

**Aesthetics of tactual experience**  
**About the body language of objects**

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# Aesthetics of tactual experience

About the body language of objects

Proefschrift

ter verkrijging van de graad van doctor

aan de Technische Universiteit Delft,

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# Chapter 1

## Introduction

### 1.1 Living in a man-made world

From the moment people are born, they are surrounded, supported and touched by man-made objects (Figure 1.1) and throughout their life they keep in close contact with this man-made world. Unless people are operating naked in some kind of natural environment, their bodies are enveloped in, supported by, bumping into, carrying, exploring, playing with, using and manipulating objects designed and manufactured by man. Moreover, it is impossible not to feel this contact: one can close the eyes, use an ear plug, pinch the nose, but it is impossible not to feel touched unless heavy anaesthetics are used.



Figure 1.1  
First tactual experiences with man-made objects: instruments, diapers, pacifiers, and floors.

A child's first tactual experiences with objects are mostly about *being* touched, such as the latex gloves of the midwife, the towels she cleans the baby with, and the textiles of the clothes that separate the baby's skin from its mother. Once children grow old enough to reach out and touch what surrounds them, their tactual experiences become *active*. They hold, squeeze, and swing whatever comes into reach. Their world becomes an exciting environment, in which they learn to develop themselves and their physical skills through manipulating balls,

dolls, grandpa's spectacles, bicycles, skates, and in which they learn how to avoid unpleasant encounters such as with the sharp edges of the table while running around. When tired of exploring and playing, a cuddly toy may wait for them to keep them company. And although children are aware that *they* are the active part in kicking the ball and riding the bicycle, it is not always clear whether they are cuddling the toy or whether the toy is cuddling them: touching becomes *interactive*.

This unavoidable reciprocity is characteristic for the senses of touch. Seeing does not imply being seen, neither does hearing imply being heard. But unlike the other senses, touching implies being touched simultaneously. Touching and being touched are integrated into one phenomenon, the tactual experience.

Because of this physical omnipresence of intimate contact, man-made objects may be considered to have a major impact on people's physical well-being, more specifically on the (un)pleasantness of people's physical experience of their product milieu (Margolin, 1997), experienced through their tactual senses.

As a researcher in human factors, these aesthetic aspects of the tactual experience in human-product interaction fascinated me. How do we experience our world through touch? How does this touching and being touched affect us? Moreover, as my research in human factors was embedded in the practice of product design, I wondered if and how designers include this world of touch into their projects. Are they aware of how their designs touch people? And if I wanted to include these aesthetic aspects of tactual experiences in human-product interaction in my research, would I know how to do it? Looking at the curriculum of different Product Design Education programmes and at the research methods in human factors, both questions could be answered fairly quickly at the start of my research on the topic: tactual experience was almost a blind spot in product design education and research.

Because touching and being touched seems important and ever present, the lack of attention for tactual experience in human-product interaction in product design education suggests that our tactual experiences of the surrounding world may not be as rich and pleasant as they could be. Comparing children playing in a down town city playground with children playing in the woods, one might indeed conclude that the tactual experiences of the latter are more diverse, less predictable, making the man-made version of a playful environment seem less challenging and pleasant than a natural one. In addition, this man-made world in itself seems to evolve into a digital, virtual world in which the direct and embodied physical human-product interaction evolves into a remote interac-

tion based on a joystick or button based control. Comparing children playing a skate game on their Sony Playstation with children skating on the street (Figure 1.2), makes evident that the virtual version lacks the challenges and thrills from a tactual point of view, although the visual effects of the virtual version may be thrilling. The tactual experiences of virtually skating, constructing or shooting are reduced to the same physical experience of pushing a button.

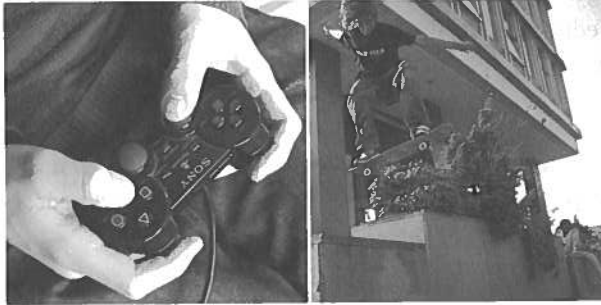


Figure 1.2  
The tactual experience of skating on a Sony Playstation versus skating on a skateboard.

This reduction of human-product interaction to button-based control leads to situations where toddlers do not feel (nor see!) the difference between a calculator, a mobile phone, or a remote control. As a result, they will try to call grandma with either one of these devices. The skill of 'pushing a button' becomes a universal physical skill to control the environment and the objects within, often even in remote control. This remoteness emphasizes the lack of true physical contact with what is actually happening in such interactions.

Because of this neglect of our senses of touch, the art critic Arnheim (1990) suggests in his essay on tactual art for the blind that we live in a sensory crippled society. He pleads for tactual art not only to gratify the aesthetic needs of the blind, but as a means to re-educate the entire population. This approach could be extrapolated from the domain of art to the domain of product design: to create opportunities for society to increase aesthetic sensitivity for tactual experiences, the domain of product design could be taken as a starting point (Frens, 2006; Rozendaal, Keyson, & De Ridder, 2006; Wensveen, 2005).

How did product designers proceed until now? Can we learn from the design projects of products that were tactually successful? Two students from the course Design Research at our faculty interviewed several product designers in the working field involved in the development of such products, like soft touch packaging or musical instruments, and asked about their methods and their know-how on the tactual aspects (Kuiper & Scheepens, 2000). The results were

both fascinating and disappointing: fascinating because the designers showed sensitive skills derived from long-term experience, and disappointing because they did not seem to be able to talk about it: *'I just do it, by trial and error, and from experience'*. Apparently, tactual skills in product design seem to be stored in memory in the form of tacit knowledge, thus serving the individual designer, but inaccessible to be shared with others, a prerequisite in design education. One of the challenges of this thesis is to make this tacit knowledge explicit, to be able to use it in education for the development of a designer's tactual sensitivity and design skills.

The starting point for this research on tactual experience is that designers and design researchers need *insight* in the tactual experience to design objects that meet the needs and dreams we have in that domain, and to design the objects we have not even dreamed of yet.

The goal of the research presented in this thesis is to explore the aesthetic aspects of tactual experience in human-product interaction and to contribute to the insight in this phenomenon through the construction of a conceptual framework describing it.

This introductory chapter sets the stage for this exploratory research. It provides an overview on the need for touch, that serves as a background to interpret the meaning of tactual experience throughout the different studies. Next, the chapter describes the concept of human experience the present research is based on and, more specifically, it outlines the concept of aesthetic aspects of human experience. Finally, different perspectives on aesthetic tactual experience are discussed on their relevance for the present research, resulting in preliminary insights that may serve as possible leads to construct the conceptual framework. The chapter concludes with a description of the research approach and an overview of this thesis.

## 1.2 The need for touch and being touched

The phenomenon of human beings touching the world and being touched by it inspired researchers in different fields to reflect on the meaning of tactual experience. In the context of the research set out for this thesis, a short overview of some meanings of touch and being touched shows that people actually *need* touch for specific reasons, a need that cannot be met by the other senses. From these reflections, four themes are considered relevant for the context of human-product interaction:

- touch as a foundation for awareness of oneself
- touch as a foundation for knowledge of the material world
- touch as a foundation for the development of feelings and emotions
- touch as a specific communication channel

The present research is about *touching* man-made objects. But the encounter with the material world is multisensory, and it is sensible to assume that the experience of this encounter should be researched as such (MacDonald, 2002). Nevertheless, the starting point for the present research is that the world of touch is a world of experience *in its own right*, worthwhile exploring and knowing. However, the tactual experience will not be researched as a world of experience *detached* and isolated from the other senses, but in the context of its multisensory character.

### 1.2.1 Touch: physical encounters and awareness of oneself

Physical interaction with the world is not limited to the hands, it involves the whole body. Physical engagement with the world, the awareness of touching and being touched, makes people aware of being a physical body themselves, sharing the physical world with other physical objects. It is within this embodied encounter that the 'I' experiences itself and its surrounding world simultaneously, making this encounter the basis for self-awareness (see Bermudez, Marcel et al. (1995) for an overview). According to Merleau-Ponty, this self-awareness is pre-reflexive, and as such the basis for a reflective awareness of the self and the outside world. In other words, the body in physical interaction is the basis for the pre-reflective 'I', that subsequently may reflect on that 'I' (Bakker, 1975).

Although people can *see* their body, they need to *sense* their body to be aware of themselves. Touch allows one to sense his body, to sense the borders between the self and the outside world, and the interaction between the two. The neurologist Oliver Sacks emphasized this aspect of physical experience of the body as the foundation for self-awareness in his descriptions of patients with disturbed self-perceptions. For example, a patient who did not experience his leg as part of himself anymore tried to throw the alien leg out of the bed (Sacks, 1984; 1987). Such situations of disturbed tactual sensations may also occur in non-pathological cases such as waking up with a numb arm or having an anaesthetized cheek at the dentist. When touching these body parts, they feel alien, as 'not part of me'; they are experienced as 'dead' matter. These findings could be summarized in the statement 'you are what you feel' (Bergsma, 1987). A world in which touch is poorly addressed is likely to weaken the feeling of being in contact with the



world, which may lead to a disappearing feeling of self-awareness.

Paradoxically, touch may also blur the boundary between the experienced self and the world. The rubber hand illusion provides a striking example: when one is watching a rubber hand being stroked, while one's own unseen hand is synchronously stroked, one may attribute the rubber hand to one's own body and 'feel like it's my hand' (Tsakiris & Haggard, 2005). Another phenomenon that blurs the experience of the border between the self and the outside world is caused by people's capacity to feel *through* objects, by incorporating these objects (Polanyi, 1967). For example, a blind person feels the world at the end of his white stick, and a carpenter feels the wood through his saw. Therefore, the American philosopher Dewey stated in his attempt to postulate a philosophy of experience that:

The epidermis is only in the most superficial way an indication of where an organism ends and its environment begins. There are things inside the body that are foreign to it, and there are things outside of it that belong to it *de jure*, if not *de facto*; that must, that is, be taken possession of if life is to continue. On the lower scale, air and food materials are such things; on the higher, tools, whether the pen of the writer or the anvil of the blacksmith, utensils and furnishings, property, friends and institutions – all the supports and sustenances without which a civilized life cannot be (Dewey, 1934).

Touch makes people aware of the self and the outside world, through experiencing the borders between these two. Simultaneously it questions these borders and thus the limits of one's own physicality, because they are not experienced as fixed. The man-made product milieu may contribute to people's self-awareness and allow people to play with the experienced borders between the self and the outside world.

### 1.2.2 Touch: a foundation for knowledge of the material world

In his philosophy on education, Dewey states that the material world people live in *and through* forms the basis of learning and personal growth, because it forms the basis for their 'experiential world'. According to Dewey, one only learns and grows through and from experience, in physical interaction with a material world (Dewey, 1938). Physical interaction puts the body, and thereby the tactual senses, back into experience as the foundation of knowledge. Moreover, the development of knowledge is grounded in a specific kind of physical interaction: exploratory behaviour, characteristic for young children who deliberately reach out and touch to understand (Gibson, 1988).

The phenomenologist Merleau-Ponty elaborated on the insight in the relation between the living body and people's understanding of the material world (Bakker, 1975). According to his insights, a body is not a physical object one owns. It is one's communication with the world, one's relation with it. It is through people's materiality that they experience and learn about the materiality of the world and, simultaneously, about their own materiality. To emphasize this shared material world, the materiality of the world was referred to by Merleau-Ponty as 'la chair du monde' (the world's flesh) (Tiemersma, 1988).

People can see the shapes and colours of the physical world, hear the events that take place, smell it, but it is only through touch that people learn about its materiality. The sight and sound of a frog for example, give some clues for suppositions about its tactual properties, but it is only through touch that one learns about its physicality: its weight, temperature, wetness, the texture and elasticity of its skin, its force and movements, and so on. The experience of touching a frog (and being touched by it) embodies what learning through touch is about. From this point of view, people actually *need* touch to get to know and understand the world. And likewise, people *need* touch to know and understand the man-made objects they are manipulating within this world to *grasp* their meaning (Lakoff & Johnson, 1999).



Figure 1.3  
Doubting Thomas by Carravaggio.

When Jesus resurrected and met his disciples again, they couldn't believe their eyes: this man could not be their master. To persuade them, Jesus showed the wounds on his hands, feet, and the deep cut in his side, but Thomas still doubted his identity. It was only after Christ allowed him to actually feel the wounds, by sticking his finger into it, that he believed his master had resurrected. For Thomas, it was not the proverbial *seeing* but *touching* that made him believe. This may be exemplary for our own attitude towards touch.

This knowing through bodily experiencing is different from the knowledge gained through thinking as deduction from theory. It is the kind of knowledge referred to as 'from experience'; it is not yet made explicit, moreover, it is often hard to *make* this knowledge explicit. That is why Merleau-Ponty refers to it as the 'knowing before knowing' (Bakker, 1975). See also Figure 1.3 on Touching is believing.

To conclude, the product milieu contributes to people's knowledge about their material world and their own materiality, and about how to physically interact with that world. A product milieu that offers poor tactual experiences may engender poor knowledge about the materiality of that world.

### 1.2.3 Touch: a foundation for feelings and emotions

Touching is being in physical contact and, as such, the basis for the *feeling* of being in contact. Within this contact, touch is a strong basis for the development of feelings of affection and intimacy (Fields, 2003; Montagu, 1971).

Touch is primordial for physical and mental development. Several experiments with rats showed that touch-deprivation leads to growth retardation and withering (Montagu, 1971). This is confirmed for people by the observation of children who grew up in Romanian orphanages, where touch was infrequent due to understaffed situations (Fields, 2003). This need for touch seems so primordial, that monkey infants deprived from their mother prefer a terry-cloth surrogate mother without milk to hang on to, over a wired surrogate mother with milk (Fields, 2003).

It is through touch that one needs to experience that one is safe and cared for. Touch during the first phases of life has to be loving and protecting to develop into healthy, empathic human beings. Consistent careless or harsh touch cuts infants off from their capacity to develop their affective life: the monkey experiment showed that the infants that were confronted with a wired surrogate mother did not develop normal grooming behaviour. (Fields, 2003).

The need for loving touch remains throughout people's lives. It is so primordial that it is referred to as touch *hunger*: one can be hungry for touching and being touched (Fields, 2003), and, like for the need for food, one can wither when this hunger it is not satisfied.

These insights on affective and emotional aspects of touch are based on studies on people touching people, and not on studies on human-product interactions. However, these insights suggest that in physical interaction, people's affective and emotional development and well being may be affected by the way they are touched by objects as well. At least, the experiment with the monkey infants showed that being touched by a non-living surrogate cloth mother contributed to the infant's well-being. This suggests that the way objects touch people may play a role in their emotional development and in their emotional well-being as adults. Transitional objects such as Linus's blanket (Figure 1.4), described by Winnicott (1964) as objects that allow the child to feel safe in a world where the mother is temporarily absent, are illustrations of this affective meaning of touch embodied by objects. Cuddly walls, developed for demented elderly to achieve this emotional well-being through touching objects, provide us with another example of the affective meaning of touching objects.



Figure 1.4

The touch of transitional objects like Linus' blanket offer a child the feeling of being safe when the mother is temporarily absent. © www.buno.nl Syndicated by Bruno Productions BV.

#### 1.2.4 Touch: a communication channel for affection

Touch implies *contact* and thus bodily involvement, whereas seeing and hearing are distant senses, and thus are more apt to create distance and 'objectification' in social contact. In social studies, touch is therefore often considered as our most *social* sense (Fields, 2003). In touch, communication is indeed embodied, and our tactile interactions convey a tangible message of interconnectedness, of not being alone (Finnegan, 2002). Interpersonal touch tells us whether we are safe, cared for and have value (Fields, 2003; Finnegan, 2002).

Fagan (1998) even suggested that touch is the first *language* we learn to commu-

nicate interpersonal affection. According to Fagan, there are different kinds of touch, ranging from the public and formalized to the intensely personal: ritual touch, athletic touch, punishing touch, nurturing touch, intimacy-evoking touch and sexual touch. These categories are not mutually exclusive, many meanings and needs can be hidden under the obvious ones. To be able to function properly in social contacts, one has to be able to understand (and express) the language of touch properly.

Thayer (1982) classified different *types* of touching, thereby establishing a taxonomy of touch: a functional-professional type (the doctor touching his patient for examination), social-polite type (the handshake), the friendship-warmth type, the love-intimacy type and the sexual type. The taxonomy is based on and illustrated by the *relationships* people have. Thayer observed that this sequence of categories can be characterized by an increasing intimacy: more body parts becoming accessible, longer and more frequent instances of touching, and an increasing variety of the types of touch involved.

These social aspects of interpersonal touch may be significant for the meaning of touch in human-product interaction. In relationships with products, touch may also be regarded as a communication channel, involving different affective styles, expressing different kinds of affective relationships, ranging from the functional-professional to the more intimate relationships.

### 1.2.5 Conclusions for tactual experience in human-product interaction

Touch confronts us with the materiality of the world and of ourselves. Thereby it allows us to experience the world as real and to say 'I exist' (Damasio, 1999). Within this experience of 'being', physical interaction forms the basis for people's understanding and for people's affective life. In either way, in exploratory or in affective behaviour, the living body is simultaneously expressing itself and understanding what is being expressed. Therefore, touch may be considered as a language, with a specific vocabulary and a specific grammar (Classen, 2005) and it is essential for people to 'speak' that language.

Although the previous thoughts on the need for touch and on its meaning are related to interpersonal touch, they offer insights in possible interpretations of tactual experience in human-product interaction. If touch can be considered as a language between people and products, the present search will be about *what* is being expressed, about its vocabulary and its grammar.

### 1.3 Experience in human-product interaction

Human experience has increasingly become the focus of design researchers, because the focus of design itself shifted from designing objects to designing for the user (Margolin, 1997; Redstrom, 2006). The more definitely and sincerely it is held that design is a development *driven by*, and *for* experience, the more important it is to have a clear view on the concept of human experience.

Several design researchers took up the enterprise to describe human experience itself and to make the concept operational in the design practice (Demir, Desmet, & Hekkert, 2006; Forlizzi & Ford, 2000; Hassenzahl & Tractinsky, 2006). There is no consensus on the definition of experience. Rather than defining the concept, design researchers presented their approaches of human experience as proposals, agendas, and as starting points to work with. Nevertheless, it seems that the different approaches can be described along two main perspectives. On the one hand, experience in human product interaction is defined as ‘the affective response of a person interacting with a product (for example (Demir et al., 2006)) thus as a *specific aspect* of the interaction. On the other hand, often based on the insights of Dewey, experience is defined as a person’s awareness of the interaction as a whole (for example (Forlizzi & Ford, 2000)).

Both approaches are valuable in their own right, because they fit the context they were developed for and prove to be valuable for that particular context. Considering the different approaches led to the insight that the value of a definition of human experience does not lie in its truth but in its consistency and soundness to build future research on, given their particular research context.

The concept of experience as the awareness of interaction seems most appropriate for the context of the present exploratory research, because it allows to consider the interaction in its wholeness, without a preliminary limitation to one of its aspects. The model developed in this thesis is based on Dewey’s observation that human experience emerges from the *interaction* of human beings with their environment (Dewey, 1934). Therefore, to understand human experience, I start out with the description of humans and products, followed by the description of the process of the interaction between the two. Finally, experience in human-product-interaction is described.

#### 1.3.1 Human and product as equivalent elements in interaction

Touch, involving bodily interaction with a material world, is about *physical encounters*. From this perspective, human and product can be considered as

equivalent physical entities, interacting with each other in a material world. Although both may be very different in nature and contribute in their specific way, the contribution of both to the interaction is grounded in and expressed by their materiality (or physicality). Considering human and products as equivalent material entities in interaction, allows us to consider their characteristics along a common structure (Figure 1.5).

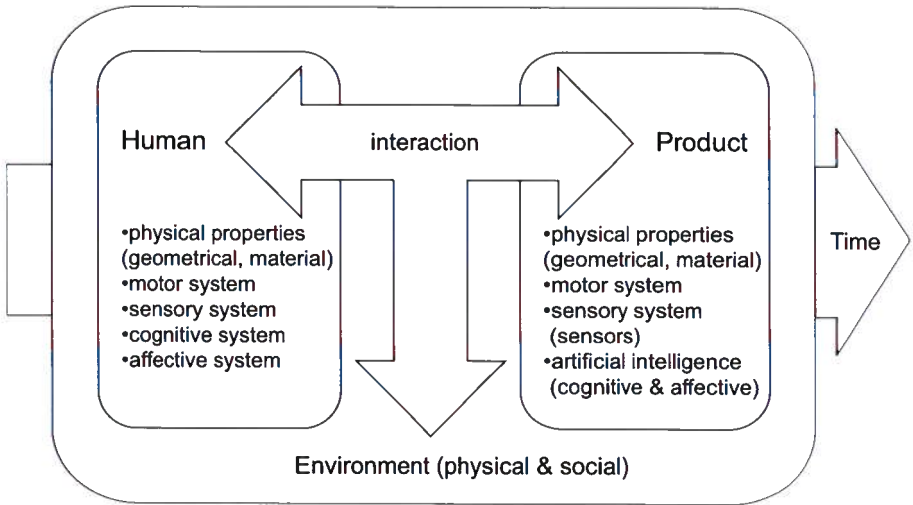


Fig. 1.5  
The model of human-product interaction used in this thesis. The basis of the model is that human and product are considered as two material entities in interaction, both can be described along the same structure of systems.

These different aspects of human-product interaction can be described as follows:

**Physical properties:** People and products both have specific geometrical properties, such as shapes, volumes, sizes, and material properties such as hardness, flexibility, and temperature. Although the research fields studying these properties differ for people and for products, the properties are measured using the same physical units, such as: geometrical measures in mm, mass in g, and material properties in strength, elasticity, temperature (coefficient), frictional resistance, etc. Human physical properties are studied in fields such as anthropometrics, biomechanics, and physiology. The physical properties of a product belong to the domain of physics, engineering, material sciences, chemistry and the like.

**Motor system:** People and products can be characterized by their motor systems and dynamic capacities. Human motor systems are studied in biomechanics and kinaesthetics, studying phenomena such as human movement, effort, and force exertion. The dynamics of products is studied in mechanical engineering. Obviously, not all products have a motor system or moving parts, as for example a simple coffee cup or a hair comb. But the history of product development shows that products become more and more complex, the first step in this development being mechanization. For example, drilling machines replaced the hand drill, and washing machines made hand washing an exception. Simple products without a motor system can be characterized as such in the context of this model: they are inert.

**Sensory system:** People and products both can have sensory systems that detect events in the interaction and in the environment. These systems can be directed towards the outside world (seeing, hearing, smelling), or the inside world (body temperature, body position, exerted forces, etc). The human sensory systems are studied in neuro-physiology and psychophysics. The domain of product sensors is researched and developed in electrical engineering. Products usually do not dispose of sensory systems, and a product that does not have sensors can be characterized as such: it does not register information. But products tend to become more and more sophisticated; mechanization is followed by automation, which relies on proper information input from the environment and from the product itself (temperature, orientation, position, etc). For example, the washing machine 'measures' the weight and dirt of the laundry it has to clean, 'measures' the temperature of the water, and the soaking time. Similar to people, the sensory systems of products tend to become multi-sensory: sensing light, pressure, sound, movement, position and so on.

**Cognitive system:** people and products both can dispose of cognitive systems that allow them to understand and interpret what is going on, to remember, to make decisions, and so on. Human cognitive capacities are studied in the cognitive sciences. In a product, this capacity is referred to as artificial intelligence, and it is studied in the domain of information technology and in computer science. Again, most products do not dispose of artificial intelligence, and products that are not equipped with such intelligence can be described as such: they do not process information. But again, more and more products start to think (Gershensfeld, 1999), and artificial intelligence will become part of our daily life, as embedded systems seem to become our future.

**Affective system:** People have an affective system that allows them to have emotions, to experience feelings and moods, to recognize and empathically under-



stand these affective phenomena in other people, and to assess what is good or bad for them (Cacioppo & Berntston, 1999). Human affective systems are studied in (neuro)psychology. Usually, we do not tend to consider products as having an affective system. However, the concept of empathic products with affective intelligence is emerging in the domain of computer science (Norman):. A first step in this direction is the development of products that are able to understand the affective and emotional state of the people they are interacting with. For example, a computer that tries to cheer one up when one is feeling down, or that avoids any kind of bad joke when one is stressed for a deadline.

**The environment of human-product interaction:** The interaction between people and products is always situated in a specific environment that can be described along physical properties (such as temperature, light, atmospheric humidity, and so on) and social properties (such as cultural values and social meaning). This environment will influence the physical encounter between human and product. For example, riding a bicycle when the sun is shining is different from when it is raining, and riding on asphalt differs from riding off the road in a forest. From a social perspective, riding a bicycle one is proud of is different from riding a bicycle one feels ashamed of. It is generally acknowledged that an interaction between people and products should be studied *given* the context, as its contribution to the interaction is evident.

**Time:** the interaction between people, products and their environment is a *process* embedded in, and developing over time. Although one may tend to consider interaction as a momentary event, here and now, 'time' is an important factor in the study and analysis of the interaction. Topics related to this time aspect are, for example, the first encounter, the frequency of interaction, and the evolvement of the interaction in time: its rhythm, repetitions, time intervals, and so on.

**Effect of the interaction:** The different aspects of people, products and their context of interaction are not static. Through the interaction between people, products and the physical context, all three may be altered. These changes may be physiological, physical, sensorial, cognitive and affective and thus affect the different systems described above.

This general model of human-product-interaction applies to all kinds of products, from simple products such as coffee mugs to complex systems such as medical devices. Complex electronic products with elaborate user interfaces can be described extensively on all aspects included in the model. Simple products without a motor system, sensors or embedded intelligence may only be characterized by their physical properties. However, in a world where products tend

to become more and more sophisticated, these simple products will probably be characterized more and more as lacking the capacity to move, to sense, to think and to feel, because people will get accustomed to consider products in the framework of the postulated complexity.

### 1.3.2 The process of human product interaction

The interaction between humans and the products in their environment can be described using the model of human-product interaction developed at Delft University of Technology (Dirken, 1997) as a starting point. In this model (Figure 1.6), interaction is considered as an exchange of input and output between human and product, in a specific environment. This continuous transformation of input into output defines the process of interaction.

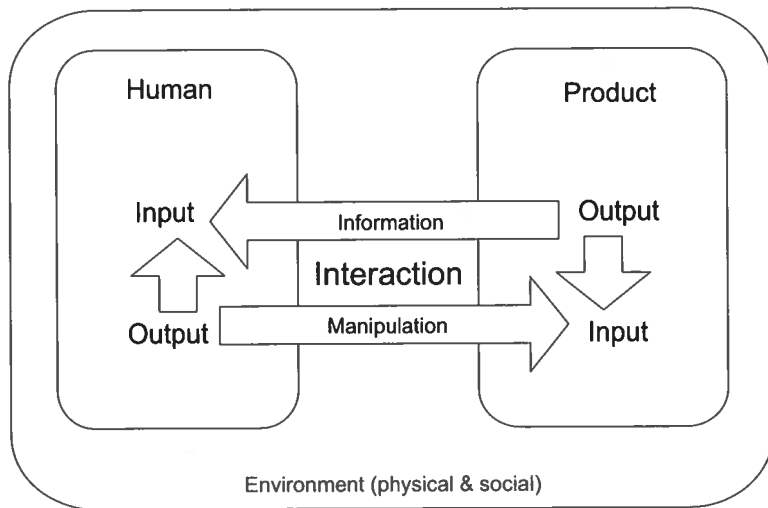


Figure 1.6  
A basic model of the input-output processes in Human-Product-Interaction (Dirken, 1997).

For our purpose, the interaction between people and products can be described by the way they both move (physically act, react), sense, think, and feel (Figure 1.7). The interaction is an *integrated process*, within which these different processes occur. Although it is possible to *distinguish* between moving, sensing, thinking, and feeling, these aspects should not be considered separately but in the context of each other.

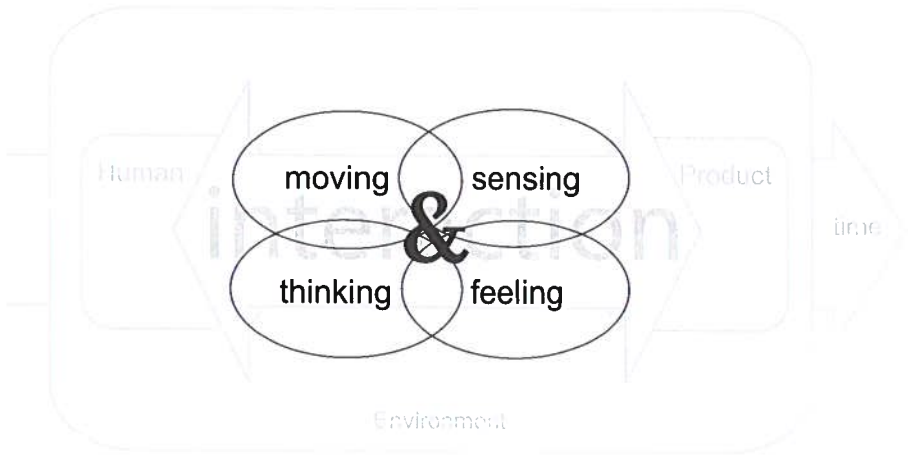


Figure 1.7  
The interaction in human-product interaction is considered as a process constituted of moving, sensing, thinking and feeling simultaneously.

From the perspective of a person in interaction with objects and the environment, these aspects can be described as follows, using the example of riding a bicycle:

**Moving** concerns the physical actions in interaction, such as: manipulating, squeezing, throwing, carrying, pushing, pulling, and so on. ‘Moving’ concerns the whole body in static posture and dynamic movements, and not just the moving body parts themselves. In case of riding a bicycle, an example of a dynamic movement is the movement of the cycling legs, whereas holding the handles is an example of a static posture.

**Sensing** concerns the bodily sensations one experiences in interaction. For the senses of touch, it is about sensations such as itch, pain, vibration, pressure and sensing ones own body moving. In the case of riding a bicycle, the bodily sensations concern the pressure on the bottom, the feet and the hands, the vibrations in the different body parts when riding over a wobbly road, the temperature changes in the skin due to sunshine and contact with handles, the forces exerted by the different muscles, and so on. Pain can be sensed when one rides over a large hole in the road. Characteristic of sensations in distinction with thoughts and feelings, is that sensations are sensed *locally*. One can always point at a part of the body where it hurts, where it itches, where the pressure or vibration is

sensed and so on. Sensations just 'exist', there is no need for knowledge about pain or itch to experience it.

**Thinking** concerns the cognitive processes involved in interaction, such as perceiving, remembering, making decisions, and so on. From the perspective of a study on the senses, perception is an important aspect of cognitive processing. In this case, perception is defined as attributing meaning to what is sensed, restricted to the physical aspects of the perceived. For example in riding a bicycle, the sensations of vibration in the hand can be perceived as 'I'm riding on a bumpy road'. Other perceptions may be: the shape of an object, its texture, its weight, on so on. Perceptions are not local as bodily sensations are, they concern thoughts about the object that is touched. For example, when grasping the handles of the bicycle, one can perceive them as being large, sticky or torn. The physical properties of an object and the subsequent perceptions should not be confounded. For example, the measure in cm of a handle allow for people to *perceive* it as 'large'. And the distribution of irregularities on a surface that can be described geometrically, allow for people to experience the surface as 'rough'.

**Feeling** concerns the affective and emotional reactions in interaction, such as feeling loved, happy, free, bored, and so on. Feelings are not always expressed as one's own feeling about something. In the case of riding a bicycle, one may express the feeling of excitement as 'I am excited!' or as 'what an exciting bike!'. In both cases, it concerns the affective response of the person to cycling with the bike. In the first case, the exclamation can be considered as a description of the experienced feeling of the person, in the second case as an experienced characteristic of the bicycle.

From the point of view of the product, the same processes can be considered: in interaction an object moves (because it is being moved or because it has self-propelling mechanisms), it can sense if it is equipped with sensors, and it may 'think' and 'feel' if it is using its artificial intelligence. In the case of the bicycle, the darkness detecting (sensing) rear light *reacts* to the darkness when it switches itself on, and the cycle-computer *translates* the way its sensors are touched into mean speed, distance, and so on. A bicycle equipped with emotional intelligence might perceive that its user is getting tired, and provide some pep-talk to help the user to reach his goal. A more physically oriented bicycle might decide to increase the moral by temporarily providing some back support.

### 1.3.3 Experience in human-product interaction

The interaction between human and products, in all its physical, physiological, psychological and social-cultural aspects can be considered as *what is going on, what is happening* (Dewey, 1934). When interacting with the world, human beings can be aware of what is going on. They can be aware of how they are moving, of what they are sensing, thinking and feeling. This being aware is a key issue in Dewey’s approach to experience emerging from interaction. Although different levels of awareness may be distinguished, leading to different kinds of experiences, Dewey’s overall concept of experiencing is defined by being aware of what is happening.

Likewise, in the context of this thesis, experience in human-product interaction is considered as being aware of interacting with an object, more specifically as being aware of moving, sensing, feeling and thinking (Figure 1.8). In this sense, our approach of experience is a phenomenological approach, studying the content and the structure of experience as what one is aware of from the first-person point of view (Van Manen, 1990).

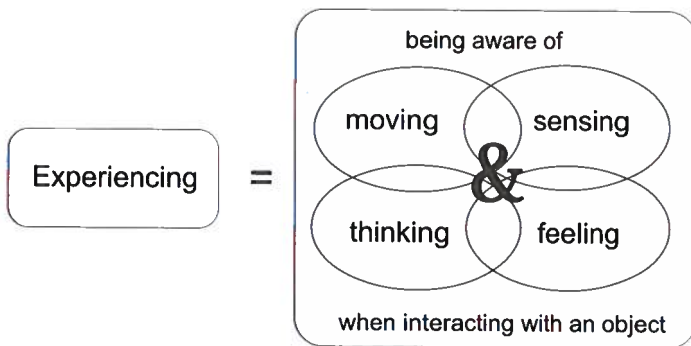


Figure 1.8 Model of human experience used in this thesis. The model is based on the processes involved in human-product interaction.

In interaction, one is not necessarily aware of *all* these aspects. One is capable of driving a car without being aware of the movements made: they are executed automatically. But one can be *made* aware by directing one’s attention towards that specific aspect. Likewise one may not be aware of the feelings one has, until somebody actually asks how one feels. To illustrate this approach, awareness can be characterized by a spotlight illuminating different aspects of the model of human experience elaborated in this thesis. Figure 1.9 and 1.10 characterize differ-

ent interactions using the spotlight to show what aspects one can be considered aware of in experience.

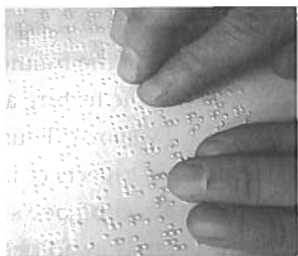
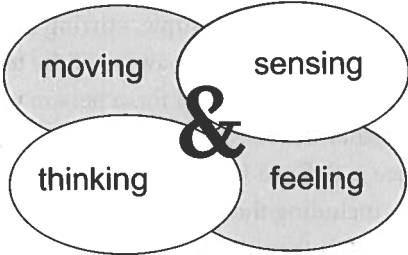


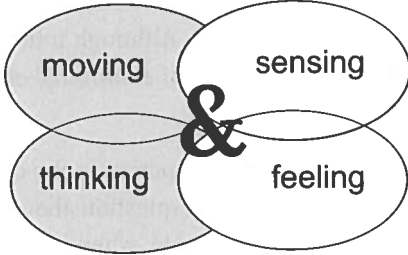
Figure 1.9  
Reading Braille.



Reading Braille (Figure 1.9) is an example of tactual interaction with an emphasis on tactual sensations and cognitive processes. The experience of reading Braille may have an affective aspect, for example, when a dirty and sticky paper elicits feelings of disgust, but without such exceptional circumstances, one will usually not be aware of such affective aspects when reading Braille. Moreover, such affective responses to the paper itself usually disturbs one's capacity to concentrate on the meaning of what is sensed.



Figure 1.10  
Kissing.



In a model characterising affective behaviour such as kissing (Figure 1.10) or caressing, sensing and feeling are placed in the foreground. Moreover, to think or to reflect while kissing or caressing usually disturbs the direct affective aspect of the experience.

These brief examples show that experience does not necessarily imply awareness for all four aspects of interaction. Moreover, some experiences may require that some processes are actually excluded from one's awareness. Awareness is closely related to attention. Awareness in interaction depends on *where* one is focussing one's attention on. For example, stirring a soup while watching television may prevent a person from being aware of the texture of the soup and of the moment it is boiling. But when asked for, a person will be able to describe the texture and report whether the soup is boiling or not (thereby missing the TV-show). Thus, experience is defined in this thesis as being aware of the different aspects of interaction, including those aspects one *can be made* aware of by directing one's attention towards them. Nevertheless, attention does not always imply awareness, because one can never become aware of *all* the sensory aspects one is attending to (Lamme, 2003).

To consider experience from this perspective defines which tactual interactions are part of the research field of the current thesis, and which interactions are not. For example, while reading this thesis, one is probably not aware of the shoes one is wearing, but now that they are mentioned, one is. Thus, the current thesis considers the interaction of wearing shoes as a tactual experience from the moment one is putting them on until one takes them off. This experience includes moments that one is not aware of the interaction, because one can be made aware of these. In contrast, *subliminal* physical interactions, for example the interaction between the body and an internal prosthesis such as a pace maker, are not considered in the context of this thesis. As people cannot be made aware of subliminal perception per definition, we do not regard this phenomenon part of the current research field. Although interesting and relevant for the practice of product design, the study of subliminal effects requires a different research approach.

Considering the aspects of experience one can be made aware of as part of the overall experience, poses the question about the role of these aspects within this overall experience. For example, when having a meal in a restaurant, one might be delighted by the food and not be aware of the fact that the chair one is sitting on is slightly uncomfortable. When asked for, one can be made aware of the fact that one is experiencing a slightly uncomfortable chair, which may affect the overall appreciation of the experience of having a meal in that restaurant. But what was the contribution of the discomfort of sitting on the chair to the experience *before* one was made aware of it? Although relevant, answering this question lies beyond the scope of this thesis, because addressing this question

requires a different approach than the exploratory research set out for in this thesis.

### 1.4 Aesthetic aspects of tactual experience in human-product interaction

Section 1.3 started with the description of a model to outline experience in human-product-interaction. The concept of its aesthetic aspects, its (un)pleasantness, is described within that same model, proposing awareness as a central issue. The outline presented in this section serves as a background to structure the analysis of the exploratory studies described in this thesis.

Tactual aesthetics in product design is not yet an established field of research with its own body of literature. But the different processes involved in human experience, moving, sensing, thinking and feeling, each offer a perspective on specific fields of research. These perspectives will be presented in this section, allowing for an overall conclusion on possible leads to explore aesthetic tactual experience as a whole.

#### 1.4.1 Aesthetics as the (un)pleasantness of experience.

The (un)pleasantness of experiencing is considered as the awareness of the (un)pleasantness of moving, sensing, thinking and feeling when interacting with an object in an environment (Figure.1.11). One is not always aware of the pleasantness of the experience, but when asked for, one can become aware of it and can account for it.

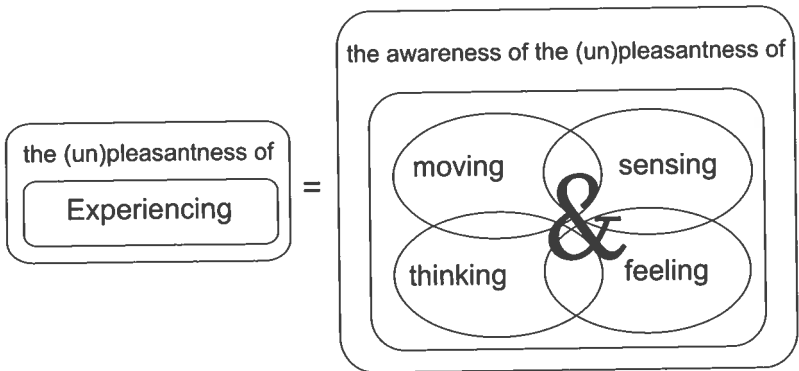


Figure 1.11 Model of aesthetic aspects of experience, in human-product interaction.



