



KEEP YOUR SHIRT ON

**wearable technology  
solutions for increased  
body awareness**



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EVERYDAY  
LAB**

## ABOUT

In our design innovation project 'Keep your shirt on!' we are investigating how we can increase our body awareness using wearable technology, with a focus on its use in psychosocial care. The project team, funded by an NWO grant, is a partnership between the Faculty of Industrial Design Engineering at TU Delft and Kudding & Partners, a leading healthcare consultancy.

We organized two workshops to identify design opportunities for how wearable technology increases body awareness. In the body awareness workshop, we examined how caregivers in the field of psychosocial care perceived body awareness in practice. In the wearable technology workshop, we asked designers how they viewed working with wearable technology, and asked them about the challenges they faced.

This booklet presents the findings of each workshop. We conclude with a sketch of future research proposal based on these the findings. The proposal focuses on how wearable technology solutions will help people with post-traumatic stress disorder (PTSD) deal with everyday life.

# BODY AWARENESS WORKSHOP

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**There are many definitions of body awareness found in the scientific literature. In general, body awareness can be considered as the awareness of sensations arising from within the body. Academics also emphasise the attention that a person pays to his or her internal bodily sensations as being important in body awareness.**

To understand more about body awareness in practice, we asked a number of practitioners in the field of psychosocial care to share their experiences. We organized a workshop to gain the information we needed to answer the questions we had concerning body awareness, for example: what is important when working with body awareness in psychosocial care, which factors play a role, how is body awareness framed, and what are relevant bodily signals?

## **PARTICIPANTS**

We asked nine practitioners from different areas of psychosocial care to participate in the workshop. As they all

work with body awareness, they were considered the perfect candidates to help us better understand the phenomenon and to think with us on possible uses of wearable technology. The participants included a neurologist, psychotherapists focusing on posttraumatic stress disorders, eating disorders and aggression, as well as a menopause consultant and a life-coach.

## **SET UP**

The workshop was divided into three parts. In the first part, we asked the participants to discuss the role of body awareness, noting how they frame and approach body awareness in their practice. In the second part, we focused on the details of body awareness in terms of experiences and locations of the body. In the last part of the workshop, we asked participants to think about finding opportunities for improvement. The participants were given actual case studies and they reflected on how increased body awareness would have helped.

# 'To consciously feel your body in relation to the context in which it is located allows you to pick-up signals from your body, interpret them in relation to environmental factors, and to possibly modify them.'

## RESULTS

The workshop gave us insights into body awareness viewed from a practitioner's perspective: what they pay attention to and how they work with it. Common themes were **Awareness, Balance, Signals, Methods** and the **Client-therapist relationship**. These results are summarized below.

### awareness

Body awareness is a complex concept as it combines internal bodily signals, the mental attention that is paid to them and the environment in which the body is situated. 'Body awareness is consciously 'being there', paying attention to your body and the signs your body gives you.' As one of the participants said nicely, 'To consciously feel your body in relation to the context in which it is located allows

you to pick-up signals from your body, interpret them in relation to environmental factors, and to possibly modify them.' Thus, in many forms of therapy and psychosocial care, it is not only about awareness of the inward body; it is also the relation with the outward body that is the environmental factors that can cause certain bodily sensations.

### balance

Balance was a term often mentioned during the workshop to address healthy functioning and wellbeing. This balance refers to experiencing a balance in feeling, thinking and doing. As a participant explained, 'You have those three aspects: thinking, feeling and doing. If they are in harmony, you are complete. Then you are in touch with yourself and,

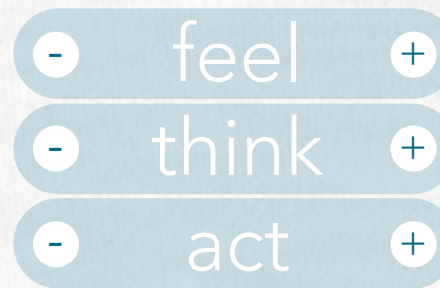


figure 1

from there, you can also make contact with others.' This balance is visualized in figure 1. An unbalance can be illustrated for thinking when you 'worry' and feel 'stuck in your head'; for feeling, when you feel 'down' or emotional without knowing why; and for doing, when you react in a certain way that is not constructive and that makes you feel 'out of control'. Body awareness is an

important entry point to help a person to readdress his/her balance.

