARMS:</p> <p>Suddenly crossing arms might be a sign of discomfort.</p>	<p>ARMY BEHIND THE BACK:</p> <p>Says "don't discuss me" - keeps people off-balance.</p>	<p>NECK TILTING:</p> <p>Indicates emotional discomfort, doubt or uncertainty.</p>	<p>LEG SHOTS OUTWARD:</p> <p>Says it's a good mood.</p>

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



bio-cues

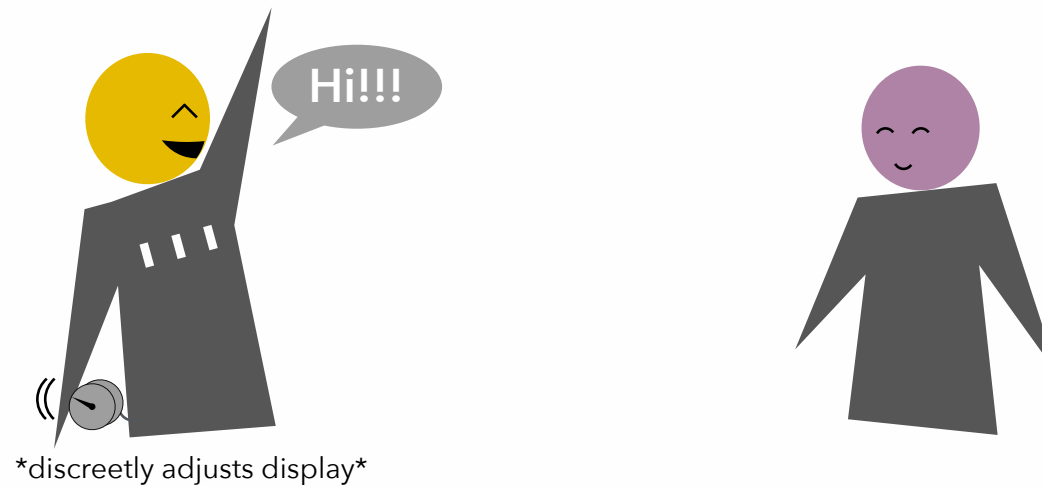


social  
contextual  
multiple meanings  
human-interpreted

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.

## Ripple: reflection in daily life

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.