From the point of view taken in this thesis, *aesthetic* is understood as an *aspect* of the experience, that can be placed in the same row with other aspects that describe the experience, such as: its functional aspects, its economic aspects, its social aspects, and so on.

Thus, from this perspective an object does not have aesthetic quality in itself, but the experience of the interaction with that object has. An object is not aesthetic in itself, but we could say that an object has aesthetic *potential*, for it may give way to experiencing (un)pleasant interactions with it. This aesthetic potential of objects counterparts the aesthetic potential of the human body itself to have aesthetic experiences (Shusterman, 1999). This strengthens the thought that human and product are equivalent entities in interaction, that both contribute their potential to create an aesthetic experience.

#### 1.4.2 Describing aesthetic aspects of tactual experience

The aesthetic aspects of the different processes involved in human-product interaction has links with different fields of research (Figure 1.12). The next section describes how each specific research field contributes to the understanding of tactual experience, more particularly, to constructing an appropriate framework to describe it.

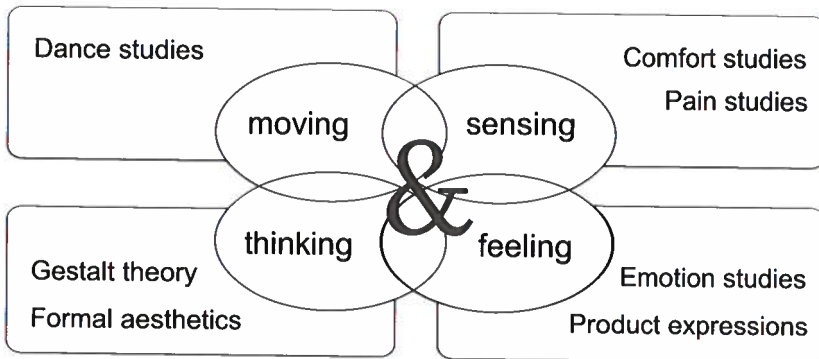


Figure 1.12  
Overview of research domains related to the aesthetic aspects of tactual experience.

##### 1.4.2.1 Aesthetic aspects of movements

Taking movement as the starting point to explore and describe the aesthetics of tactual experience leads to the art of dancing. When focusing on commonalities between aesthetics of dance and aesthetics of daily movements, what can we

learn from dance studies to structure and describe the concept of aesthetics of movements in daily life?

Rudolf Laban is fascinated by movement in the different domains of art, work, education and social life. To Laban, quality of life can be identified by the degree of sophistication of the movements involved (Hodgson, 2001). He observes that people move in order to satisfy a need, ranging from the very simple (e.g. to do something with a clear and practical purpose) to the highly complex (e.g. to dance to express the inexpressible). Therefore, to study movement the first basic question should be: *Why does one move, what are the motivations?* Thus, it is likely to assume that for the exploration of tactual aesthetics, dance studies show that it is relevant to understand why people move to understand how they experience their movements. In addition, these motivations should not be limited to the functional effects of movement, but include the possibilities of self-expression.

Next, Laban constructed a vocabulary to describe movement, identifying four basic motion elements: space and orientation, time, intensity and flow. Furthermore, the movements can be characterized by aspects such as tension, rhythm, balance, and harmony. This may offer a starting point for a vocabulary of aesthetics of movement in tactual experience.

Within the field of product design, human movement was taken up as a starting point for the design process by several designers (Hekkert, Moster, & Stomppf, 2000; Klooster, 2003; Moen, 2005). Their efforts show that movement, and in particular dance as the aesthetic aspect of movement, lead to a product design approach that can be characterized as a *choreography of interaction* (Klooster & Overbeeke, 2005). These studies made clear that the field of product design lacks the means to communicate about movement in human-product-interaction. Klooster explored several tools, such as schematic notations, photo sequences, video, and drawings, leading to the conclusion that communication about movement should preferably be dynamic (Klooster, 2003).

#### 1.4.2.2 Aesthetic aspects of sensations

Taking 'sensation' as a starting point to explore aesthetic experience leads to the notion of aesthetic experience in its purest sense: to provide sensory pleasure, to gratify the senses (Hekkert, 2006). Tactual aesthetics, from the perspective of gratifying the senses, leads to the notion of physical pleasure and of physical pain, thus to the study of comfort in human-product interaction. Although

comfort studies do not consider themselves explicitly as studies on aesthetic aspects of bodily experience, we can consider them as such, because they relate to the (un)pleasantness of the experience of physical sensations. Hence, comfort studies may shed a light on the aesthetic aspects of tactual experience in human-product interaction.

To be able to make the concept of comfort measurable, it was often described as the absence of discomfort. Discomfort, in turn, was measured by asking people about their locally experienced unpleasant sensations such as pain, itch, vibrations, muscle strain, and so on. But recently, researchers pointed out that the absence of discomfort does not imply comfort (Vink, 2005). To design for comfort, a definition is needed that approaches the concept from a positive perspective, postulating what it is, and not what it is not. One of these approaches is to identify the Wow-factor: the experience of ‘something more than one expected’, which would lead to the exclamation ‘wow!’ For example, this exclamation is often triggered by the properties of the mattresses made of Tempur, a viscous-elastic material that adapts to the human body in a sophisticated way (Figure 1.13), thus reducing the intensity of the pressure areas. This material property highly contributes to the experience of comfort when lying down, but the wow effect occurs especially on the moment one lies down and senses the process of this adaptation.

To conclude, studies on comfort and discomfort, thus on physical pleasure and physical pain, suggest that these two aspects should be studied as two distinct phenomena in tactual experience, because one can not be reduced to the absence of the other.

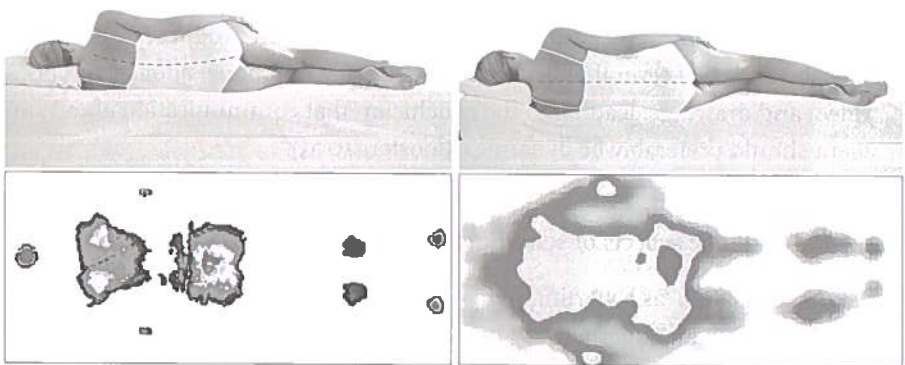


Figure 1.13  
Comfort of a mattress made of Tempur. The left pictures shows the intensity of pressure on the body on normal mattresses (dark spots indicate high pressure), the right picture shows the pressure distribution when lying on a Tempur mattress. © Tempur Benelux BV.

Melzack and Torgerson studied the dimensions on which pain can be described, resulting in three categories of words: sensory qualities (in terms of temporal, spatial, thermal, pressure and other properties), the affective qualities (in terms of tension, fear, and the like) and the overall evaluation of the pain experience (Melzack, 1975). Based on these insights, a lexicon with subcategories was established, and a questionnaire was developed to help people describe these different aspects, and to get a perspective on their experience of pain in the context of their daily life. The work of Melzack may offer a lead for a vocabulary on the aspects of pain in tactual aesthetics in human-product interaction,

#### 1.4.2.3 Aesthetic aspects of perception and cognition

To take the perception of the *properties* of the object as a starting point for the description of aesthetic experience leads to the domain of *formal* aesthetics: a perspective that considers aesthetic experience as grounded in the physical properties of the object, *independent* of its function and of its social meaning (Crozier, 1994; Hekkert, 1995). In formal aesthetics, an object *has* aesthetic qualities, regardless of the object being for example a hammer, a weapon or a kitchen utensil.

From this perspective, some aesthetic experiences *can* be 'objectified', in the sense that some objects *can* be considered as pleasant to touch, because of their objectively perceivable properties. A relevant question derived from formal aesthetics is the question about the universality of aesthetic experience. If some aesthetic experiences can be considered as grounded in the objective properties of the object, then to what extent are they experienced by *all* human beings as pleasant to interact with (Brown, 1991; Hekkert, 2006)?

In formal aesthetics, Gestalt theory offers valuable insights in possible universalities. According to Gestalt theory, visual beauty is to be found in the perception of the whole, in the *relation between* the properties of an object, rather than in its separate properties: 'the whole is more than the sum of its parts'. In other words, the beauty of the whole cannot be understood by the beauty of the separate properties (Kreitler & Kreitler, 1972; Norman, 2003). Examples of possible relations between properties of objects are: structure, complexity, balance, patterns, contrast and composition. Examples of Gestalt principles that describe relations that are pleasant to perceive are: regularity, symmetry, inclusiveness, unity, harmony, maximal simplicity and conciseness (Rompay, 2005).

The overview of aesthetics related to objectified perception is limited to the visual domain, because there does not seem to exist a related tactual counterpart as a

basis for tactual formal aesthetics. Nevertheless, conceiving of tactual aesthetics as being grounded in the tactual properties of an object leads to the question about the universalities of the aesthetics of tactual interaction and about good tactual gestalts. Do they exist?

#### 1.4.2.4 Aesthetic aspects of feelings and emotions

The aesthetic aspects of tactual experience from the perspective of feeling leads to the insight that this domain can be considered from two perspectives. On the one hand, affective aspects tend to be allocated to the experienced object. For example, we may experience a coffee machine as friendly, arrogant, or humble, thus attributing affective meaning to the object. This is related to the domain of the experienced *expression* of an object (Rompay, 2005) and its experienced *personality* (Govers, 2004). On the other hand, the affective response may be related to the *emotions* the product elicits with its user in the interaction (Desmet, 2002).

Rompay (2005) studied product expression from the perspective of embodied interaction, in which the expression can be comprehended on the basis of bodily schemata. For example, a vertical, upward directed form might be experienced as dominant, whereas a horizontal and more downwards oriented form may be experienced as servant. In her research on product personality, Govers (2004) proposed to use the vocabulary people use to describe personalities of human beings to research and describe product personality.

Although both insights were developed in the visual domain of human-product interaction, they seem to offer possible leads to understand tactual aesthetics as well: how are product expressions perceived in the tactual domain? Are they grounded in people's bodily schemata? Can they be described in terms of product personalities?

Desmet (2002) proposes a cognitive approach to understanding emotions elicited in human-product interaction, introducing the appraisal of specific concerns as the basis for the emergence of emotions. We may question whether the same appraisal model can be used to understand emotions elicited in the tactual domain, and if so, what concerns are typically involved in aesthetic tactual experience?

Expressions and emotions both belong to the affective domain, but cannot be considered as two sides of the same phenomenon (Fulton Suri, 2003): an object may express cheerfulness, but our emotional response might be irritation when cheerfulness does not seem the right attitude for that context. Likewise, an

object may be experienced as distant, but our emotional response may be positive because we do not want an intimate interaction with it. It is important to be aware of this double side of the affective domain, when structuring the conceptual framework of aesthetic aspects in tactual experience.

#### **1.4.2.5 Conclusions for the aesthetic aspects of tactual experience**

Taking the model of human-product-interaction to structure the overview of research about aesthetic aspects of tactual experience (fig 1.13) leads to preliminary insights into the phenomenon and in possible ways to understand and describe the phenomenon. These different ways of describing the aesthetic aspects of tactual experience will serve as a soundboard and a source of inspiration when constructing the new conceptual framework on aesthetic aspects of tactual experience.

#### **1.4.3 Aesthetic behaviour**

The previous section considered the aesthetic aspects of experience as the immediate experienced (un)pleasantness of the experience. In other words, aesthetic aspects of experience may be considered as the assessment of the pleasantness of an interaction, regardless of the purpose of the interaction. But there is more to aesthetics in experience than this immediate pleasantness as an *aspect* of experience. Aesthetic experience may be considered as a specific kind of interaction, deliberately sought for. This deliberately interacting for the pleasantness of the experience itself can be defined as aesthetic behaviour (Dewey, 1934) as opposed to a 'practical' behaviour, where one deliberately interacts with an object to achieve some kind of practical goal (Stolnitz, 1960). Therefore, exploring aesthetic tactual experience leads to the question about the characteristics of aesthetic behaviour in the tactual domain.

#### **1.4.4 Developing aesthetic sensitivity**

A final issue in setting the stage for the present research is the question about the development of a designer's aesthetic sensitivity in the tactual domain, defined in this thesis as one's awareness of the (un)pleasantness of the physical interaction with an object. The concept of aesthetic sensitivity is related to the concept of aesthetic intelligence, defined by MacDonald (2001) as one's capacity of perceiving and comprehending the aesthetic qualities of a product, as a basis for one's aesthetic response to that product. MacDonald suggests that we all

possess aesthetic intelligence, but that we use it subconsciously when interacting with the world. In this thesis the assumption is that designers need to become aware of this natural aesthetic intelligence to be able to design for the senses. Becoming aware of one's aesthetic intelligence is the scope of the development of aesthetic sensitivity.

In art and design education, several design researchers acknowledged the importance of the senses in aesthetic experience in human-product interaction, and therefore pleaded for the *education of the senses* (Caranfá, 2001; MacDonald, 2000; Overbeeke, 1999; Sorri, 1994). This addresses the question about *how* to develop and assess aesthetic sensitivity (Haanstra, 1994). In the field of visual aesthetics, theoreticians developed methods to *learn to look* at art (Visser, 1986) and to *learn to experience* art (Armstrong, 2000) Likewise, how can we develop research and educational tools that *learn to feel*; that support the designers' development of expert knowledge?

This brings us back to the thoughts of Dewey on experience in education. True personal growth can only be achieved *through* experiences (Dewey, 1938). Therefore, aesthetic intelligence and aesthetic sensitivity, that shape further behaviour and experiences, can only be acquired *through* aesthetic experience, in interaction with the physical world. This kind of knowing is referred to as *being experienced* (Margolin, 1997). For example, the activities shown in Figure 1.14 can only be learned *in doing*, thus becoming experienced. This implies that tactual aesthetics should be incorporated in the design education curriculum in an experiential way, because to conclude with Dewey:

An ounce of experience is better than a ton of theory simply because it is only in experience that any theory has vital and verifiable significance (Dewey, 1916) p.140.



Figure 1.14  
Being experienced: kneading dough.

## 1.5 Research Design

The experiences of touching and being touched form a strong basis for people's well being. Moreover, man-made products contribute to a large extent to these experiences because they constitute the material world people live in. The lack of attention for the tactual aspects of human-product interaction in design education may therefore reduce the designers' opportunities to contribute to people's well being. Designers should be aware of the fact *that* the objects they design will touch people, thereby influencing their well being, and formulate their designers' perspective on *how* they want to contribute to that experience. To support designers to become aware of the tactual aspects of their products, Tactual Aesthetics should be part of the field of research for design and of product design education.

### 1.5.1 Research goals

The goal of the present research is to construct a conceptual framework describing aesthetic aspects of tactual experience in human-product interaction, as a basis for the development of a Tactual Aesthetics research field in its own right. The results should be relevant and usable for the design practice as well as for the education of industrial designers. In addition, the provided framework should be solid enough as a basis for further exploration of the phenomenon of Tactual Aesthetics (Glaser & Strauss, 1967).

### 1.5.2 Research questions

About descriptions of aesthetic experience:

- What conceptual framework describes aesthetic tactual experiences: what themes are relevant, and how can these themes be described in a coherent structure?

About aesthetic behaviour:

- Is aesthetic experience related to a specific behaviour in human product interaction? And if so, what characterizes aesthetic behaviour in the tactual domain?

About the development of aesthetic sensitivity:

- How can we translate the conceptual framework of aesthetic tactual experience into useful tools in design education, to develop designers' aesthetic sensitivity?



### 1.5.3 Research approach: explorative, qualitative research

In their overview of thoughts on researching aesthetic experience, Eaton and Moore (2002) state that an important argument to leave the concept of human experience aside is based on the fact that ‘people may *say* that they have or enjoy aesthetic experience, but there is no way of making out what they really mean, let alone whether their claims are true’. However, in the present study, the starting point is precisely the fact that people do believe and *say* that they have aesthetic experiences. The present study will be about *what* people *say*, about *how* they describe their experiences.

This perspective implies a phenomenological research methodology: the study of the *lived experience* by unravelling experience itself as it manifests itself to consciousness (Manen, 1990). Phenomenological methodology implies and requires an open mind: ‘nothing about the notion to be studied should be considered ‘given’ or ‘granted’. The meaning of the researched phenomenon needs to be *found* in the experience itself’ (Manen, 1990).

The background information on tactual experience provided in this introductory chapter and in the following Chapter 2 on the tactual senses will serve as a background and a frame of thought to refer to while exploring the phenomenon itself.

The phenomenological approach implies the use of qualitative research methods to study human experience, by researching how people report about it, describe it using words, images, artefacts, and other qualitative data (Sanders, 1999). Characteristic of a phenomenological approach is an initial lack of structure describing the topic as a whole, a lack of an unequivocal definition of what is researched and, more specifically, the absence of the intention to make the research variables measurable, thus operational (Glaser, 1967). Also, qualitative research methods are best described as adventures into the unknown, without a clue to where it will lead.

Because this project is carried out in the applied area of product design, *the usefulness* of the results for this area is an important criterion to assess what has been achieved, making pragmatic criteria a strong leading force in decision making throughout the project. Like in product design, where one designs *a* product that is as suitable as possible, and not *the* product, this research is about building *a* useful framework, and not *the* framework.

In the end, the results of the study have to be judged for their validity. In qualitative research, in spite of the scientific rigor that one might strive for, validity is

not a matter of proof (Duijne, 2005). A researcher has to make the analysis of the data as insightful and as transparent as possible, by providing insight in the way the conceptual framework was constructed. But in the end:

*When the researcher is convinced that his conceptual framework forms a systematic theory, that it is a reasonably accurate statement of the matters studied, that it is couched in a form possible for others to use in studying a similar area, and that he can publish his results with confidence, then he is near the end of his research. He believes in his own knowledgeable ability and sees no reason to change that belief. He believes not because of an arbitrary judgment but because he has taken very special pains to discover what he thinks he may know, every step of the way from the beginning of his investigation until its publishable conclusion (Glaser & Strauss, 1967).*

Why does the researcher trust what he knows?

*He himself knows what he knows about what he has studied and lived through. They are his perceptions, his personal experiences, and his own hard-won analyses. A field worker knows that he knows, not only because he has been in the field and because he has carefully discovered and generated hypotheses, but also because 'in his bones' he feels the worth of his analysis (Glaser & Strauss, 1967).*

## **1.6 Structure of this thesis**

### *Part 1: Introduction and Background of the research*

This introductory chapter starts with the motivation to undertake an exploration into the aesthetic aspects of tactual experience, from the perspective of the practice of product design. The chapter introduces thoughts of different scholars on the world of touch, showing that touch meets fundamental needs in these domains. The chapter proposes a model of aesthetic aspects of experience in human-product-interaction and ends with an overview of the research goals, the research questions, and the research approach.

Chapter 2 gives an overview of the physiological and psychophysical aspects of the tactual senses. It presents the facts about tactual sensation and perception considered necessary to understand the presented results on tactual aesthetics in this thesis (see box 1.2 for an overview on the vocabulary related to the tactual experience).

### *Part 2: Towards a framework of tactual aesthetics*

In Chapter 3 a framework for understanding the tactual aesthetic experience of

objects is built using the results of a printed questionnaire study with open questions about pleasant and unpleasant experiences with objects. The framework offers themes to describe the experience, thus contributing to the development of an appropriate language about tactual aesthetic experience. It is postulated that such a tactual language is needed to get access to one's experience.

In Chapter 4 the tactual aesthetic experience is studied through observation of people interacting with objects and describing their experience. The results offer a model to structure the descriptions of tactual aesthetic experiences and, thereby, contribute to the conceptual framework developed in chapter 3. Next, the outcomes of the research suggest that products can be characterized by a specific salient tactual property. Finally, the results of the study question the nature of pleasantness and unpleasantness in aesthetic experience. Although these concepts are often (implicitly) seen as two extremes on the same dimension axis with a neutral centre, the results of this chapter suggest that aesthetic experience follow an additional dimension: from not experiencing at all (anaesthesia), to intensive experience.

### *Part 3: The Tactual Experience Guide*

Chapter 5 integrates the findings of the previous chapters in the development of the 'Tactual Experience Guide', a tool developed to describe and research tactual experience in human-product-interaction. The guide offers a conceptual map structure that allows subjects to report in an associative way about their tactual experiences with an object, considering their different ways of interacting with the object. A first version of the tool is evaluated in a design education context, resulting in a final Guide, completed with a lexicon and a description about how to use the guide.

Chapter 6 presents the results of the course *Tactility in Design*, a course set up to implement the results of the present study in the design education curriculum at the department of Industrial Design at the Delft University of Technology. The course is a combination of lectures and exercises. The goal of the course is twofold: to create designers' awareness and sensitivity for the aesthetic aspects of tactual experience in human-product-interaction, and to learn through experience about how to include this expertise in a design project. The chapter presents the different exercises offered during the course, and their results.

### *Part 4: Conclusions*

The thesis ends with chapter 7 reflecting on what has been achieved, and setting out for further possible research directions, based on the conceptual framework postulated in this research project.

## Appendix 1.1 Vocabulary of tactual experience in human product interaction

In research on touch, one encounters different words related to the topic, such as tangible, tactual, tactile, haptic, the feel, the touch, and somesthesia. Before moving towards a description of the aesthetic aspects of human experience, the different concepts used in the description of *tactual* experience are described. The tactual senses are described in more depth in chapter 2.

The following descriptions are concluded from textbooks on sensation and perception (Loomis & Lederman, 1986; Sherrick & Cholewiak, 1986; Goldstein, 2002; Saladin, 2001).

### Touch

Touch as a noun refers to a specific sensory modality, and as a verb to the *act* of touching and of being touched. As a verb it also refers to the movements made in touching and being touched.

### Tactile

The adjective tactile refers to what we experience *only* in the skin, when the skin is *mechanically* stimulated. Tactile experience thereby excludes the experience of temperature and pain. Tactile senses are part of the skin senses or the cutaneous senses. A fly tickling over one's skin or a seat pressing its texture in one's skin are examples of tactile experience. And as such, tactile perception can be considered as part of tactual perception.

### Tactual

Tactual is about what one physically experiences through touch when interacting with the environment. Tactual experience involves different sense modalities: tactile sensations in the skin, proprioception (e.g. body posture) and kinaesthetics (e.g. exerted muscle force). Most textbooks include temperature and pain as part of the tactual experience (Goldstein, 2002; Sekuler & Blake, 1994).

### Haptic

Haptic experience is a synonym for tactual experience, but limited to tactual experience through the hands. To avoid confusion, I only use the term tactual in this thesis.

## **Tangible**

The adjective tangible usually refers to the fact that an object can be touched. The word is often used in the context of human-computer interaction, referring to a specific style of interaction, where embodied action, movement and physical feedback contribute to the understanding of what is happening (Djajadiningrat, Wensveen, Frens, & Overbeeke, 2004; Dourish, 2001).

## **Feeling**

Feeling refers in daily use it to the emotions one experiences ('I am angry', 'I am happy') as well as to tactual perception ('I can feel the texture of this seat'). To avoid confusion, in this thesis feeling will only refer to the domain of having emotions.

## **Somesthesis**

Somesthesis refers to the different bodily senses involved in physical interaction: the cutaneous senses, proprioception, kinaesthetic, perception of temperature and pain, and the vestibular system. It is the most complete concept describing bodily experience. Tactual perception can be considered as part of somesthesis (Craig & Rollman, 1999).





# Chapter 2

## Tactual perception

### 2.1 Introduction

The previous chapter presented the concept of experience in human-product interaction as a process involving moving, sensing, thinking and feeling (see 1.3.2). The chapter described these different processes of experience and focussed on its aesthetic aspects, thereby elaborating on the process of 'feeling' in human-product interaction.

This chapter presents an overview of the other processes involved in tactual experience: moving, sensing, thinking in human-product interaction (Figure 2.1). The chapter describes the physiological and psychophysical aspects of the tactual senses: what mechanisms do the tactual senses consist of and what do people perceive through the tactual senses? The chapter focuses on those aspects of tactual sensation and perception that people can become aware of, and on possible ways in which people describe these perceptions.

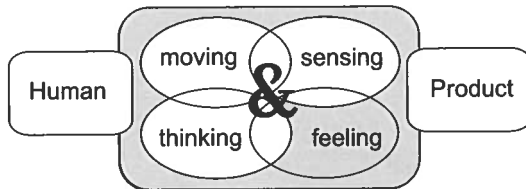


Figure 2.1  
The processes of moving, sensing and thinking in human-product-interaction are the focus of this chapter.

The purpose of this overview is twofold. First, it provides background information on tactual perception, necessary to understand the exploration set out for in



this thesis. The assumption is that insight in the physiological and psychophysical phenomena of tactual perception supports the understanding of the different aspects of tactual experience as a whole.

Next, the overview presented in this chapter offers a lead when exploring tactual experience 'in the field', thus when collecting and analysing data about real life tactual experiences. On the one hand, the insights offered by this overview provide a preliminary *structure* for the analysis of the collected data, and as such, serve as a soundboard. On the other hand, the overview generates possible preliminary leads for descriptors of tactual perception as part of the description of tactual experience, which eventually is the aim of this thesis.

The overview on the tactual senses presented in this chapter is based on a literature search in the field of physiology and psychophysics. It is necessarily concise and limited to the aspects of the tactual senses relevant to this thesis. A complete overview on the tactual senses can be found in (Saladin, 2001; Sekuler & Blake, 1994; Sherrick & Cholewiak, 1986; Goldstein, 2002); Loomis & Lederman, 1986; Craig & Rollman, 1999). A brief history of research on the tactual senses is presented in Box 2.1.

The goals of this chapter are reflected in its structure. First, the chapter presents the different aspects of the tactual senses: it describes how people tactually perceive objects and the bodily sensations involved in this perception. These descriptions are concluded with an overview of possible ways people may have to describe their tactual perceptions. The chapter concludes on the contribution of the presented overview to the general insights in tactual experience in human-product interaction and on the implications for the exploration of aesthetics of tactual experience.

## 2.2 Interacting with objects

### 2.2.1 Touch: a general sense

Walking on a floor, carrying underwear, sitting on furniture and drinking a cup of coffee, brushing teeth or bumping into a streetlight are some examples that illustrate the diversity of our ways of being in touch with the world. In physical interaction with objects of daily life our body as a whole is involved, as it is continuously touching and being touched. Therefore, the tactual senses are not limited to the hands, but may be considered the *general* senses because they concern

the *whole* body (Saladin, 2001). In contrast, sight, hearing, smelling and tasting are *specific* senses: they are '*specialized*' differentiations of the general senses of the skin. Nevertheless, although this chapter considers touch as a general sense, it focuses on the touching hands, because the hands seem to play the leading part in literature about studies on the tactual senses.

### 2.2.2 Active and passive touch

In interaction we are able to distinguish between touching an object, and being touched by an object. These two distinct phenomena are referred to as active and passive touch (Gibson, 1962).

Gibson (1962) observed that *active* touch produces a perception of the *object* being touched: one is exploring the object's properties (objective pole). On the other hand, passive touch with the same object (being touched by the object) gives an internal sensation: one experiences the sensations in the body, what is being done to it (subjective pole). To illustrate this distinction, imagine picking up a glass of wine, handling it in your hands, gently turning it to move the wine: you perceive its shape, its temperature, its fragility, and the movement of the liquid: even with your eyes closed you would know how fast you can turn without spoiling the wine (Figure 2.2). On the other hand, imagine lying on the bench of a masseur who is using a massage tool on your back: you sense the pressure on your back, the warming of your skin, but you do not sense the shape and the size of the object. (Figure 2.3).



Figure. 2.2  
Active touch: Perceiving the properties of an object.

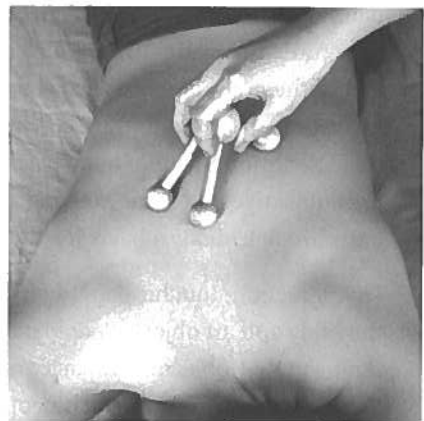


Figure 2.3  
Passive touch: Sensing the sensations involved in being touched.

In the active mode, if you focus on your hand you are able to feel the pressure of the glass against your skin, and in the passive mode you may perceive the weight of the stones on your back. Thus touching and being touched occur *simultaneously* in a physical encounter. This can be verified in a simple experiment: take a pen, hold it in your left hand and stroke it with your right hand (active touch). You will perceive a pen, and become aware of its different tactual properties. Next hold your right hand still and stroke it with the pen in your left hand (passive touch). You will become aware of the tactual sensations in your right hand: light touch, vibration, maybe some pressure, and so on. But, if you recall the active part of this short experiment you will become aware of the fact that in active touch you had these sensations as well. Apparently, in actively reaching out to manipulate and touch the world, our *attention* is directed towards the object, whereas in being touched, your *attention* is directed towards the sensations caused by that touch. But in interaction, one can be made aware of both.

Thus, although we *know* the difference between touching and being touched, in human-product-interaction it is not evident where active touch ends and passive touch begins. One can switch in attention and awareness between the objective and the subjective pole, but both phenomena occur simultaneously. The handshake is a good illustration of this statement: where does one stop touching and start being touched?

Awareness for touching or being touched is not only a matter of attention and being active or passive. The experience of touching or being touched is also related to the body parts involved in interaction, because the skin of the different body parts differs in the suitability for active or passive touch. The skin of the palm of the hand and feet seems especially suited for 'touching' because of its structure, discriminating texture and shape, whereas the hairy skin, covering the rest of the body, is more involved in signalling the locus of events touching the body, thus most of all in perceiving 'being touched' (Bolanowski, 2003). Nevertheless, although some body parts are more appropriate for the objective than for the subjective poles, the starting point for the present research is that all body parts are *potentially* a basis for the one *and* the other.

In interaction, touching and being touched is not limited to the contact between the body and an object. People have the capacity to touch the environment *through* other objects, a capacity referred to as *feeling through* (Burton, 1993). Some objects through which people touch the environment are our own non-neural extensions: nails, teeth, and hair, in anatomy and physiology referred to as accessory organs (Saladin, 2001). But the objects that interest us here are the man-made objects people touch through: people touch the bread through the

knife they are cutting with, the road through the bicycle they are riding on, the tennis ball through the racket and the paper through the pen they are writing with. Although touching through intermediate objects may be different from direct touch (Lederman & Klatzky, 1999), it will be part of the overview presented in this chapter.

The next paragraphs first focuses on the properties one perceives when *touching* objects, followed by the sensations one has when *being touched* by objects.

### 2.3 Touching objects: perceiving tactual properties

Tactual perception is not limited to the perception of the tactual properties of an object. Before perceiving these specific properties, people tactually perceive and identify an object *as* an object. Tactual perception of the object as such and of its tactual properties is intimately related to *movement*: it is *through* movement, *in* interaction that one perceives the object and its properties. These exploratory movements, considered as exploratory strategies, will be introduced before proceeding with the description of the perceived tactual properties themselves. This section concludes with an overview of the tactual properties perceived in physical interaction and of the possible ways to describe these properties.

#### 2.3.1 Object recognition

It is a remarkable achievement of tactual perception that we perceive and recognize an object as *one* object. When holding a glass of wine the skin is touched at different places with different pressure intensities. Joints, muscles and tendons have specific positions and apply specific forces to different parts of the glass. Therefore, it would not have been strange to conclude with one's eyes closed that one is holding *different* objects. Yet these impressions are integrated into the perception of *one* glass of wine.

This capacity of identifying an object as *one* object can be fooled: Aristotle discovered that rolling over a pen with two crossed fingers with one's eyes closed, gives the impression of rolling over two pens. This can be verified with other objects like the edge of a table: stroke it with two fingers crossed and you experience two edges. But overall, people identify the integrity of objects correctly.

The tactual (haptic) system is rapid and accurate to recognize three-dimensional, familiar objects. Klatzky, Lederman et al. (1985) demonstrated that blindfolded subjects recognize 96% of common objects within 5 seconds, and 94% in 1-2

seconds. Observations of people exploring these objects showed that people have specific exploring strategies, a *structured* way of tactually scanning objects. Klatzky et al. therefore concluded that the tactual senses consist of an expert system, with the capacity to structure the environment through interacting with it.

This identification phase plays an important role in blindfolded object exploration: people want to know *what it is*. The kinds of movements people make are deliberate to discover what kind of object one is exploring. Once the object is identified, the exploration usually stops (Gibson,1962), and people need to be encouraged to go on to explore the properties of the object.

### 2.3.2 Exploration strategies and manipulation style

Klatzky et al. (1985) studied the movements made by blindfolded people when physically exploring tactual properties of objects, and concluded that people have *specific* exploring movements for the perception of *specific* tactual properties (Figure 2.4). These strategies are discussed together with the various tactual properties in the next paragraph.

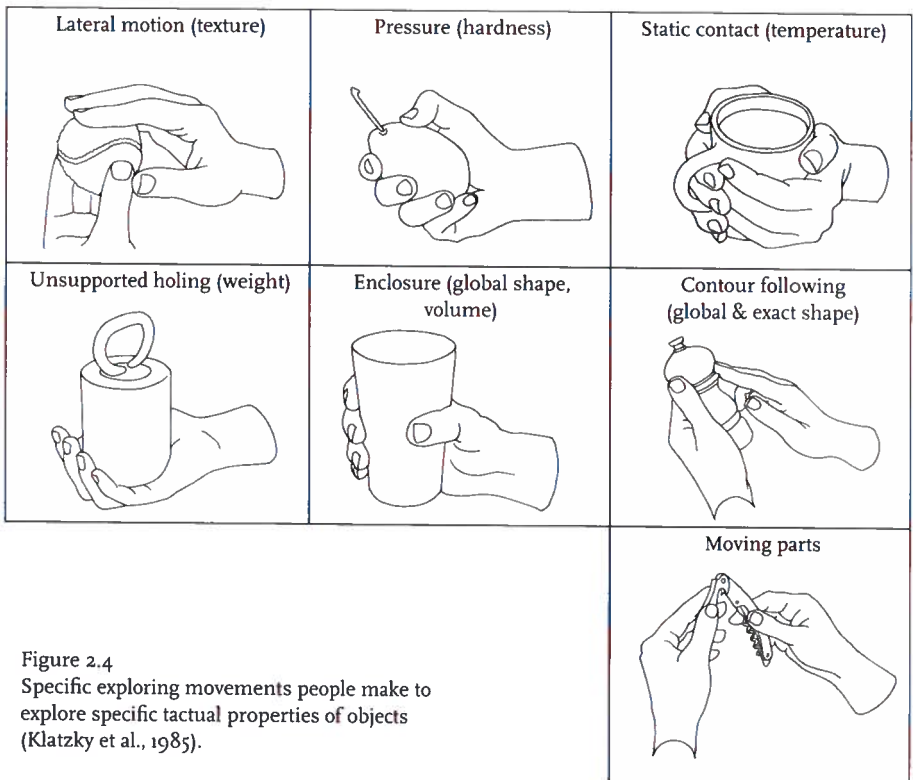


Figure 2.4  
Specific exploring movements people make to explore specific tactual properties of objects (Klatzky et al., 1985).

Tactual scanning should be done in a somewhat systematic way in order to give a consistent tactual perception of the object (Klatzky et al., 1985). Moreover, these tactual scanning strategies have to be learned: experience in touching is needed to be able to explore efficiently and accurately, as was shown in studies with blind adults and children (Davidson, 1985).

In addition, Turvey (1996) observed and researched 'dynamic touch' as an exploration style. This is an exploration style by which people *swing* objects to 'get a feel for them'. It is functional for the perception of properties such as size, geometrical properties, and weight, but especially suited for the exploration of the moment of inertia of an object: its reaction to rotation. The exploration through this type of movement is the basis for understanding how to use an object as a tool: it allows you to know how to hit a nail with a hammer and where to hit the ball with your tennis racket while looking at the ball (Figure 2.5).

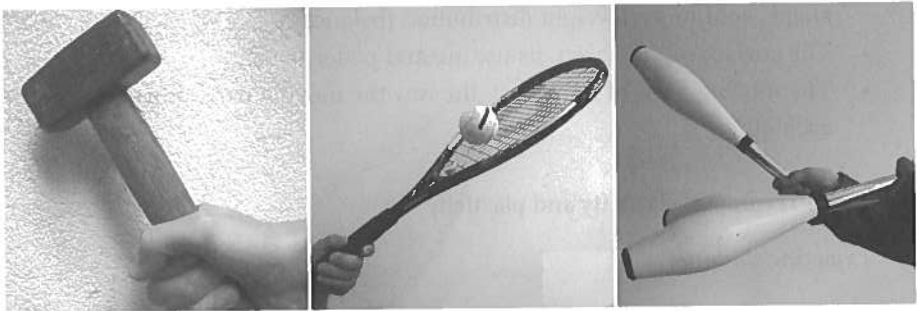


Figure 2.5  
Examples of dynamic touch (Turvey 1996).

The movements described above were documented in the context of people trying to *explore* and *identify* objects. Moreover, most studies were done with a limited set of objects and a limited variety in object properties. The presented movements and exploration strategies might, therefore, seem too limited to cover the movements people make with the wide variety of objects they encounter in daily life. People do not only *explore* the world, but manipulate the objects within their environment for many other purposes: to play, to use, to take care for, and so on. In this thesis, it is assumed that the insights in the specific movements for the perception of specific properties can be extrapolated to other contexts of use: whenever people interact with objects, it is *in* movement that they perceive the objects' tactual properties. Moreover, the kind of movement determines how people perceive the objects' tactual properties.

### 2.3.3 Tactual properties of objects

Although people seem to perceive objects as a whole rather than as the sum of its different properties, this paragraph describes the perception of the different properties. For each property, the characteristic exploration movements are described and the possible dimensions on which people perceive these properties. These dimensions of a perceptual space are researched through sorting tasks, where people are asked to sort materials based on their tactual similarities (see for example (Giboreau, Navarro, Faye, & Dumortier, 2001)). Next, for each property, the influence of the circumstances in which the object is touched on the perception of the property is described.

Overall, tactual properties can be considered as properties related to:

- The **substance**. The materials the object is made of: its hardness, elasticity, plasticity, temperature and weight.
- The **structure**. The geometrical aspect of the object: its global shape, exact shape, volume and weight distribution (balance).
- The **surface** of the object: its texture and patterns.
- The **moving parts** of the object: the way the moving parts move in relation to each other.

#### 2.3.3.1 Hardness, elasticity and plasticity

##### *Exploring strategies*

The hardness, stiffness and elasticity of an object's materials are explored when people exert pressure on the object, for example when they squeeze the object. Other possible movements are pulling, pushing or knocking on it, and bending or wrenching it. These movements have in common that they try to transform the object.

##### *Dimensions*

The different dimensions of the perception of material properties can first be characterized by the material's resistance against, or compliance to transformation: hardness and softness are explored when exerting pressure (Klatzky, Lederman, & Reed, 1987), and stiffness and flexibility, are explored when bending and wrenching (Ashby & Johnson, 2002).