### signals

During the workshop, participants were asked to map-out the body signals they focused on in their practice. The therapists used these signals to assess the emotional state of their clients. For example, emotional stress could be seen in increased muscle tension expressed in the neck and shoulders but also by overstretching of the knees and an unbalanced posture. Further, tics and tremors indicate stress, as do clamping and twiddling fingers. Breathing that is quick, shallow and that is located in the higher chest-area, can indicate high arousal. An overview of these signals in relation to the body is given in figure 2.

## methods

The participants presented a number of different methods to increase body awareness. A common technique, based on mindfulness therapy, is the bodyscan. This is a meditation exercise in which attention is gradually paid to all parts of the body. Participants also mentioned using an emometer, a simple analytical method enabling clients to reflect on their own levels of arousal on a scale from 1 to 10 and asking clients to label the emotion they experience. However, for clients to be able to have any reflections on their body, the client should be within the window of tolerance, which can be defined as the level of arousal that is within a comfortable range. Clients with either a too high (anxiety) or too low (depression) level of arousal, limit the depth of conscious body awareness. Lastly, repetition was mentioned as being critical in training body awareness. This is achieved through exercises, repeated conversations or mantras.

## relationship

Our participants addressed how critical the relationship between therapist and client is regarding the success of treatment. It is important for the therapist to be aware of his/her own body (levels of stress/agitation), as this is often copied or has an influence on the patient (i.e., mirroring effect). As one participant stated, "Clients feel it immediately when you're not feeling well. In such a situation it is better to just say it, then they are relaxed again. Otherwise they stay restless and keep looking". Participants further mentioned that authenticity, safety and non-judgment should be put above anything else, as clients need to feel that they are fully acknowledged and accepted during psychotherapy.

## conclusion

When designing wearable technology for body awareness, we need to find ways in which the awareness of a person of his/her body signals can be enhanced through direct or reflective modes of learning. These moments have to be chosen carefully, as the interventions

should occur within the 'window of tolerance' described above. Further, when designing these new technologies, there has to be a clear understanding of body awareness on behaviour and cognitive processes and the technology should be sensitive to the care-setting: the relationship between therapist and client that is based on trust and respect. Care should be taken that the technology does not negatively influence this relationship.

