RTD

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Method& Critique *Frictions and Shifts in RTD*

Soma Bits - Mediating Technology to Orchestrate Bodily Experiences

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Abstract: The Soma Bits are a prototyping toolkit that facilitates Soma Design. Acting as an accessible 'sociodigital material' Soma Bits allow designers to pair digital technologies, with their whole body and senses, as part of an iterative soma design process. The Soma Bits addresses the difficulty we experienced in past Soma Design processes — that articulating of sensations we want to evoke to others, and then maintaining these experiences in memory throughout a design process. Thus, the Soma Bits enable designers to know and experience what a design might 'feel like' and to share that with others.

The Soma Bits relate to three experiential qualities: 'feeling connected', 'feeling embraced', and 'being in correspondence' with the interactive materials. The Soma Bits have a form factor and materiality that allow actuators (heat, vibration, and shape-changing) to be placed on and around the body; they are easily configurable to enable quick and controllable creations of soma experiences which can be both part of a first-person approach as well as shared with others. The Soma Bits are a living, growing library of shapes and actuators. We use them in our own design practices, as well as when engaging others in soma design processes.

Keywords: Somaesthetic Interaction Design; Design Process.

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Introduction

We have devised a toolkit, Soma Bits, for experiencing and imagining new design concepts for soma-based interactions (Höök 2018). Soma design originates from the philosophy of somaesthetics (Shusterman 2008). In short, somaesthetics is the combination of soma as in body, mind, emotion as one subjectivity, and aesthetics is in the deepening of our sensory appreciation skills. Soma Design in turn 'allows us to "examine" and improve on connections among sensation, feeling emotion, and subjective understanding and values' (Khut, 2016). As Höök frames it, soma design concerns the orchestration of the 'whole', emptying materials of all their potential and providing fertile grounds for meaning-making through the whole soma (Höök 2018). The soma design methods and the toolkit addresses an emerging trend to design whole-body interactions thriving off advances in ubiquitous computing, tangible and embedded systems, and cloud computing. The Soma Bits is a middle-layer toolkit, facilitating an exploratory design process that sits in-between initial material explorations and designing a final prototype. The bits are explicitly designed to support first-person engagement with and somatic exploration of the affordances of actuators and digital materials. In particular, they support the design of body-based interactions using smart materials with shape-changing capabilities (Rasmussen et al., 2016) — sometimes named robotic materials, alongside interaction modalities such as heat and vibration (Jonsson et al., 2016, Bhomer et al., 2013, Tomico et al., 2017). Various sensors, such as movement or biosensors, are also integrated with the bits, feeding the somatic design explorations.

Designing with a soma design perspective entails designing with the sociodigital material - the coming together of our bodies with smart materials, and behaviours and practices arising from their interaction (Höök 2018). That is, not only are we shaping the digital and physical materials into designs, we are also shaping our own bodies, movements, and experiences in the process — both as designers and end-users. Consequently, both the development of Soma Bits and the way that they have been used in prototyping sessions and workshops aim to support an active engagement and experimentation with computational materials through touching, moving, and feeling.

Engaging in this novel design space through Soma Design requires cultivating deep knowledge of novel smart digital materials. Normally, exploring the endless number of ways in which digital materials can be combined requires a strong technical background. Although there are several toolboxes for non-engineers (e.g. Arduino.cc, littlebits.com, Microsoft gadgeteer) to facilitate such explorations, most of them have particular form-factors that do not facilitate design explorations for and with a somatic engagement. Additionally, in many physical interaction projects, there is a tendency to start from input modalities. However, from our Soma Design explorations, we found focusing on actuation to be more evocative than contemplating what can be sensed. Therefore, in developing the Soma Bits toolkit, we made a clear choice to start from actuation.

During our Soma Design research process, we engaged in a number of body practices, including Feldenkrais, slow walking in the forest and Contact Improv dance. (Please note that the choice of body practices is not a matter of choosing movements that are scientifically proven - instead our choice is merely based on what feels playful and engaging). Based on those activities we extracted many different soma-based evocative experiences. Out of these, we decided to focus on three design qualities that seem to have relevance to more than one design context: a sense of connectedness, feeling embraced, and sense of correspondence between our movements and how the smart materials respond to us. The Soma Bits were developed with these qualities in mind, however, we consider the Soma Bits to have the potential for an open-ended exploration of other qualities and possible interactions.

Below we report on the process that led to the Soma Bits, from theoretical influences, activities that inspired us to attend to our own soma, lo- and hi-fi prototypes that led to the final toolkit.

