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Communicating Emotion through Haptic Design

A Study Using Physical Keys

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Abstract: This paper explores how designers may communicate with the users of their products through haptic design. More specifically, how tactile properties of materials evoke emotions such as satisfaction, joy, or disgust. A research through design approach has been followed; mood- and material boards and prototypes of four 'haptically enhanced' (physical) keys were created. Types of keys selected include home, bicycle, hobby, and basement. An experiment with ten participants was conducted, using word association and a software to elicit product emotions (PrEmo). Results show a mapping between the designer's intent and the user's inference. We conclude that it is thus viable to communicate emotions using haptic design. Moreover, we found that when using their sense of touch, participants' previous positive or negative memories and experiences were projected onto the objects.

Keywords: Affective Engineering, Design Communication, Emotional Design, Haptic Perception, Rapid Prototyping.

1. INTRODUCTION

"I am giving them [products, added by the authors] new tactile properties, so that the user has to think while touching" (Rouillon, 2013). Artists inspire us to explore how we experience products in the digitalised world of today and make us wonder whether we are losing (the sense of) touch and thereby perhaps an important source of information, let alone an experience?

We are interested in understanding how we as designers may best evoke intended emotions in the users who are interacting with the artefacts we design. More specifically, we wonder, how we may best communicate our design intent using the senses of touch.

From a design research point of view, communicating design intent has been an important topic in trying to understand how users interact with designed systems such as physical artefacts, digital interfaces or services (Crilly, 2011). Design intents may be varied and ways of expressing manifold. We focus on emotional design through haptics. Emotions have been emphasised as a central quality of human existence, contributing to our ability to understand the world and learn new things (Norman, 2004). And in particular, the senses of touch are highlighted as part of the fabric of everyday, embodied experience (Paterson, 2007). Moreover, emotional design has been put forward as a differentiator and competitive attribute for designed products (Desmet and Hekkert, 2009; Jordan 2000).

Our aim is, therefore, to explore how we as designers may communicate emotions as our design intent through haptic design (Hara, 2007). To support this goal, we decided to use physical keys as most of us are using (physical) keys on a daily basis. Keys have for centuries accompanied our lives to open our homes, cars, workplaces, or safety deposits. And this is still the case, irrespective of the increase in use of electronic chips, codes, and fingerprints. Following a research through design approach, we created mood- and material boards and prototypes of haptically enhanced physical keys. We subsequently conducted an experiment with 10 participants, using a combination of word association and an assessment method to elicit product emotions, the PrEmo tool (Susa Group, 2013).

The article unfolds as follows: Section 2 gives the literature background for this study, in particular drawing on and integrating literature from the focus areas of design communication, emotional design, and haptic design. Section 3 provides an overview of methods used in preparing the material for the experiment with the users. Results are presented in Section 4. Section 5 discusses the results and provides conclusions.

2. LITERATURE BACKGROUND: TOWARDS AFFECTIVE HAPTICS

2.1. Design as communication

Studying design as communication has been an important topic in design research and practice (Crilly et al., 2009) where artefacts may be represented as media in the design process (Crilly et al., 2008). In this view, artefacts such as physical products are seen as media of communication between the designer and stakeholders such as users, where users infer design intent as expressed in product. Which sense do we try to appeal to when we as designers try to elicit intended emotions from users interacting with the designed object?

2.2. Design for emotion

"Nobody *would argue against the idea that usage experience should be pleasurable"* (Desmet, 2009). Users expect that products are easy to use, well-functioning and that they in some way touch them emotionally (Desmet, 2002). Knowing well that *"emotions cannot be separated from product*

function and issues of usability" (Desmet, 2009), it appears to be evident that attractive 'things' make people feel good and tend to work better (Norman, 2004). As such, an essential strategy to increase a product's competitive edge in the consumer market is to incorporate emotional values (Chang et al. 2007).

