REFLECTING ON THE DESIGN PROCESS OF AFFECTIVE HEALTH

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ABSTRACT

We describe the design process behind a bio-sensor-based wellness-system, named Affective Health, aimed to help users to get into biofeedback loops as well as find patterns in their bodily reactions over time. By discussing details of the design process, we provide a reflected account of the particular design we arrived at. Three design qualities are used to both generate and evaluate the different design sketches. They are, in short, (1) the design must feel familiar to users, mirroring their experience of themselves, (2) creating designs that leave space for users' own interpretation of their body data, and (3) that the modalities used in the design does not contradict one-another, but instead harmonize, helping users to make sense of the representation. The final user encounter of the Affective Health system shows that those design qualities were indeed both useful and important to users' experience of the interaction.

Keywords: Design research, design qualities, affective interaction

INTRODUCTION

There is a growing market of applications that relate to our bodily wellbeing or ways of expressing ourselves through bodily acts, such as monitor our sleep, deal with stress, create life logs or diaries including bodily data, or use our bodies to interact with games or other applications. These applications interact with our bodily, physical selves through bio-sensors or body movement/gesture recognition. The question is how we best design these to allow us to be empowered, recognize ourselves in the interaction and be expressive. Here we want to uncover the design process behind one such system, named Affective Health, aimed to help users to get into biofeedback loops as well as find patterns in their bodily reactions over time.

In short, Affective Health monitors users' skin conductance (e.g. sweating as picked up by a GSR senor) related to the emotional arousal, pulse and movement (Figure 1). These data are transferred in real-time to their mobile phone where users can engage in two kinds of activities. First, they can get

Figure 1. The Affective Health system with the sensor placement and representation of the bio-data on the mobile phone.

into a so-called bio-feedback loop where they can immediately see the effects of trying to relax, deep breathing, meditation, or thinking about something stressful in their life. Second, they can see the history of prior states and find patterns in their own bodily reactions relating to their everyday behavior. The system is supposed to be used daily over a longer time period so that users gradually can reflect and start to act on their everyday choices. And, indeed, in the final user encounter, the four users who used the system for a whole month each, both learnt more about

themselves, started to reflect, and, in some cases, changed their behavior.
The design of Affective Health is an example of research through design (Zimmerman et al., 2010). That is, we have explored a novel space of possible interactions through design, and the actual design process is the research process. By getting into quite some detail of our design process, showing the blind alleys, the mistakes and the design choices, theoretical input and user involvement that lead us forward, we hope to achieve three things at the same time.
First, by showing details of the design process, we provide a form of evidence for the particular design we arrived at. While we bring in users frequently to test semi-finished and finished designs, we would like to claim that it is not only user studies that provide evidence for the design choices. The actual design sketches and the criteria we apply for choosing among them is also evidence in this design-driven research process.
Second, by uncovering what is going on in the "black box", we show other designers our insights, providing them with practical, design-oriented knowledge. We show our failures, out methods for recovering, the sketches we had to throw away, the theoretical input and the knowledge gained from the users that kept changing the direction of our work. This reflected description of the design process does not necessarily consist of novel methods, but it is the constitution and order of this multi-grounded process that is of interest. Rather than giving just the ingredients, we also provide our specific recipe, but just as in cooking it has to be handled with care and gets better with experience. Sharing such processes may help us to learn from one-another.
Thirdly, as we have been building several systems in the same theme of bodily interactions, we have extracted three design qualities that have guided our design process. The three are, in short, (1) while still making sure that the design feels familiar to users, that it mirrors their experience of themselves, (2) creating designs that leave space for users' own interpretation of their body data, and (3) that the modalities used in the design does not contradict one-another, but instead harmonize, helping users to make sense of the representation. The final user encounter of the Affective Health system shows that those design qualities were indeed both useful and important to users' experience of the interaction. The qualities were used both to generate and to evaluate design sketches. In a sense, by extracting such design qualities we are not only adding an innovative application in a new space adding to the reflected design repertoire of our field in the words of (Schön, 1983), but also provide a form of generalized design knowledge on qualities that can be used and reused in whole classes of applications.