Related Work

As designers, we need to grasp the properties of the materials we work with. Digital materials like sensor data or algorithms have properties that are unlike, but comparable, to other materials such as wood, aluminium, or glass. However, these properties can be elusive to non-engineers. One way to make digital materials accessible to designers is to combine them with physical materials, creating computational composites (Vallgårda and Redström 2007). These are open-ended materials, or abstractions, that remove some, but not all the complexity of the digital materials, making it possible for designers to imagine feasible artefacts containing digital technology. For example, Inspirational Bits (Solsona Belenguer, 2015) are one-function systems that expose and make the dynamic properties of digital material available. In the same line of research, Visible Light Communication can be explored as material to comprehend light communication from a designerly perspective (Windlin and Laaksolahti, 2017), by e.g. mapping light communication properties to sound. The work by Vallgårda et al. (2017) on the Hedonic Haptic Player points to an evocative design space of exploring vibration as a material, and the possibility of using vibrotactile stimuli for creating enjoyable experiences on the body. Platforms such as Arduino, that make physical prototyping more accessible facilitates the imagining of '*harmonious intersections between what is possible, acceptable, needed, and desired*' (Ozenc et al., 2010).

Background

With the advent of new technologies, in particular, new forms of smart materials, closer and closer to our bodies, there has been a need for a novel design stance with accompanying tools, methods and theoretical concepts. Soma Design provides such an alternative stance. It promotes designing for aesthetic experiences and not necessarily for utilitarian goals, laying closer to areas where design is taught with a basis in artistic traditions (Höök 2018). Soma design proposes that one way to cultivate our somas and create for better (more enjoyable, or simply more interesting) ways of being mediated by or in collaborations with technology, is to engage in varied aesthetic experiences to spur novel design ideas. This can be achieved by moving in ways that shift us out of our habitual movements and response patterns (Wilde et al. 2017, Höök 2018, Youn-Kyung Lim et al. 2014) or by engaging in various body practices. By questioning, deconstructing or simply providing alternative ways of walking, breathing, touching or experiencing in our everyday lives, the meaning and experiential potential of our everyday activities come into focus. New experiences are enabled alongside new ways of connecting to ourselves and others. From this fertile ground, a whole range of new interactions can be imagined: extending our bodies (Svanaes and Solheim, 2016), ways of connecting through remote controls with technologies in our homes (Mailvaganam and Bruns, 2015), or technologies for health (Morrow et al., 2018) just to mention a few application areas.

According to Höök (2018), soma design includes: engaging with our own lived experience; working with the sociodigital materials; slowing down of the design process; and iterative testing filtered through a first-person, somatic perspective.

This first-person, lived experience, engagement is increasingly used by researchers designing movement-based interactions (Loke et al. 2012, Schiphorst 2009, Svanaes and Solheim 2016, Höök 2016, Hummels 2016, Höök et al 2018)). Rather than relying solely on

Body Practices Facts

Moshe Feldenkrais *sought alternatives of extending our ways of being in the world through exploring different ways of performing habitual movements (Feldenkrais 2017). This exploration can be particularly useful if we have pains or difficulties. There may be many movement patterns we have once known, but are not always aware of, and we might not be using them as one particular pattern has become habitual to us. In Feldenkrais-lessons movements are performed extremely slowly, sending signals back through the nervous system that can be decoded and extend on our repertory of movements.*

Contact movement *improvisation originates in the work of Steve Paxton, an improvisational dancer and aikido student and promoted by Nancy Stark Smith. In the 1970's Paxton held two performances, where physical intimacy of contact combined with the emotional intimacy of nonverbal communication emerged between the participants. This has developed into a multi-faceted, global phenomenon, where an improvised dance, exploring one's body in relationship to others by balancing, touching and creating movement in one another, takes place. (Koteen et al., 2008)*

"From the impossible to the possible
From the possible to the easy
From the easy to the pleasant
From the pleasant to the elegant"

(Feldenkrais 1977)

third-person observations of potential users of a technology and the use context, soma design relies on pursuing and observing our own aesthetic experiences. A first person, felt engagement, allows us to touch the complexity and nuances of bodily experiences that are often lost when designing solely through a visual, graphical, symbolic- or language-driven dialogue viewpoint (Höök 2018). Just imagine how hard it would be to teach someone to ride a bike just through talking to them.

By sociodigital material, Höök refers to not only the digital or physical materials and technologies we use to construct artefacts, but also our own somas and our interactions and how we are in dialogue with one another and these technologies. As we change some aspect of the artefact, we are spurring certain interactions, certain experiences, certain movements or emotions, which in turn shape how we approach and engage with the artefact. It is a fluid material, consisting of the combination of our behaviours and the artefacts — in particular when we engage with digital materials as they can change in and through the interaction with the user. Designers have to shape the dynamic gestalt (Löwgren and Stolterman 2004) and the gestalt is the aesthetic experience of the interaction that unfolds between user and design over time. To cater for this experience, designers themselves need to engage with and experience what the design 'feels like' when interacting with it. When the input or output is bodily, designers must put themselves in the users' position, experiencing the different possibilities in a dialogue with the ongoing bodily processes. Just as sketching is used to represent visual ideas, the body and its senses together with the digital material are here used to sketch out the aesthetic interactive experience.