Once the material is transformed, the material's elasticity and springiness are perceived in the way the material behaves when the pressure is released: does it come back to its initial shape, or does it stay transformed? If it comes back to its initial shape, the material is perceived as elastic. Plasticity refers to the property

of the material of remaining transformed.

#### *Perception circumstances*

Hardness and elasticity are not frequently described in literature on tactual perception. No experiments were found on how the perception of these properties is influenced by other properties or circumstances.

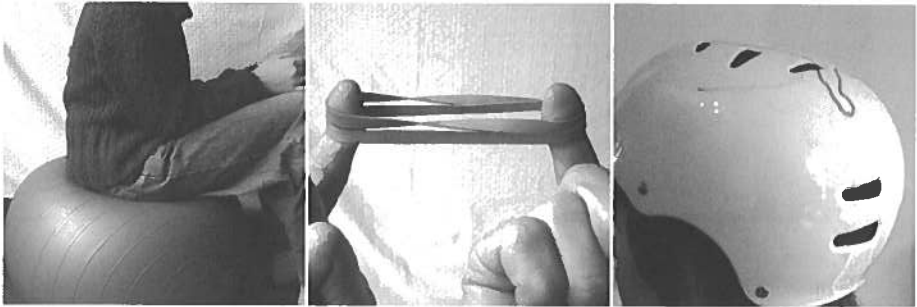


Figure 2.6  
Examples of the perception of material properties: hardness and elasticity.

### **2.3.3.2 Temperature**

#### *Exploring strategies*

Very high and very low temperatures are perceived differently from temperatures close to our own body temperature. Very high and very low temperatures are perceived immediately at initial contact, causing a strong withdrawal reflex. Temperatures that are not threatening need time to be perceived: this is why people leave their hands on a location for a while to be able to perceive the difference between body temperature and the temperature of the object.

#### *Dimensions*

Extreme temperatures are perceived as extremely hot or cold. Objects with temperatures that are not harmful are perceived as being warm or cold. People perceive warm or cold temperatures because objects with a temperature above or below body temperature cause a *temperature flow*. The perception of coldness is due to the process of warmth being extracted from the skin: the object cools one's skin and becomes warmer itself. If the process is fast (that is, when the material has a low temperature resistance, e.g. glass or metal), the object is considered 'cold' (Ashby & Johnson, 2002). If this process is slow (that



is, when the material has a high temperature resistance, e.g. wood, plastics), we consider the object as 'warm'. Due to this process of temperature flow, the temperature of objects is perceived as changing over time, eventually leading to neutral thermal perception (not warm, nor cold).

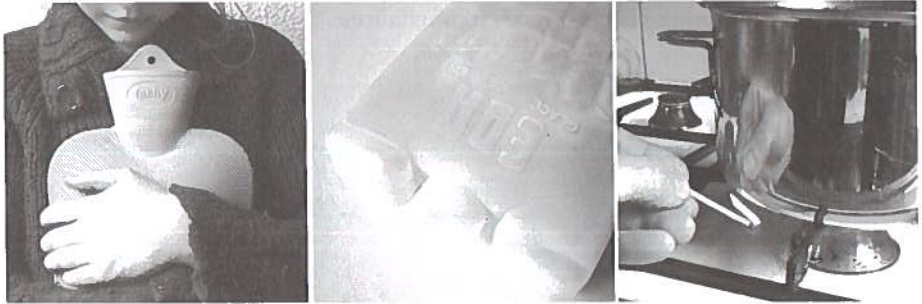


Figure 2.7  
Examples of the perception of temperature.

### *Perception circumstances*

The perception of an object's temperature depends on the (adapted) temperature of the hand. This is illustrated with the experiment where a person is asked to put his left hand in warm water and his right hand in cold water. After a while both water recipients are mixed in one recipient and the subject is asked to put both hands in that recipient. Due to adaptation of the skin, this mixture will be perceived as cold by the left hand and warm by the right hand.

Furthermore, temperature perception is dependent on the temperature differences between skin and object: the larger the difference between the object temperature and the skin temperature, the more accurate the temperature perception is (Tritsch, 1988).

### **2.3.3.3 Texture and patterns**

#### *Exploring strategies*

Texture is explored when stroking the surface of an object. This movement is especially necessary for the detection of fine textures ( $\mu\text{m}$ ) (Katz, Hollins & Risner, 2000). Textures with larger texture patterns may also be perceived through static touch (S. J. Lederman, 1981). Texture is perceived when holding an object, thereby assessing the grip on that object (friction).

## Dimensions

Lederman defines texture as ‘the microstructure of surfaces, as opposed to the large-scale macrostructure of objects, for example its shape (Lederman & Klatzky, 2003). Texture is on the one hand related to the properties of the material the object is made of, and on the other hand related to the structure of the surface of materials as the result of production techniques and surface treatment. Texture also involves patterns, such as the structured or random distribution of details on surfaces.

Texture perception is probably one of the most studied tactual phenomena (Craig & Rollman, 1999), but researchers do not agree on an unequivocal set of perceptual dimensions of tactual perception of surface texture. Hollins et al. (1993) demonstrated that subjects judge texture on three dimensions, the first two being the most important: rough / smooth, and soft / hard. The third less important dimension is related to the elasticity (‘springiness’) of the surface. In a following study, the first two dimensions were found again as prominent, and the third dimension was defined as the sticky / slipperiness of the texture (Hollins, Bensmaia, Karlof, & Young, 2000). Bumpy / flat was found as an additional fourth dimension, but it was not found to be independent from the first three. In both experiments, a set of different materials was used, such as sandpaper, velvet, and wood. Picard et al. (2003) investigated the perceptual dimensions of everyday tactual textures of textiles, and came up with another set of four dimensions: soft / harsh, thin / thick, relief/no relief, and hard/soft. From the differences between these findings, it might be concluded that the underlying dimensions describing texture may depend on the presented materials.

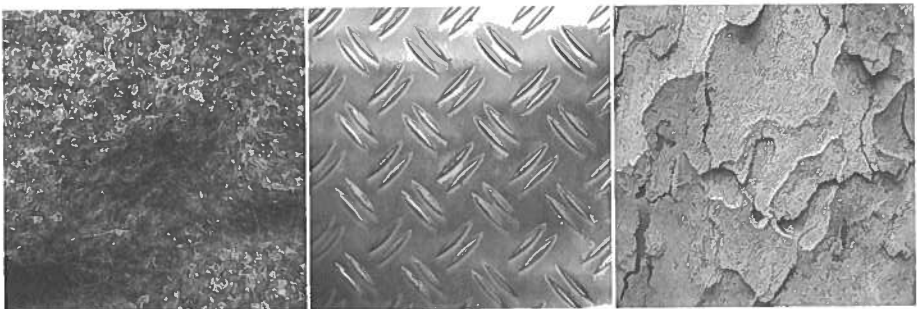


Figure 2.8  
Examples of the perception of texture.

### *Perception circumstances*

The perception of the roughness of a surface is not equal for all body parts: roughness perception is most sensitive for lips, fingers and least for the heel, the back and the thigh (Stevens, 1990). Furthermore, roughness perception is dependent on the way one moves. For example, roughness perception becomes more intense when the applied finger force increases (Lederman, 1974).

The friction between hands and objects is influenced by the condition of the skin, such as dry or sweaty, dirty, and so on. Slightly wet hands offer a greater friction force, which is why people spit in their hands before executing a task requiring firm grip. Buchholz et al. (1988) found that moisture between skin and porous materials increases the coefficient of friction. But too much water (or transpiration) forms a layer between hand and object, which causes slipping. O'Meara and Smith (2001) showed that the coefficient of friction and friction force were significantly lower when the hands were soapy than when they were wet or dry. For soapy hands, textured surfaces offer the best grip, whereas for dry hands, smooth materials perform best. Friction is also dependent on the size of the contact area: the larger the contact area, the more friction (Highley, 1977).

Bobjer (1993) and Buchholz (1988) extensively studied the friction between palmar skin and object textures. High friction may be required for people with weak hands to enable a good grip. Low friction is appropriate in situations where the hand often needs to slide over the surface of a tool.

### **2.3.3.4 Shape and size the object**

#### *Exploring strategies*

Geometrical properties of objects are explored when grasping the object, holding it, manipulating it and following the contours with the fingers. Furthermore, size and shape of bigger objects are explored through dynamic touch: by swinging and wielding them.

#### *Dimensions*

For the exploration of shape, Lederman and Klatzky (1987) found the following dimensions:

- Abrupt surface discontinuities: edge (no edge versus edge), hole (hole versus no hole, shallow hole versus deep hole);
- Continuous 3D surface contours: curved versus flat;
- Orientation of surfaces (horizontal, vertical, slant).

The dimensions of tactual perception seem to differ from the dimensions of visual perception of geometrical properties. For example, proportion, a typical geometrical aspect of visual perception of shape is not directly nor spontaneously perceived through tactual exploration of objects (Appelle, Gravetter, & Davidson, 1980). The priority of the dimensions differs as well. Changes in curvatures of an object are visually considered very important, but changes in orientation of the object (its position in space) are not. For the tactual system, it is the opposite: changes in spatial orientation of the object are considered more significant than changes in curvature (Goodnow, 1969). Size in tactual perception is referred to as volume, length and width (Lederman & Klatzky, 1987).

*Perception circumstances*

Shape perception seems to be dependent on movement. For example, curvature perception seems dependent on the direction of the scanning hand's movement: symmetrically curved edges often feel skewed in the direction of the moving hand (Goodnow, Baum, & Davidson, 1971).

Next, shape perception is influenced by what has been perceived previously, the so called after effect in perception. For example, after prolonged perception of a concave surface, a flat surface is perceived as convex, and vice versa (Vogels, Kappers, & Koenderink, 2001). Furthermore, there is an after effect in perceiving size. After a prolonged perception of an object with a certain length, longer objects are perceived as shorter than their actual length, and shorter objects as longer.



Figure 2.9  
Examples of the perception of shape and size.

Compared to the visual, the tactual space seems smaller. Thus objects that were first touched and then seen, look smaller than expected on the basis of touch. Length perception for vision differs from that for tactual perception, with judge-

ments derived from vision generally being larger than those derived from tactual perception (Teghtsoonian & Teghtsoonian, 1970).

### 2.3.3.5 Weight and balance

#### *Exploration strategies*

An object's weight is explored when holding the object and moving it up and down.

Weight distribution is explored through dynamic touch: by swinging and wielding the object or when trying to hold it still in a specific position (Turvey, 1996). Kreifeldt (2001) studied the object's moment of inertia, perceived as an object's resistance to rotational movement. This moment of inertia depends on where you hold the object. He illustrates these aspects with the swinging of a baseball bat. The bat has a specific weight and a specific centre of gravity, but the way it is experienced depends on where you hold it: the hitting hand or the holding end.



Figure 2.10  
Examples of the perception of weight and balance.

#### *Dimensions*

Weight is perceived as heavy or light and weight distribution as balanced or unbalanced. Although we do not have a specific word for what is perceived when swinging and wielding, we are aware of the existence of this specific property related to weight and weight distribution (Kreifeldt, 2001).

#### *Perception circumstances*

Charpentier was the first to demonstrate, in 1891, that the perceived weight of an object depends not only on its physical mass but also on its size (Murray, Ellis, Bandomir, & Ross, 1999). When holding two objects of equal mass but of dif-

ferent size, subjects will consistently report the bigger as lighter (Murray et al., 1999). This effect emerges only when the grip on the objects is loose, it does not occur for firm grip (Ellis & Lederman, 1999). This illusion exists in purely tactual situations, where the subjects are not able to see the objects, as well as in tactual-visual situations, where the subjects are allowed to touch and see the differences in size (Amazeen, 1997).

The perception of weight is influenced by what has previously been perceived. After prolonged holding of two objects of different weight in each hand, the weight of two objects of the same weight is estimated as different (de Mendoza, 1979).

Weight perception is also influenced by the temperature of the object. For all body parts, cold objects rested on the skin feel heavier than thermally neutral ones. Warmth intensifies weight perception as well, but this effect is not present in all body parts. For example, it does not occur on the forehead, but it is present on the forearm (Stevens, 1980).

Weight perception also seems to be influenced by other tactual properties of the object. For example, when lifting an object with the distal pads of the thumb and index finger at its sides (precision grip), the perceived weight depends on the object's surface texture. The smoother the texture, the heavier the object is perceived. This is explained by the fact that to prevent the object from slipping, a greater normal force has to be applied when the object's surface is smoother (Flanagan, Wing, Allison, & Spenceley, 1995)

### 2.3.3.6 Dynamic properties of moving parts

Objects may consist of various constructions and mechanisms, and of moving parts. So far, the perception of the dynamic properties of these moving parts have not been studied and reported in the field of psychophysics. However, in the research field of Human Factors, movement in human-product-interaction is



Figure 2.11  
Examples of the perception of moving part.

extensively studied, resulting in overviews of type of grip when holding an object (for example precision grip, force grip, antenna finger, and so on), type of movement (for example translation, rotation, and so on), force exertion, and related type of control mechanisms (for example buttons, handles, wheels, and so on). A complete overview of the resulting descriptions of these different aspects of movement in human-product interaction is provided in MacKenzie et al. (1994).

**2.3.3.7 Summary of tactual properties of objects**

The preceding overview described the different tactual properties of objects, and the dimensions on which people perceive these properties. The purpose of this overview is to provide possible descriptors people use to *describe* the tactual perceptions of an objects' tactual properties. The assumption is that these descriptors will correspond with the dimensions of the perceptual space. As a result, the preceding overview serves as a point of reference for further exploration of tactual perception, and leads to the following summary of tactual properties and their possible descriptors (Table 2.1).

Table 2.1  
Overview of tactual properties of objects and the possible descriptors of these properties.

Tactual properties of objects	Descriptors
Material properties	Hardness / softness
	Flexibility / stiffness
	Elasticity / Plasticity
	Viscosity
	Very hot / very cold
	Warm / cold
Surface textures	Rough / smooth
	Soft / hard
	Bumpy / flat
	Sticky / slippery
	Pattern
Structure / geometry	Curved / flat
	Surface discontinuities (edges, holes)
	Orientation (horizontal /vertical/ slant)
	Volume (large, small)
	Size (length, width)

Weight and balance	Heavy / light
	Balanced / unbalanced
	Reaction to swinging
Moving parts	Type of grip
	Type of movement
	Force

## 2.4 Being touched by objects: sensing tactual sensations

Like for tactual perceptions, tactual sensations depend on the movements one makes when touching an object (Gibson, 1963). However, sensations and perceptions differ in the way they emerge from touching an object: the perception of an object may be considered as invariant throughout moving, whereas tactual sensations vary while moving. To illustrate this, consider touching a wooden cube. You will perceive its shape through enclosure and contour following, moving the cube around in your hands. Throughout these different movements, the perception of the shape is invariant: it is a wooden cube. But this is not the case for the tactual sensations involved: the pressing of the edges of the corners, or of the flat surfaces of the cube on your skin varies with every movement of the hands and with every position of the cube. Thus the perception of the tactual invariant properties of an object coincides with varying sensations (Gibson, 1963). For our purpose it is relevant to conclude that a physical property of an object may evoke many different sensations, depending on the way one interacts with it.

This section presents the skin and body senses and the related tactual sensations (also referred to as somatic sensations (Vander, Sherman, & Luciano, 2001)). The section concludes with an overview of insights in to tactual sensitivity.

### 2.4.1 The skin and the skin senses

After a short description of the skin as a sense organ, the next paragraphs describe the different skin and body sensations people experience in physical interaction with objects.

#### 2.4.1.1 The structure of the skin and the skin sensors

Our skin is our largest organ: in adults, it has a surface of 1.5 to 2 m<sup>2</sup>, is 0.5 to 4 mm thick (depending on the body part), and amounts to about 15% of total body weight (Saladin, 2001).



Two types of skin cover the body: the glabrous (hairless) skin of the palm of the hands and the plant of the feet, and the hairy skin covering the rest of the body. Both skin types consist of three different layers, the epidermis, the dermis and the hypodermis containing a variety of sensors (table 2.2):

- Mechanoreceptors, sensitive to mechanical transformation of the skin
- Thermoreceptors, detecting cooling or warming of the skin
- Nociceptors, involved in the sensation of pain when the skin is (almost) damaged.

The two types of skin seem to be equipped for different functions (Figure 2.12). The glabrous skin is suited for active touch in exploring and manipulating the world and the hairy skin is suited for passive touch in signalling the locus of events, because of the following differences (MacKenzie & Iberall, 1994):

- The glabrous skin is thicker (especially the epidermis), tougher, and more resistant to pressure;
- The epidermis of the glabrous skin contains fat pads on the fingers and the other bulges on the palm of the hand. These fat pads make the skin comply with the grasped object, thus facilitating a stable grip;
- The glabrous skin has a papillary structure: the epidermal ridges form the palmar- and fingerprint. This structure has a sensory function. They allow the sensors to register lateral pressure. Hence, they contribute to the accuracy of the sense of touch.
- Furthermore the ridges are important in grasping. They offer more grip on the grasped object, much like the profile of tires offer more grip on the road;
- The distribution of the sweat glands is denser in the glabrous skin of hands and feet than in other parts of the body. The glands also differ in the way they respond to stimuli: the glands in the hand respond more to applied force (thus again facilitating grip), whereas the glands in the hairy skin respond more to temperature, thus facilitating temperature regulation.
- The hairy skin lacks the Meissner's corpuscles, responsible for the sensations of light touch and vibration. It is therefore that one is not able to perceive subtle tactual details such as texture differences with body parts covered with hairy skin.

Once the skin sensors are stimulated, neural fibres are involved in further processing the information. For each type of sensor, the corresponding neural fibre can either be slowly adapting (firing continuously) or rapidly adapting (only firing when the stimulus changes). These differences in adaptation rate strongly influence the duration of tactual sensation. Some sensations vanish rapidly be-

cause the sensor is adapted to the new situation (for example small temperature differences), other sensations will last forever (for example deep pain) because the sensors do not adapt at all.

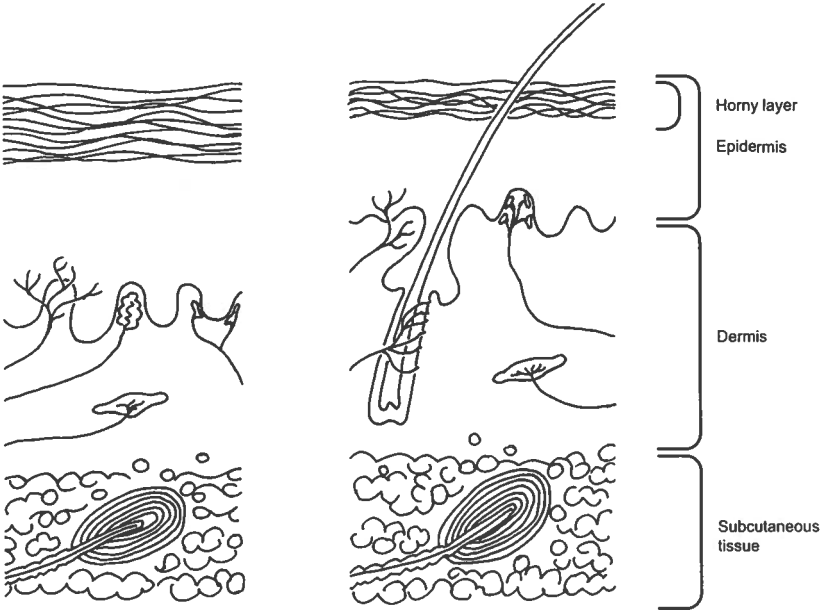








Figure 2.12 The structure of hairy skin and of glabrous (hairless) skin. (Adapted from (Saladin, 2001; Vander et al., 2001)).



The combination of the sensor type and the adaptation style of the related neuro-fibres lead to the following overview of skin sensations:

Table 2.2 The different cutaneous sensors: sensor type, location and sensation (Adapted from (Saladin, 2001; Vander et al., 2001)).

Sensor type	Location in the skin	Adaptation rate	Sensation
<b>Mechanoreceptors</b>			
Meissner's corpuscle 	Lowest layer of epidermis of glabrous skin	Rapid	Light touch, Vibration

The tactual senses

<p>Merkel's disks</p> 	<p>Lowest layer of epidermis of glabrous skin</p>	<p>Slow</p>	<p>Pressure</p>
<p>Tactile disks</p> 	<p>Dermis of hairy skin</p>	<p>Slow</p>	<p>Pressure</p>
<p>Hair follicle receptor</p> 	<p>Dermis of hairy skin, around the hair follicle</p>	<p>Rapid</p>	<p>Movement of hair</p>
<p>Pacian corpuscle</p> 	<p>Subcutaneous tissue of glabrous and hairy skin</p>	<p>Rapid</p>	<p>Vibration Deep Pressure Stretch of skin</p>
<p>Ruffini ending</p> 	<p>Dermis of hairy skin</p>	<p>Slow</p>	<p>Deep pressure Stretch</p>
<p>Thermoreceptors</p>			
<p>Cold receptors Thin myelinated fibres</p>	<p>Dermis of glabrous and hairy skin</p>	<p>Slow, Response peak at skin temperature of 30°C</p>	<p>Cooling of the skin</p>

Warm receptors Non-myelinated fibres 	Dermis of glabrous and hairy skin	Slow, Response peak at skin temperature of 43°C	Warming of the skin
Nociceptors			
Non-myelinated nerve ending 	Dermis and epidermis of glabrous and hairy skin	Slow	Intense pressure Intense temperature change Pricking Pain Burning pain Itch

### 2.4.2 The skin sensations

The skin sensations can be divided into three types, according to the type of sensors involved (Saladin, 2001; Vander et al., 2001).

- Touch sensations and sensations deriving from touch such as superficial and deep pressure, and vibration (mainly mechanoreceptors involved);
- Warm and cold sensations (mainly thermoreceptors involved);
- Pain sensations (mainly nociceptors involved).

The following describes the different specific body sensations.

#### 2.4.2.1 Light Touch

Light touch is what one senses when being touched without the skin being deformed. Light touch is mostly detected by rapidly adapting sensors (Saladin, 2001; Vander et al., 2001).

This rapid adaptation allows people to forget about the clothes that touch them during the day.

#### 2.4.2.2 Pressure

Pressure is maintained touch. It is experienced when an object is pressing on one's skin and, thereby, deforming the skin. Pressure sensors are slowly adapting (Sekuler & Blake, 1994; Goldstein, 2002). That is why the sensations of deep and heavy pressure are usually difficult to neglect.

### 2.4.2.3 Vibration

Vibration in the skin is experienced when rapidly adapting touch sensors are stimulated rhythmically, for example when the hand strokes a texture, or when one sits on a chair and a truck is driving by, causing vibration of the floor. Receptor organs in the upper layer of the skin are sensitive to low frequency stimulation, the deeper receptors to high frequency stimulation (Sekuler & Blake, 1994; Goldstein, 2002).

### 2.4.2.4 Cold and warmth

Although people intuitively consider warm and cold as two opposites of one dimension, the sensations of warming and cooling of the skin are elicited by two different sensory systems.

The skin easily adapts to temperatures between 20 and 40°C, thus resulting in a thermal neutral perception of the object. Below 20 and above 40°C, there is no adaptation, and the perception remains of a cold or a warm object. Above 45°C, the tissue starts to be damaged, and the thermal sensation becomes one of pain (Sekuler & Blake, 1994; Goldstein, 2002; Ganong, 2001).

### 2.4.2.5 Pain

Pain as a bodily sensation is referred to as somatic pain. When pain is induced by stimulation of the skin it is called superficial pain. Pain from muscles, bones and joints is called deep pain. The subjective experience of pain is a complex phenomenon; it differs from the other senses because it is intimately related to the affective meaning of the circumstances in which it is experienced (Goldstein, 2002), and the resulting motivations of the subject. An extensive discussion on pain perception can be found in the volume on Pain and Touch of the Handbook of Perception, edited by Kruger (1996).

The sensory aspects of pain are experienced in terms of temporal (how long), spatial (where), pressure and thermal properties of pain (Melzack, 1975). The pressure in pain can further be specified as: punctuate pressure, incisive pressure, constrictive pressure and traction pressure, thus related to *what is happening to skin*.

#### 2.4.2.6 Tickle and Itch

Itch and tickle are skin sensations elicited by stimulation of non-myelinated fibres in the skin, much similar to pain sensors. Itch and tickle are produced by mild stimulation when moving something across the skin (Saladin, 2001; Vander et al., 2001). Itch can also be produced by chemical stimulation of the skin. The difference between tickle and itch is not clearly defined.

#### 2.4.2.7 Physical pleasure



Olausson et al. (2002) discovered a system of non-myelinated, slow conducting sensors in the hairy skin, that responds when touched lightly, producing a faint sensation of pleasant touch, without producing the *sensation* of being touched. The research was done with a patient that did not have touch sensations. Although she was not able to tell where she was touched or to report the direction of a stroke, she reported a light stroke of a brush on her skin as 'pleasant'. The researchers concluded that we might have a special system for limbic touch, underlying emotional responses to caress-like skin-to-skin contact between individuals. But the fact that the study was done with a soft brush, and not with a human hand, suggests that the system is not only there to sense pleasant *human* touch, but pleasant touch *in general*, thus also by objects. The findings suggest that like for somatic pain, we have sensors for physical pleasure. Therefore, it seems plausible to consider the experience of physical pleasure as the experience of a physical *sensation*, related to the sensation of being touched.

#### 2.4.3 The body senses and sensations

In addition to the skin sensations, active touch involves the two body senses: proprioception, the perception of body position and kinaesthetics, the perception of movement of the body. Body posture and body movement are sensed through sensors in muscles, tendons and joint tissues (Table 2.3) (Saladin, 2001; Vander et al., 2001)

The sensations elicited by muscle sensors are exerted muscle force and muscle stretch. In addition, Mathews (1982) proposes posture and movement as the two dimensions of muscle sensations, based on the work of Sherrington, where movement is further differentiated in passive, active and restricted movement.

Table 2.3  
The different muscle and tendon sensors: sensor type, location and sensation  
(Adapted from (Saladin, 2001; Vander et al., 2001)).

Receptor	Location	Sensation	Adaptation rate
Muscle-spindle Stretch receptors 	Skeletal muscles	Muscle force Muscle stretch	Rapid
Golgi tendon organ 	Joint tendons	Body posture Limb position (tension on tendon)	Slow

#### 2.4.4 Summary of Tactual sensations

The preceding overview described the different tactual sensations elicited in touch. Like for the tactual properties, the purpose of this overview is to provide possible descriptors people use to *describe* the tactual sensations they have when touching an object. As a result, the preceding overview serves as a point of reference for further exploration of tactual sensations, and leads to the following summary of tactual sensations and their possible descriptors (Table 2.4).

Overall, sensations can be considered on the aspects of location (where), quality (what), intensity (how strong) and duration (how long does it last) (Gibson, 1963).

Table 2.4  
Overview of tactual sensations and their possible descriptors of these sensations.

Tactual sensations	Descriptors (where, what, intensity and duration) of:
Light Touch	To feel touched or not, without pressure
Pressure	Light pressure Deep pressure

Vibration	Vibration
Extreme temperatures	Heat or extreme cold
Neutral temperatures	Warm or cold
Pain	Pressure or thermal related
Itch and tickle	
Physical pleasure	Pleasant

### 2.4.5 Tactual Sensitivity

Tactual sensitivity is considered as the sensitivity to the variations in intensity of a stimulation and to its spatial and temporal aspects (Lederman & Klatzky, 1998). Thus sensitivity relates to the capacity to sense if one is touched, where one is touched, for how long, and with what intensity. The sensitivity of individuals for touch sensations depends on the *locus* of touch on the body, because the sensors in the skin are not equally distributed. The fingertips and lips contain most sensors per mm<sup>2</sup> compared to other areas, such as the back and the calf (Stevens, 1990).



Figure 2.13  
 Penfield's Homunculus. The model shows what a body would look like if each part was in proportion to the area of the somatosensory cortex involved in its sensory perception (Sekuler & Blake, 1994).



In addition, sensitivity depends on the spatial aspects of the afferent neuro-fibres. Receptive fields of fibres of the receptors in the upper layer of the skin are relatively small (2 - 4 mm) and overlapping. Thus they create a sensitive system to locate a point on the skin. The deeper receptors have larger receptive fields, making the location of a point on the skin less accurate (Sekuler & Blake, 1994; Goldstein, 2002).

Finally, sensitivity depends on the relative size of the reception area of the neuro fibres in the brain: the somatosensory cortex. These areas are not proportional to the different body parts. The lips and hands cover the largest area, whereas the back and the calf cover relatively small parts. These differences in sensitivity due to differences reception areas in the somatosensory are reflected in the homunculus defined by Penfield (Sekuler & Blake, 1994), where the different body parts are depicted as proportional to their tactual sensitivity (Figure 2.13).

The sensitivity due to the distribution of sensors and to the spatial characteristics of the corresponding neuro-fibres cannot be altered by training. But the distribution on the reception area in the brain is plastic, implying that it can be altered by experience and training (Goldstein, 2002). For example, blind people are not more physically sensitive to touch than sighted people (Hanninen, 1972). It is through training that they become better in recognizing objects (Berla & Butterfield, 1977) and patterns (Craig, 1988). Thus although we cannot train ourselves to become *more* sensitive to subtle tactual stimulation, we are able to improve our perception of objects by tactual experience.

Tactual sensitivity is not a static aspect of an organism, but varies in time. Sensitivity will decrease as we get older. For example, the spatial acuity of the skin of the fingertip deteriorates with age (Stevens & Choo, 1996). Different diseases or pathological conditions can disturb the tactual senses, such as diabetes, lepra, multiple sclerosis and Parkinson's disease (Pratorius, Kimmeskamp, & Milani, 2003). Damage of the Central Nervous System or peripheral nerve tissue through accident or tumours, may cause a loss of sensitivity as well (Franzen & Lindblom, 1976).

The concept of *physical* sensitivity in the tactual domain as described above differs from the concept of *aesthetic* sensitivity in the tactual domain, introduced in Chapter 1. Physical sensitivity refers to people's capacity to sense the variations in intensity of a stimulation and to its spatial and temporal aspects (Lederman & Klatzky, 1998), whereas *aesthetic* sensitivity of people refers to people's sensitivity towards the aesthetic aspects of tactual experience: being aware of and sensitive to its (un)pleasantness.

## 2.5 Conclusions on tactual perception

The present chapter provided usable insights in the characteristics and mechanisms of the tactual senses for further exploration of the tactual experience. Insight in the process of moving in tactual experience is developed in the description of the exploration strategies involved in tactual perception. Insight in the process of sensing is developed in the description of the sensations in skin, in muscles, and in tendons. And finally, insights in the process of thinking is developed in the description of the perceived tactual properties of objects. The overview of the different aspects involved in these processes provided a preliminary starting point to define a possible structure for the conceptual framework of tactual experience. In addition, the overview offered in this chapter led to possible descriptors people may use to describe movement, sensation and perception, summarized in Table 2.1 and Table 2.4. The structure of the different aspects and the overview of descriptors will both serve as a starting point as well as a soundboard in the studies described in the next Chapter 3 and Chapter 4.

Furthermore, the previous overview of the tactual senses leads to general insights that deepen the understanding of the phenomenon of touch, presented in the following section. Like for the previous, these concluding insights will serve as a soundboard for further exploration of the tactual experience. In addition, these insights provide recommendations for the set up of future studies.

### 2.5.1 Complexity of the tactual senses

The overview in this chapter suggests that contrarily to what might be expected intuitively, touching is a complex phenomenon. Although it is traditionally referred to as *one* of the five senses, touch should not be considered as such. The sensations and perceptions involved in touching and being touched belong to different domains, related to different types of stimulation: mechanical, thermal and chemical.

Textbooks (e.g. (Goldstein, 2002; Sekuler & Blake, 1994)) on the tactual senses emphasize that the relation between the different aspects of these domains (physical stimulation, sensor type, skin and bodily sensations, and tactual perceptions) are complex and not well understood. In constructing a framework on tactual experience, it seems that this complexity should be acknowledged. The domains of perception and sensation should be considered as two phenomena in their own right, because each domain seems to contribute in its own specific way to tactual experience as a whole. In tactual experience, one can be made aware

of tactual properties of objects as well as of bodily sensations, and these two domains can not be reduced to each other.

### 2.5.2 Temporality

The description of tactual sensations and perceptions show that touch is a phenomenon that changes over time. Touch involves slowly adapting systems, leading to slowly but constantly sensing and perceiving; and rapidly adapting systems, reacting fast but fading fast, leading to rapid but fading sensation and perception. As our body is actively involved in touch, the tactual perception should be considered as a process (spatial and temporal), wherein the perception of tactual properties of objects may vary. Thus, while touching an object, that object may *become* warmer, heavier, harder, and shapes may change through squeezing, and so on. Research should be aware of this temporal aspect, when asking the question 'how does this object feel?'. And because of its complexity and temporality, tactual perception *needs* time. In vision, one has an immediate overview of most of the visual properties of an object in an instant, but tactual information has to be gathered. Research conditions should allow subjects enough time to explore and interact with an object, and consider the experience as a process developing in time, involving changing sensations and perceptions.

### 2.5.3 Movements in the context of tactual perception

The importance of movements for tactual sensations and perceptions was emphasized throughout this chapter. Exploratory movements are characteristic and deliberate, to explore the different properties of an object. But an overview of these typical exploratory movements (Figure 2.4) shows that they do not represent all type of movements people may make when interacting with an object. It may be that movements made in the context of a specific interaction differ from the typical exploratory movements, thus leading to different sensations and perceptions than obtained when merely exploring the object. To research tactual aesthetics, the context of interaction should be taken into account, because this context will allow people to make the movements relevant for that specific context. For example, to hold a glass of wine in one's hands is different from bringing it to one's lips and sipping out of it, or accidentally breaking it and cutting oneself with it. When assessing the tactual experience of interacting with the glass of wine, it is not enough to explore it with the hands in a clean lab situation: one needs to drink out of it in the context of a real meal, where one might have greasy fingers. Likewise, the tactual experience of sleeping on a mattress

cannot be perceived through pushing it a few times with your hand. Tactual perception cannot be extrapolated from one body locus, and from one movement, to the other.

#### 2.5.4 Subjectivity grounded in physicality

From the description of the tactual senses it can be concluded that tactual perception, because it depends on one's body and skin characteristics and above all on the way one moves, is a subjective phenomenon. For example, the size of one's hands contributes to the perception of the size of an object, the intensity of the forces one applies contribute to the intensity of the sensation of pressure, the moist of one's hands influences the perception of surface texture, the temperature of one's skin contributes to the experience of warmth and coldness, and so on. Thus, although tactual properties may seem to be inherent to the physical properties of an object, they should not be considered as objective. Subjectivity of tactual sensations and perceptions in physical interaction with an object is grounded in the physical differences between the different people interacting with that object.

In other words, tactual perception is about perceiving one's *material* world, through one's *material* body, when physically interacting with this world.

#### 2.5.5 Touching is believing

Chapter 1 introduced tactual perception as the foundation for knowledge about the material world (§ 1.2.2). But like for the visual, psychophysical research shows that knowledge obtained from tactual perception can be illusive. For example, the size-weight illusion shows that two objects of identical weight are not perceived as such when their sizes differ: the biggest object is perceived as lighter (Murray et al., 1999). From a phenomenological point of view, however, it is this experienced truth that matters, and not the relation between perception and an objectively measured physical reality. To touch is to believe. It is the lived experience that will be researched in this thesis, even when wrongfully experienced as true.

#### 2.5.6 Tactual sensations and aesthetic experience

When researching the aesthetic aspects of tactual experience in interaction, it seems obvious to focus on active touch and the perception of tactual properties

of objects. But the present overview showed that touch should be considered as an interactive phenomenon: touching implies being touched, and tactual perception involve tactual sensations.

In his attempt to understand tactual perception, Gibson (1963) stated that from a cognitive point of view, thus to *perceive an object*, it is not necessary to take the sensations involved into account. He illustrated his statements with the following examples: to feel an impression on the skin is not to feel an object, having sensations of strain and pressure is not to feel the weight of an object, to feel a local pain is not to feel the pricking of a needle, to feel warmth on one's skin is not to feel the sun on one's skin, and to feel cold is not to feel the coldness of the weather (Gibson, 1963). The point made is that we do not need to be *aware* of sensations in order to perceive.

The question is whether this perspective still holds in the context of tactual *aesthetics*. Do we need to be aware of tactual *properties* of objects to *enjoy* the physical interaction with these objects? It might be that in *aesthetic* tactual experience, being aware of the tactual *sensations* in skin and body, is more important (see also section 1.4.3.2 on comfort studies). Thus, to mirror the examples of Gibson: is one not enjoying the sun on one's skin *because* one is aware of the warmth one senses? If the pricking of the needle is unpleasant, is it not *because* one is aware of the local pain it evoked? And when longing for a caress, is it the perception of the properties of the hand one longs for, or above all the sensations it evokes in one's skin?

It may be that understanding the role of tactual sensations is vital to understand the *aesthetic* aspects of tactual experience.

## Appendix 2.1. A short history of touch research

Scientific research on Tactual Perception started with the work of Ernst Heinrich Weber, professor at the University of Leipzig from 1818 to 1871 (Ross & Murray, 1996b). Weber focused on many aspects of sensation and perception, but is most famous for his conclusions on threshold values and just noticeable differences (Weber's law). Touch was considered a sense modality with a unified character, but Weber was one of the first to demonstrate that touch should be divided into different senses. He discerned between the sense of location, the sense of weight, and the sense of temperature. Other aspects, such as pain, the vestibular, and kinaesthetic sensation were considered as general sensations, or *das Gemeingefühl* (Sherrick & Cholewiak, 1986). Weber described his research in two important publications: *De Tactu* (1834) and *Der Tastsinn und das Gemeingefühl* (1851), translated by Ross and Murray (Ross & Murray, 1996a).

After the work of Weber, researchers in experimental psychology did not focus on the senses of touch as much as on the visual and auditory senses. This might result from the fact that the tactual senses are complex and difficult to research using a controlled method (Klatzky et al., 1987). Another pioneer in touch research was David Katz, who published his study *Der Aufbau der Tastwelt* in 1925, emphasizing the importance of movement in tactual perception, a conclusion still considered relevant in current research on tactual perception.

Revesz (1950) took on the research on tactual perception, for instance in the context of art for the blind. He emphasized the exploratory aspects of touch: when looking at an object, one can have an immediate overview of most of the visual aspects, but its tactual properties have to be explored, and gathered progressively in time.

Gibson studied the senses from an ecological point of view and stated that the tactual senses should be studied and understood from their functional context: to explore and manipulate the surroundings. Gibson's approach is to consider the haptic perceptual system as an integrated system, and not as a mere blend of different tactual and kinaesthetic senses. The revolutionary aspect of his approach is the insight that information is in the environment, and that perception does not result from an internal process within the organism. This led to the concept of affordances: information that is embedded in the environment on how to cope with that environment.

Lederman, Klatzky and other researchers continued the study of the tactual senses as an active, exploratory system. Lederman and Klatzky (1985) concluded

that the haptic system is an expert system, remarkable fast in recognising objects through active touch. Their research shows that each object property is analysed through specific movements of the exploring hands.

Nowadays, research on tactual perception has become relevant for the development of remote control applications and virtual reality systems, where people have to get a feel for what they are doing. The focus of the research is to understand its psychophysical mechanisms, that is, the relation between perception and physical stimuli. The assumption is that once we understand the mechanism of tactual perception, we can create virtual environments where the tactual senses are not neglected, but where haptic interfaces augment the experience of being emerged in that virtual world.

For an extensive overview of the history of touch research, the reader is referred to Kruger's Handbook of Perception and Cognition (Kruger, 1996) and to <http://haptic.mech.northwestern.edu/>, the official website of the Haptic Community.







# Chapter 3

## Themes in tactual experience

### 3.1 Introduction

When constructing a conceptual framework to describe the aesthetic aspects of tactual experience, starting questions are: How do people describe tactual aesthetic experiences in human product interaction? What do people refer to? What basic themes characterize this experience?