But how do you as a designer ensure that the users share the emotions towards a product that you may have intended to elicit? "[…] *products often evoke 'mixed' emotions. Rather than eliciting one single emotion, products can elicit multiple emotions simultaneously […]"* (Desmet, 2008). Designers want to be able to get an insight into users' emotions to understand whether a product will please the user (Jordan, 2000) and to anticipate positive emotional responses and thereby avoid potentially unwanted effects. *"[…] We all have emotions and thus, from experience we all know what they are."* (Desmet, 2008). Emotions may be evoked by different cues in the product; cues that appeal to different senses. Gant (2005) emphasises that one of the most influential ways for the designer to get a deeper emotional connection between products and users is to strategically select the material used. The choice of material influences how the user interacts with the product.

2.3. Affective haptics through the sense of touch

Vision has often been described as the most dominant sense (Dagman et al., 2010). However, recent studies indicate that other senses are as important in the way we experience products, such as the haptic sense relying on stimuli through physical contact. *"Touching is one of the ways to explore an object's aesthetics and the dimension of comfort […]"* (Jeon, 2011). Affective haptics as an emerging research area focusing on the design of systems ranging from products to services. It focuses on how the emotional state of people interacting with such systems may be elicited, enhanced or influenced through the sense of touch. The brain receives information from the sensory system that consists of receptors, including kinaesthetic receptors (the mechanoreceptors in muscles, joints and tendons) and the cutaneous receptors (the receptors embedded in the skin) (Lederman et al., 2009). When we haptically experience a product, *"[…] we are able to see an object sensorially and perceptually through our hands and body so that when designing an object, designers should consider the way people touch it to feel and appreciate it […]"* (Jeon, 2011).

3. METHODS: RESEARCH THROUGH DESIGN EXPERIMENT

The focus area for the experimental study is to incorporate specific emotions into everyday objects that will be decoded only by utilising the sense of touch. As this is an explorative study we simplified the study to increase the chance of success, by choosing a target group somewhat homogenous and equal to the designers. "*Although emotions may be subjective, the process of emotion is universal and people that share concerns and appraisals will experience similar emotions to a given product*" (Desmet et al. 2007). Therefore, the target group was chosen to be in their mid-twenties. The design objects were selected to be (physical) keys. See figure 1 for an illustration of the steps in our research through design process.