There is a difference between designing with our aesthetic sensitivities and designing a cognitive-based symbolic-oriented interaction. Language provides a shortcut to our design processes, and we can articulate ideas as long as the symbols and language are known to us. But soma-based ideas do not have such ready-made shortcuts, and, in our experience, require a different kind of engagement. To understand, articulate and share aesthetic experiences, we have to be engaged in fine-grained details. As we may not be sensitive to these nuances from the onset, we have to learn how to articulate them. To achieve this, we need to slow down, attend to one sensory signal at a time, warding off other senses (in particular visual stimuli as our visual sense is the dominant human sense), in turn allowing us to become thoughtful and leave room for reflection when approaching aesthetic experiences in design. Training this involves cultivating a somatic sensitivity by making very slow movements to properly feel them or repeatedly touching and feeling digital or composite materials to gain an understanding of their experiential potential.

When doing Soma Design, similar to most design processes, getting to the desired aesthetic experience requires an iterative process of crafting with materials, orchestration of an experience, and testing. The main difference lies in how every step in this iteration must be filtered through our somas. For example, designers may start by applying crafting skills to capture fine-grained nuances of how the aesthetics could be achieved. As a next step, they engage in the crafting of an orchestration of materials and modalities, making materials come together in a way that captures the desired aesthetic experience over time. Eventually, in order to assess whether we are getting closer to the aesthetic experience aimed for, you may want to document exhaustively every change in the properties of the material. Repeated tests and experiments are made both through a first-person engagement, as well as collectively by the design team.

Soma Design Manifesto

#1 **We design for living better lives – not for dying.**

#2 **We design to move the passions in others and ourselves.**

#3 **We are movement, through and through.**

#4 **We design with ourselves through empathy and compassion.**

#5 **We design slowly.**

#6 **We cultivate our aesthetic appreciation.**

#7 **We disrupt the habitual and engage with the familiar.**

(Höök 2018)

>Figure 1 a. An outdoor Feldenkrais session with the intent to attend to the body. **b.** A Contact Improvisation with a focus on the correspondance relationship between two people.

Soma Bits – Mediating Technology to Orchestrate Bodily Experiences

The current incarnation of the Soma Bits toolkit consists of two parts: the soma shapes and a series of actuators. The soma shapes are a collection of six different physical shapes that can be placed on different body parts, as shown in Figure 2a. They are made of foam material, covered in an elastic, cotton textile. Each shape has at least one pocket that can be opened and closed with velcro, where actuators can be inserted.

We focused on three types of actuators: heat pads, vibration motors and pneumatic shape-changing materials (see figure 2b), based on some of our prior work (see below). We "packaged" each separately so that they can be easily switched "on" or "off", regulating their intensity/shape interactively, while also being portable and robust enough to be explored in combination with the soma shapes, on the body. This was done in order to make the technology accessible to a broader audience, without requiring hardware prototyping skills. We made custom boxes with a laser cutter for enclosing the electronics of each Actuator separately and the actual component, being a heat pad, or a vibrator, can be inserted inside the shapes to be explored on different areas of the body. The pneumatic shape-change has the size of an inflatable pillow de- and inflated with a compressor. The bit will be shrunk in volume to fit with the physical soma shapes of the Soma Bits toolkit. The Soma Bits can be used one by one or in combinations of several on different locations of the body (see figure 2c), the aim is to inspire designers' imaginations and provide an early opportunity for the direct experience of a potential soma design.

Rather than being a finished, closed, toolkit, the Soma Bits are intended to be a living, growing library of shapes and technology. The design qualities we explored, and subsequently the shapes and actuators we built are aimed for designers to immediately start exploring and ideating with smart materials, instead of having to create fully working artefacts. However, the Bits we designed are only a starting point. Our aim is that, with time, designers craft new shapes and new actuators to capture other fine-grained nuances of experiencing smart materials.

>Figure 2 a, b, c. The Soma Bits in it's pure form consistent of the shapes a), the actuators (b). An example for how to combine the shapes with the actuators to create a soma bit(c).

Figure 3.
Example Design - Soma Mat
Before we created the Soma Bits toolkit, we had engaged in several soma design-informed design processes. Let us just briefly introduce one of them as you can see how it informed our toolkit. The Soma Mat (Höök et al., 2015, Jonsson et al., 2016) was designed as a means to wind down and become more aware of your body. In one of its incarnations, as you lie down on the mat, listening to a voice telling you to focus on different body parts, the heat elements in the mat will follow the voice instructions. As you are asked to turn your attention to, for example, your left foot, the mat heats up under that foot. The heat as a material is carefully crafted and orchestrated to create a somaesthetic experience which guides your attention to different parts of your body. In an interview, users explained what they felt as something close to a form of correspondence, dissolving the distinctions between self, body and mat: *'After a while, it is like you cannot really tell if it is you or the heat, you become one with the heat, where do I end and where does the mat start?'*

Design Process

Let us describe how we came to design the Soma Bits, through a process of lived experience, sociodigital materials, slowing down of design process, and iterative testing (visualised in figure 4).