This chapter presents a first study to discover the themes that characterize tactual experience, through analysis of reports of tactual experiences in daily life. The study of tactual experience is approached from a phenomenological perspective: the study of people's conception and experience of the world through self-report by the one who is experiencing.

The tactual experience is considered a non-verbal experience (Polyani (1967), Merleau-Ponty (Bakker, 1975)). To choose for a verbal report may therefore seem inappropriate. Nevertheless, because we *are* researching the aspects of experience as present in people's awareness, or the aspects that can be made aware of, the starting point for this study will be the verbal self-report. It is assumed that in a first study, verbal reports are more appropriate for interpretation because they are more accessible than images or other collected qualitative data. The question whether a verbal report is a useful and fruitful way to get access to, and insight in tactual experience will be part of the discussion concluding this chapter.

### 3.2 Design of the study

#### 3.2.1 Research method

The social sciences contain an established set of research methods for exploring new concepts. Among these, the methods based on grounded theory start out

formulating a theory about the concept through coding these qualitative data (Glaser, 1967). Based on these codes, themes are formulated that characterize the concept that is researched. Subsequently, these themes can be elaborated upon with a description of the theme and of possible descriptors that characterize the theme. This can be seen as a conceptual mapping of the concept that is researched, analogous to mapping a newly explored geographical area. Figure 3.1 visualizes this method of coding and grouping qualitative data as a basis for a descriptive map of the concept that is researched: units of qualitative data are coded, grouped, and described as a set of themes that form the conceptual map of the phenomenon that is researched. Coding is not mutually exclusive; one piece of data can be coded with several codes, thus illustrating different themes simultaneously.

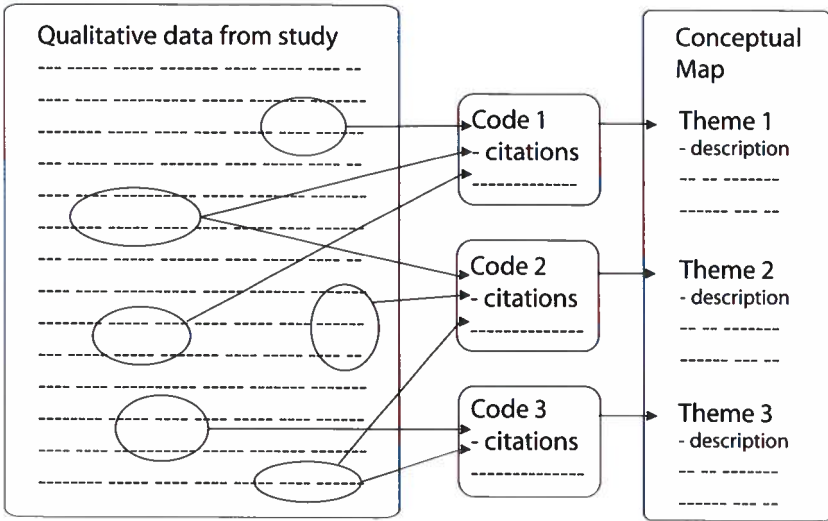


Figure 3.1  
The structure of methods based on grounded theory.

### 3.2.2 Data collection

#### *First Pilot test*

To research the possibility of collecting useful data on tactual experiences through verbal reports, a pilot test consisting of an open interview was held with three subjects. The first open question was: ‘Can you give me an example of an

object that is pleasant to touch?', followed by the question: 'Can you tell me what is pleasant about it?'

The three subjects had difficulties answering these questions. One of the participants felt uneasy about not being able to answer on the spot and reported: '*I'm sorry, maybe I'm not sensitive enough?*'. However, a few days later this subject came back to the question with an example: '*Now I know! An unpeeled, boiled egg in the morning at breakfast feels wonderful. It nestles itself in your hand, and you can play with it forever*'. It was the time of Easter and the subject had the boiled eggs for breakfast.

This first pilot confirmed the impression that people have difficulty putting their experience into words. Nevertheless, the results suggested that it can be done, provided that people are allowed some time to answer. It seems as if people need to have the question in mind to be able to recognize the experience as it happens in daily life, to become aware of it and to be able to describe it.

### *Second Pilot test*

To allow people to think about the questions for a while before answering, a printed questionnaire was designed that people could take home. The questionnaire contained the same starting question as the first pilot: 'Can you give me an example of an object that is pleasant to touch?'

Based on the insights from Chapter 2 on the relevance of movement and context for tactual experience, the next questions were formulated as: 'Describe when and how you use the object', followed by 'Can you describe the tactual properties of this object?'. The questionnaire concluded with the question: 'Can you describe your feelings when touching this object?'. These questions were repeated for an object that was unpleasant to touch. This questionnaire was given to three subjects from the Department of Industrial Design of the Delft University of Technology.

The subjects mentioned that the questions were difficult to answer, but that it was possible. As expected, the objects described were all from the direct environment of the respondent when answering the questionnaire (coffee mug he is drinking from, chair she is sitting on, pen he is writing with). This seemed to confirm the assumption that people need to actually experience an object to recognize the tactual experience as pleasant or unpleasant. Based on the results of this second pilot, it was decided to go on with collecting data through printed questionnaires.

### *Final design*

The final design of the questionnaire about pleasant and unpleasant tactual experiences was structured as follows.

The respondent was asked to describe the experience with two objects, the first pleasant, the second unpleasant to touch. For both objects, the following questions were asked:

- Describe the interaction with the product
- Describe the tactual properties of the object
- Describe your feelings when touching the object

To stimulate the participants to describe experiences less 'on hand', a question was added about a childhood memory involving the touch of an object. In the questionnaire it was not specified whether this memory had to be pleasant or unpleasant. At the end, the participants were asked to evaluate the questionnaire.

The questionnaire concluded with questions concerning the participants' age, gender, and profession. A stamped and addressed envelope was added to send back the questionnaire.

### **3.2.3 Participants selection**

120 questionnaires were distributed among students and researchers of the Delft University of Technology, of the Design Academy Eindhoven, to people in the street, in trains, and to friends and relatives. 46 out of 120 questionnaires were completed (38.3% response rate), 24 men and 22 women. The participants' ages varied from 18 to 67, the mean age was 37.2.

Although a large part of the participants (38%) was somehow related to the practice of industrial design (as a professional, a student or a teacher), several different professional backgrounds were reported, varying from information technology, education, and medical professions to politics and finance.

### **3.2.4 Data analysis**

At the start of the data coding, a first and global structure was used, based on the model of human-product interaction presented in chapter 1. This initial perspective was necessary to obtain a first ordering in the vast amount of data, and to ensure the relationship with a design-oriented perspective. In other words, the requested 'open mind' towards the gathered data was employed *given* this per-

spective, and not from a completely blank point of view. The coding and analysis of the data was structured along the following questions (see Figure 3.2).

- 1 What are the characteristics of the respondents?
- 2 What kinds of objects are mentioned?
- 3 What kinds of interaction with these objects are described?
- 4 How do the participants describe their sensations?
- 5 How are the objects' tactual properties described?
- 6 How are the participants' feelings described?
- 7 How is the expression of the objects described?

The data and resulting themes are reported in a qualitative manner. Subsequently, for each theme the frequency of its emergence in the descriptions of the participants is reported and discussed.

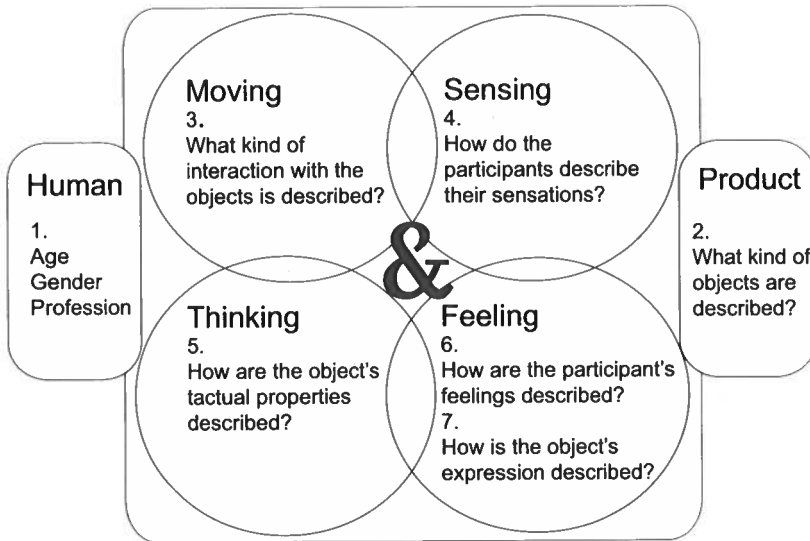


Figure 3.2  
Structure of the data analysis, based on the model of human-product interaction presented in Chapter 1.

The analysis of the data was an iterative process, going back and forth from data to themes, to work towards a consistent conceptual map. It is common practice in qualitative research to discuss the obtained themes with others, in order to get feedback on the credibility and consistency of the generated framework. To ensure this dialogue, the provisional results were presented during lectures for design professionals, courses for Industrial Design students and design confer-

ences, throughout the analysis. The comments and suggestions obtained from these different occasions were used to improve and complete the outcomes of the present study. In addition, when the results of this study were presented in lectures for students or for professional designers, people often came up with their own examples illustrating and thereby articulating the different themes. When appropriate and illustrative, these examples 'from outside' were added to the data.

### 3.3 General remarks of the participants

The respondents commented at the end of the questionnaire on the experience of filling it in, and gave additional comments on the topic. From these data, the following general aspects emerged.

#### 3.3.1 Searching for examples

The common reaction to the questionnaire was that although it was pleasant to fill it in, it was very difficult to answer the questions, because the experiences referred to are not in one's primary attention. *'It takes a long time to figure out the answers, evidently because it is something I usually don't think about'*. This confirms the findings in the first and second pilot.

For some participants, this difficulty concerned only one part of the questionnaire. *'It was easy to come up with pleasant examples, but it was very difficult to find the unpleasant examples'*. This is confirmed by the fact that three participants actually could not find an example of an object unpleasant to touch, leaving the question unanswered. Moreover, the question about the childhood memory seemed difficult to answer: nine respondents reported that they were not able to find an example.

Filling in the questionnaire seemed a confronting and personal experience: *'It's a good self-analysis'*. In addition, the topic seemed to make participants aware of the intimate aspect of touch: *'It is a Freudian experience. I have the feeling that all my answers have a sexual undertone, carefully hidden in an acceptable story'*. As a result of this association, the participants may have self-censored the examples they described, avoiding taboo-related topics.

Finally, the participants were triggered and stimulated by the questionnaire itself. Several reported that the questionnaire functioned as an eye-opener (in this case a 'hand-opener'): *'This is unusual stuff. Without such a questionnaire nobody*

would think about these things. I think I will go on being aware of them, now more than before’.

### 3.3.2 Talking about touch: the lack of words

Although the questions about tactual experience were split up between the objects’ properties and the participant’s affective response, the participants still found it difficult to put their experiences into words. The insight that the tactual experience seems an unarticulated, nonverbal experience, came as a surprise to some of the participants: *‘It is nice to experience that I know these feelings very well, but that I’m not used to putting them into words’.*

More specifically, it seems that it was difficult to describe the nuances, to elaborate on the subtlety of the experience: *‘It just feels good. I cannot say more about it’*, and *‘I feel too much to be able to describe it very precisely’*. This lack of words is reflected in the nature of the answers as well. The texts are concise, fragmented, sometimes using only keywords.

Respondents had to split up their answers between the properties of the objects and the feelings elicited by touching them, but it seems that it was difficult to do so: *‘It was difficult to split up touch & feel. I think my answers are mixed up’*. And the results clearly show that this mix up is a common phenomenon throughout the different participants. During the analysis, this mix up will not be taken into account, the data will be analysed in their own right, regardless of their location on the questionnaire.

### 3.3.3 Touch and the other senses

People indicated that it was difficult to describe the experience only from the tactual point of view. An experience is a whole: *‘It seems a little artificial to consider touch as separate from the other senses’*, and it seems difficult to discern what aspects are particularly related to the tactual senses. Moreover, it is difficult to avoid the other senses in the descriptions: *‘It is difficult to write only about how it feels. Several times I mistakenly wrote about how it looks’*.

## 3.4 The objects

Considering the objects people chose as examples, the question was whether it was possible to characterize them along a specific structure. First, an attempt



was made to code the objects along the materials they are made of, inspired by the fact that materials seem to play the leading role in tactual experience, but this proved to be fruitless. The types of materials were not described well enough to characterize objects and conclude on it. Moreover, most objects seemed to consist of various materials, making a characterisation difficult.

Eventually, a coding based on the type of function of the object proved to be more insightful (Table 3.1, p.90). The themes that characterize these functions reflect specific motivations that people have to interact with objects, as will be elaborated on in paragraph 3.5.1. The themes are:

#### **3.4.1 Functional objects and tools**

Objects are characterized as functional, or tools, when they are *functionally manipulated* to achieve a kind of physical result in the environment. The intention of the interaction is directed towards the outside world, for practical reasons. Examples of such objects are cameras, scissors, pocket knives and lighters.

#### **3.4.2 Leisure objects**

Objects are characterized as leisure objects when they are used to *play* with, in the broadest sense of the word. As opposed to functional use, this playing may be seen as a non-functional interaction: the purpose of the object is not primarily a functional change in the environment. This theme includes cuddling toys, sports and mobility objects used for leisure (sports bicycle). Examples are bowling balls and yo-yos, but also surfboards and tennis rackets.

#### **3.4.3 Furniture**

The theme furniture includes all objects that are used to physically *support and protect* people. These objects may be distinguished from objects characterized as tools by the fact that their use is oriented towards the personal body, rather than towards the outside world. Examples are chairs and beds.

#### **3.4.4 Personal care**

The theme personal care characterizes objects people use to take care of their body, in the broadest sense of the word. This includes hair combs, clothes, shoes, and objects carried on the body, such as jewels.

### 3.4.5 Natural objects

Although the questionnaire was explicitly asking for material objects, participants also referred to (living) objects from nature such as pebbles, shells, a frog, a snail, or a calf. On the one hand, because they were not able to think of something else, as one of the participants stated. On the other hand because the tactual experiences with these natural objects were considered exemplary for a special experience: *'I know the frog is not a man made object, but to hold it in my hands was a very special way to get to know it'*. It was decided to leave these objects in the data collection, because the experiences with these (living) natural products articulate a specific aspect of the aesthetic tactual experiences (see § 3.5).

## 3.5 Description of the human-product interaction

Initially, the question about the way the participants interacted with the objects was motivated by the fact that specific tactual properties are perceived through specific movements (Chapter 2). The purpose of the question was to assess whether the descriptions of movements during interaction are relevant in mapping the tactual experience. But this did not seem a fruitful track: the results did not contain descriptions of specific physical movements.

The analysis of the interaction with the objects introduced a different perspective on movement, which may be related to the findings of Laban (see 1.4.2.1): the participants did not describe *how* they interact, but *why* they interact. In other words, the way to code interaction is through *motivation for interaction*.

The motivation to interact is evidently elicited and reflected in the function of a product, but the results show that the motivation is not *limited* to that function. People have motivations to interact that are not primarily related to the function of the product, and these interactions play an important role in understanding tactual experience. The interactions of the participants with objects could be coded according to the following motivations to interact:

### 3.5.1 Interaction for practical, functional use, as a tool

The motivation to interact with an object was coded functional use when the object is used as a tool, in a very broad sense. The objects are *functionally manipulated* in order to achieve some kind of result in the environment. The intention of the interaction is directed towards the outside world, for practical reasons.

Evident examples are the use of scissors to cut paper, the use of a knife to slice bread, the use of a camera to take a picture, or the use of a car to get somewhere.

Objects can be used for practical reasons the object was not intended for, for example when using scissors to open a paint jar. Thus the motivation for practical tool use should not be confounded with the function of the object.

Table 3.1  
Objects mentioned by the participants in positive and negative experiences, and in childhood memories

Theme	Objects described for positive experience	Objects described for negative experience	Objects described for childhood memories (Positive and negative)
Functional objects, tools	Camera Lighter Tea cup Blender Chef knife Paint brush Pocket knife Keys Zip drive Telephone (2) Paperweight Measure tape Amplifier knob Book Smooth paper Agenda (2) Door Concrete Steering wheel (2) Gear knob	Ball pen (2) Keys (2) Dish washing brush Metal Flowerpot PC mouse (2) Drinking glass TV set Wire with tape PC accessories Kitchen cloth Pocket knife Sewing needles Gardening tools Sand paper Cutting board (glass) PS foam coffee cup Roll of garbage bags Newspaper Car (2)	Hand-gun Frozen door knob Barbed wire Tiles Cupboard
Leisure	Moped Surfboard Metal balls Yoyo Cuddling toy (2)	Slimy Bicycle (2) Balloon Bouncing ball Bowling ball	Marbles Base ball Swimming pool toys Windsurf suit Tennis racket Bicycle Touch games Moped Trampoline

			Skis Cuddling toy (4) Woodcarvings
Furniture and accessories	Bed cushion (2) Leather couch Bed quilt (2) Chair	Chair Bed sheets Wooden bench Wet shower curtain	Bed
Personal care	Leather boots Bracelet Clothes (wool) Clothes (cotton) Clothes (silk)	Shaving knife Clothes (synthetic) (4)	Plastic medical apron Woollen Scarf Towels
Nature	Rock (3) Shell Beach sand Baby	Dirty hair Snails Chopped wood Sea urchin Thorn bush Excrements Cat's tongue	Frog Raw egg Mud (2) Wet rocks (2) Excrements Beach sand Water Thorn bush Dough Dolphins Grass
Total	46	45	37

### 3.5.2 Interaction to play

Motivations for interaction were coded as playing when the primary goal of the interaction is to use the object for non-functional reasons, for playing in the broadest sense of the word, including sports or just messing around. Some objects are actually meant to play with; the motivation is then inherent to the function of the object. Examples are tennis rackets and yo-yos. But many participants describe a kind of playing with objects that were not initially meant to play with. This playing has a specific character: it is physically moving and interacting with the object just for the sake of the resulting sensation. It is sometimes referred to as 'thoughtless' playing with the object.

Some examples of this kind of interaction are: *'The lighter feels nice and heavy in my hands and has carvings that are nice to play with when I have it in my pocket'*, *'I often play with my bunch of keys: turn it round and round, and stick my finger through the ring'*. And: *'I like to play with the paint brushes, to push against the hairs again and again'*.

Besides, this playing has a development of its own. It is not only related to thoughtless fiddling, but it may present a challenge to develop specific physical tricks. Again, these tricks are done for the sake of doing it, without practical intentions: *'I play with the measure tape: I keep rolling, unrolling, and trying all kinds of tricks'*.

This theme includes cuddling as well, as a specific kind of playing with objects that expresses and satisfies affective needs (see Chapter 1, § 1.2.3).

### 3.5.3 Interaction to care for and to be taken care of

A specific theme in interaction with objects is 'to take care'. First, objects are used by participants for personal care, that is, to brush one's teeth, or to comb one's hair. Next, this taking care can be seen in a broader perspective: supporting someone is a way of taking care. In that sense chairs and beds take care of people. In both ways, this taking care of people can be the object's primary function, like a towel that dries, a chair that supports or a coat that warms. But this taking care of people by an object can be sought for independently from its function. For example, an object can warm or cool somebody, and can be held for that reason: *'Sometimes I hold the warm mug against my cheek'*. Or: *'I like to hold it, it cools my hands'*.

Participants also report that they interact with an object to take care of the object: to wash it, repair it, store it, and so on. In other words, 'taking care' is a mutual aspect of the human-product-interaction.

### 3.5.4 Interaction to explore

Regardless of its function, an object can be touched for the sake of exploring it, because it is unknown and participants want to discover how it feels: *'I saw he had a new zip-drive and I had to pick it up'*. This motivation is not necessarily restricted to unknown objects. Also familiar object can be touched just for the sake of touching it, to make contact with it, for example as is the case with a surfboard standing in a room: *'When I walk by, I touch it and feel it'*.

### 3.5.5 Interaction to carry

Some interactions with objects derive from the fact that objects are movable or portable, which involves a specific kind of interaction: carrying the object. This

carrying can be done in different ways: in a pocket, on the back, in one's hands, and so on.

### 3.5.6 Interaction by accident, by coincidence

Some interactions are not intentional or prompted by a specific motivation, but just happen by accident: participants accidentally sit on something, or bump into something.

### 3.5.7 Frequency of themes

The frequency of the emergence of themes is represented in Figure 3.3. Each theme includes the interactions with objects that are explicitly meant for that specific purpose, as well as objects that are used for that specific purpose while having another primary function. For example: the frequency of playing includes cuddling with a cuddle toy as well as fiddling with a bunch of keys.

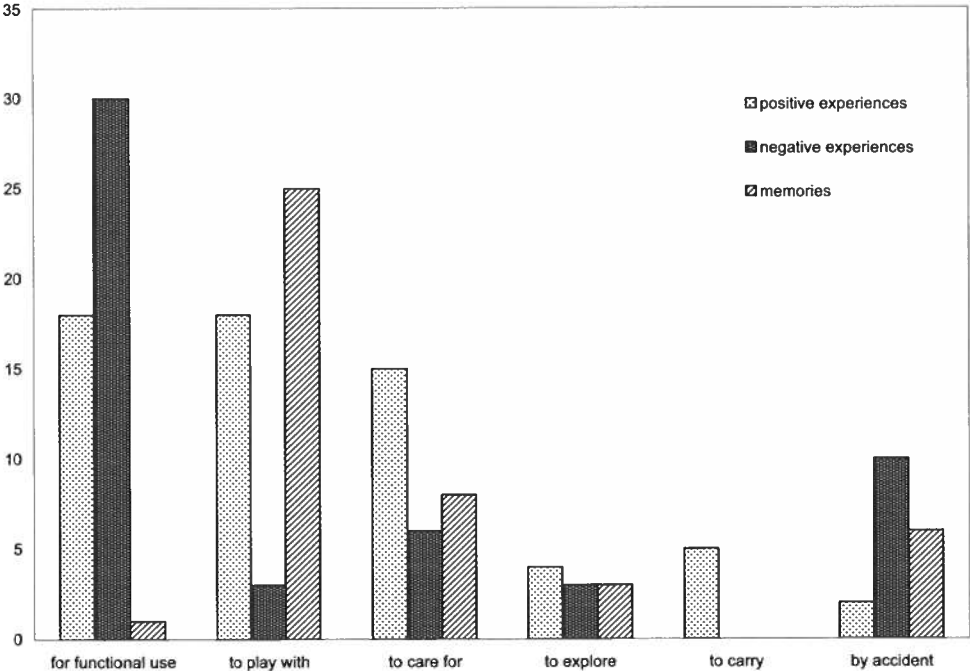


Figure. 3.3  
Frequency of the description of the motivations for interaction.

For each type of experience (positive, negative and childhood memory), the frequency of the themes is reported as the percentage of the total amount of data coded as ‘motivation for interaction’ for that specific type of experience.

The results show that for the theme functional use, the negative experiences are most frequent [ $\chi^2(2) = 23.30, p < 0.05$ ]. For the theme to play with, the childhood memories are most frequent [ $\chi^2(2) = 22.04, p < 0.05$ ]. For the theme to carry, the positive experiences are most frequent [ $\chi^2(2) = 7.69, p < 0.05$ ]. For the theme by accident, the negative experiences and the memories are most frequent [ $\chi^2(2) = 7.69, p < 0.05$ ]. For the other themes, no significant differences were found between positive experiences, negative experiences and memories (to take care [ $\chi^2(2) = 2.45, p > 0.20$ ]; to explore [ $\chi^2(2) = 0.05, p > 0.20$ ]).

Furthermore, the results suggest that the frequencies of the different themes differ for each type of experience. Positive experiences seem to occur with approximately the same frequency for functional use of the object, for playing with it, and for taking care. Unpleasant experiences seem to occur most frequently for functional use and for accidental interactions, which in some cases actually led to having an accident. It is not surprising to find playing as the leading motivation for interaction in childhood memories.

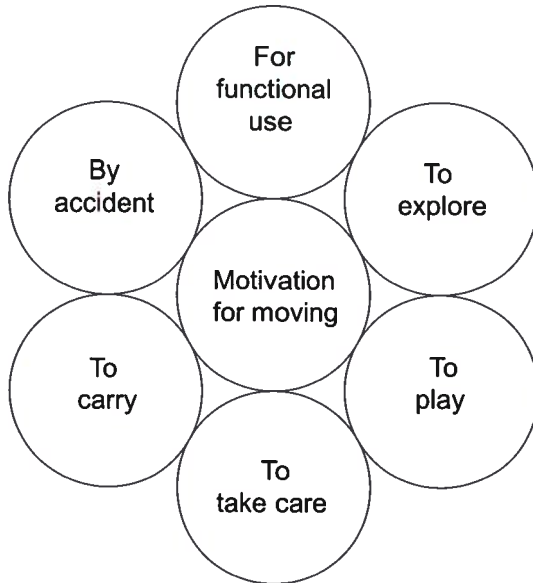


Figure 3.4  
Overview of the themes describing the motivations to interact with an object.

### 3.5.8 Conclusion on movements in interaction

Concluding, the interaction with the objects can be characterized by the motivation people have to interact with the object. The coding of these motivations led to different themes, presented together in figure 3.4 in a non-hierarchical way.

Although it did not seem fruitful to characterize the interaction through themes based on the *type* of movements involved (for example lateral movement, pressing, holding, and so on, see Figure 2.4), it should not be concluded that the type of movement is not relevant for the conceptual mapping of the tactual experience. Apparently the *type* of movement is not primarily in one's attention when describing a tactual experience. Incorporating awareness for the type of movement remains a fruitful thought, but the data did not allow proceeding on this track.

### 3.6 Description of the sensations and the body parts involved

The participants were not explicitly asked to report on the different bodily sensations involved in the interaction with the objects, nor about the different body parts involved in interaction. Nevertheless, both aspects will be discussed in this section, because chapter 2 concluded on the presumption that sensations might be a strong basis for understanding tactual aesthetics.

The section does not include physical pleasure and somatic pain. Although these aspects of tactual experience may be considered as bodily sensations (see § 2.4.2.5 and § 2.4.2.7), the descriptions of the participants did not allow distinguishing them from their affective response to these sensations. Pleasure and pain are therefore reported in section 3.8 about the feelings of the participants.

#### 3.6.1 Bodily sensations

The participants' answers were scanned for explicit reports on bodily sensations described in Chapter 2 (light touch, pressure, vibration, pain, itch, temperature, body posture and muscle force). But most participants did not comment spontaneously on bodily sensations involved in physical interaction. This underscores the assumption that in active touch our attention is directed more towards the object that is touched, rather than towards our own bodily sensations.

Three participants reported about pressure, and these descriptions are limited to just mentioning the sensation, such as '*Pressure on the palm of my hand*', or the



intensity of it, for example for light touch: 'You almost feel nothing on your skin', 'It is close to your skin but it feels light'.

In contrast to bodily sensations as such, many participants reported on strong bodily reactions to touching the object, such as nausea, disgust, goose bumps, cold shivers, raised hackles, and feelings of suffocation. These reactions will be discussed more extensively in section 3.8.

Three participants reported on the experience of a slight electric shock due to static electricity in the object: touching a railing or through synthetic clothes. This experience of static electricity is not reported in the literature on tactual perception, but does seem to be experienced by the participants as part of it.

To conclude, if bodily sensations are an important domain of aesthetics, the researcher explicitly has to ask for it, because people do not seem likely to report about them spontaneously.

### 3.6.2 Body parts involved

In Chapter 2 it was observed that awareness for tactual perception mainly concerns the hand interacting with the environment and the objects within. To substantiate the afore-mentioned observation, an overview was made of the different body parts involved in interaction. The descriptions of the interaction often do not explicitly mention which part of the body is touching and being touched. Therefore, an interpretation had to be made based on the descriptions of the interaction. The interaction was coded 'whole body' when the whole body was involved, for example when laying on a bed or playing in water. Next, the interaction was coded along a specific body part, when the description of the interaction leads to the conclusion that these body parts must have been involved. For example, sitting on a relaxing chair implies that the buttocks, the back, the legs and the arms are touched. Playing with a yo-yo implies that the hands are touched and shaving involves the hands and the head.

The results suggest that for the hands [ $\chi^2(2) = 5.29$ ,  $p < 0.10$ , tends to be significant] and for the whole body [ $\chi^2(2) = 5.58$ ,  $p < 0.10$ , tends to be significant], the frequencies differ between positive experiences, negative experiences and memories. Furthermore, the results suggest that the frequencies of the different body parts involved differ for each type of experience. The results seem to confirm that attention for the tactual experience of material objects is mostly oriented towards the hands. But it should not be concluded too quickly that hand-object interactions *are* dominant in our tactual experience of the material world. In childhood

memories the whole body seems to be involved more often, suggesting that tactual experience might have been a broader experience in childhood, gradually reduced to our hands. It might also be an indication that it is difficult to talk about the tactual experiences beyond our hands, due to the intimate aspect of these experiences. As one of the participants stated: *'These questions are too Freudian to me...'*

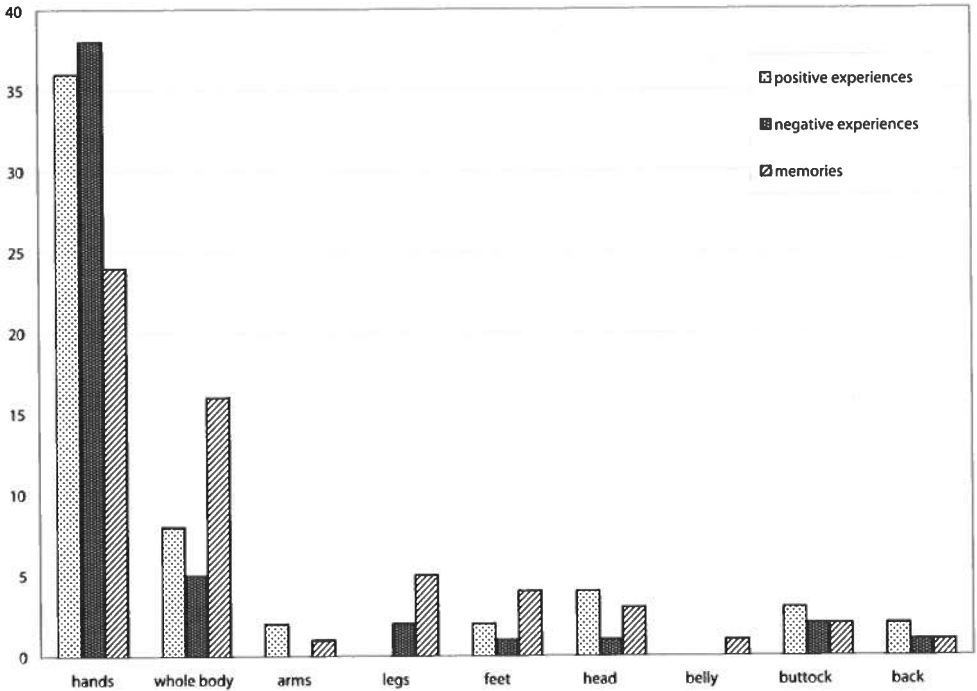


Figure 3.5  
Frequency of the descriptions of the body parts involved in the description of the interaction with the objects.

Figure 3.5 shows the frequency of the body parts involved. For each type of experience (positive, negative and childhood memory), the frequency of the body parts involved is reported as the percentage of the total amount of data coded as 'body parts involved' for that specific type of experience.

### 3.7 Description of the tactual properties of the objects

This section analyses the description of the perceived tactual properties of the object and the frequency with which these properties were described. Table 3.2 to 3.7 illustrate the descriptions of the different tactual properties with examples of

quotes of the participants. The section concludes with a description of an overall theme to describe tactual properties of objects.

The descriptions of the tactual properties were coded using the set of tactual properties described in Chapter 2. No additional properties were found.

However, the results led to some additional descriptors to characterize these properties. The properties used to code the descriptions are:

- Geometrical properties: shape and size
- Texture and surface
- Hardness, elasticity and plasticity
- Temperature
- Weight and balance
- Properties of moving parts

### 3.7.1 Geometrical properties: shape and size

The geometrical properties concern the shape and size of the objects. The descriptions of the geometrical aspects confirm the descriptors formulated by Lederman and Klatzky and reported in chapter 2. Table 3.2 reports these descriptors, illustrated with quotes from the participants. In addition, some descriptions show that objects can be experienced as *'Shapeless'* in the hands of the participants, as for example a lump of bread dough.

The descriptions of the geometrical properties show that participants perceive these properties in relation to their own body shape and measures. Thus shape and size are not only described as properties of the object, but also as fitting (or not fitting) the user.

Table 3.2 Descriptions of geometrical properties.

Descriptor	Examples of quotes
Curvature:	<i>'Straight'</i> <i>'Rounded'</i> <i>'Flowing transitions'</i> <i>'Funnel shaped'</i> <i>'It has a waist'</i> <i>'Curved'</i> <i>'A little rounded'</i>
Surface discontinuities	<i>'No sharp edges', 'Sharp', 'Sharp edges everywhere'</i> <i>'All kinds of protruding parts'</i>
Orientation:	<i>'Good angle of inclination'</i>

Size and volume	<i>'Doesn't fit', 'Good fit', 'Fits the hand well', 'Diameter is perfect', 'Too thin' 'Too small' 'Too big'</i>
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### 3.7.2 Surface texture

Texture and surface are mainly characterized by the descriptor rough / smooth. The descriptors sticky / slippery also emerge from the data. Bumpy / flat and pattern are joined into one descriptor: structure. In addition, wet / dry seems to be a descriptor characterizing texture. The descriptor soft / hard is not coded as an aspect of texture but of material properties, see paragraph 3.7.4.

Especially for the descriptor roughness, participants seemed to experience difficulty in describing the texture of a product, because the vocabulary lacks nuances. Some participants used analogies to overcome this shortage of words, such as *'It feels like a smooth rock'*. Another way to describe the texture properties, seems to be by describing what has happened to it: *'It feels worn out', 'It is polished'*.

Table 3.3 Descriptions of surface texture.

Descriptor	Examples of quotes
Rough / smooth	<i>'Something between smooth and rough' 'Smooth in the wrong way' 'Smooth but not completely smooth'</i>
Sticky / slippery	<i>'It sticks' 'It has friction'</i>
Wet / dry	<i>'It is sweaty' 'It absorbs fat and moisture from your hands' 'Greasy', 'Slimy', 'Dusty', 'Dry'</i>
Structure	<i>'Hairy' 'With splinters' 'With engravings' 'With ribs'</i>

### 3.7.3 Hardness, elasticity and flexibility

The material properties involve the hardness, elasticity and plasticity of the material: what happens when you squeeze it, bend it, and so on. Descriptions related to viscosity were not found in the set of data.

When these properties were described in terms of adjectives, the short descriptions and restricted set of words, mainly 'Hard' or 'Soft', suggest that it is difficult to describe material properties with nuance.

Material properties were often described as a reaction of the object, elicited by the action of the participants, for example: 'It offers resistance'. Although closely related to elasticity, flexibility were coded as a separate descriptor, because it seems to represent a specific behaviour: it describes the reaction to bending, whereas elasticity describes the reaction to squeezing and stretching.

Table 3.4 Descriptions of material properties

Descriptor	Examples of quotes
Hardness / softness	Adjectives: 'Hard' 'Soft' Actions: 'Doesn't give in' 'It offers resistance' 'It resists'
Elasticity / plasticity	Adjectives: 'Transformable' Actions: 'It comes back to its initial shape'
Flexibility / stiffness	Adjectives: 'Flexible' 'Springy' 'Rubbery' Actions: 'It bends' 'It bounces'

### 3.7.4 Temperature

The descriptions of the temperature of the object can be factual, using adjectives; also as an active aspect, for example 'It warms me'. Also, more than once people appreciated the fact that an object could 'Easily take over the temperature of the body'.

Temperature was not only described as an aspect of the object, but perceived through, and related to the temperature of the body, for example 'Too warm'

*'Slightly too hot', 'Body temperature' or 'A little cooler than my hands'.*

Table 3.5 Descriptions of temperature

Descriptor	Examples of quotes
Warm / cold	Adjectives: 'Cold', 'Cool', 'Warm' Actions: 'It refreshes me' 'It cools my hands' Related to body: 'Too warm' 'Slightly too hot', 'Body temperature' 'A little cooler than my hands'

### 3.7.5 Weight and balance

Weight and balance form a single code, as it seemed difficult to distinguish one from the other in tactual experience. Well-balanced objects can feel light because they are easy to move, and badly balanced objects can feel heavy because they are difficult to handle. Participants mostly used adjectives to describe these properties, and qualified them in relation to the desired situation: *'Too heavy'*, *'Too light'*, or *'Good balance'*.

Table 3.6 Descriptions of weight and balance

Descriptor	Examples of quotes
Heavy / light	'Heavy', 'Light' 'Too heavy', 'Too light'
Balance	'Good balance' 'Centre of gravity in the hand'

### 3.7.6 Moving parts

Participants described the way the movements were made in terms of duration, speed, flow (the development in time, the term is borrowed from the vocabulary developed by Laban, see 1.4.3.1) and force. Next, the movements were described in terms of what the object was doing, its activity and its effect. In addition, participants commented on the mechanical aspects of the construction (its strength). Although this does not belong to moving parts strictly speaking, these

descriptions were coded as such because they were experienced as the possibility of movement between the different parts of the object.

The descriptors of moving parts will need further elaboration in future studies, through analysis of descriptions of a set of objects that offers a broad pallet of mechanisms.

Table 3.7 Descriptions of moving parts

Descriptor	Examples of quotes
Force	<i>'Too much movement resistance'</i> <i>'It is stuck'</i>
Development in time: Duration	<i>'It takes a long time'</i> <i>'It suddenly starts and ends'</i>
Development in time: Speed	<i>'This object has speed (and rhythm)'</i> <i>'It is slow'</i>
Development in time: Flow	<i>'This object has rhythm'</i> <i>'Smooth suspension'</i> <i>'It glides smoothly'</i> <i>'Jolting'</i> <i>'Shaking'</i> <i>'It gets jammed'</i>
Activity	<i>'It scratches'</i>
Strength of construction	<i>'Solid' 'Fragile'</i> <i>'Tough' 'Robust'</i> <i>'Weak' 'Too weak'</i>

### 3.7.7 Frequency of tactual properties

To get an impression of the awareness of the participants of the different tactual properties, the frequency of the data coded with these labels is reported in figure 3.6. For each tactual property, all units of data were counted. A set of data from one participant may contain several units of description referring to that specific property, for example the texture of the object. In that case, all the data units were counted, resulting in a higher amount of data units than participants for some properties.

For each type of experience (positive, negative and childhood memory), the frequency of the themes is reported as the percentage of the total amount of data coded as 'tactual property' for that specific type of experience.

The results suggest that overall, the frequencies of the different tactual properties differ. Most descriptions (75 % of the total amount of descriptions) concern the properties related to the materials the objects are made of (texture, hardness, elasticity, temperature and weight), whereas only 20.5 % of the descriptions concerns the geometrical properties of the object (shape/size). This confirms the conclusions of Lederman and Klatzky (1993) on the prevalence of matter over form in tactual perception. Texture seems the most extensively described property of these material properties (51 %) and the most extensively described property of all descriptions (38.9%).