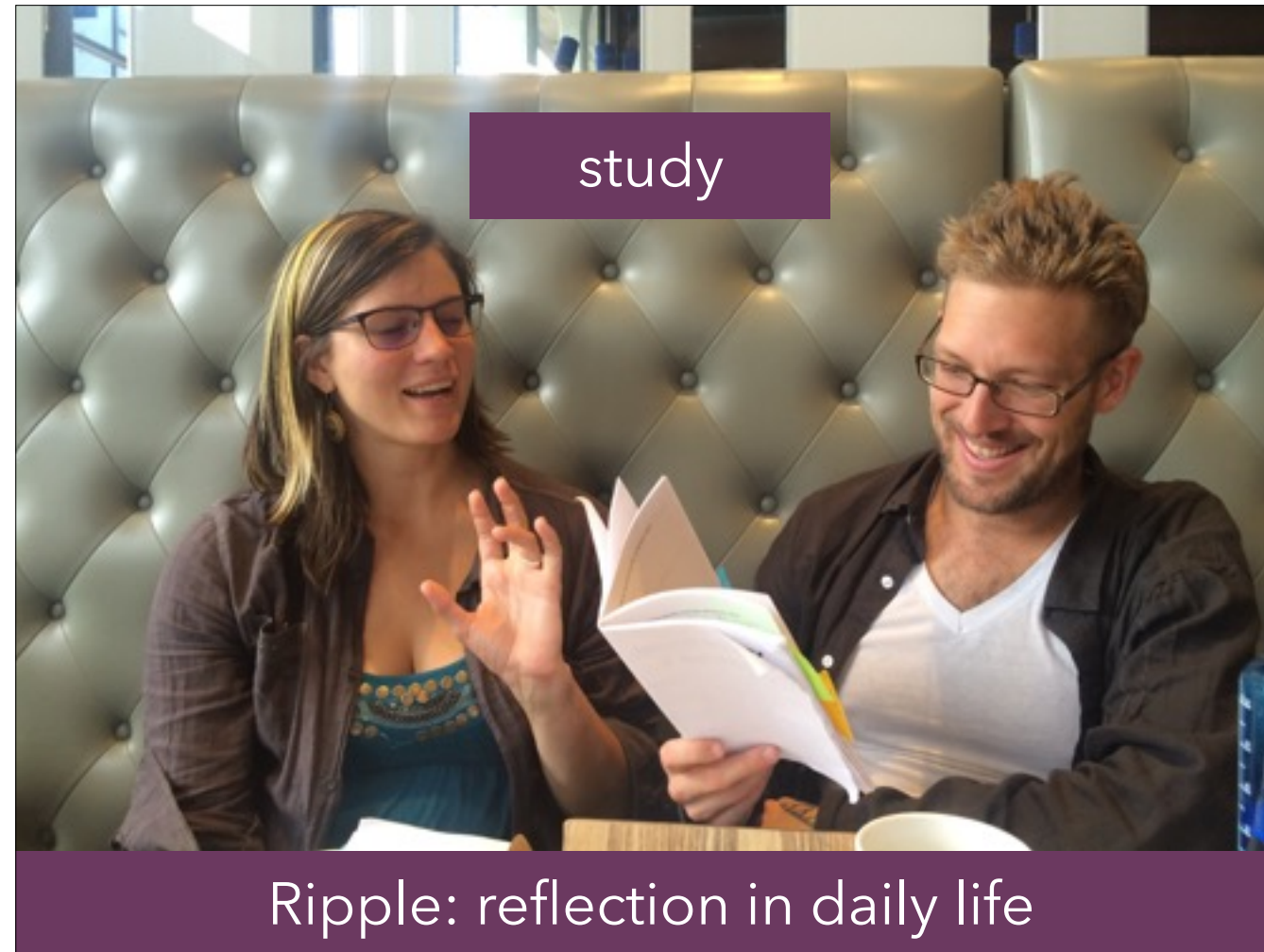
## technology



## Ripple: reflection in daily life

For Ripple, we used the same basic color-changing thread technology. We altered the design to be on the shoulder because this seemed like an easier place for participants to check. Rather than glancing down at their chest like they were checking to see if they stained their shirt, they could quickly and unobtrusively glance at their shoulder. Also, instead of screen printing with color-changing pigment, we used the color-changing threads and embroidered them into the fabric of the shirt in a technique similar to woven inlay.

For the electronics, my co-author made a PCB shown on the right, to be smaller, lighter, and more robust than the breadboard electronics of previous iterations.