Becoming Aware of Lived Experiences

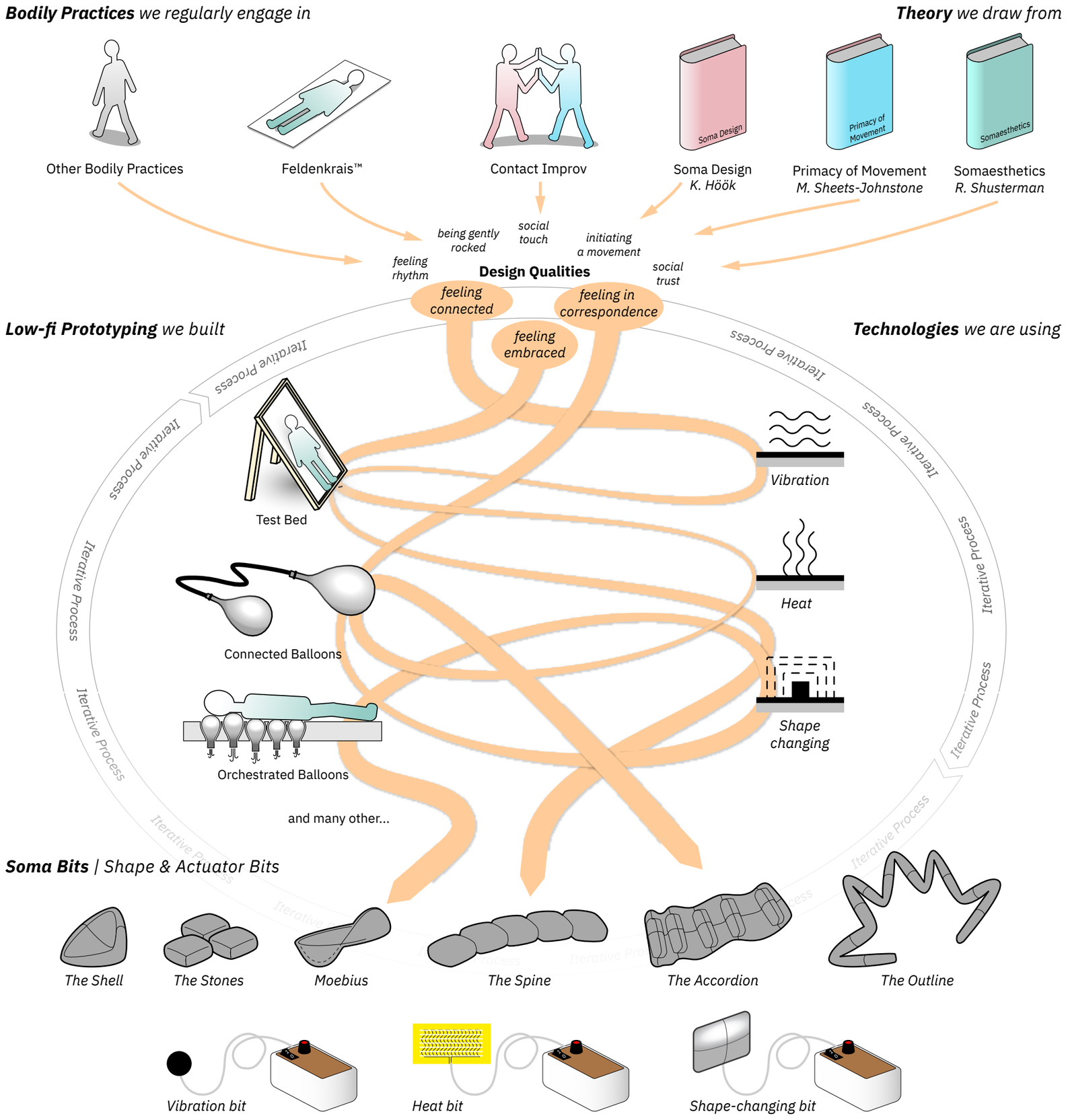
Our design team started by engaging in several bodily practices of which two had the most impact: Feldenkrais and Contact Improv (see sidebar explanations above). We invited a professional Feldenkrais instructor and a Contact Improvisation instructor to give us regular lessons, each lasting about an hour. These lessons occurred once a week, during an intense period of half a year — and are still ongoing on and off in the team. To document, reflect and articulate our felt bodily experiences before and after each session, we used a version of a body map adopted from the work of Loke et al. (2012), where two outlines of a human body are pre-printed on a paper. We used them to reflect over the body in drawings and notes (see fig). Over time, these maps became a rich source of data for first-person perspectives of bodily experiences and sensations. They also created the basis for empathy and compassion within our group. While our experiences were widely different, the mere fact that we had engaged in the same lesson allowed us to achieve a sense of intersubjectivity (Mearleu-Ponty 1962). They also contributed our ability to be attentive to, and extract, the design qualities that later shaped the toolkit.