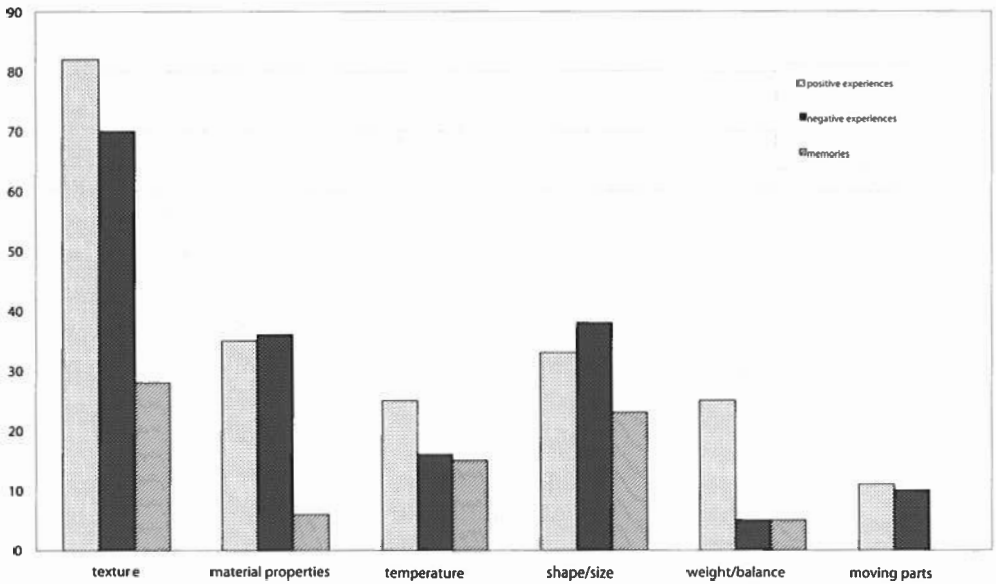


Fig 3.6  
Frequency of the descriptions of tactual properties.

### 3.7.8 Conclusion: about physical behaviour

In the analysis reported above, the properties were coded along the different properties distinguished in Chapter 2 (Figure 3.7). This might suggest that these properties are perceived as distinct from each other, but the descriptions show that the properties seem to be perceived in relation to each other. Separate properties are described as ‘fitting’ together or not, and contrasting aspects may be part of one experience, for example: *‘It was soft, and at the same time a little rough, especially on the edge, and that was actually the best of it’* and: *‘It is the combination of something smooth and something rough that I like’*.



In addition, people seem to perceive objects first of all as objects, and not as the sum of their properties. For example, *'Your fingers can glide over it in a natural way'* seems an overall description of a combination of different tactual properties. This leads to the conclusion that perception of an object's properties should be considered from a holistic perspective, in the context of each other, thus as tactual gestalts (see 1.4.2.2 on Gestalt theory). The question is whether it is possible to define an umbrella concept describing the tactual properties of an object as a whole.

This umbrella concept can be found in the observation that the tactual properties of the object are often described in terms of actions, using verbs. The actions of the user, such as *'I push it'*, *'I hold it'*, *'I shake it'*, *'I sit on it'*, and *'I drink out of it'* result in reactions of the object, such as *'It resists'*, *'It moves along with me'*, *'It cuts'*, and *'It scratches'*, *'It sticks to my lips'*. This seems especially to be the case for texture, material properties, balance and for the descriptions of an object's moving parts. Therefore, it may be concluded that in physical interaction, the physical properties of an object are experienced in terms of the *physical behaviour* of the object. This enforces the observation of Chapter 2 that the notions of 'active touch' and 'passive touch', described as a person touching an object and being touched by an object, form a two-way concept: 'interactive touch'. In other words: one has to move to touch and, inversely, the object that is touched is perceived in terms of the way it moves.

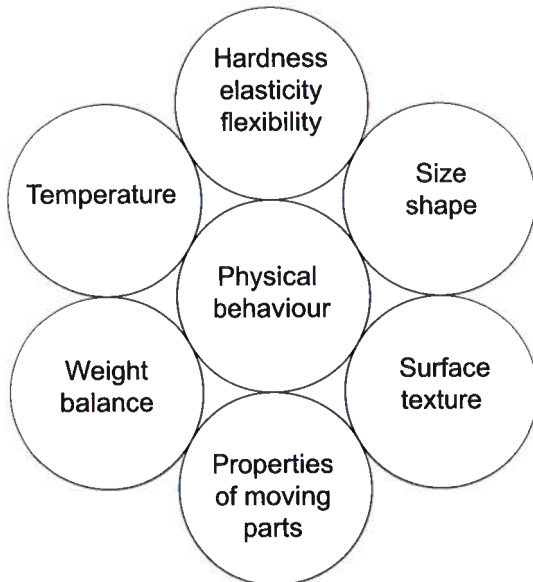


Figure 3.7  
The themes representing the tactual properties the participants described.

### 3.8 Description of feelings in tactual experiences

This section discusses the description of the participants' feelings elicited in interaction. The themes are described as concepts structured along polarities, coded as follows:

- Physical pleasure: lust and pain or disgust
- Affection: love and hate
- Vulnerability: trust and fear
- Energy: tension and relaxation
- Action tendency: approach and avoidance
- Self experience

#### 3.8.1 Physical pleasure: lust & pain or disgust

Obviously, (un) pleasantness in tactual experience is related to lust and physical pleasure. Many descriptions of participants were coded along this theme (Figure 3.9), generally characterized by *'It feels good'*, with superlatives such as *'Delicious'* and *'Delightful'*. The superlatives often included an element of being amazed by the pleasantness of the experience: *'It was even better than I thought it would be'*.

Physical pleasure does not seem to have one single counterpart. The counterparts reported were coded along two descriptors: on the one hand pain (for example: *'Painful'*, *'It hurts'*, *'It stings'*) and light to strong discomfort (for example: *'Uncomfortable'*, *'Annoying'*, *'Terrible'*, *'Horrible'*), and on the other hand disgust (for example: *'Repulsion'*, *'A dirty feeling'*, *'I have to use it, but with repugnance'*).

People were not elaborate in the descriptions of the feeling of physical pleasure or pain and disgust, these feelings were not described with nuances. The fact that these feelings are non-verbal seems emphasized by the fact that physical pleasure, pain or disgust were sometimes exemplified by expressive sounds, for example: *'Wow'*, *'Mmmmm'*, *'Ulgh'*, *'Yuk'*, *'Ouch'*, or *'I almost feel like growling'*, *'It makes me grind my teeth'*. Furthermore, the experience of physical pleasure, pain or disgust, seems grounded in a physical reaction. Therefore, people described these experiences *through* these elicited physical reactions, for example: *'Goosebumps'*, *'Cold shivers'*, *'Makes my hackles rise'*, *'It makes me feel sick and gives me nausea'*, and *'It gives me the creeps'*.

In time, the aspects of physical pleasure or disgust of the tactual experience may become worse, better, or fade away. For example about writing with a pen: *'It gets increasingly unpleasant'*, or about putting on a wet surfing suit: *'First cold and wet,*

*then nice and warm*, and about playing in mud: *'First it was gross, but at the end of the week it was delicious'*.

Physical pleasure and pain or disgust should not be confounded with the overall assessment of the (un) pleasantness of the experience. The fact that the polarity of physical pleasure on the one hand and pain and disgust on the other, does not coincide with pleasant versus unpleasant experiences is emphasized by the report of mixed experiences, for example: *'Its sliminess was disgusting, but at the same time that was also what made it attractive to touch'*, *'It hurts so good'*, and *'It is very pleasantly blubbery'*.

Moreover, it seems difficult to describe this distinction between pleasure and pain, as shown by one of the comments of a student: *'Sometimes there can be an intensive pain when the watch gets stuck on my wrist and I make the wrong move. But if I wear it there is no real pain, but I do feel some tickling. It is hard to describe this. Maybe this is also a sort of pain...like when you have a small wound: you are continuously tempted to touch it because you like the thrill of feeling pain'*.

### 3.8.2 Affection: love & hate

The feelings involved in interaction seem to be related to the experience of mutual affection, of feeling love for the object as well as feeling loved by the object. This theme reflects the observations of section 1.2.4 about touch being a communication channel for affection. This is well known in interpersonal interaction, but seems to be *experienced* as such in human-product interaction as well. The theme has different descriptors.

First of all, this feeling involves the polarity of feeling love / hate for the object. Examples of feelings of love are: *'It has cuddle value for me'*, *'I feel tenderness'*, and *'It gave me the feeling of being loved'*. And examples of feelings of hate are: *'I see it as a necessary evil'*, *'It drives me mad'*, *'Angry'*. These polarities may be experienced simultaneously: *'It is a love/hate feeling'*. The aspect of feeling affection is related to the intimacy between the participant and the product (see also § 1.2.4), which seems to emerge from the different descriptions of the feelings involved, although the concept of intimacy itself was not mentioned explicitly. Examples of descriptions that relate to intimacy are: *'I have my own way of cuddling it'*, and *'Nobody else is allowed to touch it'*.

The second descriptor involves the polarity of feeling respect / contempt: *'When you push it harder it still feels soft, but at the same time it gives some resistance, which evokes respect'*.

Third, it involves the polarity of feeling accepted / rejected. For example: *'I can be myself, it accepts me the way I am'*. Or *'It is hostile, I feel rejected'*.

And to conclude, the feelings of affection may lead to attachment: *'Although it doesn't function anymore, I can't throw it away because of the feeling of it'*.

Feelings of affection and hate may develop over time. Feelings are involved in first encounters (*'It was love on first touch'* or *'I didn't like it at first'*) and evolve through the relation between the person and the object (*'I had to get used to it, but now I love it'*).

### 3.8.3 Vulnerability: trust & fear of getting hurt

Touch involves the body in physical contact, and confronts people with their physical vulnerability. This theme is coded along the descriptor trust / distrust, which has to do with people's fear of getting hurt: *'Alarm!'*, *'I'm afraid to use it'*, *'I have to be careful not to hurt myself'*, and *'I have to stay alert'*. On the other hand, this theme relates to the feeling of being reassured, of trusting the object and feeling safe with it: *'It feels safe'*, *'Reassuring'*, and *'Trustworthy'*. Again, mixed experiences are described: *'Under water, the muddy soil was an unknown world, but once you overcame your fear, it was a source of pleasure'*.

Next, this theme is related to the feeling of freedom or oppression. For example, some clothes may give *'The feeling of being free, like Peter Pan'*. Whereas other clothes make the participant *'Feel oppressed, like suffocating'*.

### 3.8.4 Action tendency: approach & avoidance

The participants reported on action tendencies elicited by the interaction with the object, which may be considered as a component of experienced emotions (Frijda, 1986). The theme is coded along three descriptors: to approach / avoid, to hold on to or let go, and to take care of / to neglect.

First, this tendency is described in its basic aspect of approaching or avoiding the object, when the actual touching actually did not take place yet. This illustrates that the tactual experience might start before we actually have physical contact; touching with the eyes: *'I had the uncontrollable urge to feel how it feels'*. But once a person knows how bad something feels, he may *'Try to avoid it'*.

Next, once touching the object, participants describe the tendency to hold on to it: *'I never want to take it off!'* or to let go: *'Horror, when I feel it, I immediately want to pull back my hand, by instinct'*, or *'I want to throw it far away'*.

Finally, the action tendencies described by the participants may include affective behaviour. Participants reported that touching an object elicited the reaction to take care of the object, to neglect it or even to take vengeance on it: *'I want to destroy it'*.

### 3.8.5 Energy: tension & relaxation

Physical interaction with an object influences people's energy level. The energy may increase or decrease, and the energy may be experienced as positive or negative energy (Table 3.8). This leads to a coding along four descriptors: being physically excited, stressed, relaxed or washed-out.

Table 3.8 Descriptions of energy

	Positive	Negative
Increased energy	'Excited' 'Thrilled'	'Stressed' 'Irritated' <i>'I have to have something in my pocket to fiddle with, if not I'm restless'</i>
Decreased energy	'Relaxed' <i>'It calms me, and makes me daydream...'</i>	'Washed-out'

### 3.8.6 Tactual characteristics reflected in self-experience

The tactual properties of the objects being touched seem to be reflected in the self-experience of the participants. This phenomenon may occur for physical aspects; for example feeling something cold makes one feel cold: *'The glass feels cold and icy, and that is exactly how I feel'*, or: *'It feels light and therefore I feel light and free; all the burden falls from my shoulders: no worries!'*. And obviously, touching something dirty may make one feel dirty.

But the same phenomenon occurs for the experienced personality aspects of the object (see § 3.9.1). For example, when a participant experienced an object as impressive, he felt like being more impressive while using that object: *'I feel like being something 'more''*. Other examples of personality traits of objects reflected and experienced in oneself are: *'I feel elegant'*, *'Sensual'*, *'Chic'*, *'Playful'*, *'Adventurous'*, *'It is a clumsy thing, and it makes me feel clumsy'*.

### 3.8.7 Frequency of descriptions of feelings

The frequency of the different themes in the descriptions of the participants is assessed and reported in Figure 3.8. For each type of experience (positive, negative and childhood memory), the frequency of the themes is reported as the percentage of the total amount of data coded as 'feelings' for that specific type of experience.

The results show that for the theme vulnerability, the childhood memories emerge more frequently than the positive and negative experiences [ $\chi^2(2) = 10.9, p < 0.05$ ]. For the theme action, the childhood memories did not emerge [ $\chi^2(2) = 6.23, p < 0.05$ ] at all. In addition, the results show that there are no significant differences in frequencies of the different experiences for the other themes, for example for physical pleasure [ $\chi^2(2) = 0.23, p > 0.2$ ] and for affection [ $\chi^2(2) = 0.85, p > 0.2$ ].

The results suggest that the frequencies of the different themes differ for each type of experience. Not surprisingly, the aspect of physical pleasure (and its counterparts) seems to be most frequently described for all types of experiences. In addition, the theme of vulnerability (feelings of fear and of being safe) seems to play an equally important role in the tactual experiences in childhood.

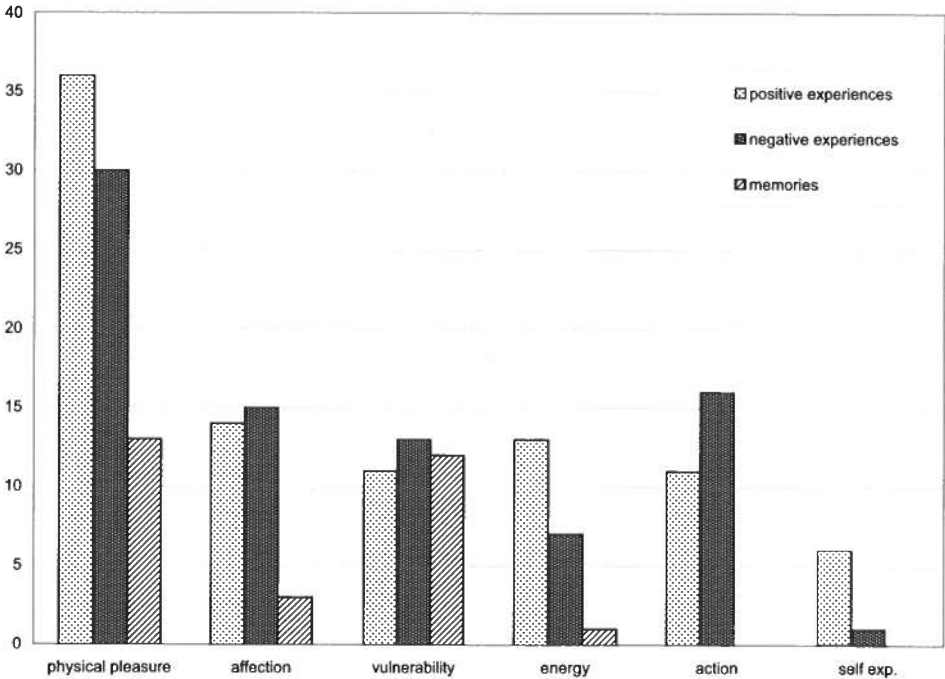


Figure 3.8 Gut Feelings. Frequency of themes describing the feelings of the participants, emerging from the descriptions of the participants.

### 3.8.8 Conclusion: about gut feelings

An attempt to characterize these themes all together led to the umbrella concept of gut feelings as the basic concept for the emotions experienced in tactual interaction (Figure 3.9). Gut feelings are characterized by feelings emerging from a non-reflective, direct interaction with the world, and may be related to the visceral level of interaction as defined by Norman (2002). Gut feelings are related to our intuitive orientation on the world, grounded in our physical actions and physiological reactions, rather than our cognitive orientation to the world, grounded in our thoughts. This explains why it is so difficult for participants to talk about touch and feelings: it is a non-verbal (or as some would say pre-verbal), intuitive mode of interaction. Studies on emotions elicited by visual stimuli led to a cognitive appraisal theory on emotion in human-product interaction (Desmet, 2002). The present study suggests that emotions elicited in the tactual mode add the intuition of the guts to this appraisal model.

The Dutch have a specific word for this sensually feeling good which is 'lekker'. This word is also appropriate for taste and smell, thus for the 'lower' senses. Unfortunately, the English language does not have such a specific term for 'gut' pleasure. Translations such as 'nice' and 'good' suggest a relation with social and ethical aspects.

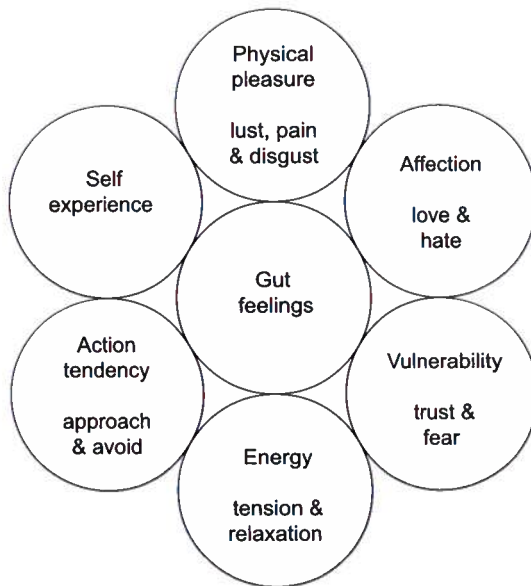


Figure 3.9  
Overview of the themes describing basic feelings of tactual experiences: The gut feelings.

### 3.9 Description of the experienced expression of the object

The affective aspects of human-product interaction involve the experienced expression of the object. In the descriptions of the participants, these expressions are coded along the following themes:

- Personality
- Intention
- Integrity
- Perfect match
- Familiarity
- Power match
- Physical skills
- Attention

#### 3.9.1 Personality

To consider objects as entities expressing personality, a phenomenon acknowledged in the visual domain (Govers, 2004), seems to be a fruitful approach to describe expression in the tactual domain as well. Product personality is defined as the set of human characteristics that people use to describe an object (Govers, 2004). The descriptions of the participants were coded as ‘personality’ when such characteristics were used.

People’s personality can be characterized by words used for material properties that can be perceived tactually: people are experienced as weak, strong, hard, soft, flexible, rigid, warm, or cold, and so on. Therefore, the world of tactual properties of objects seems a familiar world to describe personality. Also, when describing objects through their physical properties, it seems that participants actually experience the object’s personality in the same way. A cold object expresses a cold personality, and a flexible product may be experienced as having a flexible personality.

Inversely, the participants used human characteristics to describe objects, for example: *‘It is obeying, but with dignity’*, *‘It feels strong and playful’*, *‘It is arrogant: It feels like a ‘take it or leave it’ wheel’*, and *‘Untrustworthy and dangerous’*.

The personality traits experienced in tactual experience may seem related to the themes described in the section on gut feelings. For example, the wheel that expresses an arrogant personality may elicit the feeling of being rejected by the object. And an object that expresses a strong personality may elicit the feeling of being able to trust the object. Nevertheless, it is relevant to consider personality



and elicited feeling as distinct, because they are not related in an unequivocal way: a playful personality may be appreciated in a specific context, but may be irritating in another setting.

Next, it seems that objects are able to elicit feelings of sympathy in people *because* they seem social entities with personalities. For example, people reported that they feel sorry for an object that seems sad because it had a broken part, or that they wanted to take care of objects because they were cute and soften their heart.

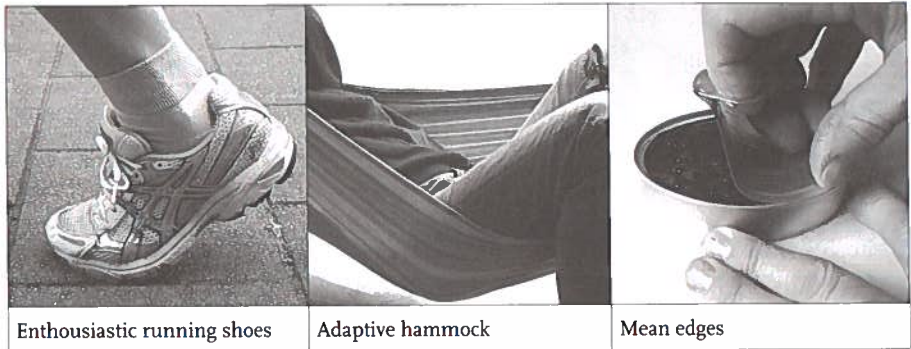


Fig. 3.10  
Examples of Personality in products.

Compatibility of personality is a leading concept in the experience of affection: a person must recognize something of him- or herself in somebody else to love the other (Armstrong, 2000). Govers (2004) showed that this is the case for objects as well: people tend to appreciate objects whose appearances match with their own personality traits. This raises the question about the relationship between perceived product personality and perceived self in tactual aesthetics. The previous section on feelings experienced in tactual interaction showed that the interaction contributes to the self-experience of a person. In physical interaction, one may experience oneself as elegant, impressive, or clumsy, and so on. In other words, the experience of personality, of the object as well as of the self, may be considered as created *in* interaction. This refines the results of Govers: to what extent is it possible to consider an a-priori personality match in tactual interaction, and to what extent is this personality match created *in* interaction?

### 3.9.2 Intentions

People have specific motivations to interact with objects (section 3.5) and it seems that people experience objects as having intentions as well. Tactual experi-

ences are coded along this theme when people describe the object as having a will of its own, expressed as intentions in its behaviour. These descriptions seem to reflect the intentions people have when they interact: it wants to be explored, to take care, to cooperate, to play, and so on. And, on the other hand, the object may refuse to play, to be explored, to cooperate and so on.

This perceived intentionality seems related to the fact that objects are experienced as having a specific physical behaviour in interaction. People move in order to experience an object. In return, the object is perceived as moving, and this movement is experienced as meaningful behaviour. The phenomenon of attributing meaning to movement is well known in the visual domain (Michotte, 1963), and the present study shows that it seems to occur in the tactual domain as well. People perceive movement, but experience intentional behaviour. Thus when an object does not react, it is experienced as refusing, rejecting. And when a chair collapses under somebody's weight, that chair may be experienced as literally and deliberately letting that person down.

The following intentions were found in the descriptions of the participants, partly reflecting people's motivations to move the objects:

*Wanting to be touched and explored.* For example: '*The balloon had some kind of 'I don't want to be in your hands' reaction*'. This intention can be illustrated by the cactus or the porcupine, that do not allow one to get closer.

*Wanting to cooperate.* For example: '*My walking shoes are much too heavy, they feel like they do not want to walk at all, they are too tired to do so*'. And '*My skateboard is stubborn and has its own will, whatever I try, it wants to go straight on!*'. This intention to cooperate or not is further illustrated by a drilling machine, that due to its perfect balance, drills holes wherever you want to drill them, or by a pair of scissors that cut in their own way, but never the way you want them to.

*Wanting to play.* For example: '*It encourages you, it says 'go on!*'. This intention is illustrated by objects that invite you to play with them, for example due to the repetitive movements they elicit. And they seem to ask you to go on playing, because they do not stop moving. Examples of such objects are rubber bands, springs, paper clips, and moving parts such as on/off switches, and ball pen mechanisms.

*Wanting to take care of,* and related, *wanting to love or hurt* somebody. This intention is illustrated by objects that literally support and take care of people, due to their function, or by objects that express these intentions in the way they fulfil their function. For example, a shaving knife may feel cooperative

in making your skin feel nice and smooth, but one moment of distraction and it strikes to cut you: *'It is sneaky: it strikes you when you don't expect it'*. Actually, an object may *'Sometimes feel as if it punishes you'*.

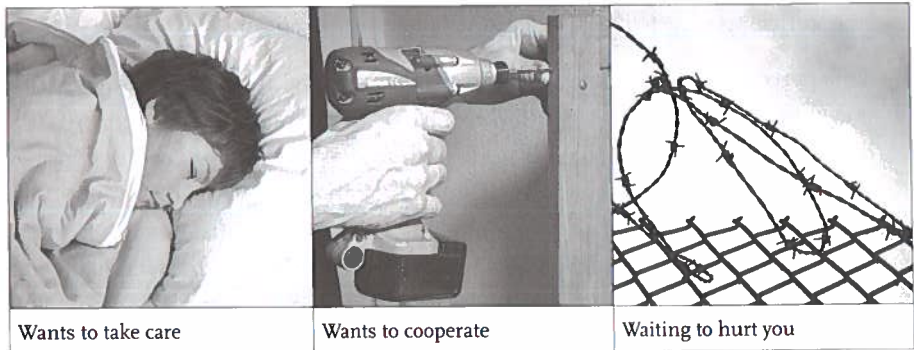


Fig. 3.11  
Examples of Intention in products.

### 3.9.3 Integrity: tactual feedback

In interaction, an object provides people with information. On the one hand, it provides information about itself, for example about its properties, about what it is (*'I recognize the right key by touch'*) and what it is doing, and on the other hand, about the physical world around it, about what is going on. With the information it is supplying, an object can guide a person in what he or she is trying to achieve: *'At the end of the measuring tape, you can feel from the tension and the curvature how tightly you have to roll it up, to be able to close it with the button'*. The way in which objects give this tactual feedback is experienced and coded as the integrity of the object.

To start with, the integrity of the object is related to the question whether the object gives any feedback at all: products can be rich in tactual information or very poor. For example, touch screens do not let the user feel what they are actually doing, whereas other interfaces, such as steering wheels of cars, let you know exactly what is going on. Likewise, traditional photo cameras let you know through touch when they take a picture, whereas a digital camera does not give this tactual feedback. Remote control devices are good examples of objects that do not provide you with information about what is going on. More than once, people reported that they had to get used to the remote control of their car lock: in the beginning they walked back to the car to check whether it was locked or not.

Next, if objects do give information about what is happening, they can seem hon-

est about it or not. For example, coffee mugs of porcelain provide the user with the right information about the temperature of the coffee inside, they are honest about it. Polystyrene foam cups do not provide this information. People feel fooled when the coffee in the polystyrene cup is much hotter than expected.

The appreciation of the integrity of objects is not unequivocal. Like for the interaction with people, being teased or fooled may be part of a pleasant experience, depending on the context of the interaction. This principle is often applied in toy design, for example, in the case of the crocodile that bites when someone pushes one of his teeth: one never knows which tooth it is going to be.

The experience of tactual feedback is much influenced by the experience of the user. An experienced car mechanic will get a lot of information through manipulation of the different parts of an engine, whereas a layperson will not be able to interpret what he feels.



Fig. 3.12  
Examples of Feedback in products.

### 3.9.4 The perfect match

When touching an object, people assess the way it fits them, the way they match. People seem to enjoy the feeling that something feels perfectly right. Objects can be experienced as if they were made for the user: the perfect match. Experiences that refer to this aspect of ‘fitting’ (or not) are coded as ‘perfect match’.

This experience of being a perfect match is primarily obtained through its geometrical properties (Section 3.7.2). Examples are the tightness of a (driver’s) belt, the fit of shoes and clothes, the shape of a car seat, and the shape of tools. But examples can be found for other tactual properties as well, for example the temperature of a shower or the balance of a tool. The perfect match is also reported for

dynamic properties: for example when the object moves with you and it seems to dance with you, or when it seems effortless to operate it.

A perfect match may be experienced immediately during the first encounter, or it may emerge from an intensive interaction in time. Some objects slightly adapt themselves to the user, thus becoming the perfect match in interaction. Examples are fountain pens that adapt themselves to the hand of the user, the knife of the chef and the scissors of the hairdresser. These adapted objects, experienced as a perfect match, are so well adapted to the body of the owner that they often seem ‘impossible to work with’ for other people. This may be experienced when borrowing a bicycle: the adapted position of the pedals seems so awkward, that one initially wonders how the owner manages to move forward.

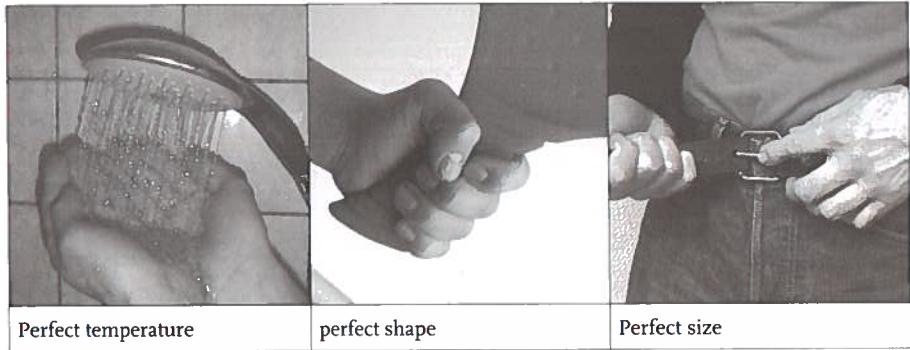


Fig. 3.13  
Examples of Perfect match in products.

### 3.9.5 Familiarity: feeling ‘mine’ or alien

When an object is frequently touched, it becomes familiar, it feels as one’s own and one is able to recognize it as such. This familiarity has its counterpart in the experience of an object as ‘alien’ and even as somebody else’s.

The new, the non-familiar can be a burden: people reported that as a child they had difficulties in accepting new clothes, because they did not feel as ‘own’. It is in wearing these clothes that they become familiar, ‘mine’. This process differs from the theme of the perfect match, in the sense that these changes do not necessarily lead to a perfect fit with the user, they just contribute to the familiarity of the object. Vice versa, the experience of a perfect match does not necessarily lead to the experience of familiarity.

In addition to frequent touch, the feeling of familiarity is created through various processes: First, the object may be unique in shape, texture, or other details, which allows the user to recognize it in time as 'his' object. Next, small changes in time due to the interaction with the object, such as small dents, scratches or other details allow the user to recognize the object as a familiar object.

To feel somebody else 'through' an object can be a bewildering experience, as some people commented on this theme. A handicrafts man stated about his old workshop: *'We all had our own utensils, stored in a personal place. When by mistake you took the utensil of a colleague, you would immediately feel it in your hands, it would feel strange, almost impossible to work with'*.

Or, as many probably experienced at one time: *'When I sit on a toilet and I feel somebody else has just used it before me, it feels strange, an intimate contact with somebody else'*.

Another student was impressed and touched by the wear of the marble steps leading to a church: *'I could feel the thousands footsteps of the people who walked there before me'*.

Familiarity is related to the aspect of time in experience: the memories of past experiences contribute to the actual one. For example: *'The bear was worn out, bald, but still had some velvet spots. I caressed these spots, they reminded me of the bear as it used to be'*. And as another participant stated: *'Every time I feel it, it remembers me of that first time'*. Touch allows people to recognize objects in an affective, intimate way: *'I was wondering if it was my grandmother's cupboard, I used to play with. When I let my hands glide across the surface of the woodcuttings, I suddenly knew: it's hers. This tactual memory was very strong'*.

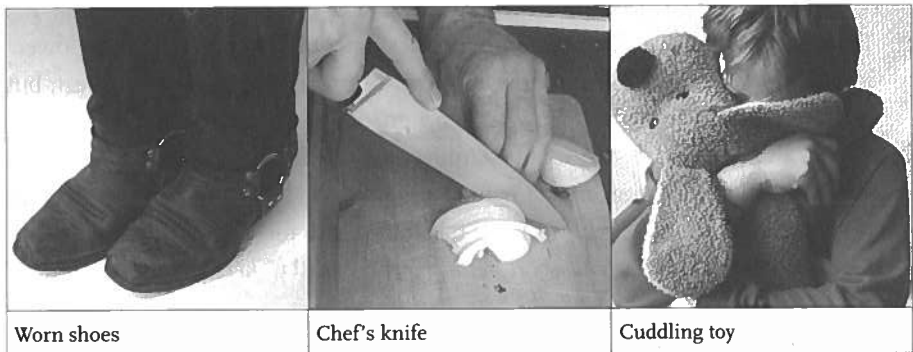


Fig. 3.14  
Examples of familiarity in products.

### 3.9.6 Power match and being in control

A physical encounter may elicit a power measurement: who is the strongest? Some products literally challenge people to arm wrestling, like a marmalade jar with a tight lid. Who doesn't want to win, and stick the lid with triumph in the air once the jar has been defeated? Or as is made explicit in the following description of one of the participants (about a yo-yo): *'On the one hand, the object keeps me busy all the time, because I want to make it move and do all kinds of tricks. On the other hand, it seems to go by itself, and especially the moment it lands with a certain speed in my hands gives me the feeling of "Gotcha!". I think it's a feeling of power, of control'*.

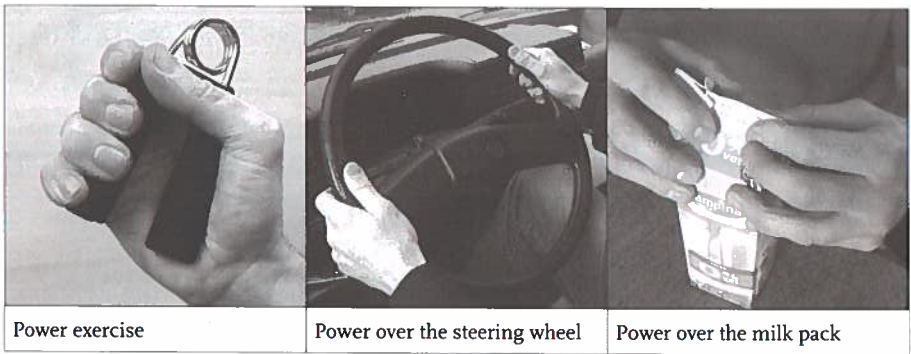


Figure 3.15  
Examples of power match in the interaction with products.

In addition, the theme of power match refers to the question about who is in control in the interaction: who leads whom?

Power seems to be mainly explored in a first encounter. Exploring this power match has two sides: it is not only about winning and being the strongest, but also about exploring limits: how far can I go? How much can I bend this stick, stretch this band, and so on. Little children learn that this exploration has a destructive side: you know once it is too late. Also, the theme of power and control is related to the requested effort one has to put into the interaction: *'You could manipulate it almost without effort, and yet get it exactly where you wanted it to ...'*

It can be overwhelming to sense the power one has, to feel that one is completely in control, for example in a car, or as in the following description of a student who activated the emergency break in a train: *'I was amazed and thrilled*



to feel that I was able to stop that train by pulling the emergency break in one, clear and strong movement'. But the opposite can be exciting as well. Luna Park attractions can be attractive because people experience that they are completely out of control: they do not have any power at all. They feel it the moment the buckle is clicking.

### 3.9.7 Challenge of developing physical skills

Physical interaction involves physical skills. For example, about a measuring tape from his mother while she was sewing: *'I tried all kinds of things with it: roll it up, roll it out. Throwing it out, making it peak or jump. Making arrows as long as possible, trying to close the button, making a whip. Rolling it up and making a little bowl or different curvatures with it, etc.'*

Objects differ in the way they challenge people to develop their skills. Some objects require great skills, such as musical instruments, and some do not, such as push buttons, although it must be emphasized that buttons do not exclude skills, as one of the students pointed out: *'I remember my phone numbers by the movements I have to make with my fingers. If somebody asks me a number, I have to make the movement to see what number I am actually dialling'*.

People may have to go through a lot of pain to develop these skills, for example in case of playing the guitar: *'Of course you have to feel from the start that somehow, some day, you will be able to do it, and that it will feel great. And the funny thing is, in the end it will look really easy to do. As if it were no trouble at all'*.

On the other side, being able to use a product right away, without feeling clumsy, may be a pleasant surprise as well: *'I was amazed and thrilled to feel that I was able to stop that train by pulling the emergency break in one, clear and strong movement, what a kick!'*

Once acquired, the practice of a physical skill can be a source of pleasure, of flow (Csikszentmihalyi, 1990). People are biologically programmed to like to develop their physical skills and to exercise them (Veenhoven, 2006).

To be able to develop skills, one has to develop 'tactical knowledge' through interacting with the objects (see also § 1.2.2 and § 1.4.5). For example, a masseur needs to 'know' from experience the human body in its different qualities, to be able to work with it. Likewise, a sculptor needs to 'know' the material he is working on from experience. The development of this tactical knowing is a relevant part of the development of physical skills, and may be appreciated as such. It is what



one refers to when saying 'I have a feel for it'. For example: *'The shape and size is perfect to be able to skim the stones on the water'*. This aspect of the theme of physical skills is closely related to the theme of tactual feedback.

Furthermore, objects differ in the way they allow people to develop a personal style when developing these skills, often referred to as a doing things with a 'personal touch': *'The movements you make can feel really sensual. I always like to close the door of my refrigerator by swinging it with my hip, and whenever I do I feel cool'*. Some objects prescribe skills in a rather unequivocal way, such as the keys on a mobile phone. Other objects allow for more freedom to develop one's own style, such as cocktail shakers.

Some objects have their own, personal user manual that only the user knows. This is a particular form of physical skill and of 'knowing', because it has nothing to do with an established skill. This skill is related to objects with a stubborn personality, who are manageable in a particular way, that one has to discover and to know. For example: *'The door of the microwave needs a particular approach: you have to close it with quite some effort, open it again, and then close it while you slightly lift it up and hold the 'open' button while you close it. That's the only way it will work'*. People may recognize that behaviour in using their keys as well: these stubborn objects often need a specific approach.

The theme of physical skills is closely related with the theme of power. When objects require physical skills to interact with them, they will have power over a person as long as this person does not develop these skills. For example, a car seems uncontrollable when you do not know how to drive it, and juggling balls obligate you to run after them as long as you do not master them.

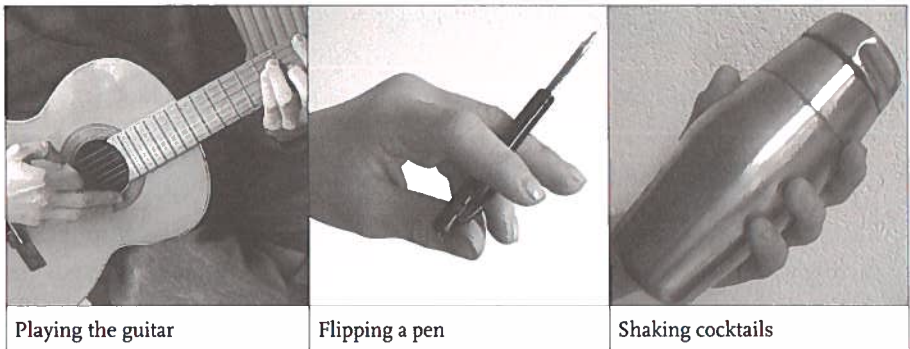


Fig. 3.16  
Examples of Physical skills in products.

### 3.9.8 Attention: tactual transparency and tactual noise

When touching an object, people are in contact with that object, but their attention is not necessarily directed towards the object. The theme ‘transparency’ refers to the capacity of the object to allow people to *feel through* the object, to incorporate it, and to direct their attention to something else in their environment. For example, a mobile phone may ‘disappear’ in one’s perception, allowing one to direct attention to the person one is talking to. But a sharp edge on the telephone, or a sticky material, may cause ‘tactual noise’: the object does not become tactually transparent, but keeps asking for attention. Likewise, driving a car or a bicycle is a typical example of this capacity to ‘feel through’: people experience the road surface through the steering wheel and through the seat or saddle. A bicycle may give the feeling of *‘Having a good contact with the road, and to feel the road instead of the bicycle’*. But a shaky construction or sticky handles may ruin this tactual transparency, for example, about the handles of a bicycle: *‘It irritated my hands, and therefore diverted my attention from enjoying the environment’*. When playing tennis, people experience the impact of the ball against the racket, and a blind person experiences the environment at the end of his stick.

Condoms and surgical gloves with *true touch* are typical examples of products for which manufacturers have tried to decrease tactual noise. But notwithstanding these efforts, these objects may stay in one’s attention: *‘Making love when using a condom is like washing your feet with your socks on’*. Also, condoms are a good example of the dual design possibilities of tactual transparency: either they are designed as tactually transparent as possible, or the designer accepts the fact that people perceive it anyway, and designs that tactual experience.