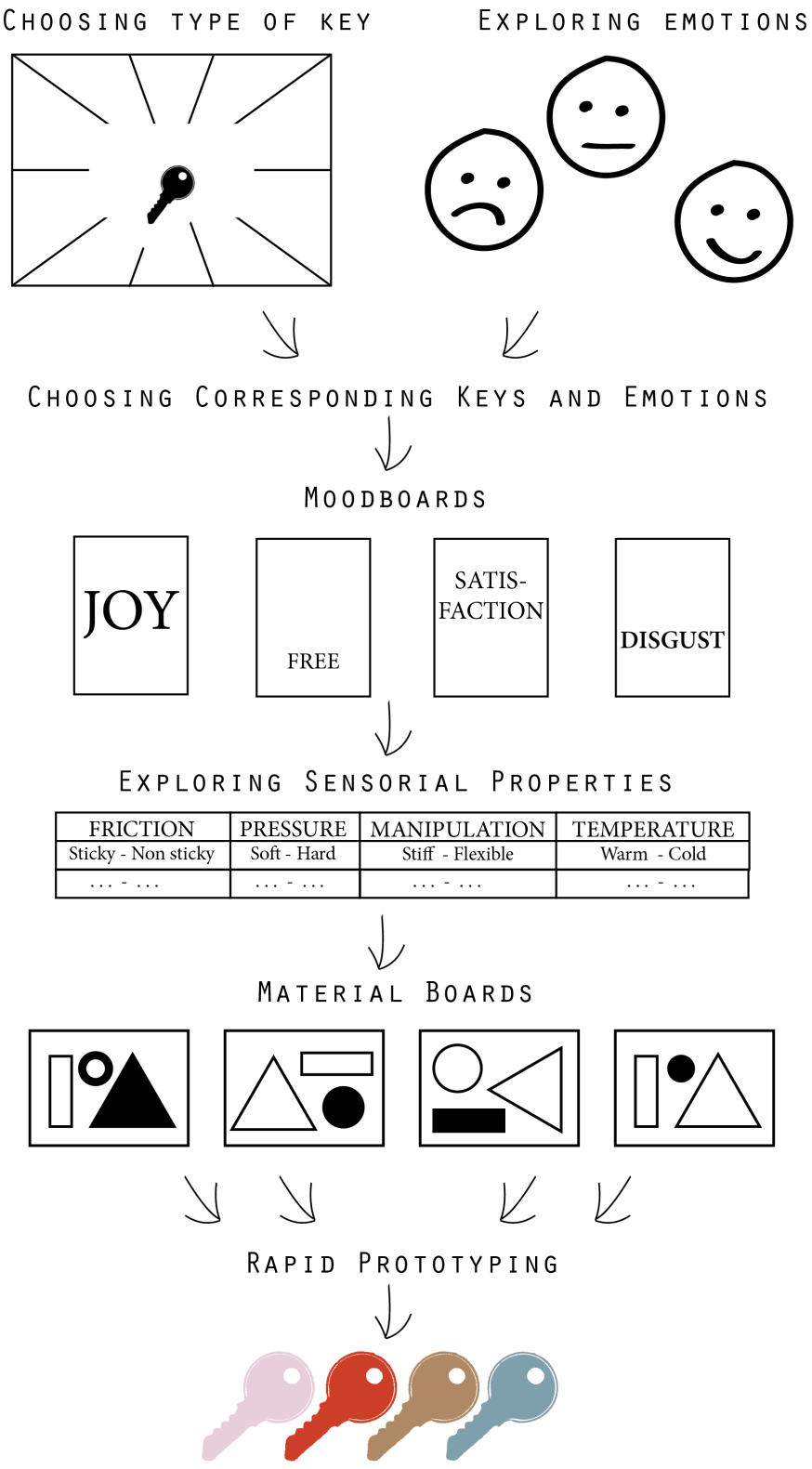

Figure 1: Towards haptically enhanced keys: A research through design process preparing the experiment

3.1. Preparing the keys to be used in the experiment

3.1.1. Selecting a set of different type of physical **keys** as our study object

To explore the types of keys the target group was using on a daily basis, a field study was conducted. In total, 33 people participated, 18 women and 15 men. A standard setup, which can be seen in figure 2, was used to structure and document the different types of keys.

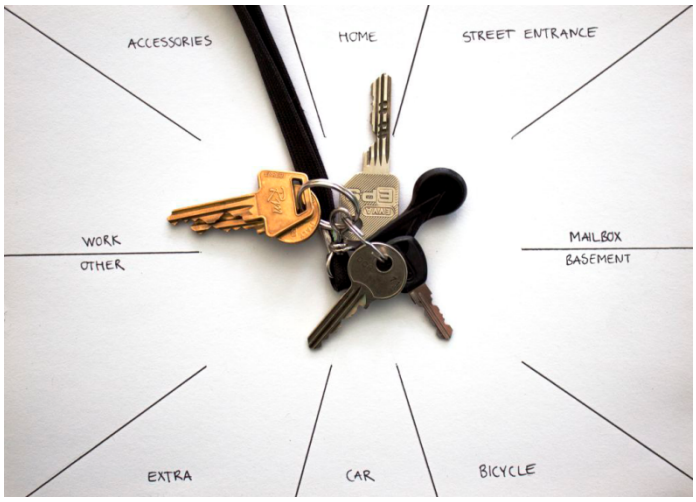

Figure 2: Eliciting which type of keys people carry with them on a daily basis

We selected the keys present in most key chains for incorporation of haptic- and emotional design aspects. The four keys were: Home, Bicycle, Hobby and Basement.