Extracting Aesthetically Evocative Qualities

After a half a year of Feldenkrais and Contact Improv sessions a range of strong experiences had surfaced and been discussed in the design team (initially five people) — experiences we all felt had an impact on us, even if our experiences were individual and varied. We sorted them into eight categories: feeling embraced; social touch; being gently rocked; connectedness; social trust; feeling rhythms: initiating a movement; and correspondence relationships. Here we will describe the origin of three: achieving a sense of connectedness, feeling embraced and being in correspondence, since they formed the basis for our current set of Soma Bits. These qualities could also function as examples of how to observe and extract qualities to extend our toolkit further.

Feeling connected: Feldenkrais exercises often emphasise the experience of connection between individual body structures, like feeling each vertebra and how they together form the whole spine or the different parts of the fascia connecting our inner organs and limbs. It became particularly apparent in one exercise focusing on the upper body (see figure 5a). We were asked to move our shoulders up towards the ceiling without moving any other body parts. Gradually the movement of other parts that were connected to the shoulders was included, such as supporting the movement by directing the gaze towards the feet, rolling your head and neck, and finally supporting the head and neck in rolling. In the end, the experience of moving the body parts changed from jittering, trembling muscles into a smooth pleasant aesthetic experience of connected parts — shoulders, eye gaze, neck, head and supporting hands. The movement of the spine became flexible and fluid. We experienced a change in fidelity and fluidity from the beginning to the end of the exercise leaving us with the sensation of connecting parts into a whole.

>Figure 4. The messy & iterative design process.



In summary, a feeling of connectedness makes us experience individual parts of our body, moving towards understanding their interdependency, and how they together form an experience of a whole.

Feeling embraced: The sense of feeling embraced originated both in Feldenkrais and Contact Improv lessons (see figure 5b). During a Feldenkrais exercise, we were lying down on our backs, on a mat on the floor, and were instructed to lift our heads, just a few millimeters several times. This was taking a lot of effort; the head was heavy and straining to the neck. Bit by bit our instructor deconstructed the movement into smaller units and contrasted it with alternative movements to achieve the lift. She asked us to interlace our fingers behind the head and lift it again, then changing the position of the elbows to face the ceiling, and lift again in this position. She continued by asking us to tilt our pelvis upwards and contract our abdominal muscles and then lift the head. Later she asked us to bend our knees and place our feet on the floor close to our buttocks and then lift the head. Each change made it easier and easier and eventually we lifted our heads using alternative muscles and movements almost without any effort. This deconstruction both made us aware of different parts of our soma (our bones, muscles and how we activate them) and how these movements can become a pleasant, effortless experience. As the movements were done slowly, with our eyes closed, it became possible for us to really discern every small detail of the movement as well as the emotional experiences this movement spurred. The feeling became one of embracing your head, the support from the hands interlaced behind the neck gave the sensation of 'hugging your head', 'helping, lifting, letting your head go', taking care of yourself, and becoming empathic with yourself.

In a Contact Improv exercise, the experience of being embraced became even stronger, providing a strong sensation of being cared for. We were asked to hold and carry the weight of another person's arm (as they were laying on the floor) by supporting the elbow and the wrist with our hands and then slowly start to indicate and perform movements in any direction with the arm. The person being held had to let go of their arm, not engaging any muscles or 'helping' to lift it (except indicating unpleasant movements). The sensation of having your arm lifted was both one of being held and cared for, but also stimulated the nervous system in the arm and shoulder, a form of activation. In another Contact Improv exercise, we worked in pairs slowly accentuating different body parts by cupping our hands around different limbs, thereby steering the other person's attention. When someone puts their palm around a convex body surface, like the heel or the elbow, you became aware of the rounded shape of this part of your body, creating a sense of compassion for this part of your body. Through engaging a sense of feeling embraced, we achieve not only a sense of being compassionately cared for, but also a way to put attention to certain body parts, their actual shape, whether round, bony, curved or convex. Whether we enclose a heal, an elbow, or the shoulders — the same feeling of being embraced arises.