INTERACTIONAL EMPOWERMENT

Our work starts from the idea that mind, body and emotion needs to be seen as a whole when we design for e.g. well-being. We employ a design perspective that we have named interactional empowerment (Höök et al., 2008). It builds on the ideas of Boehner and her colleagues (2005, 2007) and our own work (Sundström et al., 2007), drawing on what might be called a socially situated and constructivist position on emotion. Emotions are created in a co-constructed, co-interpreted fashion between people in social situations. In designing for emotional experiences Boehner et al. state that the focus should be moved *"from helping computers to better understand human emotion to helping people to understand and experience their own* emotions" (Boehner, et al., 2005).
This perspective on how to design for emotional interaction puts users' own interpretation of their own life, bodily

processes or sociality at core. It empowers them to make their own choices, rather than being told by a system what they are experiencing, when they should stop stressing around or when they need to take a break.

THREE DESIGN QUALITIES

The three design qualities we used in the Affective Health design process came out of our previous work on building a range of other applications from an interactional empowerment stance; e.g. a mobile emotional messaging service named eMoto, (Fagerberg et al., 2003) and a digital diary that makes use of bio-sensors to add some reminiscence of bodily emotional experiences named Affective Diary (Ståhl et al., 2009). A reflected account of the design process for these two systems can be found in previous publications (Ståhl et al., 2005, Ståhl & Höök, 2008). In here we just provide a description of the three design qualities that came out of those design processes.

FAMILIAR EXPRESSIONS

When we express ourselves emotionally to one-another, or when we experience emotional processes, the experience is influenced or composed by many different processes: processes in our brains affecting our thinking, hormone levels in our blood, or attention direction; muscles tensing or relaxing leading to facial expressions, body postures, movements; our interpretations of what is going on; our perceptual coding and decoding of what we see in others, hear, or experience in our environment; etc. (Davidson et al., 2003). If we want to design an interaction that expresses emotion that users can understand, identify with, use to express themselves and that will evoke emotional experiences, we need to find expressive modalities and mold them into interactions that resembles and feels *familiar* to the kinds of experiences we want to evoke. While it might be tempting to think that the easiest solution is to create some anthropomorphic character in the interface that mirrors human emotional expression, we would like to suggest that there are other ways of creating expressions that still remind us of our own, human-like experiences of emotion processes and that will not raise our expectations of human intelligence in the system or be crude imitations of emotion. This can be achieved by trying to find and imitate underlying dimensions in our emotional processes, how emotional expressions feels in the body and try to find metaphors in other designed modalities. This can, for example, be animated, colorful abstract shapes, building on color theory and semantics, that can be formed to remind us of what an emotional experience feels like. There is, of course, a risk that they become too abstract and thereby incomprehensible to understand and learn – almost like having to learn a new emotional language, which is why they have to be carefully crafted by a skilled designer considering the aesthetics.

When we design these expressions, we need to avoid crude simplifications of emotion experiences if we want users to recognize their own complex, shifting, ever-changing emotional variations. We have learnt how the elements in the designed expressions therefore need to feel on the one hand *familiar*, but at the same time open-ended enough to allow users to read their own subtle emotion nuances into them. An expression that draws upon a sense of familiar recognition related to e.g. anger could be ragged animations of spiky shapes, a calm experience could be portrayed as wavelike, slow, animations, and so on.

As bodily emotional expressions are not singular states but mixed, complex, continuously changing processes, the expressions must also be designed to allow for blending from one expression to the next – increasing, decreasing, sometimes disrupting the flow. After all, we perceive ourselves as one person, fleetingly moving

between environments and experiences, while remaining a whole self.

CO-CONSTRUCTION OF EMOTIONAL EXPERIENCE

As mentioned above, we take a constructivist perspective on emotion, one where we assume that emotion experiences are often created together with other people, when talking, laughing, joking, confiding or quarrelling, or through elaborately setting the scene for an experience, as when attending an opera event, going to a party or sloughing in the sofa, watching a movie.
Therefore, if we want users to not only be influenced by the expressions in our designs, but actively take part in constructing their experience in and through the interaction with the system, we have to strike a good balance between making the user an active co-constructor of expressions versus making a too strong, interpretative design that excludes the users' own interpretation, experience and expression. Providing users with too distinct and perhaps even labeled cues, such as smilies, does not leave much leeway for interpretation or personal expressivity. The designer needs to find a suitable level on the scale from abstract to depictive. Abstract and ambiguous cues allow for personal expressivity and meaning-making by the users, but if they are too abstract they become incomprehensible.