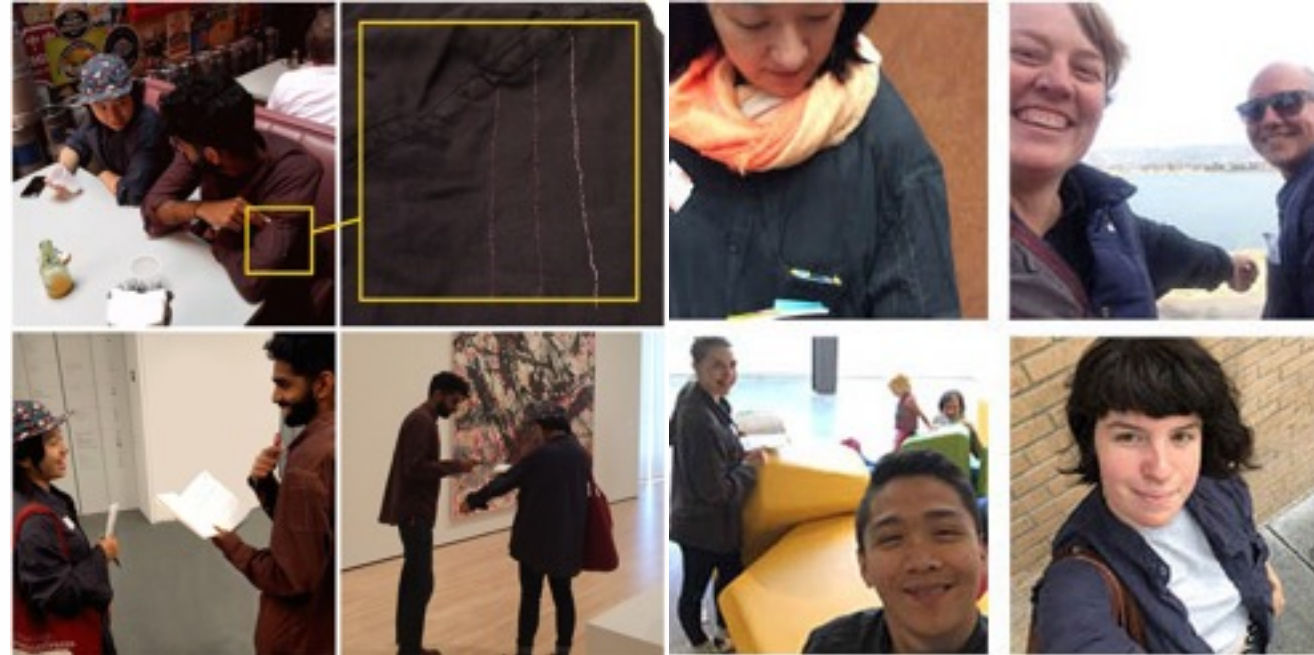
introduction:  
pairs of friends, or couples  
museum, cafe, or park  
45 minutes observation and socializing

24 hours solo wear:  
diary entries, selfies

post-interview:  
experiences & interpretations



## 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

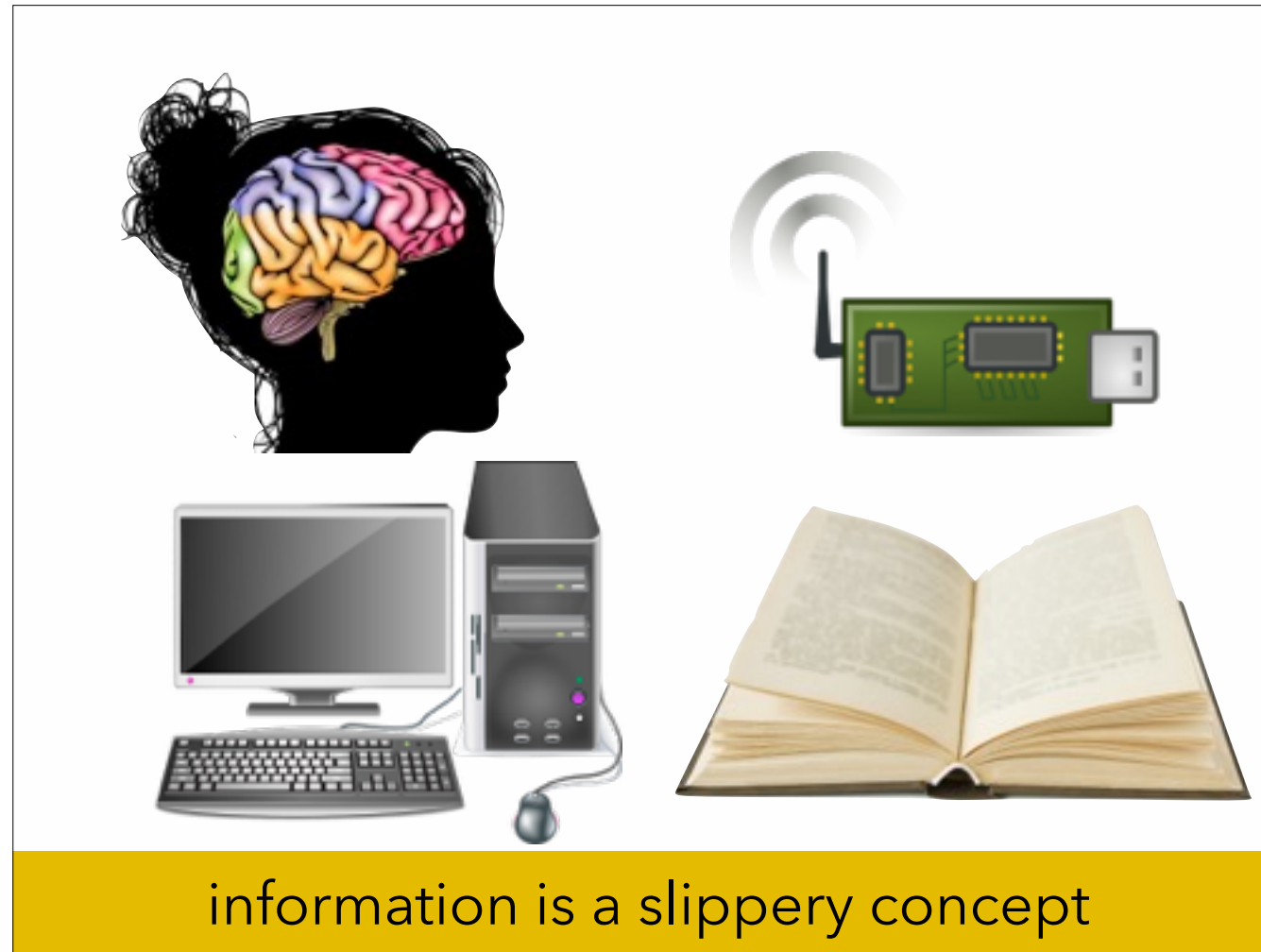
I want to dive into this one quote because I think it highlights the kind of embodied reflection participants engaged in with Ripple.