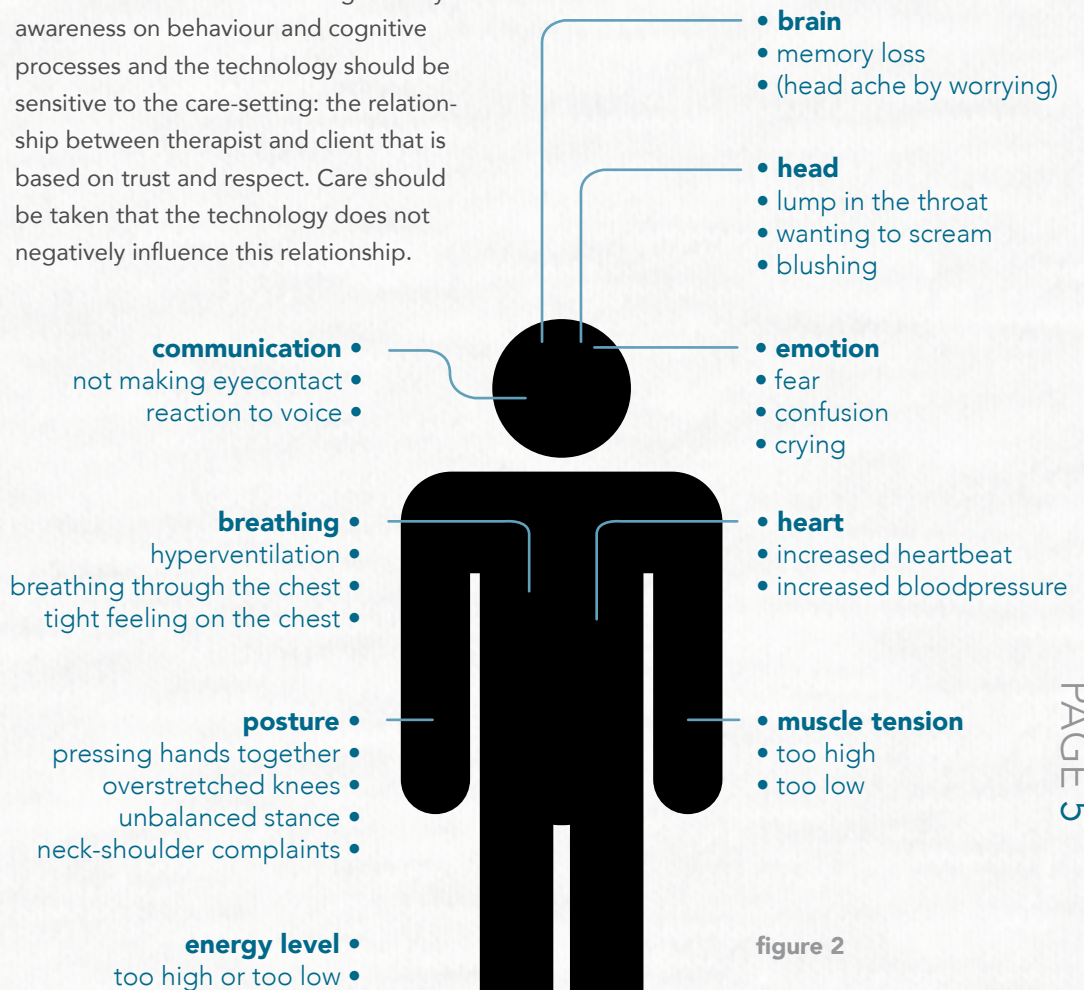


figure 2



**the participants of the workshop were given actual case studies and they reflected on how increased body awareness would have helped**

Participants during the workshops

# WEARABLE TECHNOLOGY WORKSHOP

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**Wearable technology is simply defined as technology that can be worn on the body. It can involve different types of technology such as electronics, computers, sensors and displays. Wearable technology is interdisciplinary, involving different fields of science and technology. Wearable technology is still a largely uncharted territory and common synonyms for wearable technology are: smart wearable's, smart clothing, intelligent fabrics, electronic textiles, body sensor networks.**

Wearable technology has a great potential for different areas of healthcare. For example, wearable technology that can measure and analyse body signals can be of value in monitoring a patient's rehabilitation process. Smart wearable systems can share data with other artefacts and digital social networks, thus data can be shared with healthcare professionals and, when aggregated, it can lead to a better understanding of the health problems. However, little is known about how to best design wearable technologies so

that they are accepted and become embedded in patient's everyday lives.

To understand more about wearable technologies in practice, we asked designers who have worked with wearable technology to share their experiences with us. We set up a workshop to gain insights into practical issues encountered when designing smart wearable systems and we asked the participants to think with us on how smart wearable technology could assist in increasing body awareness. Some of the practical questions included: Which technologies do you currently use in your practice, what requirements must they meet and, what are the challenges you face when designing them?

## **PARTICIPANTS**

Six design professionals from different disciplines who all have worked with wearable technology were asked to participate. They included an artist who focuses on interactive art, a future concepts designer, and several product

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designers. Their first-hand experience with designing wearable technology is of great value, as they understand the possibilities and pitfalls of dealing with these technologies in a design.

## SET-UP

The workshop was divided into three parts: In the first part, the participants were asked about the materials they worked with by discussing some recent design projects. In the second part, we asked them, in a larger group, to discuss the requirements in relation to these projects. In the last part of the workshop, we focussed on the challenges they faced. The workshop concluded by asking them to sketch some ideas about how wearable technology could be used to assess body awareness.

## RESULTS

This second workshop gave us insights into the range of components that designers of wearable technologies use and how they work with it, the requirements they set for themselves, and some

of the challenges they face in the design process. We discuss these insights in more detail below.

### components

Wearable technology consists of many components and, during the workshop, the participants discussed them in detail. We have summarized these components below, adding a short explanation:

**Sensors gather information about physical stimuli such as light, force/pressure or sound**, and transform this information into electric or digital signals. A common example is a microphone that picks up sound waves, but there are many other sensors such as touch sensors, pressure sensors, etc.

**Actuators produce physical effects based on electric or digital signals** (i.e., the opposite of sensors). A common example is a speaker to produce sound based on an incoming input, but there are many other actuators that produce physical effects in a variety of ways, such

as motors and vibrators or LEDs that produce light.