HARMONIZE MODALITIES

In many cases, a design will be a combination of several different modalities – physical, visual, auditory and so on. When designing the various cues in each of these modalities, it is important that they harmonize and strengthen one-another rather than contradicting one-another. Just to take a very simple example: the experience of your own pulse, reflected back to you in a pulsating animated surface using a color scale to show changes in pulse, needs to follow the actual pulse you have as well as your *experience* of your pulse as portrayed by the energy level in the color chosen. The animation and color choice needs to work together, not contradicting one-another, otherwise, you become distanced from the representation, unable to identify and empathically feel yourself reflected in the interface.
If a contradiction is used, the designer should be doing it purposefully with the aim to, for example, creating subtle or dynamic expressions mirroring how bodily emotional processes can be subtle, complex, and combined.

AFFECTIVE HEALTH: DESIGN BRIEF

As in any design process, the designer formulates the problem in parallel with formulating the design solution. The starting point for the Affective Health system was therefore quite far from what the design problem and solution ended up being. The initial design brief can be described as: "*is there a way to show people, in the moment and over a longer time period, how their body is responding to various everyday situations – stressful, relaxing, boring, fun – in such a way that they can learn how to regulate their own behavior and become less stressed?*". Initially, we assumed that we would be able to measure negative, long-term effects, of stress from bio-sensors. People who are very stressed for a long time, step by step empty their resources and can end up with various illnesses. We wanted to mirror long-term stress effects back to users so that they could become more aware of both negative and positive behavior patterns.
The system we ended up with, tells a different story. We had to back off from measuring long-term negative stress effects as those could not be measured reliably in everyday life.

Figure 1. The process behind the dots concept, image board and early sketches, on the top right color scale by Ryberg.

In short, the Affective Health system measures your pulse (ECG), movement (accelerometer) and arousal (GSR) level, through bio-sensors attached to your body. Galvanic Skin Response (GSR) measure changes in the electrodermal activity that is characterized by perspiration, a basic manifestation of short-term stress. But, the body may respond with increased perspiration and heart rate for many reasons, not only because of stress, but, for example, from energetic physical movement. We therefore also measure users' movement using a triaxial accelerometer. Taken together these can portray situations that are stressful, engaging or peaceful. The bio-sensor data is displayed in real time, transmitted via Bluetooth to the mobile phone. It is visualized in an abstract way using shapes to portray movement and a color scheme for pulse and arousal. The visualization is displayed in time cycles growing out from the centre in a spiral, fluently blending one state into the next (Figure 1).

AFFECTIVE HEALTH: DESIGN PROCESS

Let us now try to articulate some of the processes that lead to this final design. We will try to honestly portray some of dead ends we ended up in – even if those may seem very naïve given what we know now. Below, we describe the design process in a linear, logical fashion, while, of course, it went back and forth, branched off, came back together, stepwise exploring a whole design space.

In the Affective Health project, there were two main parallel tracks of design work that fed into one-another: one technically/medically-driven track that explored what sensors we could use and what they would measure, and another that explores how that data would be displayed on the mobile. In here we mainly focus on the second.

MEASURING LONG-TERM AND SHORT-TERM STRESS

When we started, we believed that we could get reliable measurements of long-term stress effects by measuring HRV (Heart Rate Variability), which is the inter-beat variation of the heart. HRV decreases with both physiological arousal and long-term wear and tear of the body (e.g. Stys & Stys, 1998). A healthy person's heart beats irregularly when resting and regularly when exercising. A stressed person's heart beats regular *all* the time – even when resting. In laymen terms, the heart has 'lost' its ability to adapt to different situations and has become too 'rigid'. Our initial designs therefore focused on how to portray this data in a way that could make sense to end-users as HRV is not something you necessarily understand or can feel when you listen to your heart.