Being in correspondence: During several contact improv exercises, we worked in pairs interacting with each other through touch and movement. During one particular exercise, we stood in pairs, opposite one another making our palms meet. We were first asked to explore what it was to simply follow the other person's hands

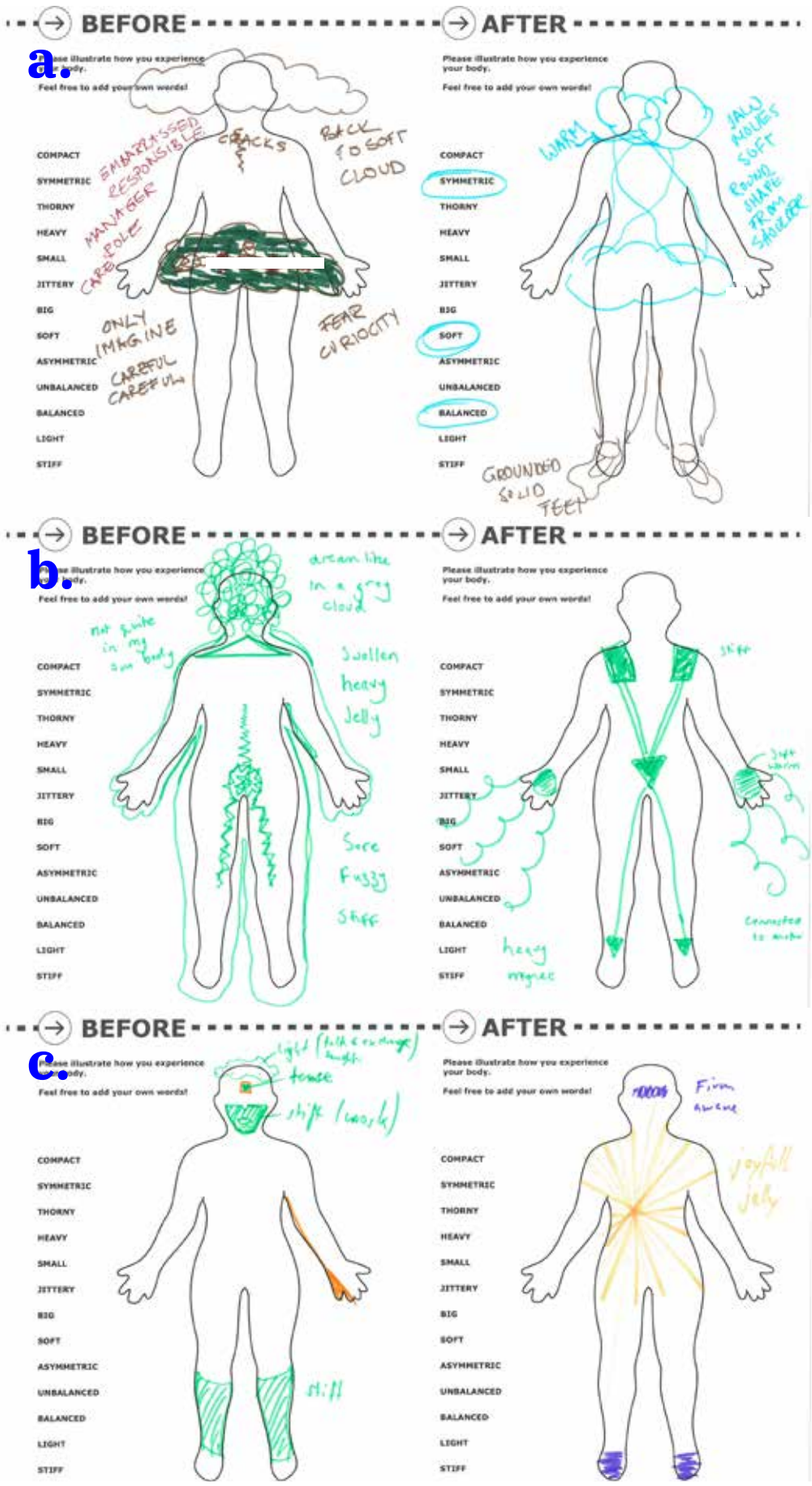


Figure 5 a, b, c. An example of body maps for each quality.

a. "Feeling connected"
b. "Feeling embracement"
c. "Being in correspondence"

moving, taking alternate roles in leading and following. Later, the follower could decide to resist the movement. We were then asked to not think of who was leading or following but instead simply act together. The hand and arm movements were gradually expanded to include the whole body — leading one another towards the floor or moving through the whole room. At the end of the lesson, most of us were able to move in a manner where it was no longer clear who was leading or following, but instead move together as one body — one movement corresponding to the other, mutually feeling each others' movement. Occasionally couples came out of sync and then small break-downs in the feeling of correspondence appeared. Sometimes this was fun — feeling like teasing or joking, sometimes it required some work to overcome. In this process immediacy and synchrony were key. Höök and colleagues (2016) describe the moments where being in intimate correspondence happens seamlessly, where the feedback of an interactive system becomes an extension of the body rather than a separate entity or communicating counterpart. The concept correspondence is used by Ingold (2011) to describe a relationship between a person and an artefact, such as between a cello player and his cello. His point is that when playing music with a cello, the music and the movements of the bow and engagement of the musician, lives in a correspondence relationship.