**Processors are small computers** that **analyse incoming data** (called 'input') to produce outgoing data (called 'output'). In the case of wearable technology, processors connect sensors with actuators with a number of 'rules' about how to connect the two. Common examples of processors are the Arduino™ and LilyPad™ systems.

**Power supplies are needed for wearable technology to be able to function as stand-alone units.** Depending on the needs of the wearable technology, appropriate energy sources can be chosen, preferably those that are small and lightweight. Examples are: batteries and amplifiers, solar panels or motion-powered energy chargers.

**Physical communication channels are needed to physically connect components for information and energy purposes.** Examples of these



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are: wires or conductive fibres that can be integrated in fabrics and require snap buttons as connecting elements.

**Digital communication channels are needed to share information between wearable components of the wearable technology** or to link data with other objects of systems, such as the Internet. Examples are Bluetooth™, WiFi and Xbee™.

## requirements

In design and engineering, requirements refer to the demands that a design must answer to in order to be successful.

**Embodiment-related** requirements (B) deal with the concern of designers to make wearable technology small and lightweight, so that the technology used can be seamlessly integrated into the garments, and flexible, so that technical components can be taken out easily when problems arise.

**Experience-related** requirements (E) deal with how the technology relates to the visual style and identity, if the technology is comfortable to wear, and whether it is easy to use.

**Technology-related** requirements (T) refer to the accuracy of the sensed signals, the speed of technology and energy consumption.

**Sustainability-related** requirements (S) include issues such as the durability of the fabric when worn and the extent to which it can be washed.

B. Size
B. Weight
B. Flexibility
E. Visual style and identity
E. Comfort
E. Usability
T. Accuracy
T. Transmission speed
T. Energy
S. Durability
S. Launderability

**table 1**  
requirements when designing  
wearable technology

## CHALLENGES

The designers noted the following four main challenges when talking about designing wearable technologies.

### CHALLENGE 1 How to best integrate the technology?

With the current state of technology, it is difficult to integrate some of the components easily in clothing. For example, they are not flexible enough, too big, not sturdy enough, etc. A designer may choose to hide the technology by covering it up with fabrics or other types of material, or to simply show the technology in an aesthetically interesting way.

### CHALLENGE 2 How to deal with power supply?

Powering wearable designs elegantly remains a struggle, for example battery packs are still large and lumpy, and need to be frequently recharged, which is inconvenient for wearable technology solutions. Creative ways have to be found to implement batteries in the garments and to reduce energy consumption to a minimum.

### CHALLENGE 3 How to deal with data?

One of the challenges mentioned was how to conceptualise the type of data that allows the wearable technology to function, and how it can be sensed and actuated through the software. The data to be processed is gathered by sensors and distributed by actuators. This raises questions like: What kind of data is needed for the actuator to distribute the desired action? Digital, analogue? Which resolution should this data have? What level of detail is needed for the interactivity to work properly?

### CHALLENGE 4 How to do troubleshooting?

When wearable technology doesn't function well, this may be for many reasons. For example, connections might be lost because wires break or digital signals are not transmitted from one component to the other. Problems can also occur in software programming or processors that 'freeze'. Given this range of problems, the workshop participants mentioned that trial and error is the best way to pinpoint and solve these issues.

## **CONCLUSION**

As wearable technology is a developing technological field, innovative ways of working with the technology are needed to seamlessly integrate technology into garments and textiles. When designing wearable technology for body awareness, iterative design processes are needed to help designers understand which body signals are meaningful and need to be taken into account, and what type of feedback is appropriate to help people become more aware of their bodies and emotions.

## **FUTURE RESEARCH**

Based on the insights gained during both these workshops and earlier literature research, we are currently setting up a research proposal that specifically addresses wearable technology for patients with post-traumatic stress disorder (PTSD). People who encounter possible (life-) threatening events, such as soldiers and policemen are at risk of developing PTSD. Wearable technology solutions might help them deal with their symptoms in their everyday life during psychotherapy, as the disorder can severely impact their personal and social lives. In these cases, body awareness can play an important role in the healing process.

At the moment, we are actively recruiting research partners for this project. So, after having read this booklet, you have become enthusiastic about this project and you would like to participate, or if you want to learn more, please feel free to contact us using the information below.

Last but not least, we would like to thank the healthcare providers and designers who participated in the workshops, for sharing their experiences with us.

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