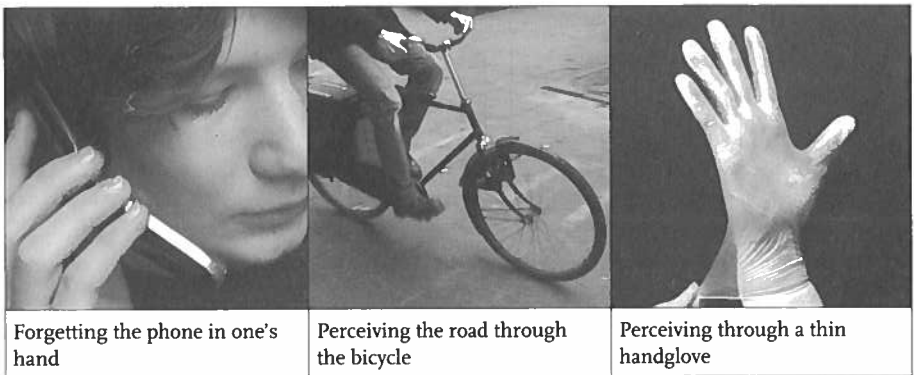


Fig. 3.17  
Examples of tactual transparency in products.

### 3.9.9 Frequency of the themes

The frequencies of the themes characterising affective behaviour is shown in Figure 3.18. For each type of experience (positive, negative and childhood memory), the frequency of the themes is reported as the percentage of the total amount of data coded as 'affective behaviour' for that specific type of experience.

The results show that for the theme intention, the positive and negative experiences emerge more frequently than the childhood memories [ $\chi^2(2) = 6.73, p < 0.05$ ]. For the theme familiarity, childhood memories are most frequently described [ $\chi^2(2) = 41.56, p < 0.05$ ]. For the theme perfect match, the positive experiences emerge most frequently [ $\chi^2(2) = 7.3, p < 0.05$ ]. Next, the results show that there are no significant differences in frequencies of the different experiences for the other themes, for example for personality [ $\chi^2(2) = 1.36, p > 0.20$ ] and for power match [ $\chi^2(2) = 3.2, p > 0.20$ ].

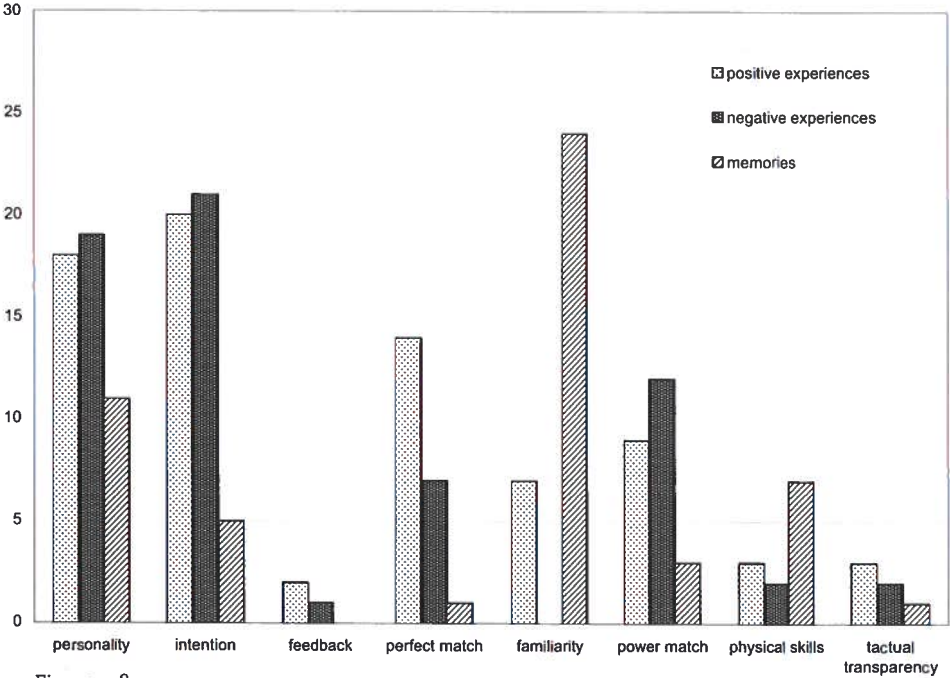


Figure 3.18 Frequency of emergence of the themes of affective behaviour in the descriptions of positive and negative experiences, and of memories.

Furthermore, the results suggest that the frequencies of the different themes differ for each type of experience. Personality and intention seem to be most frequently described for both positive and negative experiences (together 49%

of the total amount of descriptions of affective behaviour) which might be explained by the fact that these themes are more 'general' themes, whereas the other themes highlight more specific aspects. The theme 'familiarity' (involving experiences of objects as being familiar as well as of being alien) seems to be an important aspect of childhood memories (46.2% of the descriptions in childhood memories coded as 'affective behaviour' were related to familiarity). On the one hand, these memories described the joy of recognition. On the other hand the theme familiarity emerged from memories involving the excitement of the discovery of new, unfamiliar and alien sensations.

### 3.9.10 Conclusion on the themes: affective behaviour

The previous paragraphs discussed the different themes involved in the tactual experience of objects. Although some themes are more relevant than others to understand and describe *specific* experiences, they are all useful to describe the different aspects of a tactual experience as a whole. The themes should therefore be seen as different aspects of the same phenomenon. Also, they are not mutually exclusive but related to each other. Thus, whatever the perspective taken, the other themes will emerge as context.

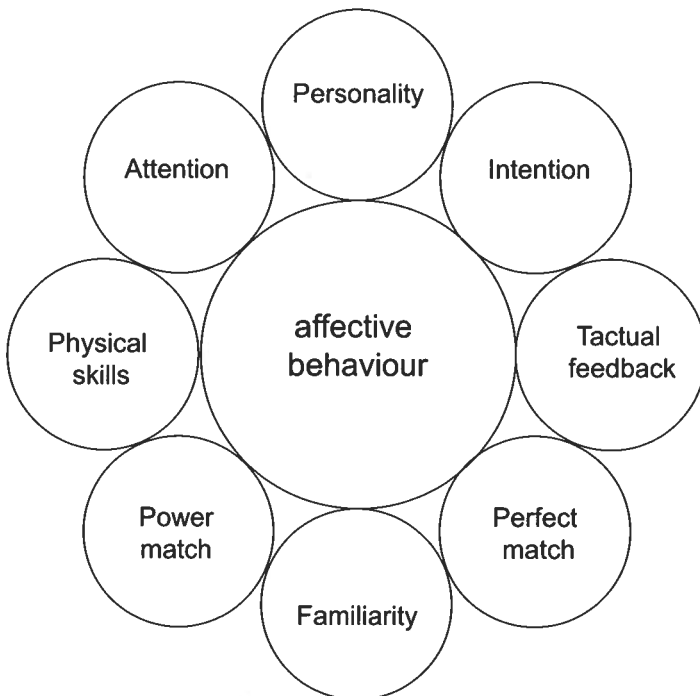


Figure 3.19  
Themes in the experienced expression of the object: its affective behaviour.

Starting point for the formulation of an umbrella concept that characterizes the experienced expression of the object as a whole is that an object seems to be perceived as being active, having a specific *physical behaviour* (see section 3.7.8) People experience meaning in behaviour (see section 3.9.3). The themes describing the experienced expression of the object could therefore be described as the experience of *affective meaning* in the object's physical behaviour. Therefore, in tactual experience, the expression of the object can be characterized as the *affective behaviour* of the object.

### 3.10 Conclusions

The exploratory study of people's tactual experiences with objects led to the necessary ingredients to construct a conceptual framework. This framework consists of different layers (Figure 3.20). Based on the processes in human product interaction, five domains of experience were discerned in tactual aesthetics (Figure 3.21). Each domain is characterized by a set of different aspects, based on the themes that emerged from the study in this chapter. In turn, these aspects can be described along the different descriptors that were found in this study.

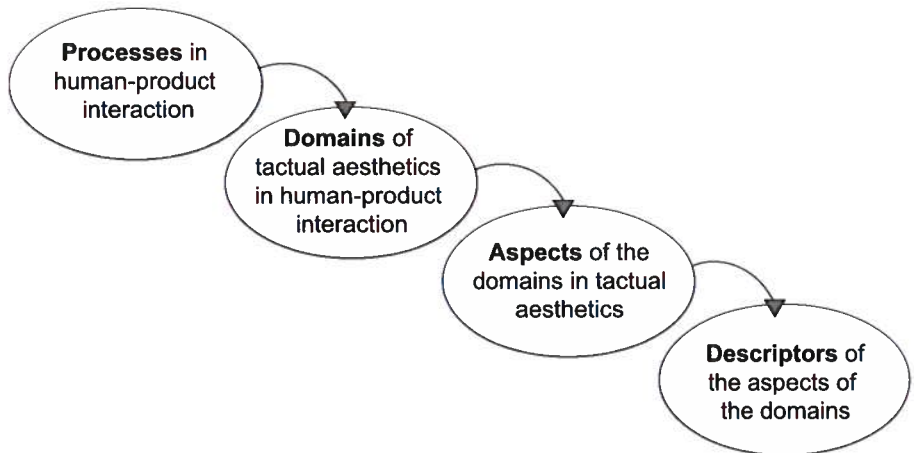


Figure 3.20  
The terminology of the structure of the conceptual framework describing Tactual Aesthetics.

This chapter concludes with an overview of the constructed framework, a description of an overall umbrella concept as characterization of the tactual experience in human product interaction, and a discussion on the appropriateness of words to describe such experiences.

### 3.10.1 Description of aesthetic tactual experiences

The five domains of tactual aesthetics are summarized in Figure 3.21. An overview of the framework, its domains, aspects and descriptors is provided in table 3.9.

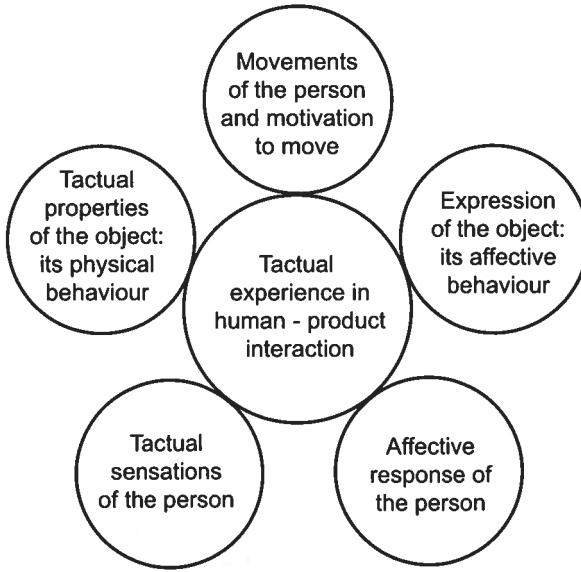


Figure 3.21  
The five domains of tactual experience in human product interaction.

### 3.10.2 Umbrella concept: the body language of animated objects

The present study shows that when people physically interact with objects, they seem to experience these objects as animated and as expressing affective behaviour. The experience can be described using a conceptual framework that reflects to the interaction as if people and objects were social entities. Movement is experienced as intentional, resulting in physical behaviour, and as having affective meaning, thus experienced as affective behaviour. This confirms the observation made in the introductory chapter that touch can be considered as an embodied communication channel for affection (Fields, 2003). Although objects cannot literally be considered as communicating affection, they do seem to be experienced as such. In touch, people express themselves and understand each other, touch can therefore be seen as a body *language* (Classen, 2005).

The present chapter described each domain of tactual experience in human product interaction with an umbrella concept that characterized the different aspects of that domain as a whole. Likewise, the tactual experience as a whole can

be characterized by the experience of an animated object with a *body language* of their own. This body language has two aspects: first, a physical behaviour, based on the tactual properties of the object. Next, this physical behaviour is experienced as having affective meaning, thus as affective behaviour. To touch is to be touched.

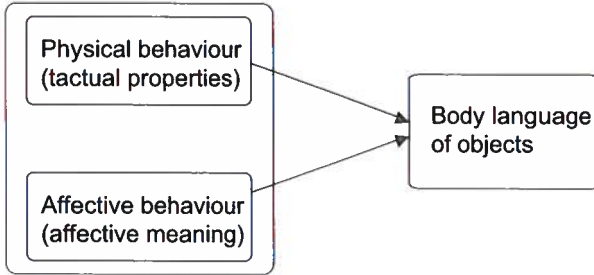


Figure 3.22  
Body language of objects.

The insight that objects are experienced as animated entities in physical interaction, with a body language characterized by the set of themes as described in this chapter, opens up new research areas as sources of inspiration for the development of further research on tactual experience. Theory on human personality, on human expression through body language, and on social aspects of human interaction may serve as starting points to formulate future research questions (Chapter7).

### 3.10.3 Time in tactual experience

The descriptions of the participants show the importance of time in experience. Interactions with objects have a history. The experience of an interaction depends on this history and changes over time. In addition, time plays a role in the interaction itself, emphasizing that the interaction is an evolving process. Chapter 2 concluded that tactual perceptions may change over time: person and object adapt to each other, influencing sensations of pressure, pain or itch, and perceptions of temperature, of size, shape and so on. The effect of time in the physical process is mirrored by its effect in the affective process. Experience in tactual interaction should therefore be considered and researched as a process evolving and developing in time.

#### 3.10.4 Verbal report as a means to gather information on tactual experiences

The present study seems to show that aesthetic tactual experiences with objects can be researched through verbal report of the participants. However, it is difficult to do so. People often lack the words to express the nuances of their experiences. These findings confirm the observation of different scholars that ‘the essentially unique and private qualities of inner experience will ultimately be beyond our linguistic reach’ (Arnheim, 1998; Manen, 1990).

The question about the appropriateness of words has two sides: the appropriateness for people to describe their immediate personal tactual experiences, and the appropriateness of words to *describe* the conceptual framework characterizing tactual experience. In the latter, it seems that words are essential to *think* about touch.

But in case of describing personal experiences, it might be that people need support to be able to express themselves. The findings of the study offer leads for the development of such a language. To start with research on tactual experiences could be structured along questions concerning *what* is being experienced in the physical and affective behaviour of the object, using the themes developed in this chapter. For every theme, a personal and refined language could be developed to answer these questions with a subtle vocabulary. Nevertheless, as verbal reports seem to miss the fullness of the tactual experience, next to verbal reports other means of reporting about the tactual experience should be explored.



Table 3.9 Themes in tactual experience.

Process in human-product interaction	Domain of tactual aesthetics	Aspect	Descriptors
Moving	Motivation for movements	For functional use To explore To play with To take care To carry By accident	
Sensing	Sensations	Location	Whole body Head Back Belly Bottom Legs Arms Hands Feet
Thinking	Tactual Properties physical Behaviour	Material properties	Hardness / softness Elastic / plastic Flexibility / stiffness
		Texture	Roughness / smoothness Slippery / sticky Wet / dry Structure
		Temperature	Warm / cold
		Shape and size	Curvature Surface discontinuities Orientation Size and volume
		Weight and balance	Heavy / light Balanced / unbalanced
		Moving parts	Force Development in time: Duration Speed Flow Activity Construction

Feeling	Gut feelings	Physical (un) pleasure	Physical pleasure (lust) Pain Disgust
		Affection	Love / Hate Feeling accepted / rejected Respect / contempt Attachment
		Vulnerability	Trust, distrust Feeling safe / Fear (of getting hurt) Freedom / oppression
		Energy	Tension / Energy leak Excitement / Relaxation
		Action tendency	Approach / Avoid Hold / Let go To take care of / to neglect
		Self experience	Reflects the object
	Affective behaviour	Personality	Tactical characteristics Human characteristics
		Intentions	To be explored or not To cooperate or not To play or not To take care / to support or not To please or to hurt
		Integrity/Feedback	To give information or not To be honest or not
		Perfect Match	To fit or not To comply or not
		Familiarity	Feeling mine / alien Familiar / new discoveries
		Power Match	To be in control or not To be dependant or not
		Physical skills	To allow to develop skills To challenge to develop To allow personal style
		Attention/ transparency	To ask for attention To become tactually transparent







# Chapter 4

## Structuring descriptions of tactual experience

### 4.1 Introduction

The exploration of aesthetic aspects of tactual experiences with objects led to a conceptual structure of aspects that characterize this phenomenon (Chapter 3). These aspects emerged from a collection of descriptions of varying objects *familiar* to the participants. Therefore, the aspects are strongly related to the context of a shared personal history with the object. The question is whether these aspects apply to first tactual encounters with *unfamiliar* objects as well and, in addition, whether the analysis of descriptions of first encounters with objects adds new aspects to the previous ones.

Furthermore, in the previous study the majority of the objects were selected by the participants, based on the pleasantness or unpleasantness to touch them. Again, the question is whether the set of aspects also applies to objects that are not specifically selected and assessed on their (un)pleasantness to touch.

Finally, in the previous study based on a written questionnaire, the objects could not be observed, nor the interaction between the participant and the object they described. The movements made in interaction are essential to the tactual experience of the object (Chapter 2). It is therefore expected that observing the interaction may lead to additional insights in the tactual experience with objects.

The exploration in this thesis is not limited to finding a set of aspects characteristic for the tactual experience. In language, in addition to a vocabulary, people also need a structure to describe their experiences. Besides addressing the appropriateness of the aspects developed in Chapter 3, the present study addresses the *structure* of the descriptions people give: *How do people describe these different aspects?*

To reach the aforementioned research goals, a second study is set up, approach-

ing the tactual experience from a different perspective: the observation of first encounters with unfamiliar objects. This chapter presents the results of the study and concludes on the relevance of the results for the design of research on tactual experience of a specific set of objects.

## 4.2 Method

### 4.2.1 Study design

Similar to the previous study, the present research approach was exploratory, based on descriptive analysis of collected qualitative data: verbal reports of people describing their tactual experience with unfamiliar objects.

Different objects were presented one by one to each participant. The participants were blindfolded to help them focus on the tactual senses, without being diverted by vision.

For each object, the participant was asked to describe how the object feels, and how he or she feels about the object. The question about the (un)pleasantness of touching the object was not addressed directly, to avoid inducing answers. It was assumed that people would spontaneously describe the (un)pleasantness of touching the stimuli when this aspect was relevant.

### 4.2.2 Participants

Fifteen people participated in the study, 7 men and 8 women, with ages ranging from 16 to 65 years (mean age 33.4 years). The participants constituted a convenience sample, recruited from the Faculty of Industrial Design of the Delft University of Technology (9 in total), students as well as staff. In addition, acquaintances of the researcher were asked to participate (6 in total), varying in background from high school students to housewives.

### 4.2.3 Stimuli

The set of stimuli had to be representative for varied tactual experiences and at the same time as limited as possible to avoid complex data analysis. Lederman (1993) showed that in tactual perception, the material properties prevail over geometrical properties. Therefore, the stimuli differed in material properties, but

they were as similar as possible in their geometrical aspects. Besides, the objects were without moving parts and without clear functional purpose, to avoid that people assessed the functioning of the object rather than the aesthetic tactual experience with the object. Balls seemed to be exemplary objects for the aforementioned requirements.

The set of stimuli consisted of 15 balls of approximately 5 cm in diameter, and differing in material properties: weight, texture, temperature, elasticity and plasticity. Together, the selected materials covered a broad range of each tactual property, in their extremes as well as in their neutral values. The properties of the stimuli are described in Table 4.1. A visual impression of the stimuli is presented in Figure 4.1. The same balls were used for all sessions. The balls were cleaned after each session, to feel as 'untouched' as possible.

Table 4.1 The tactual properties of the selected stimuli for the study.

The tactual properties were assessed by the researcher as follows:

- Texture varied from very smooth (---) to very much textured (+++).
- Hardness varied from very hard (---) to very soft (+++)
- Weight varied from very light (---) to very heavy (+++)
- Temperature varied from very cold (---) to very warm (+++)

The shape of all balls was in principle round, and thus assessed with neutral (o). But some balls differed slightly from this rounded shape, and were therefore assessed with an (+) or (++)

Material	Texture	Hardness	Weight	Temp.	Shape
Metal	---	+++	++	---	o
Marble	---	+++	+++	---	o
Crystal	---	+++	+++	---	o
Jelly	+	---	o	+	o
Wood	o	++	o	++	+
Cork	+	+	--	+++	o
Elastics wrapped	+++	-	+	-	+
Polystyrene foam ball	+	-	---	+++	o
A small tennis ball	+++	--	o	+	o
A massage ball, made of rubber with small protrusions	+++	--	o	+	o
A HDPE hollow ball	++	++	---	+	o



Structuring the tactual experience

A Hacky sack, made of suede and filled with rice	+++	---	-	+++	+
A bouncing ball, made of rubber with a smooth, sticky surface	+++	-	-	-	o
A bouncing ball, made of rubber with a rough, dry surface	+	-	-	-	o
A Koosh ball	+++	---	--	-	++














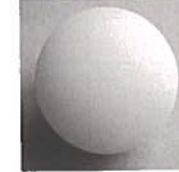

		
Metal	Marble	Crystal
		
Jelly	Wood	Cork
		
PS foam	Small tennis ball	Rubber massage
		
HDPE hollow	Wrapped rubber bands	Hacky sack, suede
		
Bouncing ball, sticky surface	Bouncing ball, smooth surface	Koosh ball

Figure 4.1  
The stimuli selected for the study

#### 4.2.4 Data collection

The participants were interviewed one at a time. To start with, the researcher gave a brief introduction to the goal of the study: collecting and exploring people's descriptions of tactual experience of objects. Each participant was seated, blindfolded, and was presented with the balls one by one in random order.

The first question was to describe 'how the ball feels'. The question was deliberately ambiguous, because it addressed the tactual properties as well as the affective response of the participant.

It was expected that the participants would spend some exploration time at guessing what the object was and what it was made of and that they would stop once they had guessed (Gibson, 1962). The researcher stimulated the participants to go on describing the objects, without confirming or contradicting what was guessed.

To address the question about pleasantness in an indirect way, the participants were asked at the end of each evaluation whether they would like to keep the ball. The participants were free to talk as much as they wanted; they got another ball when they stopped describing the properties of the stimulus. After the whole set was described, the participants were allowed to look at the stimuli, and were asked to comment on the study.

Each session lasted about an hour. The interviews were recorded on video.

#### 4.2.5 Data analysis

The descriptions and comments of the participants were analysed using the same method as in Chapter 3. The descriptions of the participants were segmented into units of descriptions, and each unit was coded along a specific aspect of the tactual experience. In addition, the data were analysed for new aspects. The analysis was less 'open-minded' than in the previous chapter: the codes did not 'emerge' from the data, but derived from the previous study. For each aspect of the tactual experience, the descriptions were analysed on their contents, as well as on the frequency of the emergence of the aspects in the descriptions of the participants. In addition, the descriptions were analysed on their structure, to find out if an overall structure for description of aspects of tactual experience emerged from the data.

### 4.3 Structure of descriptions

Prior to the analysis of the content of the descriptions of the stimuli, the overall structure of the descriptions is presented. First, the sequence of the different descriptions is presented, followed by the possible styles of the different descriptions, to conclude with an overall structure that characterizes the descriptions of the participants.

#### 4.3.1 Free flow of descriptions

The participants' descriptions of the different domains of tactual experience were mixed (the object's tactual properties, its expression and the participant's sensations and affective responses). The participants jumped from one aspect to another and back again, there does not seem to be an overall consistent sequence of exploring the stimuli's properties and their expression. For example, for one participant the exploration of the hardness of the content of the Hacky sack led to further comments on the softness of the texture of the outside material of the sack, that was already described for its stitches, and thereby for its associations with pleasant clothes. In addition, tactual experience of one stimulus sometimes even led to further descriptions of other stimuli that were already discussed previously.

This switching back and forth between one domain of experience and the other seemed to have a specific value, because the discovery of some aspects led to further comments on properties, expressions and feelings that were already discussed before. A free flow of descriptions seems, therefore, to lead to more complete description of the tactual experience.

#### 4.3.2 Description styles: keywords, the narrative and non-verbal body language

The descriptions of the participants showed two different verbal styles. On the one hand, they described their experience through short descriptions, involving keywords (for example, *'Heavy'*, *'Too light'*, *'Dangerous'*) and short sentences (*'It sticks to your hand'*), and on the other hand through a more narrative character. These descriptions concerned events, little stories. For example: *'It has to be yours if you want to enjoy it, if it is somebody else's, I wouldn't pick it up'*, *'You really have to get into it, to its core, if you want to get a hold on it'*. And: *'It is like swimming under water and accidentally touching an animal'*. Overall, as the results in Appendix 4.1 suggest, the descriptions of the affective behaviour were mainly

described through the narrative, whereas the descriptions of the tactual properties were mainly described along keywords and short sentences describing the physical behaviour of the stimuli. But it seems that participants differed in their preference for a specific type of description style as well, which leads to the conclusion that the style of the descriptions depends on the domain that is described as well as on the personality of the participant.

In addition, participants were very personal and expressive in their descriptions. People used exclamations such as '*Ulch!*' and '*O my God!*' to illustrate their disgust ('*This is a really dirty feeling!*'). And in addition, participants used mimicry and gestures to express their feelings. For example, when receiving the jelly ball in her hands, one of the participants immediately let it go again, and turned away her head, making sounds of disgust. She picked the ball up again when she thought she was ready for it. These expressive reactions can be considered as meaningful data and reveal that people do not only describe the tactual experience of an object using a verbal language, but using their own non-verbal body language as well.

### 4.3.3 General structure of the descriptions

Although the participants' descriptions of their experiences with the stimuli differed in style and in elaborateness, an overall structure that characterizes the descriptions as a whole could be generated from the data.

This overall structure was constructed by analysing each unit of description, and by characterizing its elements. Thus, each unit of description contributed to the general structure, but does not necessarily contain all the elements of the overall structure.

Overall, people described an aspect of the tactual experience by naming the aspect, by formulating a qualification of the aspect, followed by a quantification of it, and by describing how the aspect changes in time (Figure 4.2).

This structure was found for the different domains and the aspects within these domains of the tactual experience: the descriptions of the perceived properties of the object, of its affective behaviour, of the participant's sensations, and of his feelings (Table 4.1). The examples show that a specific description may not include *all* the elements of the structure, but the structure shows that these elements *could have been* part of the description.

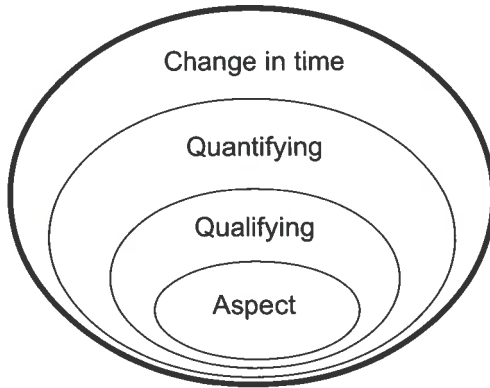


Figure 4.2  
The structure of the descriptions of the different aspects of the experience.

Table 4.2  
Examples of quotes, structured along the elements of descriptions.

Quotes:	Aspect	Qualifying:	Quantifying:	Change in time:
<i>'The texture becomes a little sticky after a while'</i>	<i>Texture</i>	<i>Sticky</i>	<i>A little</i>	<i>After a while</i>
<i>'It immediately gets my body temperature'</i>	<i>Temperature</i>	<i>Gets my body temperature</i>	-	<i>Immediately</i>
<i>'It starts to hurt after a while'</i>	<i>Pain</i>	<i>It hurts</i>	-	<i>After a while</i>
<i>'I would like to destroy it completely'</i>	<i>Power</i>	<i>Like to destroy it</i>	<i>Completely</i>	-
<i>'A little nausea in the beginning, but that vanished after a while'</i>	<i>Gut feeling</i>	<i>Nausea</i>	<i>A little</i>	<i>In the beginning, but that vanishes after a while</i>

#### 4.3.3.1 Qualifications: adjectives, nouns, associations and verbs

The qualification of the different aspects of tactual experience can consist of an adjective (*'Smooth'*, *'Rough'*), a noun (*'Grooves'*, *'Bumps'*), or a verb (*'It sticks'*). But as in the previous study (see § 3.10.4) the comments of the participants suggest that the mere use of adjectives, nouns or verbs as descriptions was not always subtle enough to describe what they perceive. Rather, this subtlety was searched for in the description of the associations one had (*'Like velvet'*, *'Like a chicken skin'*, *'Like a cactus'*). Also, the use of associations as qualifications seemed to come very easily (see the results in Table 4A.1 to 4A.15 to this chapter).

#### 4.3.3.2 Quantifying and comparing

The participants quantified their qualifications, for example, by quantifying a texture as *'A little'*, *'Very'*, or *'Way too'*, *'Rough'*. Or by characterising that an object felt *'A little'*, or *'Very much'* like an animal. In addition, besides these general qualifications, the participants frequently quantified the different aspects by comparing the stimuli in the set to each other. For example: *'This one is much heavier than the previous one'*.

The first objects presented in the set lacked this possibility to be compared to the other objects, which was reflected in the comments of the participants.

#### 4.3.3.3 Changes in time

The different aspects of tactual experiences were described as events evolving in time. A reaction of the stimulus, or of the participant, could be *'Immediate'*, *'Slow'*, *'Constant'*, or *'Increasing'*. For example: *'I remain fascinated'*. Or *'It becomes increasingly irritating'*.

#### 4.3.3.4 Conclusion

For each aspect of the tactual experience, the structure of the descriptions can be characterized by the following questions:

- How would you qualify this aspect?
- How would you quantify this aspect?
- How does this aspect change in time?

The examples presented in Table 4.2 concern the description style based on keywords and small sentences. However, more elaborate narrative descriptions fit this structure as well, because for each narrative description, the questions above help to elaborate the story that is told.

#### 4.4 Descriptions of tactual properties

The descriptions of the perceived tactual properties of the stimuli could be coded according to the aspects found in Chapter 3, confirming the usefulness of these aspects (Table 4A.1 to 4A.6). No additional tactual properties were found and, therefore, the properties will not be discussed per se.

This section starts out with two general aspects of tactual exploration that emerged from the participants' behaviour and descriptions: getting to know the object *as an object* and perceiving its physical behaviour. The section concludes with the frequency with which the properties were described for the different objects.

##### 4.4.1 What is it & What is it made of?

For every stimulus, an important goal of the exploration was to get to know the object: guessing what material the stimulus was made of (*'First I thought it was some kind of stone, but it must be glass...yes ...it is glass'*) and what could possibly be its function (*'I know it's not a golf ball, but I don't know what it is'*). The participants seemed triggered to guess both material and function, and did not stop until they found a satisfying answer to these questions. Not all materials were guessed correctly. For example, 5 participants were unable to identify the wooden ball (*'This is the most indefinable material I have had in my hands so far'*); it was mistaken once for clay and once for plastic. The jelly ball was indefinable as well for some participants, whereas metal, crystal and stone were sometimes mistaken for each other. The results of the present study seem to confirm Gibson's conclusion that people tend to stop exploring when they find a satisfying answer. Therefore, during the present study, the researcher stimulated the participants to go on with their descriptions after the guessing was done, to gain information on the tactual *experience* of the object, beyond the mere description of the kind of object and its material.

This guessing behaviour partly structured the participants' exploration strategies. For example, when one thinks it must be a tennis ball, one would explore the rubber lines on the ball more carefully, to assess whether they match the expected pattern. Likewise, guessing that the ball must be made of polystyrene was followed by a more subtle exploration of its texture as well (*'Yes, it is made of these little balls, I can feel it'*). These observations reflect the conclusion of Klatzky, Lederman et al. (1985) that the tactual system is an expert system able to recognize objects through a structured exploration (see also § 2.3.1).

#### 4.4.2 What does it do & What can you do with it?

Not all descriptions of the tactual properties could be related to one of the specific aspects of tactual properties. On the one hand, some descriptions characterized an overall behaviour of the object, such as: '*It sits in your hands*', or '*It lies in your hands*'. The stimulus was often described as responding to action, thus as being active in interaction. This behaviour could be characterized by the questions 'What can you do with it?' and 'What does it do?'. This confirms the findings of the previous chapter that objects are experienced as having a physical behaviour (see § 3.7.8). In addition, especially for the descriptions of texture, the question 'what happened to it?' characterizes some descriptions in the present study, thereby describing texture as previous reactions to actions.

On the other hand, reflecting the findings of chapter 3 that tactual properties may be experienced as tactual gestalts (§ 3.7.9), some descriptions of tactual behaviour covered several aspects simultaneously. For example, the qualification 'soft' seems to cover texture as well as hardness/elasticity, as an object can be soft to caress as well as to squeeze, as well as to do both simultaneously (caress and push). '*Fitting the hand*' is another qualification that describes an overall physical property, including for example texture, shape, elasticity and balance.

#### 4.4.3 Frequency of descriptions of properties

Figure 4.4 reports the frequency of the descriptions of properties mentioned per aspect and per stimulus. For each ball, the descriptions were separated into data units concerning a specific aspect of the tactual properties of the stimulus. The frequency of emergence of each property was counted for each stimulus. Some participants described a particular property with several different descriptions, which leads to an overall amount of descriptions that exceeds the amount of participants for some stimuli.

For each property, the frequency of the descriptions differs between stimuli: texture [ $\chi^2(14) = 88.52$ ,  $p < 0.05$ ], hardness [ $\chi^2(14) = 88.52$ ,  $p < 0.05$ ], temperature [ $\chi^2(14) = 118.2$ ,  $p < 0.05$ ], weight [ $\chi^2(14) = 108.27$ ,  $p < 0.05$ ], and shape [ $\chi^2(14) = 81.89$ ,  $p < 0.05$ ]. Overall, texture descriptions seem to dominate the comments of the participants (43.1% of all descriptions of tactual properties are descriptions of texture), suggesting that texture is the most assessed tactual property for this set of stimuli. In addition, there often seems to be a specific property for each ball that distinguishes it from the other balls. Participants emphasize this property in their descriptions and thereby neglect the other properties. For example, the



Structuring the tactual experience

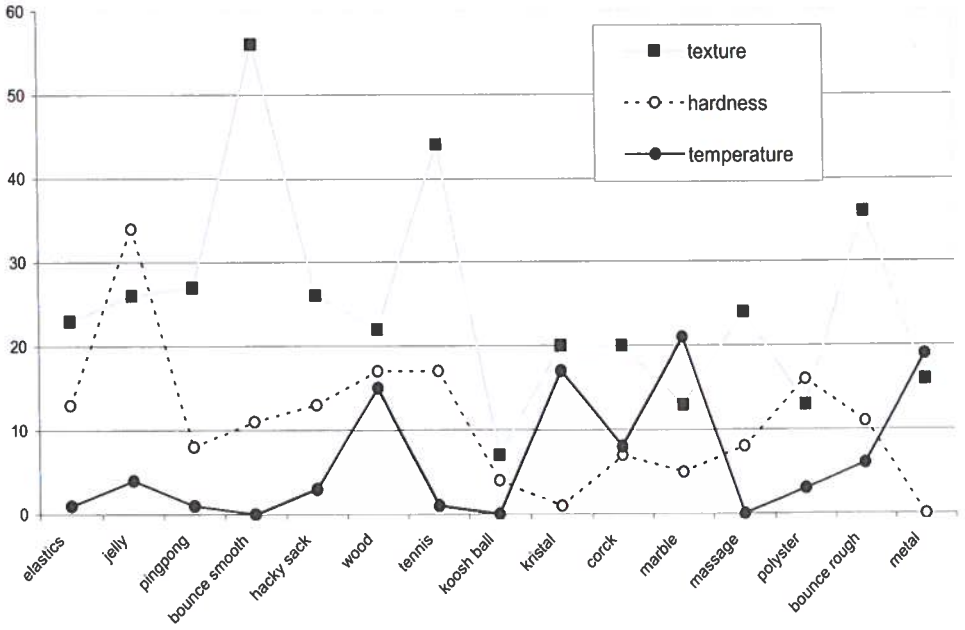


Figure 4.3 a  
Frequency of the descriptions of the perceived tactual properties: texture, hardness and temperature .

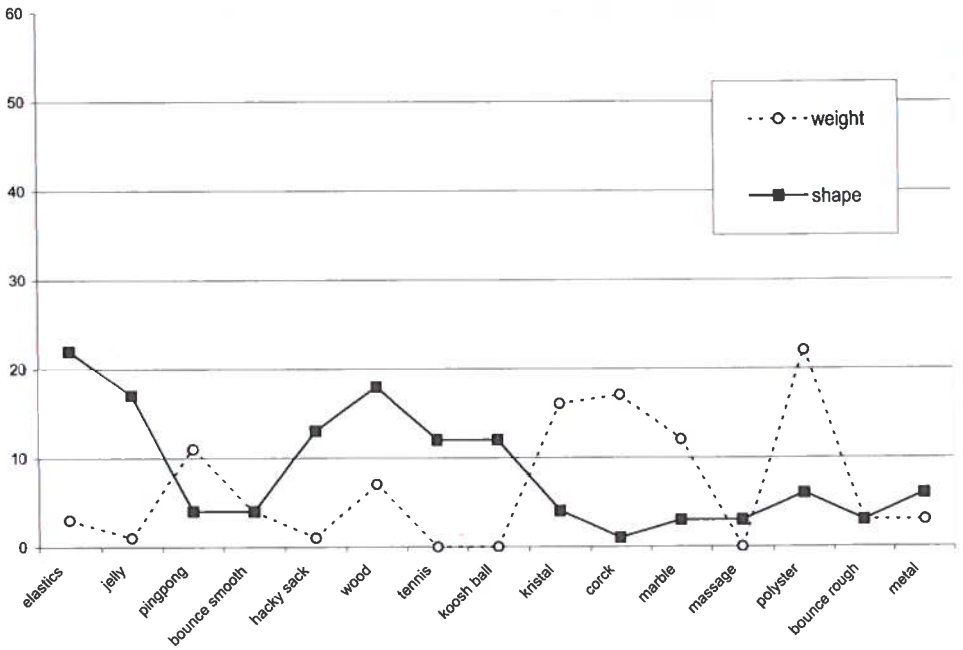


Figure 4.3 b  
Frequency of the descriptions of the perceived tactual properties: weight and shape.

texture of the rubber bouncing ball with a smooth surface was very sticky, which triggered the participants to talk extensively about it, while its weight was hardly described and its temperature was not described at all. The polystyrene foam ball seems to stand out for its lightness (weight) and the marble ball for its coldness (temperature).

#### 4.5 Descriptions of bodily sensations

The participants were not elaborate on the descriptions of the experienced tactual sensations. The sensations match the descriptors described in chapter 2. This section shows the results for the umbrella concept characterizing the sensations as a whole. Next, the frequency of the described sensations for each stimulus is presented.

##### 4.5.1 What do you sense & what does it do to you?

Overall, the descriptions of the bodily sensations could be framed by the questions: 'What do you sense?' and 'What does it do to you?' (Table 4A.7). For example, a participant may have sensed tactual sensations such as: 'Tickle', 'Pain' or 'Pressure', but these sensations were also described in terms of the object doing something to the participant: 'It hurts me', 'It tickles me', or just 'It touches me'. This underscores that sensing is about being touched when touching. Moreover, it emphasizes the fact that the object is experienced as actively involved in touching.

##### 4.5.2 Frequency of descriptions of bodily sensations

For each stimulus, the frequency of descriptions concerning a tactual sensation was counted. Some participants described more than one sensation for a specific stimulus, which led for some stimuli to an overall amount of descriptions that exceeded the amount of participants. The present study seems to confirm the results of the previous study showing that people do not often include descriptions of their sensations in the description of tactual experience.

The frequency of the description of sensations varies between stimuli [ $\chi^2(14) = 188.98, p < 0.05$ ] (Figure 4.5). It seems that the tactual experience of a specific stimulus can be characterized by the awareness of the elicited sensations. Especially the interaction with the massage ball resulted in the experience of sensations, described as pain and deep pressure. The Koosh ball, although less

frequently mentioned than the massage ball, elicits descriptions of sensations as well, described as itching and tickling. The touch of the metal ball with a moving part sometimes caused a sensation of light vibration in the hand, but this did not seem to be experienced by many participants. For the other stimuli, no sensations were reported.