The other measurements, sweat (through GSR) and pulse, would measure short-term stress peaks – not necessarily indicating that a person is in risk of getting ill from stress, but giving feedback on which situations that stresses you so that you can, in the long run, find patterns and reasons to your stress experiences. Pulse and sweat makes immediate sense to end-users, so portraying those in the interface was a less difficult design problem – we hoped.

FIRST DESIGN: THE DOTS

To portray short-term stress, we returned to our design qualities and were inspired by color psychology and color theory (Ryberg, 1991, Goethe, 1976, Itten, 1971) (Figure 2) – the higher energy level of the color the more arousal. Movement, we hypothesized, would be best visualized through a pulsating animation, increased movement rendered higher pulsation frequency. This was done in line with using expression forms that felt familiar to us in this area. The expressions were crafted in such a way that the user could be an active co-constructor of the interpretation of the visualization, but still trying to find the delicate balance between open interpretation and information. The visualization of HRV and its adaptability became inspired by how HRV is plotted out when it is measured in a medical setting. A spread-out plot indicates a good HRV and a less spread plot indicates loss of HRV-capacity. The adaptation was visualized through a round shaped space in the background of the cloud of dots, if this space was smooth, large and round the adaptability of the heart was good, if it was smaller with a spiky border the heart was more 'rigid', less adaptable.

Sketching in Illustrator and creating Flash-animations followed ending with a proposal that used color for GSR, pulsating animation for movement and mirrored the HRV plot in a quite straightforward manner, where the visualization started with one dot building up a pattern of dots showing the HRV. The dot representing what is going on right now was pulsating with users' movement (thereby also making it clear that this was the latest sensor reading). The next dot was placed on a shorter or further distance from the last dot depending on whether the heart rate was varied or regular- the more regular, the closer. Later we understood that users found this confusing, as they never knew for sure where the dot was that was portraying what was going on right now. The dots gradually faded away, which meant that time progression was progressing 'towards' the user. The total space the dots occupied gradually changed the size and shape of the circular shape portraying adaptability in the background – we hypothesized that this would happen over a long time period – probably weeks.

During the design work we concurrently evaluated the idea of the dot-interface and we ran into several problems. First, when going back to our design qualities, the representation of the HRV-plot was not a familiar way of bodily expressions, it was not something people could recognize and understand. The diagonal shape of it was also interpreted an having a meaning. Second, it was also hard to see the actual colors (representing the GSR) of the dots due to the transparency on the black background. Finally, the representation was too precise in its expression with very precise colors and precisely shaped dots, giving it a medical feel.

We instead went for a more circular shape of the plotted dots to remove the unintended meaning and sense of an HRV-plot. The problems with the transparency was solved through letting the dots have a thin white outer border to define them and even fade on a white background, behind the dots. We worked with small details to make the representation feel more alive and less static. The colors within the dots were changed into a gradient between the

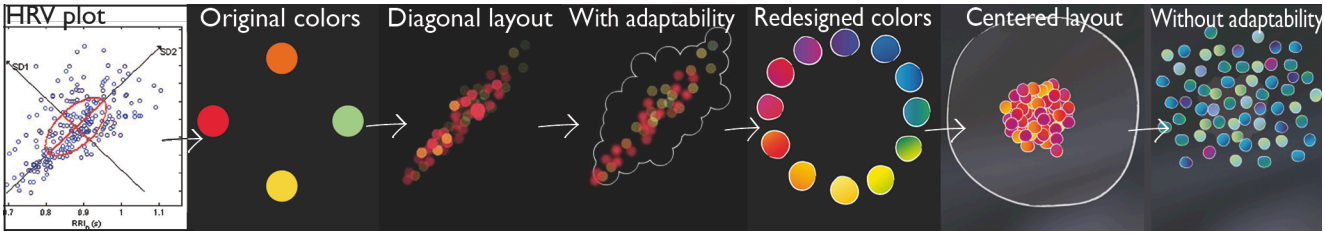

Figure 2. The process of developing the dots interface.

colors being close on the scale, the shape of the dots was also changed so they were round, but not perfectly even or having the exact same shape, but still similar enough to not convey any unwanted meaning. The white border added was also an uneven stroke. This design was far from perfect but captured some of the design qualities we wanted to express and communicate (Figure 3).