In summary, being in correspondence is one where two or more entities (two persons interacting, or, as we shall see below, one person interacting with technology or having their movements mediated by technology) move or work together so they perceived themselves in unity. This experience is not necessarily something that just arises. It needs to be orchestrated by finding processes that allow us to sync — and it is an experience that is achieved. Throughout the interaction, you need to 'feel' the unity in order to stay within this experience.

Transferring Qualities To Interactive Soma Bits

To further develop, refine and transfer these experienced qualities into the forms and interactions in our Soma Design toolkit, we made several design explorations within the design team. We searched for modalities that might allow for an interaction where the three qualities would be experienced. We did not aim for all three to be unified into one experience, but often the qualities coincided. The explorations started out with non-technological materials (low-fi) in order to understand how modalities such as shape-change interactions, stroking, heat or change of structure might be experienced and crafted.

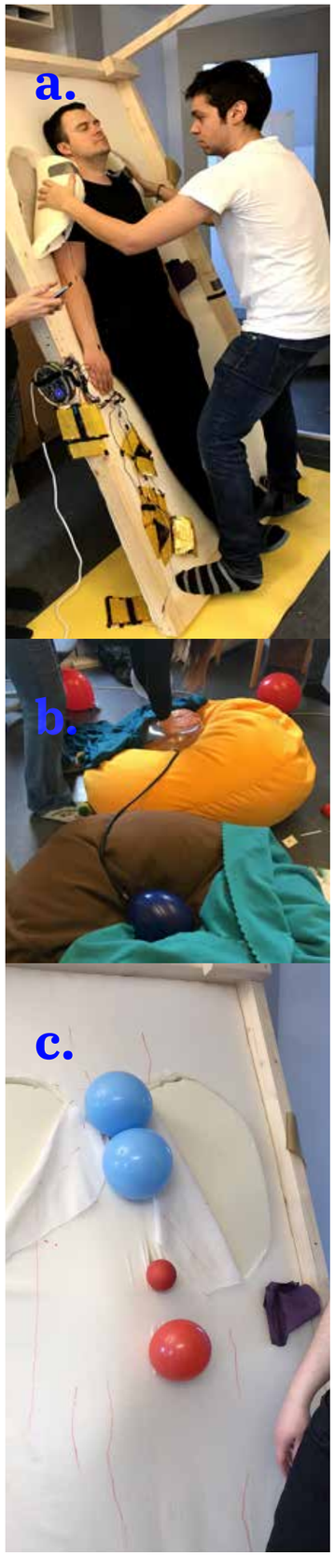
The experience of feeling embraced was explored by mimicking a shape-changing surface that you lean against where a memory foam mattress is suspended on a frame (see figure 6a) and where cut-outs in the mattress allow us to make the material change shape and start to embrace you. Through these explorations, we understood the subtlety that is needed when an 'alien' material starts to move and touch you. It needs to move slowly, embracing you gently. Heat was added to the shape-changing interaction, giving a sense of intimate care and reducing the uncanny feeling of being touch by technology rather than another person.
On the same mattress surface, we rolled a paint roller on the back of a person's leg imitating a shape-changing surface. It provided for the experience of feeling connected if the speed was slow enough together with pressure adjusted to the sensitivity of different parts of the leg. For the back, we tried to create the sensation of feeling each vertebra as part of the spine and as a whole structure by push-

ing gently on different points of the spine. Although this showed promise, it was hard to find a comfortable pace of letting the pressure come and go. Instead, we tried balloons (see figure 6b), where we could control the airflow and thereby orchestrate a sequence of shape-changing interactions (see figure 6c). The slow, soft and small changes were perceived as putting attention to different parts of your spine and increased the awareness of one's posture. With heat, the differentiation of body parts close to each other became harder, since heat diffuses and lingers in the surrounding material. However, when a subtle shape-changing movement was combined with heat, the heat was experienced as having a clear direction.

The in- and deflation of two big interconnected balloons (see figure 6c) helped explore how being mediated correspondence between two people could be perceived. The balloons were connected through a hose and each balloon was embedded in a bean bag you could lay on. By changing the weight impact of our bodies, one person on each bean bag, we could inflate and deflate the connected balloons. The slowness of the air moving and the resistance of the rubber material in the balloons created the sensation of moving in sync, where you have to balance the leading/following act.