Although speculative, it might be concluded that sensations seem to be elicited mostly by stimuli offering rich textures and moving parts. It might be that properties such as weight and shape, although eliciting sensations such as pressure, make people less *aware* of these sensations.

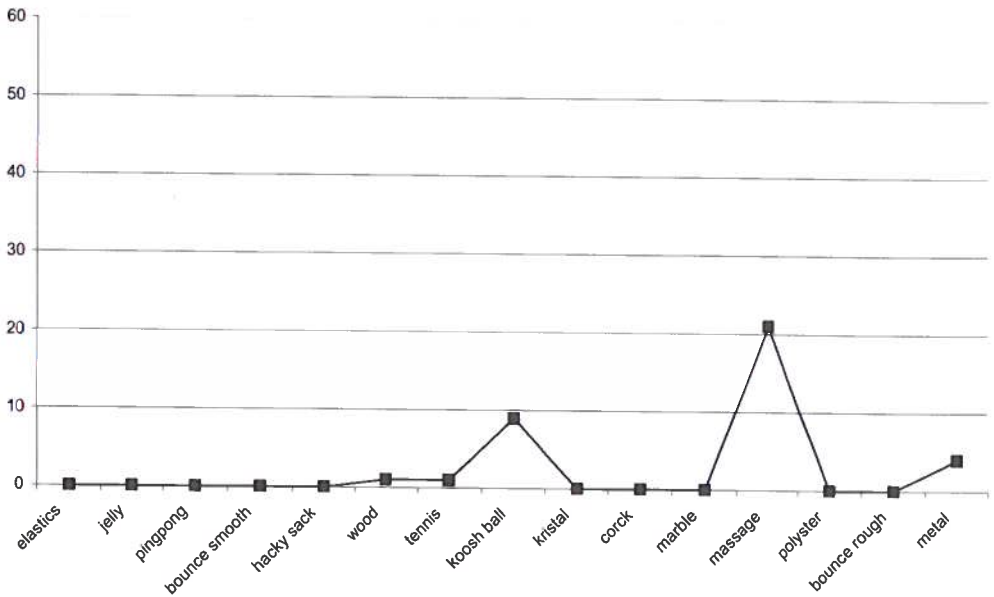


Figure 4.4  
Frequency of the descriptions of bodily sensations in tactual experience.

#### 4.6 Descriptions of feelings

The overview of the feelings reported by the participants (Table 4A.8) enforces the insight that they could be characterized by gut feelings, as described in Chapter 3: the visceral aspects of emotions. In addition, the setting of the present study adds the descriptor of feelings of surprise: *'Am I actually holding something in my hand?'* and of being intrigued: *'I cannot think of what kind of shape this is'.*

#### 4.6.1 How does it feel, How do you feel & What does it do to you?

People described their feelings as personal experiences of an emotion (as an answer to the question 'How do you feel?'), or as a characteristic of the object ('How does it feel?'). In addition, and like for the other domains of tactual experience, the question about the elicited feelings could be characterized as an action of the object as well: 'What does it do to you?'. For example, to be scared could be expressed, as 'This is a scary thing', but was expressed as 'It scares me' as well.

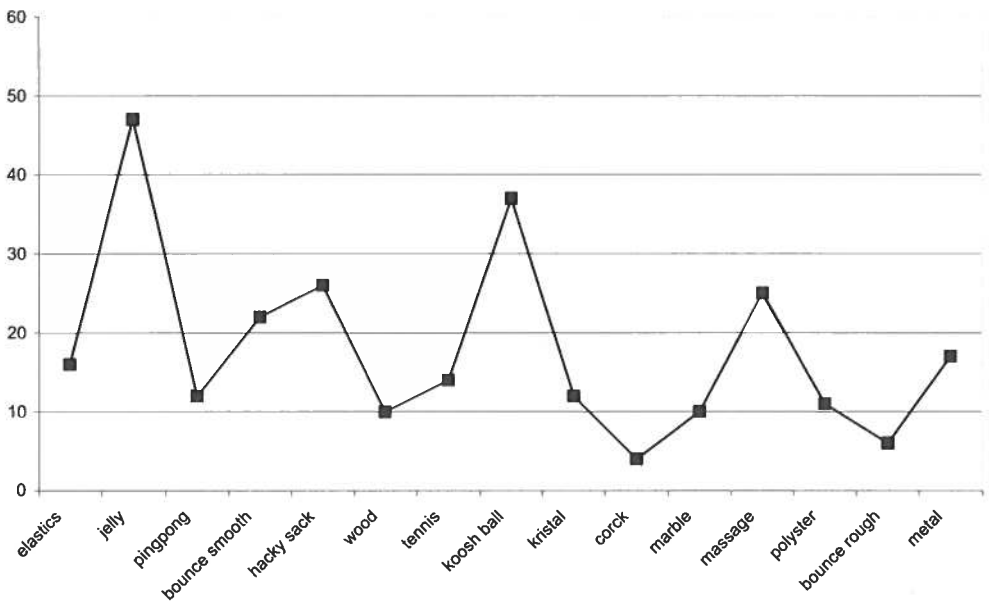


Figure 4.5  
Frequency of descriptions of gut feelings experienced by the participants.

#### 4.6.2 Frequency of descriptions of gut feelings

For each stimulus, the frequency of descriptions of elicited feelings was counted. Some participants described more than one feeling for a specific stimulus, which led for some stimuli to an overall amount of descriptions that exceeds the amount of participants.

Overall, the stimuli differed in the amount of feelings they elicit [ $\chi^2(14) = 108.82$ ,  $p < 0.05$ ] (Figure 4.6). It could be concluded that the experience of some stimuli

could be characterized by the fact *that* they elicited gut feelings. The frequencies of descriptions were not differentiated for each specific aspect characterizing the gut feelings introduced in Chapter 3, because the data were too limited to lead to additional insights. But an overview of the descriptions (Table 4A.8) suggests that the aspects 'energy' and 'pleasure & disgust' were prevailing.

The jelly ball, the Koosh ball and the massage ball elicited most feelings, whereas the wooden and the cork ball elicited gut feelings least often. The content of the descriptions of the participants suggest that they were most elaborate about their feelings when these feelings were a mix between pleasure and pain (for example for the massage ball) or between pleasure and disgust (for example for the jelly ball or the Koosh ball).

#### 4.7 Descriptions of the affective behaviour

The overall concept of affective behaviour of animated objects (Chapter 3) was appropriate to code the different descriptions in the present study. More than once, the participants used the pronoun 'it' as well as 'he' to refer to the stimulus, thus emphasizing the experience of a separate social identity. For example: *'He comes back to his old shape'* and *'He sticks to your hands'*. Some objects were explicitly referred to as *'Alive'*, *'Living'* and *'Very lively'*; *'It doesn't feel like it was manufactured, but more as if it grew like this on its own'*. The appropriate question to address the tactual experience of objects therefore seems to be: If it were alive, how would you describe its affective behaviour?

Nevertheless, not all the aspects developed in the previous chapter were relevant. The aspect 'transparency', characterising the ability to let people 'feel through' the object was not used. It does not seem to apply for this specific set of stimuli, or maybe it is not a relevant aspect when people are deliberately asked to focus on the object itself. Likewise, the aspect 'feedback' did not emerge from the data, probably due to the choice for simple stimuli and the lack of context of interaction. The aspect 'physical skills' was also not used for coding. Although many balls made people imagine what they could do with it, the participants did not refer to these possibilities in terms of physical skills to be developed. Finally, although the aspect of the object expressing intentions was appropriate to code several descriptions (Table 4.10), it emerged only incidentally (less than 2 per stimulus). The aspect is therefore not discussed further on. Thus, the affective behaviour was characterized by the aspects 'personality', 'familiarity', 'power' and 'perfect match'.

#### 4.7.1 Personality

The personality of the object is characterized by the question about the personality traits it expresses (Table 4A.9). The results led to the additional conclusion that this aspect also includes the associations that are elicited to objects for their personality traits. For example, the marble ball, due to its weight and temperature, was sometimes referred to as a weapon, emphasizing the fact that it is experienced as dangerous, whereas other participants associated it with something industrial, emphasizing its distant and impersonal character. In other words, personality may not always be described through *human* character traits, but may also be illustrated with the character traits of other *objects*, like weapons or toys. Therefore, the appropriate questions concerning the aspect 'personality' are: what are its personality traits? And 'What associations to other objects do you have?'

Much was said about the personality of the jelly ball and the Koosh ball, whereas the bouncing ball and the cork ball were described far less in terms of personality traits (Figure 4.7). This shows that objects not only differ in their character traits, but also in the amount of 'having character'. Some participants directly referred to the aspect of personality in this sense: '*It has a strong personality*'. This leads to the conclusion that a preliminary question introducing this aspect could be: does it have personality?

#### 4.7.2 Perfect Match

The aspect of the perfect match is about how well the object's properties fit the user, as well as about the object's tendency to try to fit, to adapt itself to the person (Table 4A.11). The appropriate question addressing this aspect is therefore: Does it fit me or does it adapt to me?

The descriptions showed that the aspect became important when the match is perfect, as is the case of the elastic ball, which fits well in the hand due to his slightly deformed shape. On the other hand, the aspect became also important when the match is disturbing, as is the case of the cork and polystyrene balls, which do not 'fit' because of their weight, but also because of their texture, which did not seem to 'match' the human skin. This confirms the observation in § 3.9.4 that the aspect is related to different tactual properties of the object: shape, size, texture, temperature and material properties.

For some objects (the elastic ball for example) it was an important aspect, whereas for other objects (for example the wooden ball) it was not an issue at all (figure 4.6).

### 4.7.3 Familiarity

The aspect of familiarity seems to play an important role when encountering an object on first touch (Table 4A.12 and Figure 4.6). First, the aspect was related to the attempt to try to recognize the object: Do I know it? The participants seemed to try to relate it to something familiar, and are disorientated when they did not succeed. The stimulus was then considered 'Alien', 'Weird'. If it was possible to relate it to something known, the association could be with a *familiar* thing, thus eliciting the experience of familiarity. Moreover, this often led to the phenomenon of joy of recognition: *'Ah yes, I know this feeling! It reminds me of home, I had them when I was a child!'*

Next, the aspect also plays a role from the perspective of possessing the object: *'It has to be yours if you want to enjoy it'* or *'If it were mine, then I would pick it up and hold it, but if it is somebody else's, I would not touch it or hold it'*. The appropriate question to address this aspect is: Could it become 'mine'?

Finally, the issue of familiarity seemed related to some kind of naturalness as well. As one of the participants stated: *'Maybe it is natural, but it certainly doesn't feel natural'*.

### 4.7.4 Power

In the present study, the aspect 'power' could almost be taken literally: who is the strongest? (Table 4A.13 and Figure 4.6). Especially the polystyrene ball was clearly experienced as 'Weak'. The descriptions also related to the aspect of limits: How far could one go before destroying it? It seems that some stimuli, especially the jelly and the polystyrene ball, elicited these reactions more than other balls. Obviously, some limits were clear right from the beginning, eliminating the challenge to find out. The weakness of the polystyrene ball actually elicited the participants' wish to destroy it. Having to be careful seemed a nuisance to some people, and irritated them. It was appreciated when the stimuli allowed rough handling.

### 4.7.5 Frequency of aspects of affective behaviour

For each stimulus, the frequencies of descriptions related to the different aspects characterizing affective behaviour were counted. Some participants described more than one aspect for a specific stimulus, which led for some stimuli to an overall amount of descriptions that exceeded the amount of participants.

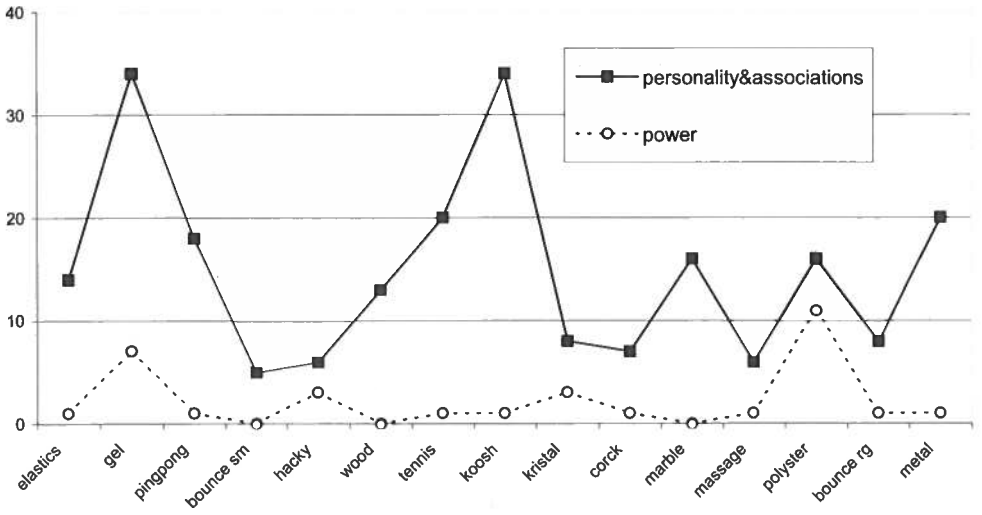


Figure 4.6 a  
 Frequency of the descriptions of aspects of affective behaviour, in the descriptions of the tactual experience: 'personality & associations' and 'power'.

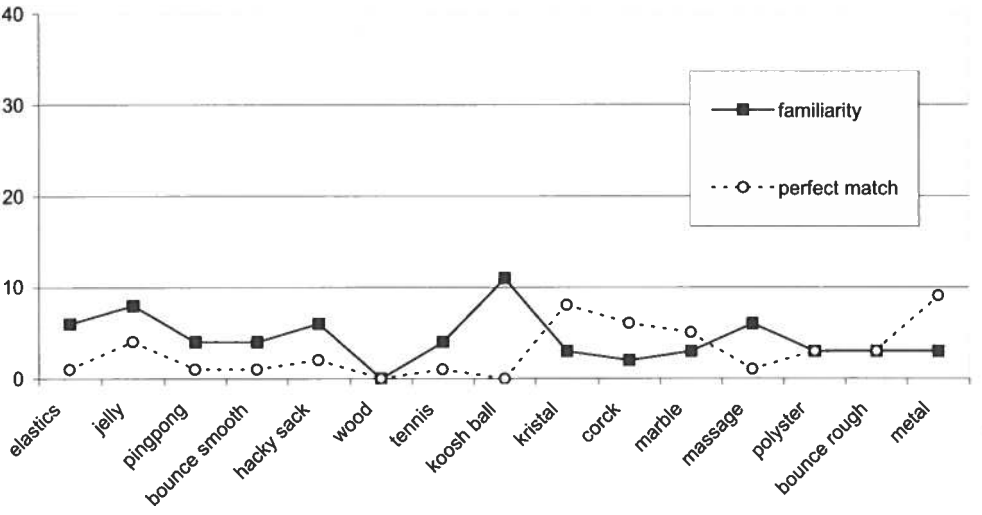


Figure 4.6 b  
 Frequency of the descriptions of aspects of affective behaviour, in the descriptions of the tactual experience: familiarity and perfect match.



For three aspects of affective behaviour, the frequency of the descriptions (Figure 4.6) differs between stimulus: personality and associations [ $\chi^2(14) = 81.28$ ,  $p < 0.05$ ]; perfect match [ $\chi^2(14) = 37.97$ ,  $p < 0.05$ ]; power [ $\chi^2(14) = 60.38$ ,  $p < 0.05$ ]; and tends to be significant for the theme 'familiarity' as well, [ $\chi^2(14) = 22.58$ ,  $p < 0.10$ ].

Overall, the stimuli seem to differ in the total amount of aspects of affective behaviour that were described (Figure 4.6). Some stimuli elicited many comments (for example the jelly ball and the Koosh ball) whereas other stimuli did not (for example the Hacky sack and the crystal ball). This suggests that the experience of some stimuli can be characterized by the fact *that* they seem to be experienced as having an elaborate behaviour, whereas others are not.

Most descriptions concerned the experience of personality of the object, described in terms of human character traits as well as in terms of associations with characteristics of other objects. This might be a result of the fact that the aspect 'personality' is a more general aspect whereas power, familiarity and perfect match are more specific aspects (see also § 3.9.9). This suggests that the aspects characterizing affective behaviour need further analysis on overlapping aspects.

#### 4.8 Descriptions of aesthetic aspects of tactual experience

The question whether the stimuli were pleasant to touch or not was not explicitly asked, but the participants reported on it extensively. Their comments will be discussed on two aspects: aesthetic behaviour of the participants, and (un) pleasantness of the experience.

##### 4.8.1 Aesthetic behaviour

The question raised in this thesis is whether people have a specific aesthetic behaviour in aesthetic experience. This question was addressed through observations of the physical movements the participants made, and through their comments elicited by the question whether they would like to keep the balls.

The observations of the participants interacting with the stimuli showed different exploration strategies. First, the participants seemed to differ in style of moving to explore the stimuli. Some people held and caressed the stimuli mostly between the tips of their fingers, thus exploring mostly the texture of the stimulus. Others held the ball in one hand, thus most of the time squeezing and manipulating the ball, and some explored the ball with both hands, moving the ball from one hand to the other, and throwing it up in the air. However, although

people showed a personal style, which could be seen as their own body language, they all showed a pallet of movements to explore the stimuli.

Next, the participants showed a specific behaviour for each stimulus, and felt that this behaviour was specific for and elicited by the stimulus: *'You see, you do this automatically: you turn it, roll it...'* The jelly ball for example, was often repeatedly squeezed but not often caressed, whereas the tennis ball was often caressed, and less frequently squeezed. The wooden ball did not elicit a lot of typical movements, and most people did not spend much time with it. Thus, the objects differed in the way they elicited the participants to move, in type of movement as well as in time spent with the object, due to its specific tactual properties.

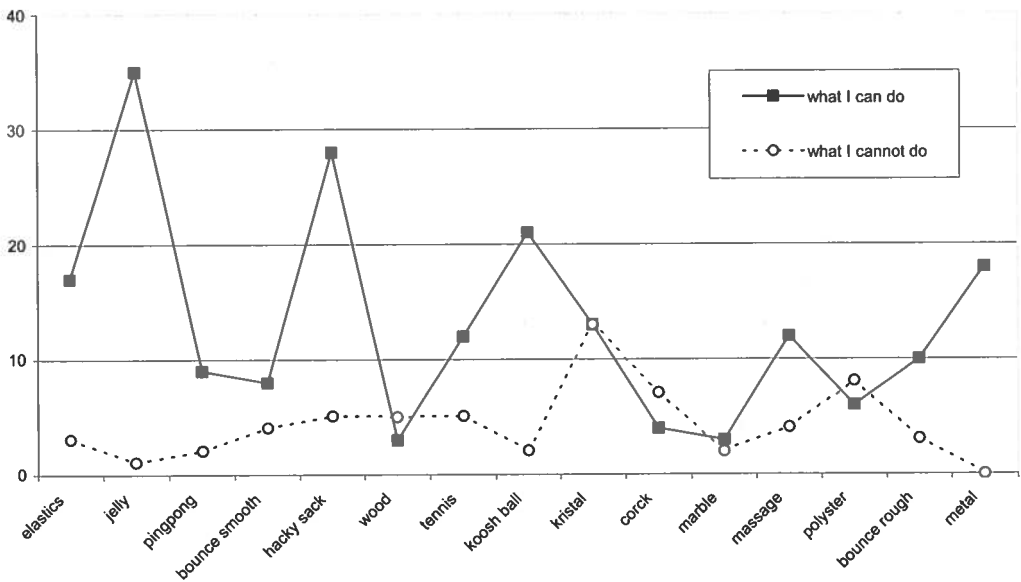


Figure 4.7  
Frequency of the described possibilities for interacting with the stimuli: the amount of reports about what can be done with a stimulus and reports about what cannot be done with it.

An important part of the descriptions of the stimuli dealt with descriptions of possible activities with the objects such as: *'I could play with it'*, *'Fiddle with it'*, *'Shape it the way I want'*, *'Massage myself with it'*, *'Warm my hands with it'* (Table 4A.14) and of impossibilities: *'There is not much you can do with it'*, *'You can not play with it'*. These (im) possibilities seem to reflect the non-functional motivations for interaction described in Chapter 3: playing and taking care of. Therefore, one could argue that aesthetic behaviour in tactual experience is related

to people exploring possible interactions with objects, especially the non-functional, playful interactions. Thus, aesthetic behaviour could be characterized by the exploration of the question: what can I do with it? Furthermore, aesthetic experience is related to the pleasure of making tactual discoveries about possible interactions.

Obviously, one could argue that balls are *meant* to play with, which explains why the participants come up with these possible interactions. The suggestions about aesthetic behaviour should therefore be verified with other type of stimuli. However, observations of people interacting with functional objects, for example paperclips and pens suggest the same type of behaviour: besides their instrumental use, people may play with them in different ways, and may use them to scratch their head or clean their nails and ears.

As stated above, the stimuli differed in the way they stimulated the participants to move. In addition, it seems that objects differed in their capacity to stimulate aesthetic behaviour, to discover possible tactual experiences. Figure 4.7 reports the amount of possibilities described for each stimulus, in terms of positive descriptions (what can be done with it) and negative description (what you cannot do). The results suggest that some objects elicited many descriptions of possible interactions, for example the jelly ball, whereas other objects did not, for example the wooden ball [ $\chi^2(14) = 90.02, p < 0.05$ ]. This can be related to the notion of an object's aesthetic potential, described in chapter 1 (§ 1.4.1) as an object's capacity to elicit aesthetic experiences. Objects seem to differ in their capacity to stimulate people to explore and discover tactual experiences related to playing and taking care of. In that sense, the jelly ball, for example, could be considered as an object with a high aesthetic potential.

#### 4.8.2 Structure of aesthetic assessment

The descriptions show that the assessment of (un) pleasantness of the experience is not only an overall assessment. (Un) pleasantness of an experience can also be assessed on the level of its different aspects (Figure 4.8). For example, a specific temperature may be described as pleasant, whereas the texture of the object is not. Likewise, a specific personality may be described as unpleasant, whereas the weight of the object is not. Furthermore, the overall assessment of an experience may be pleasant whereas some specific aspects of the experience are not.

For each aspect of the experience, the aesthetic assessment can be considered

along the structure presented in the paragraph 4.3.4 and Figure 4.2. For example, the texture of a surface can be appreciated because it is smooth (qualification), but it can be assessed as unpleasant because it is too smooth (quantification). In addition,

(un) pleasantness of an experience, or one of its specific aspects, changes over time. For example, a specific texture may be experienced initially as pleasant, but as unpleasant after a while because it becomes sticky. Likewise, a specific bodily sensation may at first be pleasant but in the end unpleasant because it irritates the skin.

Thus, the assessment of the (un)pleasantness of an experience can be considered as the assessment of the different aspects of the experience, of the elements of these aspects. Next, these assessments are embedded in an overall assessment of (un) pleasantness (Figure 4.13).

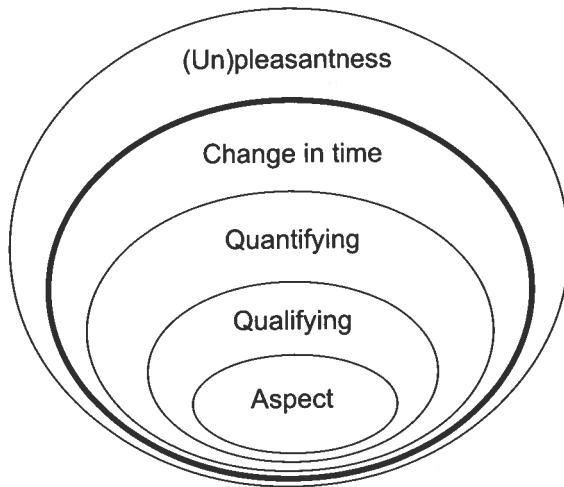


Figure 4.8  
The structure of the descriptions of the (un) pleasantness of the tactual experience.

The *qualification* of a specific aspect should not be confounded with the assessment of its pleasantness. For example, a stimulus may be described as having a rough texture, but this texture may be experienced as pleasant. Likewise, a bodily sensation such as pain or itch may be qualified as pricking, and nevertheless be assessed as pleasant (about the massage ball: *'It hurts so good'*). Thus, when researching the pleasantness of a tactual experience, it seems useful and feasible

to ask people to assess the pleasantness of the experience as a whole, but also to reflect on the pleasantness of the different aspects separately.

### 4.8.3 Pleasant, unpleasant and indifferent experiences

The participants' descriptions of the pleasantness and unpleasantness of the different aspects of the tactual experience revealed that people seemed to distinguish between something either *being experienced aesthetically* (pleasant/unpleasant) or *not being experienced aesthetically* (not pleasant nor unpleasant, but neutral). For example, the jelly ball elicited many comments about its (un)pleasantness, whereas the polystyrene ball and the two bouncing balls did not. In addition, pleasantness and unpleasantness do not seem opposites on a linear scale excluding each other, but they may co-exist during interaction. For example, several people reported that the jelly ball is simultaneously pleasant and unpleasant, because its surface is tenderly soft and its substance disgustingly jelly-ish. Likewise, the massage ball is simultaneously pleasant and unpleasant because it hurts so good. On the other hand, some objects were assessed as either pleasant or unpleasant. For example the Hacky sack did not lead to mixed feelings.

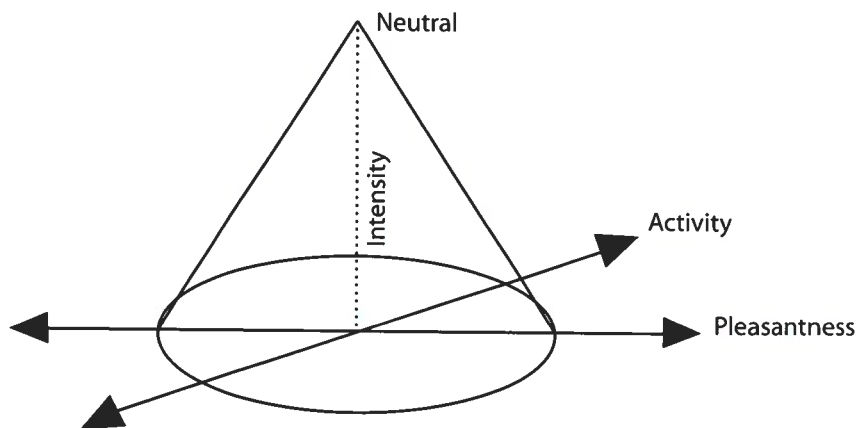


Figure 4.9

Conical model of the three dimensions of core affect: unpleasant-pleasant, active-passive, and intensity. Source: Daly, Lancee & Polivy (1983).

The objects that were not experienced as pleasant and/or unpleasant were reported as such (Table 4.A15): '*Neutral*', '*Nothing*', '*It does not get me*', and '*There is nothing going on between us*'. Examples of such objects are the cork ball and the ping-

pong ball. Thus, *neutral* seems to be an experience in its own right, and should be acknowledged as such when researching aesthetic experience. Prior to asking if an object is pleasant/unpleasant to touch, one should assess if the object is perceived as (un) pleasant at all, or if the participant experiences indifference. This relates to the findings of Daly, Lancee and Polivy (1983), who concluded in their study on basic dimension of core affect, that the traditional two dimensions of pleasantness and activity should be completed with a third dimension: the intensity of the affective experience. The neutral state added to the planar dimensions of pleasantness and activity represents the state of indifference reported in the present study. Although the cone model still does not account for mixed experiences, it is a valuable model to acknowledge ‘neutral’ as a separate state.

#### 4.8.4 Frequency of assessments of pleasantness, unpleasantness and of neutral experiences

The assessments of pleasantness, unpleasantness and of neutral for the different aspects were counted for each stimulus (Figure 4.16). The frequency of the assessment of pleasantness [ $\chi^2(14) = 85.58, p < 0.05$ ], unpleasantness [ $\chi^2(14) = 28.79, p < 0.05$ ] and of neutral assessments [ $\chi^2(14) = 78.02, p < 0.05$ ] differs between stimuli.

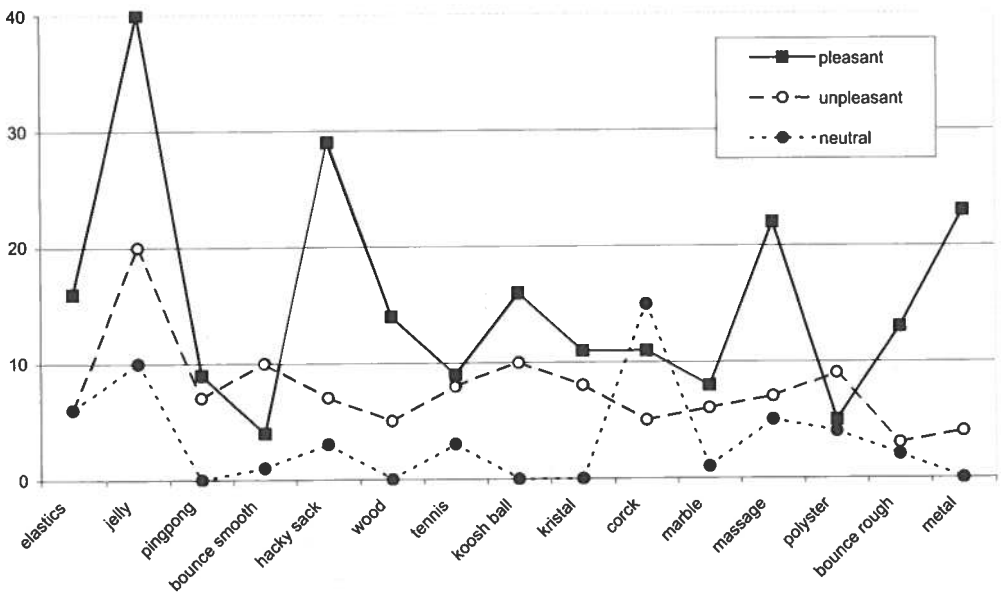


Figure 4.10  
Frequency of descriptions of (un) pleasantness and indifference in the descriptions of the stimuli.

In addition, the stimuli seem to differ in the total amount of assessments of (un)pleasantness they elicited. For example, the jelly ball, the Hacky sack and the Koosh ball elicited many comments on their (un)pleasantness, whereas the small tennis ball and the marble ball did not. The results suggest that objects differ in their capacity to elicit aesthetic experiences, described in Chapter 1 (§1.4.1) as an object's aesthetic potential. Some objects seem to be able to elicit many experiences of (un) pleasantness, thus having a high aesthetic potential (such as the jelly ball, the hacky sack, the massage ball and the metal ball), whereas other objects may be considered as having a low aesthetic potential: they seem to elicit few comments on (un) pleasantness.

#### 4.8.5 Discovering preferences

At the start of the experiment, the participants seemed naïve about exploring their own tactual experiences with objects. Most participants reported that they were curious about what was going to happen, about what they would experience and what they would have to say about it, because they were not familiar with the topic. During the session, it seemed that the participants gained in confidence, were able to relate to previous experiences, other objects, other contexts, and became more familiar with the different aspects of tactual experience. Moreover, it seems that participants started to develop certain general preferences, or become aware of preferences they were not aware of before. Some examples of discovered preferences are:

*'I like things that I can squeeze';*

*'I don't like objects with these kinds of protrusions';*

*'I don't like it when I have to be careful with objects';*

*'The fact is: I like wood'.*

Several participants reported that these discoveries of preferences deepened their self-knowledge and insight in their experiential world. These tactual discoveries sometimes seemed an intimate and personal experience, and it seemed that some aspects were difficult to express aloud, without feeling ashamed or compromised: *'I'm not going to tell you more, I would reveal things about myself I don't want to reveal'*. Also, to observe the participants touching and being touched, and to listen to the reports about their experiences sometimes felt as being a voyeur.

In researching tactual experiences, researchers should be aware of these feelings of intimacy and should make the participants feel at ease by emphasizing the anonymity of the results and by being open-minded. Nevertheless, not all participants became confident with the matters that were discussed. For some the

topic remained unfamiliar. This could lead to uncertainty throughout the whole session: 'Was it OK what I said?'. In future research it is important to be aware of the possible uneasiness of the participants, to give positive confirmation on a regular basis.

#### 4.9 Conclusions and recommendations

The present study confirms the usefulness of the aspects to describe tactual experiences with objects developed in Chapter 3. Moreover, the study shows that a tactual experience with a specific object may be *characterized* by one of the aspects, thus distinguishing the experience from interactions with other objects. For example, an object may be outstanding for its weight, for its temperature, or for its texture. Likewise, the personality it expresses, the way it adapts itself to the user, or the skills it challenges to develop, may be characteristic for its behaviour. In future studies, the fact that some aspects are *characteristic* for the tactual experience of specific objects may be used in defining an explicit research strategy.

Insight in the tactual experience was deepened and completed with a possible structure to describe the different domains in tactual experience and its aesthetic aspects. In addition, observations of the participants led to insights in aesthetic behaviour involved in tactual experience: exploring and imagining possible interactions of making tactual discoveries, of playing and of taking care of. Objects differ in their capacity to stimulate this behaviour and attitude, that could be characterized and approached in future research as their aesthetic potential (Shusterman, 1999).

In the present study, the participants were not supported or guided in their attempts to describe their experiences. This limits the descriptions to the aspects of the experience people *are* aware of. However, for a more complete overview of possible tactual experiences with a set of objects, the research should include the aspects that people can be *made* aware of. The research design should then support and guide people in their attempt to describe their experiences. Recommendations for future studies are developed in the following paragraphs

##### 4.9.1 Tactual experience in the context of time

In contrast with the study in Chapter 3, the present study is about the tactual experience in the context of a first encounter with an unknown object. The difference between the two settings becomes explicit in the way people use the aspects



to describe their tactual experiences. The experience of a personal object in the context of a shared history defines the aspects within this history: the context of *what has happened* (memories). But an object in a first encounter is experienced in the perspective of *what is happening*, here and now, as an event. Moreover, it is experienced with imagined possibilities of actions for the future, of possibilities of *what could happen* (figure 4.18) (Sanders, 2001). These imagined future possibilities are inspired by past tactual experiences with other objects. This phenomenon is what Dewey (1938) defined as the experiential continuum: 'no experience lives and dies to itself. Every experience lives on in future experiences'. Thus, in future research, to get a complete overview of the aesthetic aspects of tactual experiences with objects (known as well as unknown), it is wise to research the present experience in the context of time: past, present and future.

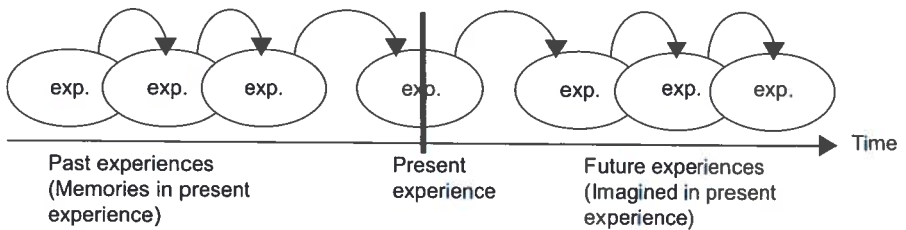


Figure 4.11

Present tactual experience is situated in the context of time: of past and possible future experiences.

#### 4.9.2 Relative assessment of stimuli

The experience of objects is in part based on inter-object comparisons. People find it easier to describe objects when they have the possibility to compare them with other objects. Moreover, objects will be described mostly on the properties that let them stand out from the set of stimuli. Therefore, researchers should be aware that the composition of the *set* of stimuli will influence the experience of each *individual* stimulus. It seems recommendable to let participants experience the set as a whole before assessing each object individually, to avoid that the first object in the set lack the other object as a frame of reference.

#### 4.9.3 Aesthetic behaviour and aesthetic potential

The results of the study led to the conclusion that objects differ in their aesthetic potential: their capacity to elicit aesthetic experiences. On the one hand, aesthetic potential is related to an object's capacity to stimulate the participant's aesthetic

behaviour: to discover different movements for interaction, with an emphasis on the aspects 'playing' and 'taking care of'. On the other hand, aesthetic potential is related to an object's capacity to elicit experiences of (un)pleasantness in these interactions.

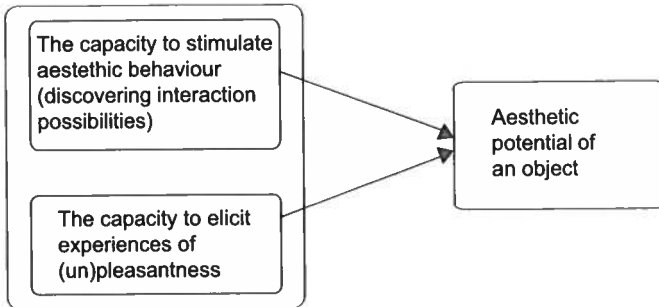


Figure 4.12  
The aesthetic potential of an object.

Tactual experience of an object is created in the way people move (with) it. But the study showed that people have to be stimulated in their aesthetic behaviour, in order to discover an object's aesthetic potential. Thus, to obtain an overview of an object's aesthetic potential, and elaborate descriptions of these aesthetic interactions, participants should be stimulated to move with an object and should be encouraged to explore and play with it, to discover its possibilities. But the researcher should not actually *describe* the movements that should be made (as is the case for example in psychophysical research (Essinck, James, & McGlone, 1999)). This may block the participants' imagining their own movements, and thus block their aesthetic behaviour.

The results of the present study show that people tend to define personal preferences when exploring their tactual experiences with objects. The pitfall of a defined personal preference is that participants lose their open mind, and start to rely on their prejudices ('I like wood, it is natural'). Researchers should be aware of this pitfall, and ask participants to approach the experience with an open mind. Blindfolding might help to achieve this unprejudiced attitude, because it prevents people from initial prejudices and expectations based on visual information.

#### 4.9.4 The appropriate questions

The present study gives insight in how to formulate appropriate questions to support people in describing their tactual experiences. To consider the object as *if it were animated* seems a natural and fruitful way to *describe* the experience of interacting with the object. Thus, in future studies, to stimulate participants to describe their experiences, one could start by asking the participants literally: 'if it were alive, how would you describe its body language?'.

Table 4.3  
Recommended survey questions to describe the different aspects in tactual experience.

Aspect of experience	Question
Aesthetic attitude of the participant	What movements does it stimulate? What can you imagine doing with it?
Tactual experience of the object as a whole	If it were alive, how would you describe its body language?
Tactual properties of the object, its physical behaviour	What can you do with it? What does it do? What happened to it? What is most characteristic about its behaviour?
The expression of the object, its affective behaviour: Personality Associations Intention Perfect match Familiarity  Power	What are its personality traits? What are your associations with other objects? What are its intentions? Does it fit you / adapt itself to you? Does it feel familiar / strange? Can it become yours? Who is stronger / in control?
Bodily sensations	What do you sense? What does it do to you?
Gut feelings	How do you feel? How does it feel? What does it do to you?
Aesthetic assessment of the experience	Do you experience pleasantness/unpleasantness in the experience as a whole or do you experience indifference? What specific aspects are (un) pleasant or indifferent?

It is likely that this approach will trigger the right mindset to describe tactual experiences. In addition, for each aspect in tactual experience an appropriate question can be formulated, as summarized in table 4.3.

Following the structure of descriptions that emerged in Chapter 4, for each aspect mentioned above, the following additional questions may be formulated (table 4.4):

Table 4.4  
Recommended survey questions used to elaborate on the different aspects in tactual aesthetics.

Structure of descriptions	Question:
Qualification	How would you qualify this aspect? What adjectives would you use? What associations do you have? What is happening?
Quantification	How would you quantify this aspect? How intense is this aspect?
Changes in time	How does this aspect evolve in time?

#### 4.9.5 Allow time to experience

In the context of a first encounter, the researcher should be aware that participants need time to assess tactual properties, because the property is an event. The longer people interact with objects, the more elaborate their descriptions will be.