MAPPING SENSORS TO THE DOT INTERFACE - OFFLINE

Before implementing the interface for real we wanted some fast insights into what kinds of experiences people have of their own physicality. We asked four potential users to write a diary for a 24 hours period. They wore bio-sensors measuring GSR, movement, pulse and rated their experienced arousal and stress level on scales from 1-10. They also got to rate their overall stress level from the last 6-month time period to help us make some fake hypothesis about their adaptability level. After the 24 hour time period users got printouts of their bio sensor data portrayed as graphs over time, their diary notes were placed alongside with the data, and we glued a printout of faked screenshots of the dot-interface mapped to their own subjective ratings. This small user encounter gave us interesting feedback on how well our intended design qualities were captured in the design. Overall the visualization seemed open-ended enough to allow these four users to be co-constructors and make their own interpretations, they also seemed to grasp the cues building from familiar expressions mirroring bodily processes, even if the HRV visualization was a bit harder to understand. They had to compare different ratings before they understood in which way it represented long-term stress.

GIVING UP ON ADAPTABLITY

In parallel to the design investigations, we were testing the HRV-sensor. As it turned out, this measurement was nowhere near the robustness required for use in everyday life. The stress research experts we consulted warned us that HRV could work in several different ways with users who are ill from stress (Chang et al., 2007, Parati et al, 2006, Stys & Stys, 1998). We had to give up entirely on mirroring long-term stress effects (Sanches et al., 2010).

To reflect this in the interface, we simply removed the circular shape representing adaptability in the background of the dots. After doing so, we could test the interactional animated visualizations, connecting them to real sensor readings. But before doing so, we had to adjust one more design problem: how to portray time progression.

TIME PROGRESSION

The representation we had chosen failed to capture the subjective experience of events happening over time. The representation, as it was looking at this time, showed the last 60 minutes with 60 dots, where each dot represented one minute. When tested, one of the subjects held a ten-minute presentation that he experienced as very stressful, but this whole experience only showed as ten red dots spread over the interface. We also noted that if the representation updates with one dot/minute it would take a whole hour before you get a sensible overall picture.

Figure 3. The three concepts used for discussion, where the aim was not to select one of the concepts, but to pick out the best parts from all of them.

This representation also risked 'chopping up' users' experience of themselves into small separate dots without any clear, strong, coherent progression of data portrayed over time as a unity – missing to reflect the sense of unity of bodily/emotional experiences familiar to the user. To settle how to deal with this problem, we devised a Wizard of Oz-study (WoZ) (Dahbäck et al., 1993).

MAPPING FAKE SENSORS TO THE DOT-INTERFACE IN A WIZARD OF OZ-STUDY

Seven participants were first put in a stressful situation (being interviewed for a job – based on the Trier Social Stress Test) and afterwards in a more relaxing setting (have a coffee break sitting in a sofa). Fake sensors were attached to the participant's body and the visual feedback was given on a mobile phone.

We learnt that the participants were usually focused on the stressful situation and only looked at the interface afterwards to reflect back on the stressful situation after it had happened. In doing so, they had to be able to compare different states in order to make sense of it. At least 60 minutes of data was needed, but they asked for more data – days or weeks – in order to compare their own behavior and reactions. It became clear that there was no way we could continue to work on the dots-interface as it would be hard to follow and compare dot-patterns over longer time periods.

We checked how well the current design captured the design qualities. When it came to co-construction of meaning most of the participants felt that they could read in both their personalities and the situations they were put in. The color scale was interpreted as the familiar expression it was intended to be, the metaphor with the HRV-plot did not fully come through here either. The animated movement was understood, but the historical movement information was lost, since the faded dots were not animated. This was tried earlier on and you could not grasp much of the visualization since everything was blinking in different paces. The flashing animation for movement was also too close to how we feel the heart beats in our body e.g. our pulse, and thereby created confusion. The different modalities seemed to harmonize, we could not find any direct contradictions, but as mentioned one of the modalities were lost in the historical information. Another thing that became clear to us was that we should not aim at diagnosing people's conditions, instead open up for reflection.