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.

information is a slippery concept



When I first came to the School of Information, I spent the first year pretty much ignoring the fact that we had “Information” in our name. I didn’t really see what the point was of so much focus on one word...

But now I’m starting to see how information is a slippery word, and it’s good to question what it might mean in different contexts.

So, in common or even academic usage, all these things — the human brain, a sensor, a computer, a book — can be said to contain “information”. Sensors give us information about the environment or our bodies, and books and computers can store that information, and when we look at data visualizations we can take in that information, right?

So, in a sense, it’s pretty convenient that information can be used in all those different ways.

But, in addition to what we gain from a broad word like “information,” what do we lose? Or what does it make it easy to overlook?

Well, as a starting point, computers, books, sensors, and our brains are really not dealing with the same kinds of information.

With emotion for example, if I’m thinking about an emotion, that’s very different than a computer storing a symbolic category that represents that emotion. Say I’m thinking about embarrassment, well it probably won’t even just be in my brain, I might feel it in my stomach or elsewhere in my body. Whereas a computer might just store the category “embarrassment” as a string. For me, embarrassment is tied to different memories of situations in which I felt that way, each one highly specific to my social and cultural context, whereas for a computer all “embarrassment” might be considered equivalent.

With a skin conductance sensor for example, that’s two electrodes on the skin and a circuit that measures the resistance between them. We can talk about skin conductance as if it’s some inherent property of our body, but as the sensor measures it, the sensor co-creates our skin conductance. The sensor generates the electrical fluctuations that are then stored as numbers by the micro controller. Finally, in my work, that is transformed into heat and color change in the fabric-based display. None of these forms of the “information” is really perfectly equivalent, and each lends itself to different kinds of interpretations.

So, although it took me a few years, I’m finally starting to appreciate that we are at the School of Information. I think one of our department’s strengths is our ability to think critically about information, what it means, what might get glossed over, and to do work that is both highly technical and also meaningfully engages with social and cultural contexts.

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

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