While the low-fi prototyping allowed 'quick and dirty' testing of how these qualities could be transferred into dynamic experiences, it limited explorations of the digital technological material, and an understanding what affordances they could add. Our aim here is not to simply replicate the experiences from the Feldenkrais and Contact Improv lessons, but to use them as a stepping stone to engage with the dynamic qualities and affordances of the digital materials and what they can add — shifting into the sociodigital materials. To this effect, we built the Soma Bits comprised of the actuator bits and the soma shapes (see Figure 2a & b). The cuts in the memory foam culminated in the Shell shape, aimed at embracing one body part. The Moebius shape is a variation of the Shell and contains two concave surfaces, aimed at embracing and connecting body parts naturally separated by a gap, such as the knees. The orchestrated balloon shape-changing behaviour served as inspiration for the Spine shape. Similarly made to support connectedness, the Accordion, Stone and Outline shapes were made to be adaptable to different body parts, that are not located in a line. Different to feeling connected and feeling embraced, being in correspondence refers to a dynamic behaviour that, in the Soma Bits we present, is orchestrated through actuators. However, this quality also guided the form giving process of the shapes, since each is to be actuated through shape changing, vibration, or heat technologies.

Actuator Bits of three different types were constructed. Each representing a certain sensory modality — vibration, heat or shape-changing (figure 2b). While a single actuator does not serve as a direct representation (mapping) of the three extracted qualities, several of them can be combined with the shapes, as well as various other materials, forming a complex experience. The first actuator bit is a simple vibrator that is controlled by a 'volume' button. The second is a simple heat-pad, again controlled by a volume button. The third actuator bit is a shape-changing pillow that can inflate and deflate by pushing one of two buttons: activating either the compressor or an air valve. When you put several vibration bits next to one another, inside one of the soma shapes, they can be orchestrated into a whole sequence of interactions. You might choose to instead



combine vibration with heat or shape-changing, placed inside the shapes, and through this, a whole repertory of experiences can be evoked. This takes us beyond the original experiences, adding new dimensions to what can be felt.

These three actuator bits, together with the soma shapes, are the beginning of our toolkit. Our aim is that other bits including both new experienced soma qualities and other digital technologies can and should be added to this toolkit. We are currently developing wireless bits so that they can be combined and form more complex behaviours. We are also developing tools to facilitate orchestration of different materials coming together, linking sensing to actuation and back, in ways that capture the desired aesthetic experience over time. Here we are exploring the use of interactive machine learning technologies (Fiebrink et al. 2009) allowing bits to learn those interactions automatically, and take into account different body sizes or other differences of relevance to individual users.

Discussion

The contribution in this paper is twofold. First, the Soma Bits in themselves contribute to explore actuation in connection to the body, making properties and affordances of interaction modalities tangible. Secondly, the reported design process, together with the extracted experienced qualities of feeling connected, embraced or engaging in a correspondence relationship, exemplifies how an interaction gestalt can arise from using the bits in an interactive, iterative soma design process, experienced through a soma engagement.

<Figure 6a, b, c. Lo-fi prototyping with a testbed (a), interconnected balloons (b) and balloons incorporated into the testbed to test a sequence (c).

Our intention with the bits is that designers (especially those without an engineering background) may take a shortcut to explore and understand the potential aesthetics of an interaction, without building a system from scratch. We have already used the Bits in two workshops with evocative results. Having several Soma Bits gives the designer the opportunity to work with multiple actuators on the body, allowing, e.g. for building a sequence of somatic feedback of a larger area. The bits allow to engage with the sociodigital material, exploring how it can be manipulated in order to cater for dynamic interaction experiences. Once these dynamics are in place, the crafting and orchestration of an aesthetic experience come into play. A modality must be experienced, it is not enough to simply trying to imagine how it would feel. For example, heat as a modality cannot be manipulated in the same way as with e.g. vibrations. Heat lingers since the surrounding material is also warmed; it cannot simply be turned off, and next time the heat is turned on, it is not experienced with the same intensity because the skin gets used to the lingering heat. In addition, when using several actuators, the parts need to work together in a way that gives the designer the intended somaesthetic experience. Insights like these come through the experiential design explorations with the combination of the soma and the digital material. In Soma Design processes, the desired final artefact is not known in advance. It is instead an open-ended design process where several possible ideas need to be tried out and explored iteratively. Digital materials can open up for new unintended and yet to be imagined design possibilities. The Soma Bits allow for explorations situated in between low-fi testing, such as using hot water in balloons or replicating a shape-changing surface without technology, and the fully implemented systems that take an effort to implement. Together with our design process and experienced qualities, we intend to create an understanding of the properties and possibilities of designing with these materials.

Conclusion

In this paper, we have focused on the development of soma bits around three qualities (the feeling of being embraced, connected and feeling in correspondence in-between people, or between a user and the interactive material) allowing for exploration with three different modalities: shape changing interactions, heat and vibrations. These bits should be seen and used as a starting point, where designers can develop an understanding of the affordances of these modalities, and the possible directions these modalities might take the design. Other combinations of bits could be built capturing combinations of other qualities and modalities, such as light, sound, smell, air, humidity, etc.

The Soma Bits - designed for placement on and around the body - offer a unique middle-layer prototyping toolkit for soma designers to engage in easily configurable first-hand experiences of potential soma-inspired designs. They constitute an accessible, sociodigital material that places emphasis on the whole-body experience of actuation.

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