Except for the guiding design qualities, design requirements for this specific case now became clearer to us:

- no valence – that is, the interface must convey data without (by mistake) communicating that a particular state is negative or positive – as stress can be both and there is no way this can be determined from the bio-sensors
- comparison – the interface must allow users to compare different states over long time periods
- fluency – states needs to flow fluently into one-another
- aliveness – the interface must feel like it is mirroring a pulsating, alive body
- context – other contextual factors are needed in order to make sense of why what happened
- history – a longer history than one hour is needed

At this stage we found ourselves at a fork, where we could try to twist and turn this semi-successful solution into one that captured the aspects we found important (which would be quite tricky and time consuming) or we could kill our darling and see this as a dead end. We decided to kill the dot-interface.

BACK TO THE DRAWING BOARD

We created a range of new concepts, later narrowed down into three concepts to spur

Figure 4. The process of exploring an aesthetic look and feel and finally capturing the design requirements in the Layers interface.

discussions in the design team (Figure 4). The three concepts exemplified the amount of active user interaction, ranging from a concept that merely presented the data but not allow the user to do anything with it, to a concept where the user had almost an endless amount of opportunities to manipulate, sort and work with the data. The concepts were discussed in terms of how well they captured the design requirements and also to some extent how the desirable design qualities came through. For example; all three concepts managed to avoid putting any positive or negative value to the bio-sensor data – proving to us that we could find value-free representations that would still make sense. Comparisons were only really possible in a concept including a computer screen, which spurred a discussion on how to make comparisons available even in a small interface of a mobile. Continuous, fluent flow of the biosensor data was mainly achieved in one of the three concepts. Its continuous, whole, shape became a source of inspiration to later concepts.

HALL OF FAME

While we now had a fairly good grip on what was needed, we needed a bigger range of aesthetic expressions to free ourselves from prior ideas of how to portray time, and how to do comparisons in a small interface. We used a method named *Hall of Fame*. A couple of famous persons are selected whose characteristics are well known. Each of these persons is then described in terms of shape, color, size, tone and their target. For each of these celebrities, visual metaphors are then selected that corresponds to their characteristics, arranged as mood boards. We chose Dr Slump, Carl von Linné, Vladimir Putin and Maria Callas.

For example, in the Linné mood board earth layers and falling leaves were used, "*time falls from the sky, lands on the ground and creates layers of history*". For Putin a hole was used "*where history disappeared*". These mood boards were translated into graphical design sketches using visual metaphors extracting the characteristic traits. For example, in the Linné mood board earth layers and falling leaves were used, "time falls from the sky, lands on the ground and creates layers of history". This phase ended in three concepts exemplifying different aesthetic look and feel.

Six participants were asked to share their understanding and associations spurred by these concepts. Dr Slump and Putin were dismissed because they did not show the bio-data as a fluent whole. The Linné concept seemed to capture most of the list of design requirements and the design qualities, and it incorporated the important feel of fluency. We refined that concept into what we named the *Layers Interface*. (Figure 4)

LAYERS INTERFACE – FULLY IMPLEMENTED

In the Layer's interfaces, users' most recent state is shown at the leftmost top of the screen, falling on top of previous states moving towards the rightmost bottom building layers of historical data. Each layer represents a mean value of one minute of data. The topmost layer shows the data in real-time and when a whole minute has passed it will be summarized (using the most prominent biosensor data averaged from the whole minute). In the Layer