3.1.2. **Selecting emotions** associated with the design object

It was important that the four keys represented different types of emotions to challenge us as designers and to see if the participants would be able to perceive and identify the intended emotions. Inspired by a list of emotions (Desmet, 2012) and the circumplex model of affect with product relevant emotions (Desmet, 2008; adapted from Russell, 1980), the authors associated the following emotions with the four keys (table 1):

Table 1: Emotions associated with the different keys

Home	Bicycle	Hobby	Basement
Relaxed	Free	Passion	Cold
Warm	Eager	Satisfaction	Alarmed
Comfortable	Impulsive	Joy	Disgust
Joy	Reliable	Puzzled	Fear
Love	Exposed	Amused	
Secure		Thrilled	

3.1.3. Developing **moodboards** for mapping keys with intended emotion

To get a clear understanding of the different emotions associated with each key, four different moodboards were created. The moodboards served as visual tools to agree on what overall sensation we as designers wanted to convey with each key (see figure 3).

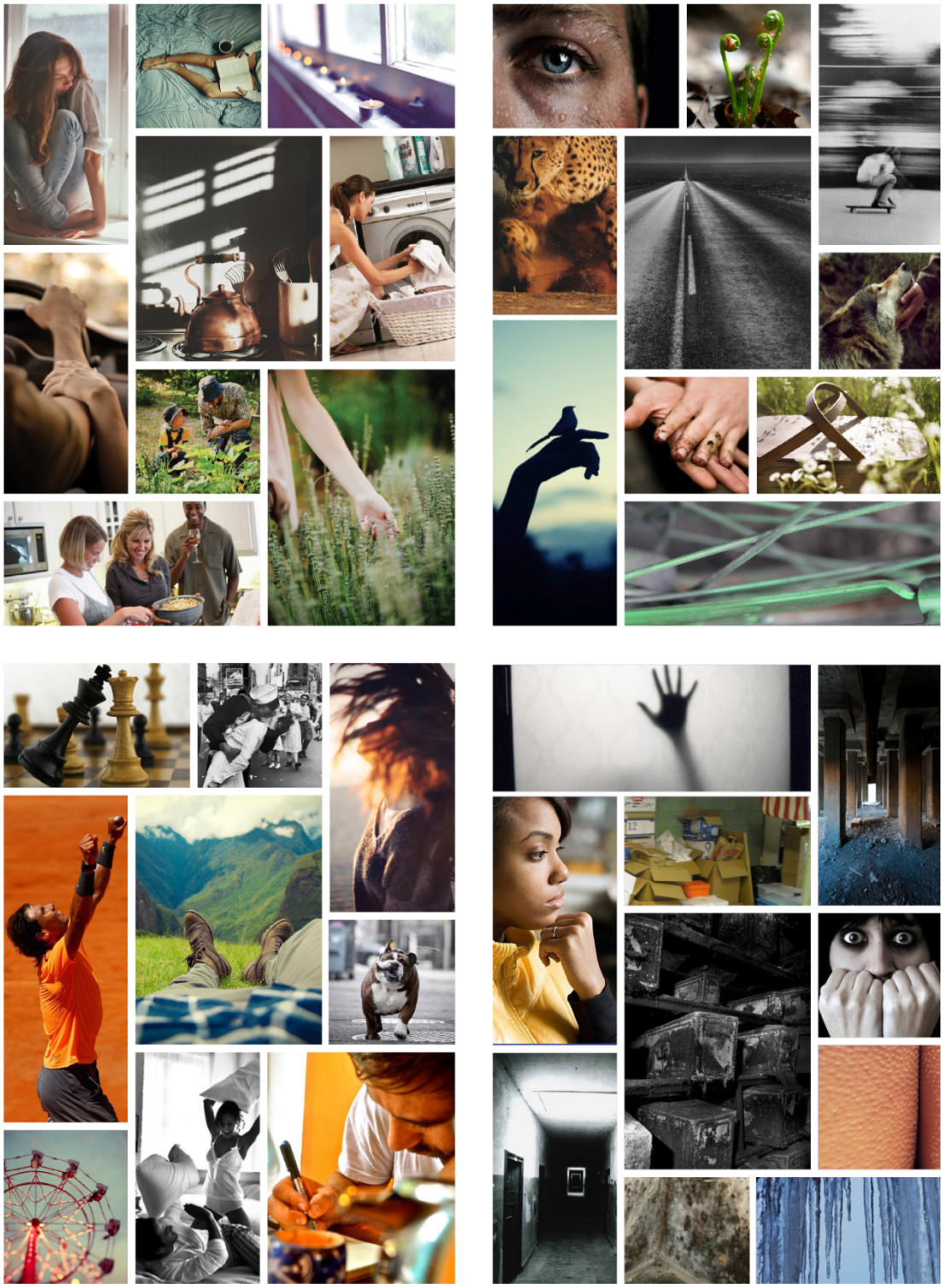

Figure 3: Moodboards for the four keys from top left to bottom right: Home, bicycle, hobby, and basement

3.1.4. Developing **material boards** to include intended sensorial properties

The Materials in Product Selection tool (van Kesteren et al., 2007) was used as inspiration for defining the material profile of our new products in terms of sensorial properties and for choosing the specific material. Four material boards were created with different sensorial properties. This was done to emphasise the emotions in each moodboard. Examples of the material boards can be seen in figure 4.