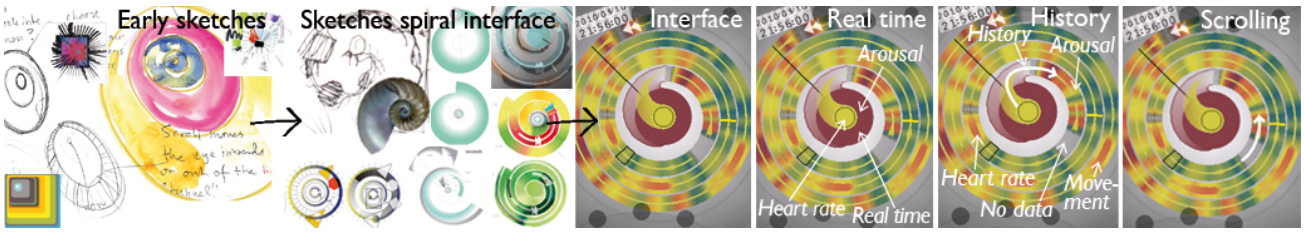

Figure 5. The process of the spiral interface, where the real time is in the center growing outwards in a spiral. Arousal is the background color in the center and the in the spiral, the heart rate is the circle on top in the center which also is represented by color, inside the increasing and decreasing shape that represents movement.

interface, a circular shape pulsating with the heartbeats visualizes the heart rate. Movement was shown by a wheel spinning faster the faster you were moving. Accessing the parts of the history was done by scrolling back in time by pushing layers upwards or downwards, using your finger. We decided to go for a fully functioning prototype of the Layers Interface pretty fast, as we needed insights on how it felt when the bio data was your own, real data – up till this point all our user encounters had been with faked systems in some way or other. A limitation was also added; this prototype would only display arousal, pulse and movement over time - not visualize context, position or other parameters at this stage – as we wanted to avoid some of the implementation complexities.

USER ENCOUNTER – LAYERS INTERFACE

We could now let four users use a (more or less) fully functioning system for two days each. We were happy to see that our four users could link the interface to their experience of their own bio-data. What became evident was that this representation did not really allow for proper comparisons or prior situations, since you could only see a couple of minutes back in history at a time. Unfortunately, we had also made a short-cut in the graphical implementation that happened to kill the nice fluent blending of states into one-another. The aim was that the colors would blend into one another, but we simplified these into separated layers as blending costs much more in terms of graphics processing. The movement visualization did not mirror movement as how we experience it, the wheel was slowly turning all the time, even when standing still. This did not mirror movement in a way that feels familiar to us.

REDESIGN – SPIRAL INTERFACE

Again, we decided to go back to the drawing board. One idea that had been present during the whole process of concepts and sketching was the idea of visualizing bio-data in a circular way, like a shell, a snail, a spiral. Using this spiral, but now working in close cooperation with the programmer to avoid any simplifications of the graphical animations and blending of colors, we finally arrived at a working interface, the *spiral interface*. In this representation we had the desirable design qualities in mind, we used color theory to visualize different levels of arousal (GSR) and for different pulse levels in an abstract way, the movement was visualized using shape and the bigger the shape growing out from the center the more movement. The visualization is displayed in time cycles growing out from the centre. The real time data displayed continuously in the middle, mirroring the view of human lives and emotions as ongoing fluent processes. The interface is described more in detail elsewhere (Kosmack-Vaara et al. 2011). This way of laying out the bio data captured to represent the data in a continuous, fluent way, it allowed for comparison in the history since more data fits into the screen. It also allows for comparison, for example, if you are in the days view, the data is laid out so that the three past hours are equally

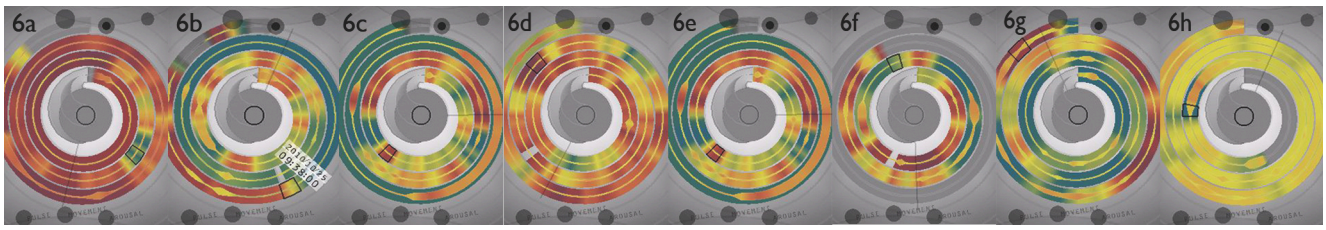

Figure 6. Screen shots from long-term user encounter, visualizing the citations.