Figure 4: Material boards for *home and basement* respectively

We examined the material boards with a number of actions that people undertake when manually exploring products: they may stroke, lift, press, squeeze, feel the temperature or follow the outline (Lederman et al., 2009). These actions encompass activities for both the cutaneous- and kinaesthetic receptors and were used when examining the material boards.

3.1.5. Rapid prototyping: **Making 'haptically enhanced'** keys

The material boards served as inspiration for combining different materials and as the basis for prototyping. Specific emotions were selected to be incorporated into each key, see table 2:

Table 2: Keys and intended emotions

Key	Home	Bicycle	Hobby	Basement
Emotion	*Joy*	*Free (as a combination of pride and joy)*	*Satisfaction*	*Disgust*

Based on our own interpretation, we express 'free'/'the sense of being free' through a combination of pride and joy. This way, we include the sense of being free', currently not present in the test programme PrEmo (described in section 3.2).

The development and outcome of a rapid prototyping session can be seen in figure 5 and 6.

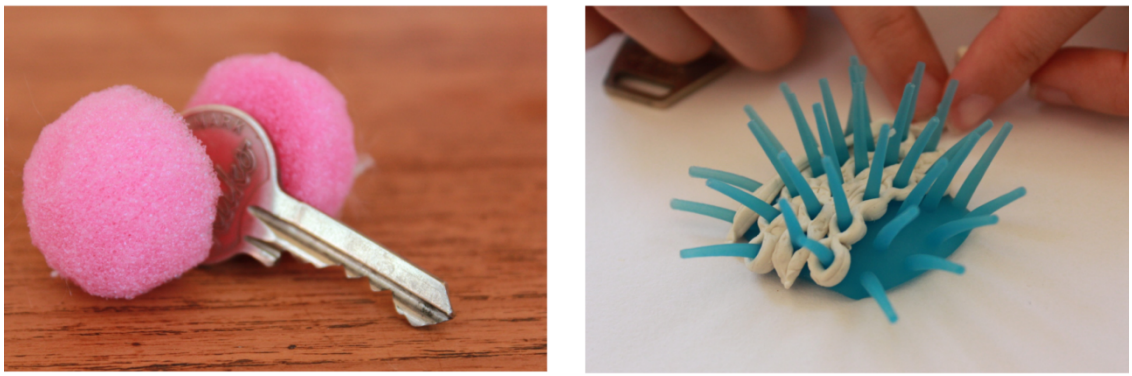

Figure 5: Development of the prototypes for home and basement respectively

Figure 6: Rapid prototyping results for the keys from the top left to right:
Home, Bicycle, Hobby and Basement

The four keys that were haptically improved had all somewhat similar sizes and weights. A description of each key can be found below.

Home: The overall geometric shape is chosen to be spherical, so the weight is equally distributed. From the material boards the properties furry and squeezable are chosen, so the test person is able to compress the key. When using lightweight foam to create the shape, a relatively large, but in comparison light key is created, which feels comfortable in the hand. When interacting with the key pleasant and joyful emotions should come to the mind of the user.

Bicycle: This key provides circular movement which should be joyful to play with. A functional element is also incorporated to allow the user to feel pride when decoding the moving pattern, just as if they had successfully accomplished a task. Rubber was chosen to give a none-smooth surface resembling the control and stability of tires. When combining these interactive elements, this key should relate to being free.

Hobby: From the material board the properties hard and warm are chosen, along with the overall round geometric shape. The surface should be smooth and have some convex curvature, which should influence the test person to follow the smooth round curvature continuously. The intention is that the participant does not want to stop the movements, just as it is hard to stop doing something you are fascinated about.

Basement: The key for the basement should be sticky to clarify the feeling of disgust when touching. Also the surface should have some irregularities. The key chosen has an overall trapeze shaped outline and is on purpose kept cold.

3.2. Conducting the experiment using PrEMO

3.2.1. Describing PrEMO

With our 'material' in place, we then prepared the experiment to see whether the emotions we would like to elicit as designers are indeed evoked in the user. For that, we used the Product Emotion (PrEmo) Tool (SusaGroup, 2013). The PrEmo tool is a nonverbal self-reporting instrument that uses animated cartoon characters to represent 12 distinct emotions. The PrEmo tool depicts a 0-4 point scale where the participant chooses to which degree an emotion is present while being influenced by the stimuli. An overview of the different emotions is shown in figure 7. The participants are able to report their emotions with the use of these visual characters instead of relying on words. This is an intuitive method that prevents the problems with interpretation of different words, *"...participants, when describing haptic product experiences, sometimes used adjectives that referred to 'visual experiences'"* (Dagman et al. 2010).

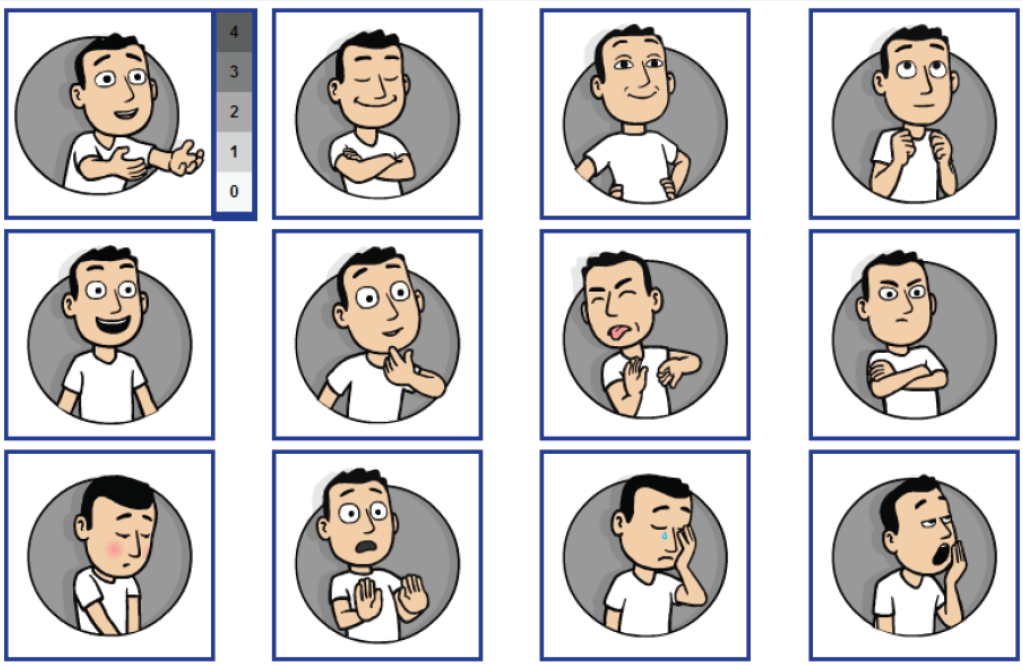

Figure 7: The PrEmo tool's different animated characters showing different emotions. The emotions are from the top left: Desire, Satisfaction, Pride, Hope, Joy, Fascination, Disgust, Dissatisfaction, Shame, Fear, Sadness and Boredom (SusaGroup, 2013)