spread out over each circle, so you can compare the data, for example, 12 o'clock everyday. (Figure 5)

LONG TERM USER ENCOUNTER – SPIRAL INTERFACE

Along this design process we have checked the design against our design requirements and also had our desirable design qualities in mind. Brief user encounters had shown that the spiral interface was working as we wanted. But the whole point of the system was long-term usage where users would learn about their behavior patterns over time. The aim was also to get insights to further discuss and refine the qualities. We therefore let four users use the system daily for four weeks. We conducted a videotaped interview every week, discussing their interpretation of the data rendering in total 16 interviews. Below, we restrict our analysis of the data to the three experiential qualities we set out to design for.

1. Familiar expressions

We were keen to see whether our users could recognize themselves, their bodies, in the interaction. As it turned, all of the participants easily connected their arousal to the color and even started to talk about themselves as 'being a color':

"[..] Here I start at 2 pm again, so here I am kind of red and then it goes away a bit, and then there is something else so that… and then all of a sudden I am green" (Figure 6a)

They talked about 'going down' or 'going up' according to the color scale:

"OK, blue then I am calm. And then green and then I kind of move up in the color-scale." (Figure 6b)

They easily connected the growing shape to their movements, and the color to pulse:

"Then I am sitting still on the train, and then the pulse goes down. And then there is a hill, as I live fairly high up, so I have to climb this hefty hill, and then there is plenty of pulse here, and It keeps that way as I am now at home. And now I need to fix food, and now I need to do this and that, the table needs to be set, and there has to… and here all of a sudden it starts to change colors, that is the pulse is higher which is really, really exciting compared to my, kind of, arousal-color". (Figure 6c)

Users also identified longer-term behavior with summaries of patterns that arose over time:

"You know, if you look over all the days I am, I think, I am in summary kind of yellow, orange and when I see that, I know that it is as usual [as it should be]." (Figure 6d)

2. Co-construction of Emotional Experience

From the study material we found numerous of examples where the participants could almost from the same screen shot, remember and construct different interpretations. For example, one user interpreted and constructed two completely different stories based on very similar screens. She was recently divorced and whenever her ex-husband called her she got an emotional reaction that she saw in the data as a red area:

"And then I have talked to my husband again about this apartment-business". (Figure 6e).

But a similar screen-shot with a red area she related to a whole different experience:

"It was a somewhat more stressful morning that it is usually is [..] other routines, made some calls, and that made it more rushed than it usually is" (Figure 6f)

Their interpretations seemed to work when the event was not older than a week and

they could check their calendar to see what they had been up to. Triggering information like tags, scribbling, photos, records of phone calls, etc, would have made it even easier to interpret. As it turned out, the portrayed movement and pulse became their memory triggers (Figure 6g), providing a backdrop to the arousal.

3. Harmonize modalities

Two of the bio-sensor readings used the same output modality; color. Since arousal and pulse are behaving quite differently, the arousal is fast changing, pulse is slower in its variations, we were happy to see that this never became a problem to our users: *"and then there was a stressful walk to the commuter train, and then I relaxed when I got there. So the pulse is up [pointing to color of pulse], but I have become this calm and cool [pointing to color of arousal]"* (Figure 6h)

DISCUSSION

We have provided a reflected account on the design process of the Affective Health system. By articulating and describing the transformation of the three experiential qualities into specific design element we have put words on what is often black boxed in the literature. We would, in particular, like to emphasize how these qualities were used to both steer the generation of design ideas and also evaluate (and dismiss) designs on the fly or after user encounters. It became much clearer why we should dismiss (or not) an early design sketch when using these articulated qualities. As they are, in turn, tied to a whole theoretical framework for emotion processes, they are grounded both in theory and in practical design experiences. Important to have in mind when using these qualities is that they need to consider aesthetic skills. We believe that this is a fruitful form of design knowledge that can be shared between design researchers and practitioners.

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