3.2.2. User experiment

In our user experiment, we use in-depth interviews for the purpose of collecting emotional- and haptic responses from 10 participants, 6 women and 4 men within the target group. Each test lasted about 30 minutes and followed the same protocol, documented by video recordings. Participants were all first introduced to the key for home, followed by the keys for bicycle, hobby, and basement. After examining each key with their hands, participants were tasked to use the PrEmo tool to click on a corresponding emotion of their choice. Through the whole experiment, participants were encouraged to think- and talk aloud. The test setup can be seen in figure 8.

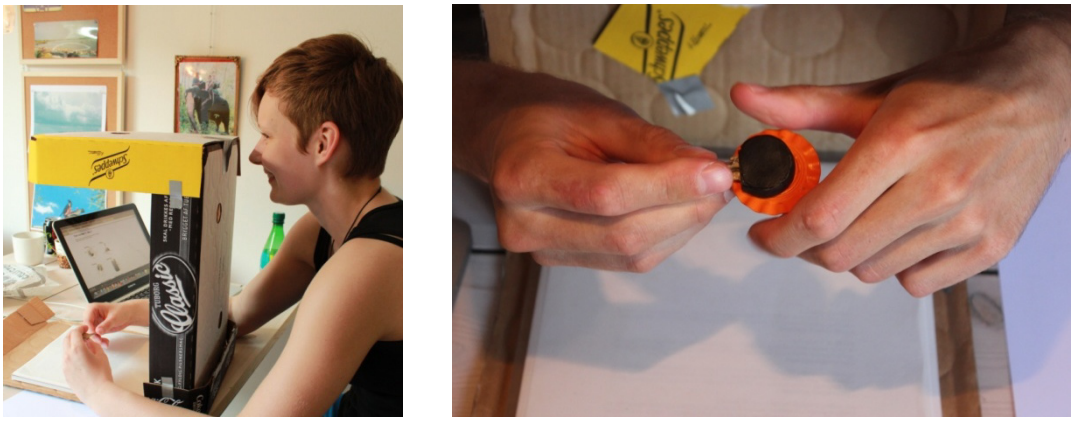

Figure 8: Testing the keys only by using the sense of touch

4. RESULTS FROM WORD ASSOCIATION AND EXPERIMENT

Data from the PrEmo tool was extracted and the average score was placed in a spider web revealing the degree to which the emotion is present (see figure 9). Word association through verbalisation by participants enrich interpretation of the results.

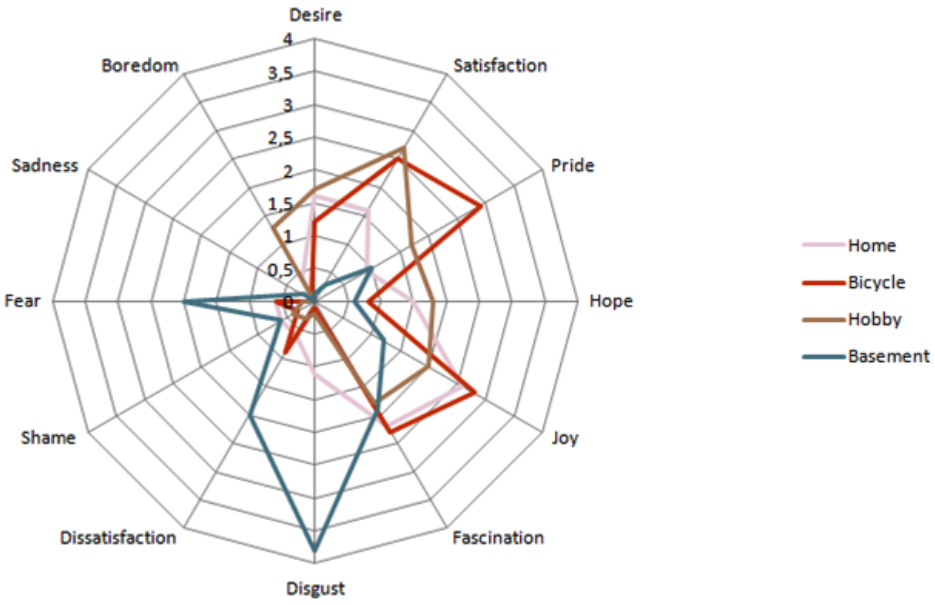

Figure 9: Reported emotions through the PrEmo tool

Home: Joy and fascination are the two emotions that the users first of all associate with the home key. It is seen that the home key overall relates to positive emotions which also are supported by the following quotes: *"It is nice that the material is soft", "It reminds me of a teddy bear, which I like",* and "*It makes me feel happy".* This correlates with the intended positive feeling of joy.

Bicycle: The bicycle key engenders most of all joy and pride, but also to some extent fascination and satisfaction. The tactility of this key is mostly related to positive emotions. The users articulated their impressions as follows: *"It seems to be functional", "Something you can walk around and play with in your pocket", and "The moving pattern is attractive".* Our intended emotion was freedom by combining joy and pride – and this was achieved.

Hobby: Satisfaction and joy are the most distinct emotions, along with a few more positive emotions. An interesting thing to notice is that some of the users found the key boring. *"Organically formed, it's nice to touch", "A little boring", "It is nice to hold in your hand"* where some of the words that were said in relation to this key. The 'inscribed' emotion was satisfaction which is one of the dominating emotions in the result.

Basement: Disgust is the emotion that gets the highest score and most unanimous indication. Fear and dissatisfaction are also highly present and is found to have the same presence as fascination. *"Ieww", "This is disgusting", "I don't really like this one" and "I am tempted to touch it again"* were some of the words that were mentioned in relation to the basement key. The aim to design for disgust has been reached.

5. DISCUSSION AND CONCLUSIONS

In this paper we have introduced a design approach to develop objects that communicate emotions through haptic design. The tactility of the applied materials in the prototypes served as a communication channel and evoked intended emotions. In the experiment, the 'targeted' emotions were articulated and verified through the use of PrEmo tool.

When communicating emotions through haptic design, manual explorations of the object are of most importance. During exploration, a communication platform emerges as the user gets familiar with the object's texture, shape and function. Combinations of these different elements arouse emotions depending of the user's relation to the elements.

Emotions are subjective and associated with previous experiences. We found that when using their sense of touch, participants' previous positive or negative memories or experiences seemed to be projected onto the objects. Participants mentioned often that the surface they touched seemed familiar, and by trying to determine the origin of the material relating to prior experience.

Results reveal that there was a mapping between the participants' inference and the designer's intent and we conclude that we were successful in communicating intended emotions through haptically enhanced design objects, also when aiming at two emotions instead of only one. The specific emotions designed for were not the only emotion present, however, the chosen ones ranked highest in the results. This demonstrates that products oven evoke a mix of emotions and that it is, however, possible to amplify the direction of desired emotions through design.

Methodologically, we observed the tendency that participants were being modest when grading the first key. It could therefore be considered to implement a test round. Also, the order of the keys had an influence on the way each key was experienced. The key (hobby) that followed the bicycle key was mentioned as *boring* since it had no significant function compared to the previous ones. The results reflect that the key (hobby) that you cannot manipulate (for example through compression, rotation, or deformation) scores higher on the scale for boredom. In further studies, a 'regular' key could be implemented as a reference product.

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