Furthermore, people seem to go through an initial exploration stage, to understand what it is made of, made for, etc. The research protocol should allow participants some time to get through this stage. In addition, the researcher should be aware that participants tend to stop exploring once they 'understand', and should encourage the participant to go on and to describe how the object is actually experienced.

#### **4.9.6 No step-by-step structure of the experience, but a free flow of descriptions**

The tactual experience of interacting with objects can be described along different domains, different aspects, and along different descriptors. But the boundaries between these aspects are fuzzy. People experience the object first of all *as* object and not as the sum of its properties, and their descriptions should be considered in the context of this holistic perspective. Research on tactual experience should acknowledge and allow the fuzziness of these boundaries, because they lead to more complex descriptions of the experienced behaviour of the object as a whole.

People differ in the sequence of the aspects they describe. Some start with details, switch from one aspect to the other, come back to other details, and conclude with an overall assessment of the experience. Others start with the overall description, switch from one aspect to the other, and end with a general statement about themselves. People do not use a specific description process, one step following the other. Rather, there seems to be a free flow of associations, changing from one topic to the other, back and forth from general to detailed comments and vice versa. This associative process has an added value because it generates more complete descriptions. To research tactual experience in its full right and to obtain complete data, supporting structures in research on the tactual experience should therefore be open, flexible, and associative, allowing people to follow their own track when exploring their experiences.

#### **4.9.7 Experiencing body language through body language**

The participants were asked to verbally describe their tactual experiences. However, the observations in this study showed that people express their experience of the body language of objects through their own body language. Non-verbal expressions such as body movements, facial expressions and exclamations seem to be valuable means to express one's experience, and these means should be acknowledged as such in the set up of future studies on the tactual experience of objects.

**Appendix 4.A Quotes of the participants per aspect.**

The qualifications in terms of adjectives, nouns, associations and descriptions of behaviour, is given for each tactual property.

Table 4A.1. Descriptions of texture.

Adjectives, nouns	Associations	What happened to it?	What does it do?	What can I do with it?
It is: <i>Dusty</i> <i>Smooth</i> <i>Coarse</i> <i>Rough</i> <i>Dry</i> <i>Clammy</i> <i>Sticky</i> <i>Smooth</i> <i>Soft</i> <i>Fluffy</i> <i>Dirty</i> <i>Harsh</i> <i>Raw</i> <i>Bumpy</i> <i>Closed</i> <i>Soggy</i> <i>Sweaty</i> <i>Dirty</i> <i>Dusty</i> <i>Thick layer</i> <i>Thin layer</i> <i>Greasy</i> <i>Wet</i> <i>Stiff</i> <i>Sharp</i> <i>Grainy</i>  It has: <i>Protuberances</i> <i>Hard spots</i> <i>Bald spots</i> <i>Stripes</i> <i>Grooves</i> <i>Ribs</i> <i>Bumps</i>	It is like: <i>A dirty carpet</i> <i>A skin</i> <i>A chicken skin</i> <i>A bald spot</i> <i>A porcupine</i> <i>A spider</i> <i>A cactus</i> <i>A animal</i> <i>A lot of worms</i> <i>A balloon</i> <i>Velvet</i> <i>Silk</i> <i>Talcum</i> <i>Felt</i>  It is: <i>Hairy</i> <i>Woolly</i> <i>Rubbery</i> <i>Woody</i>	It is: <i>Flattened</i> <i>Indented</i> <i>Damaged</i> <i>Polished</i> <i>Stitched</i> <i>Bitten</i> <i>Intact</i> <i>Rounded</i> <i>Hand made</i> <i>Unprocessed</i>	It: <i>Slips out of your hand</i> <i>Slides</i> <i>Sticks</i> <i>Comes of</i> <i>Clings itself to me</i> <i>Offers resistance</i> <i>Absorbs moist</i> <i>Dries</i> <i>Becomes dirty</i> <i>Makes my hands dirty</i> <i>Slips through your fingers</i> <i>Is lot of fiddling</i>	I can: <i>Caress it</i> <i>Hold it</i>

Strange little shapes on it Little holes every- where Irregularities Imperfections A weld Veins Grains Facets Points Prickles				
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Table 4A.2 Descriptions of Harnes, elasticity and plasticity.

Adjectives	Associations	What does it do?	What can I do with it?
It is: <i>Hard</i> <i>Soft</i> <i>Supple</i> <i>Springy</i> <i>Bouncy</i> <i>Solid</i> <i>Flexible</i> <i>Stiff</i> <i>Strong</i> <i>Loose</i> <i>Fluid</i> <i>Elastic</i>	It is like: <i>Like clay</i> <i>Like dough</i> <i>Like a sand bag</i> <i>Like a bean bag</i> <i>chair</i>  <i>Some sort of slippers</i> <i>Candy</i> <i>Bubblegum</i>	It: <i>Bends</i> <i>Bounces</i> <i>Springs</i> <i>Gives in / way</i> <i>Resists</i> <i>Stays the way you leave it</i> <i>Stays were it lands</i>	I can: <i>Ply it</i> <i>Bend it</i> <i>Squeeze it (hard)</i> <i>Pinch it</i> <i>Press it</i> <i>Indent it</i> <i>Set my nails in it</i> <i>Tear it apart</i> <i>Shape it</i> <i>Change it</i> <i>Knead it</i> <i>Stretch it</i> <i>Destroy it</i> <i>Break it</i> <i>Break my teeth on it</i>

Table 4A.3 Descriptions of temperature.

Adjectives	Associations	What does it do?	What can I do with it?
It is: <i>Cold</i> <i>Warm</i> <i>Warmy</i> <i>Chilly</i>	It is like: -	It: <i>Takes over my body-temperature</i> <i>Isolates</i> <i>Stays cold</i> <i>Becomes warmer</i> <i>Warms up</i> <i>Warms me</i> <i>Can radiate my warmth</i> <i>Could cool my hands</i>	I can: -

Table 4A.4 Descriptions of weight and balance.

Adjectives	Associations	What does it do?	What can I do with it?
It is:  <i>Heavy</i> <i>Light</i>  <i>Unbalanced</i>	It is like:  <i>A breath of air</i> <i>A hollow egg</i> <i>Like a sea sponge</i> <i>As if its weight is cancelled</i>	It:  <i>May fly away</i> <i>May fall on the ground</i>	I can:  <i>Lift it</i> <i>Throw it</i> <i>Let it drop</i>

Table 4A.5 Descriptions of moving parts.

Adjectives	Associations	What does it do?	What can I do with it?
It is:  <i>Loose</i>	It is like:  -	It:  <i>It vibrates</i> <i>Inside it goes back and forth</i> <i>It falls apart</i> <i>It moves</i>	I can:  -

Table 4A.6 Descriptions of shape and structure.

Adjectives	Associations	What does it do?	What can I do with it?
It is: <i>Small</i> <i>Big</i> <i>Round</i> <i>Strings</i> <i>Ball</i>  <i>Amorphous</i> <i>Shapeless</i> <i>Symmetrical</i> <i>Simple</i>	It is like: <i>A flat pancake</i> <i>An orange</i> <i>A chestnut</i> <i>A nut</i> <i>An apple</i> <i>An egg</i> <i>A porcupine</i>	It: <i>Changes continuously</i> <i>Looses its shape</i> <i>Comes back to his own shape</i>	I can: <i>Shape it</i> <i>Make something out of it</i> <i>Make it round</i>



Table 4A.7 Descriptions of sensations.

What do you sense	What does it do to you?
I sense: <i>Vibration</i> <i>Pain</i> <i>Points on my skin</i> <i>A movement of my skin</i> <i>Tingling in my fingers</i> <i>Prickling on my skin</i> <i>Pressure</i> <i>Light touch</i> <i>Itching</i> <i>Tickling</i>	It: <i>Touches my hand</i> <i>Hurts me</i> <i>Irritates my skin</i>

Table 4A.8 Descriptions of Gut feelings.

How does it feel?	How do you feel?	What does it do to you?
It feels: <i>Fine</i> <i>Good</i> <i>Nice</i> <i>Pleasant</i> <i>Unpleasant</i> <i>Awful</i> <i>Dirty</i> <i>Creepy</i> <i>OK</i> <i>Energetic</i> <i>Cosy</i> <i>Exciting</i> <i>Repugnant</i> <i>Disgusting</i> <i>Stimulating</i> <i>Relaxing</i> <i>Calming</i> <i>Thrilling</i> <i>Scaring</i> <i>Interesting</i> <i>Fascinating</i> <i>Intriguing</i>	I feel: <i>Fine</i> <i>Good</i> <i>Nonchalant</i> <i>Irritated</i> <i>Sicky</i> <i>Dirty</i> <i>Uncomfortable</i> <i>Not at ease</i> <i>Attracted</i> <i>Playful</i> <i>Scared</i> <i>Happy</i> <i>I love it</i> <i>I like it</i> <i>I can not stand it</i> <i>Carefree / Careful</i> <i>Energetic</i> <i>Oppressed</i> <i>As if I swallowed it</i> <i>Frustrated</i> <i>Angry</i> <i>Aggressive</i> <i>Nausea</i> <i>Surprised</i> <i>Fascinated / Curious</i>	It: <i>Bothers me</i> <i>Begs for my compassion</i> <i>Makes me shiver</i> <i>It gives me the creeps</i> <i>Rejects me</i> <i>Calms me</i> <i>Surprises me</i> <i>Makes me curious</i> <i>Makes me wonder</i>

Table 4A.9 Descriptions of personality and associations.

Personality characteristics	Associations
<p>It is:</p> <p><i>Pathetic</i></p> <p><i>Funny, comic</i></p> <p><i>Friendly</i></p> <p><i>Cosy</i></p> <p><i>Intriguing</i></p> <p><i>Distant</i></p> <p><i>Calm</i></p> <p><i>Pure</i></p> <p><i>Cool</i></p> <p><i>Playful</i></p> <p><i>Strange</i></p> <p><i>Mysterious</i></p> <p><i>Blank</i></p> <p><i>Dull</i></p> <p><i>Energetic</i></p> <p><i>Dynamic</i></p> <p><i>Discrete</i></p> <p><i>Chilly</i></p> <p><i>Superficial</i></p> <p><i>Ephemeral</i></p> <p><i>Tough</i></p> <p><i>Rigid</i></p> <p><i>Aggressive</i></p> <p><i>Natural</i></p> <p><i>Phoney</i></p> <p><i>Conflicting</i></p> <p><i>Vulnerable</i></p> <p><i>Sensitive</i></p> <p><i>Childish</i></p> <p><i>Crazy</i></p> <p><i>Indefinable</i></p> <p><i>Sound / honest</i></p> <p><i>Fishy</i></p> <p><i>Artificial</i></p>	<p>It is like: (a thing)</p> <p><i>Clothes</i></p> <p><i>A little puzzle</i></p> <p><i>A toy</i></p> <p><i>A rattle</i></p> <p><i>A cuddly toy</i></p> <p><i>A little mouth</i></p> <p><i>Computers</i></p> <p><i>Dead meat</i></p> <p><i>An octopus (with a sucking cup)</i></p> <p><i>A weapon</i></p> <p><i>A bullet</i></p> <p><i>Furniture</i></p> <p><i>Packaging</i></p> <p>It is like: (a kind of):</p> <p><i>Something industrial</i></p> <p><i>Something primordial</i></p> <p><i>Something organic</i></p> <p><i>Something animal</i></p> <p>It is like: (a person):</p> <p><i>A pain in the ass</i></p> <p><i>A sweet thing</i></p> <p><i>A softy</i></p> <p><i>A strong character</i></p> <p><i>A character of its own</i></p>

Table 4A.10 Descriptions of intentions.

<p>Intentions</p> <p><i>It invites you to play with it</i>  <i>It nestles itself in your hand</i>  <i>It does it on purpose</i>  <i>It begs for compassion</i>  <i>It wants to be protected</i></p>
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Table 4A.11 Descriptions of a perfect match (or not).

<p>Perfect match</p> <p><i>(Not) too ... (property, personality)</i>  <i>Perfectly.... (property, action)</i></p> <p><i>It's just right</i>  <i>It adapts itself to you (temperature, shape, skin, hand)</i>  <i>It fits (your hand, skin, pocket)</i>  <i>It doesn't match</i></p>
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Table 4A.12 Descriptions of familiarity.

<p>Familiarity</p> <p><i>I would recognize it among others</i>  <i>It reminds me of the past, I used to have them</i>  <i>It makes me think of home</i>  <i>Its movements remain unpredictable</i>  <i>It is strange</i>  <i>Alien</i>  <i>Weird</i>  <i>I have never touched something like that before</i>  <i>It sure is different</i>  <i>I used to have them a lot</i>  <i>I know these, I have them myself</i>  <i>It feels familiar</i>  <i>It is absolutely nothing I know</i></p> <p><i>If it was mine I would shine it</i>  <i>It has to be yours if you want to enjoy it</i></p>
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Table 4A.13 Descriptions of Power.

<p>Power</p> <p><i>I don't want to have it if it is vulnerable</i></p> <p><i>It is fragile</i></p> <p><i>Can I ruin it?</i></p> <p><i>It is very tempting to just destroy it</i></p> <p><i>Actually, I would like to destroy it completely, but I won't</i></p> <p><i>I don't like it because you have to be careful with it</i></p> <p><i>It feels as if you can not destroy it</i></p> <p><i>Its nice to be able to put all your aggression into it, and that it will not ruin</i></p> <p><i>You can really hold it well, it won't fall</i></p> <p><i>I know I'm stronger</i></p> <p><i>It takes too much effort</i></p> <p><i>You can manipulate it easily</i></p> <p><i>May I try to squeeze it really hard?</i></p> <p><i>I would like to find out about its limits</i></p>
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Table 4A.14 Descriptions of aesthetic behaviour.

What can I do with it? Positive	What can I do with it? Negative
<p>Exploring:</p> <p><i>Search for details</i></p> <p><i>Explore it</i></p> <p><i>Knead it</i></p> <p><i>Take it apart</i></p> <p><i>Squeeze it</i></p> <p>Playing:</p> <p><i>Play with it (when I'm nervous/bored)</i></p> <p><i>Use it as a toy</i></p> <p><i>Throw it (really hard/far/fast)</i></p> <p><i>Make bouncing balls of it</i></p> <p><i>Bounce it</i></p> <p><i>Peel it</i></p> <p><i>Fiddle with it</i></p> <p><i>Try to make it round</i></p> <p><i>Pull on it</i></p> <p><i>Exercise a strong force on it</i></p> <p><i>To make something out of it</i></p> <p><i>To tease somebody with it</i></p> <p><i>Roll it</i></p> <p><i>Turn it around and around</i></p>	<p><i>There is not much you can do with it.</i></p> <p><i>It is too light to be able to do anything with it</i></p> <p><i>Leave it alone</i></p> <p><i>Put it aside</i></p> <p><i>You cannot bounce it</i></p> <p><i>You cannot play with it</i></p> <p><i>You cannot squeeze it</i></p> <p><i>There is nothing to explore or to discover</i></p> <p><i>just look at it</i></p> <p><i>Do not want to touch it</i></p> <p><i>I don't know what to do with it</i></p> <p><i>I don't know how to hold it</i></p> <p><i>Dump it</i></p> <p><i>Can not use it for something</i></p> <p><i>It is not to hold</i></p> <p><i>I cannot change it</i></p> <p><i>Destroy it</i></p> <p><i>Throw it away</i></p>

<p><i>Shape it</i></p> <p><i>You can do anything with it</i></p> <p><i>Let it go through your hands</i></p> <p><i>Do something funny</i></p> <p><i>Follow its lines</i></p> <p><i>Make it completely fit to your hand</i></p> <p>Associations with playing actions:</p> <p><i>With throwing at cans</i></p> <p><i>With playing marbles, jeu-de-boules, pool</i></p> <p><i>With making dough for going out fishing</i></p> <p>Taking care:</p> <p><i>Put your hand around it</i></p> <p><i>Hold it in your hands (in all kind of ways)</i></p> <p><i>Exercise your muscles fingers</i></p> <p><i>Be gentle with it</i></p> <p><i>Massage yourself with it, or somebody else</i></p> <p><i>Caress it</i></p> <p><i>Caress yourself with it, or somebody else</i></p> <p><i>Discharge your anger/frustrations on it</i></p> <p><i>Wash it</i></p> <p><i>Take care of it</i></p> <p><i>Warm my hands with it</i></p> <p><i>To cool your hands with it</i></p> <p>Carry:</p> <p><i>Put/carry it in your pocket</i></p> <p>Other:</p> <p><i>Almost would like to eat it</i></p>	
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Table 4A.15 Descriptions of pleasantness, unpleasantness and indifference.

Pleasant	Unpleasant	Indifferent
<i>Good (Lekker)</i>	<i>Not nice</i>	<i>Neutral</i>
<i>Fine / Nice</i>	<i>Not good</i>	<i>Nothing</i>
<i>Delicious</i>	<i>Unpleasant</i>	<i>Meaningless</i>
<i>Pleasant</i>	<i>Nasty</i>	<i>It does not get me</i>
<i>Enjoyable</i>	<i>Bothering</i>	<i>I don't know</i>
<i>Beautiful</i>	<i>Ugly</i>	<i>I don't have a feeling</i>
<i>Comfortable</i>	<i>Uncomfortable</i>	<i>Nothing special</i>
<i>Rich</i>	<i>Misery</i>	<i>Not good or bad</i>
<i>Cool</i>	<i>Painful</i>	<i>Nothing going on between us</i>
<i>Great</i>	<i>Terrible</i>	
<i>It fits</i>	<i>Absolutely nothing</i>	
<i>I like it</i>	<i>I don't like it</i>	





# Chapter 5

## The Tactual Experience Guide

### 5.1 Introduction

What would a person do when asked to describe how the pen he usually writes with feels? Very likely, he would pick up the pen and start to manipulate it, turn it over, hold it in different positions, consider different surface textures of the pen by stroking it, swing it between his fingers, possibly slightly hit the table with it, and put down some lines on a piece of paper. Obviously, this manipulating is different from the interaction when actually writing with it, or when carrying it around. Sooner or later the person will become aware of the complexity of the question asked and will reply: 'What do you mean, how it feels? When I write with it, play with it, carry it, or what?'. We cannot simply ask people how an object feels, we need to take into account that the answer depends on the nature and context of the interaction with the object (Figure 5.1). Likewise, the question about the aesthetic aspects of the tactual experience with an object depends on the context of interaction: a pen may be very pleasant to play tricks with because of its on/off mechanism, but unpleasant to write with because of its shape. In addition, people lack the vocabulary to describe their tactual experiences of interacting with objects.



Figure. 5.1  
Different interactions with a pen: holding, chewing, tapping on a table and writing.



To support designers as well as users in describing and aesthetically assessing the experience of interacting with objects, tools and methods are required. This chapter describes the development of such a tool, the Tactual Experience Guide, based on the conceptual framework constructed in the previous chapters. The tool helps people to describe their tactual experiences with objects, by offering a consistent framework of aspects that can be used to describe their experience (the content of the tool), and by offering a format that guides people through this experience (the design of the tool).

The development of the tool evolved with the development of the insights in tactual aesthetics. It went through different stages, starting with a rather primitive raw form and ending in the more complete and layered version presented in this chapter. The present chapter motivates the starting points for the development of the tool in the context of product design education and describes a first version of the complete tool, evaluated by students from the department of Industrial Design at the Delft University of Technology. The chapter ends with a description of the final version of The Tactual Experience Guide and recommendations for further development.

## 5.2 Context and goal for the development of the tool

The Tactual experience guide is developed for the context of human-centred product design and, more specifically, for the context of designing for the senses. Human-centred design focuses on human experience and contexts of interaction as starting points for products that address people's needs and dreams (Mattelmaki, 2005; Sanders, 2001; Sleeswijk Visser, Stappers, Van der Lugt, & Sanders, 2005). In this context, designers need to communicate and become empathic with the people they design for (Fulton Suri, 2000a, 2000b). Next, designers need to develop design knowledge and design skills to translate the findings of their explorations into material designs for the senses (Figure 5.1). For both processes, (that is, communicating with users and designing for the senses) supporting tools and methods are required (Figure 5.1).

This section focuses on the tools and methods for designer and users to support the communication between each other (Figure 5.1). The tools and methods to support the designing for the senses will be discussed in chapter 6.

The assumption developed in this section is that to be able to develop empathy for users, designers need to develop their personal aesthetic sensitivity towards the different aspects of human experience. Therefore, from a designer's perspec-

tive, first tools and methods are needed for the development of designers' aesthetic sensitivity. From the users perspective, tools are needed to express themselves about their experiences, to be able to communicate about them with the designer. The question addressed in this section is whether the tools required by designers and by users can be addressed with the same tool, or whether different tools need to be developed.

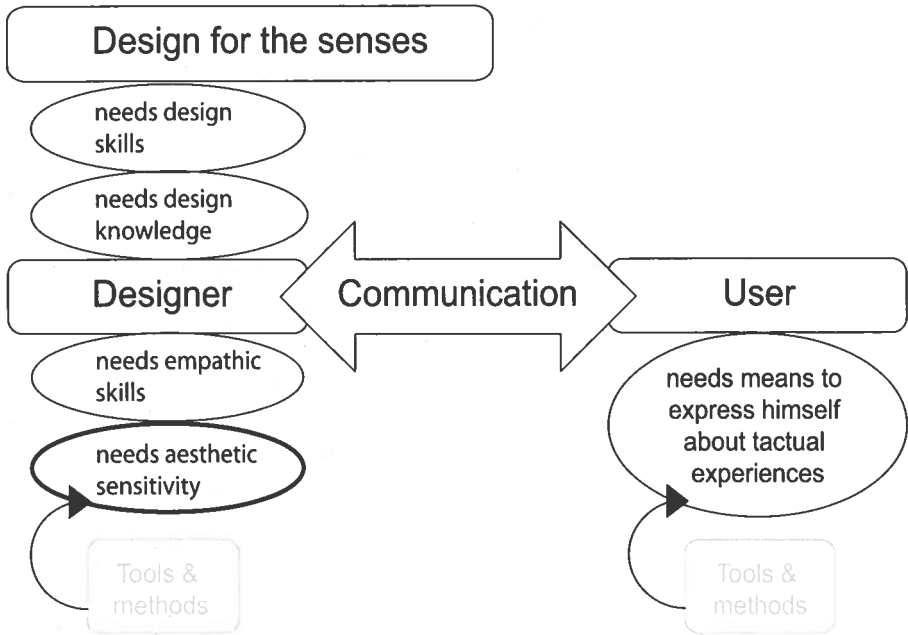


Figure 5.2  
Tools and methods needed in designing for the senses, in the context of human centred design. Empathy and expression in design

### 5.2.1 Development of tactual aesthetic sensitivity: to learn to feel

In design education, students need to develop their awareness, insight and sensitivity for the different aspects of experience in human-product interaction. This education cannot be achieved by a mere transfer of knowledge through lectures and readings, it is generally acknowledged that personal hands-on experiences should be part of the educational setting.

In educating the designer's senses, it is therefore appropriate to develop tools

and methods that offer a conceptual framework about the sensory experience, embedded in practical, sensory experiences. This approach is based on the interplay between cognitive learning and perceptual learning: once people have a set of concepts to describe what they feel, they will be able to perceive more nuances, and thus describe their experiences more extensively. And vice versa, the more they have experienced physically, the more they will be able to give content to the specified concepts (Chollet, Valentin, & Abdi, 2004).

Product design education does not seem to offer such educational tools and methods yet. But other domains, as for example art education or wine tasting offer valuable insights in possible starting points for such educational tools and methods.

In art education, several methods were developed to *learn to look*. These methods offer a set of concepts people may use when looking at and experiencing art. For example, Visser (1986) developed a framework that guides people through the process of experiencing art, focussing on the formal aspects of art perception, such as: materials, composition, size, space, point of view, abstraction, and so on. On the other hand, Armstrong (2000) proposed a set of different stages that people may go through when experiencing art, such as: gathering information, dreaming, contemplation, investment (engagement), and so on. Both approaches are characterized by a conceptual framework illustrated with examples, that the perceiver must apply in his own situation to assimilate their meaning.

In the domain of sensory evaluation, tools and methods were developed to allow people to develop their sensitivity. For example, the Sensory User's manual for wine tasting (LaMar, 1997) provides an overview of the different sensory aspects of wine and instructions on how to drink it in order to perceive its different aspects. People who attend workshops of wine-tasting are thus provided with a frame of thought on how to describe wine in its different aspects. They are presented with words that describe these concepts, but these words remain empty shells when they are not supported by wine tasting itself. The concepts become meaningful when they are experienced physically. It is only *through* experience that the concepts become embodied knowledge, and thus recognizable *in* experience. Therefore, to become wine tasting experts, people need to build up a personal, embodied 'database' of sensory experiences, linked to the framework that is offered, to be able to work with that framework when actually tasting wine. Such a database is constructed through actively searching for possible examples of related experiences in one's own daily life. An interview with an expert in wine tasting showed that this process of building such personal, embodied insights

and knowledge was an individual process, resulting in individualized, and therefore customized sets of words and concepts. Conceptual frameworks are altered and adapted when people start to work with them.

To conclude, tools and methods in the education of the tactual senses in product design should provide designers with a frame of thought introducing the sensory, perceptual and experiential aspects of the specific sensory domain, a structure to guide the designers through these aspects, and insight in appropriate ways to explore these aspects. Moreover, the tool should support designers to build up a personal, embodied database linked to the conceptual framework that is offered on tactual experiences and to customize the framework to fit the personal world of experience.

### 5.2.2 Researching tactual experiences in human-centred design

In human-centred design, tools and methods are used to explore people's experiences in the context of their daily life. Merely observing people does not allow researchers to get access to people's experiences and to understand what they think and dream of (Sanders, 2001). To support people to make their tacit knowledge about their own experiences explicit, probes are developed to help them to *create* rich descriptions of their experiences using different creative means, rather than to merely formulate them (Mattelmaki & Batterbee, 2002). For example, people are asked to make a collage about their experience, using images and words collected from a set provided by the designer/researcher. Characteristic of the use of these probes is that they try to tap into the creative capacities of people, rather than the cognitive.

In human-centred design, people are considered experts about their world of experience, but they do not need to become experts in human-product experience. It is sufficient that they are provided with the right tools to express themselves. Thus, tools to research tactual aspects of experiences of people in a specific future context should stimulate a creative, associative way of exploring and communicating about one's experiences, without requiring a mainly rational, cognitive analysis.

### 5.2.3 Conclusions

To conclude, designing for the senses requires future users that are able to express themselves about their needs and dreams and sensitive designers that are able to empathically understand them. The tools required to support these pro-

cesses differ in their character: supporting creative and associative expressions, versus supporting the interplay between perceptual and cognitive learning.

This chapter introduces a tool aimed at the first purpose: educating the designers senses (the bold section of Figure 5.1). It is assumed that this first step is needed as a basis for the development of the other tools, because to be able to understand the other, it is important to possess self-knowledge. For example, if one does not know from personal experience what fear is, one will not understand what the other is referring to when expressing his fears. Knowledge and understanding of people will not reach beyond the level of self-knowledge (Gerritse, 2000) . Consequently, to be able to sympathize with potential users, and to create empathy for their needs and dreams, it is important for a designer to gain insight in his own world of experience, and of his own dislikes and preferences. It is this first, educational scope that serves as a starting point to develop the tool, and serves as a criterion for evaluation of the tool in this chapter: does the tool actually help designers to get insight in their world of tactual experience and to become sensitive to this world?

### **5.3 Requirements for the Tactual Experience Guide**

The requirements for the new tool are based on the insights gained from other sensory domains, as described above and insights gained from the previous chapters on exploring tactual experience.

#### **5.3.1 Providing an overview of tactual experience**

The tool should give a clear overview of and introduction to the different aspects of the tactual experience. Moreover, the tool should give a clear overview of possible descriptors to describe these aspects.

The studies in the previous chapters showed that people do spontaneously describe all aspects of their tactual experience with a specific object. The content of the Tactual Experience Guide should allow people to become aware of and reflect on these different aspects of tactual experience. Therefore, the content of the guide was made as broad as possible, including all the aspects found in the previous studies. This might lead to a situation where some of the aspects seem superfluous or irrelevant when used in a specific context. However, the guide should be suitable and applicable to all research situations and is therefore necessarily broad. It was expected that users would be able to make their own choice

of relevant aspects, and leave the others aside.

### **5.3.2 Allowing personal interpretation**

The tool's structure should encourage the interplay between cognitive learning and perceptual learning. The tool should encourage people to look for examples in their *own* world of experience, to understand these aspects *from* their own experience. Subsequently, people should be allowed to refine the aspects of the tool as a result of their own personal tactual discoveries. This means that the tool should not be too strict about the aspects, but should allow for personal interpretation, and, vice versa, that the personal tactual experience should refine and redefine the aspects of the tool. To become an expert, the tool should be personalized: in concepts as well as in examples illustrating these concepts (Brochet & Dubourdieu, 2001). The Tactual Experience Guide should support this personalisation, by offering a structure with an open end allowing growth, rather than offering a closed structure with a strictly defined set of aspects.

### **5.3.3 Supporting free associative thinking**

The previous studies showed that people do not have a well-defined step-by-step approach to describe their tactual experiences: the descriptions seem to emerge in an associative way. This associative process of switching back and forth between different aspects is essential to reach a complete and rich description of the experience, because becoming aware of a specific aspect may give way to additions to previous descriptions, making the descriptions more elaborate and refined. The new tool should support this associative, free flow of description, by offering a loose structure with which people can make their own choices about what to describe and when.

### **5.3.4 Allowing a personal expression**

People differ in the way in which they express themselves: for example, some use elaborate, narrative structures, while others use short sets of key words. To allow people to use their personal style seems a prerequisite for a free flow of descriptions. The tool should therefore allow and support the different descriptive styles. Irrespective of these differences in personal style, the tool should stimulate the participant to be elaborate and subtle. Moreover, people should be able to *develop* a personal style when familiarizing with the Guide.

### 5.3.5 Being neutral about aesthetic aspects of tactual experience

The tool itself and the information included in the tool, should be neutral about aesthetic aspects of the tactual experience, to prevent interference with the experience of the tool user. Therefore, the tool should present the different aspects of the tactual experience and their possible domains for descriptions, in an aesthetically equivalent way.

## 5.4 The design of the Tactual Experience Guide

The design of the new tool includes the structure of the tool, the content of the tool and the means to use and complete the guide.

### 5.4.1 Mind-mapping as an associative structure

The structure of the Tactual Experience Guide should allow and support an associative way of thinking. This requirement excludes structured questionnaires or checklists, because they are hierarchical and, moreover, might suggest a step-by-step approach. The mind-map structure proposed by Buzan & Buzan (2000) meets the required open-ended, non-hierarchical approach. For each of the five domains of tactual experience (Figure. 5.2), a specific map with the domain in the centre and the different aspects around it (Figure. 5.3 to 5.7), allows users to associatively put their own descriptions of these specific aspects on the map, in random order. In creating their descriptions, participants can switch back and forth from one aspect to the other, and from one map to the other.

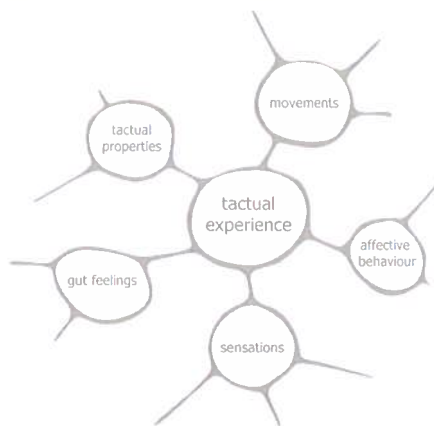


Figure. 5.3  
Overview of the five domains of tactual experience presented as a mind-map structure

## 5.4.2 The content of the Tactual Experience Guide

The Guide consists of six maps: one for each domain of tactual experience: moving, sensing, perceiving, feelings and experiencing affective behaviour, and one overall map to summarize and conclude on the tactual experience. Each map is provided with a heading, containing the central question that is addressed in the map, and a footer containing the title of the map. In the centre of the map, the domain is presented as the start of a possible answer to the questions formulated in the header of the map. Around this centre, the possible aspects to describe the domains are presented as keywords, for participants to elaborate on.

To give the participants sufficient writing space on the maps, the graphics are light grey. In addition, each map is provided with an empty bullet, to encourage people to come up with personal, additional aspects. With this design, it is expected that participants will consider the structure of the map as a template, on which their own map can be constructed, rather than as a rigid structure.

This section gives an overview of the different aspects included in the map created for each specific domain of the tactual experience. For an elaborate description of the aspects, the reader is referred to the previous chapters.

### 5.4.2.1 Mapping movement

The map 'movements' (Figure 5.4) is created to study the movements they make when physically interacting with objects. To create a complete overview of all the movements make, people are asked to be aware of the different motivations they have to interact with objects.

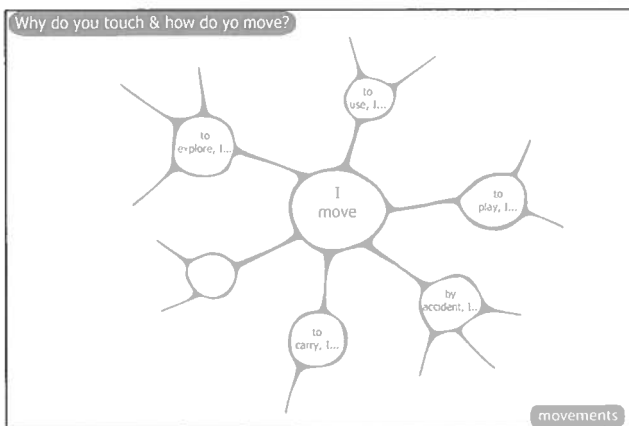


Figure 5.4  
The mind map on movements



These motivations can be characterized by the following aspects on the map:  
(At the time of this first version of the Tactual Experience Guide, the aspect 'to take care' was not yet discerned as a separate aspect, and is therefore not included on the map):

- To explore the object, to get to know it (What is it? What does it do?)
- To use the object for its functional purpose
- To play or fiddle with the object, just for the fun of it (What can I do with it?).
- To carry the object
- Touching the object by accident

### 5.4.2.2 Mapping tactual properties

The map 'tactual properties' (Figure 5.5) is created to describe the tactual properties they perceive in the object when interacting with the object. People are aware of these tactual properties when their attention is directed towards the object as a material object per se, regardless of its functional or affective value.

These tactual properties of the object can be characterized by the following aspects on the map:

- Shape
- Size and volume
- Texture
- Hardness and Elasticity of materials
- Temperature
- Weight and balance
- Dynamic properties of moving parts (force)

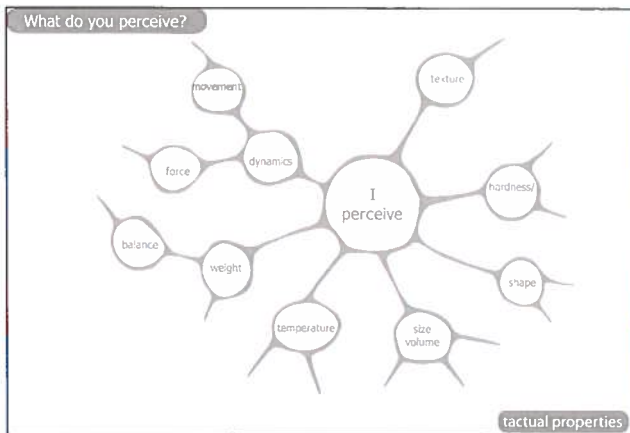


Figure 5.5  
The mind map on tactual properties

### 5.4.2.3 Mapping bodily sensations

The map 'sensations' (Figure 5.6) is created to study the bodily sensations people have when interacting with objects, such as pressure, vibration, itch, pain, heat, and so on. People are aware of these sensations when their attention is not directed towards the object, but towards their own body. The focus is on how they experience *being touched* by the object. For this domain it is relevant to give an overview of where people are touched: what body parts are involved. These bodily sensations can be characterized by the following aspects on the map:

- Temperature
- Pressure
- Vibration
- Body posture
- Pain
- Itch and tickle

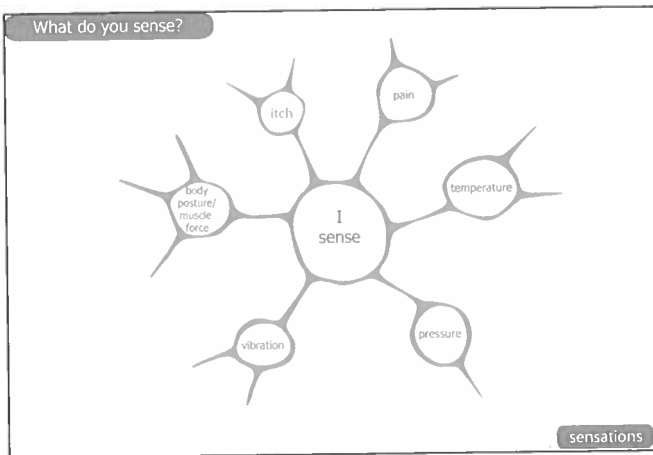


Figure 5.6  
The mind map on bodily sensations

### 5.4.2.4 Mapping affective behaviour of the object

The map 'affective behaviour' (Figure 5.7) is created to describe the affective aspects of the body language of an object. People become aware of this affective behaviour of an object when they are made aware that objects can be experienced as if they were animated.

This affective behaviour can be characterized by the following aspects on the map:

- Personality
- Intentions
- Power match
- Physical skills
- Transparency
- Familiarity
- Perfect match
- Integrity

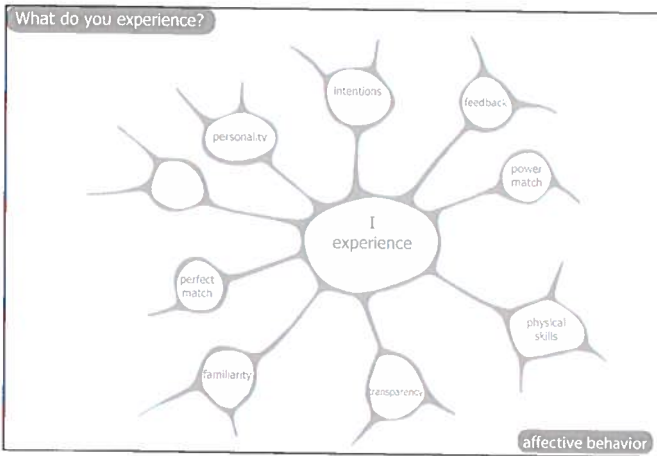


Figure 5.7  
The mind map on affective behaviour

#### 5.4.2.5 Mapping gut feelings

The map 'gut feelings' (Figure 5.8) is created to describe the feelings they have when interacting with objects. People are aware of these feelings when they pay attention to their own affective response to the affective behaviour of the object. These feelings can be characterized as a whole by the concept of 'gut feelings', and more specifically by the following aspects on the map:

- Energy
- Lust (physical pleasure)
- Action tendency
- Vulnerability
- Affection
- Self-image

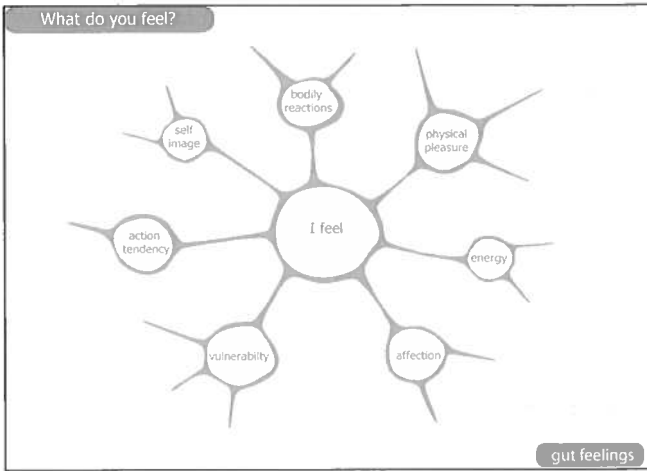


Figure 5.8  
The mind map on gut feelings

#### 5.4.2.6 Mapping the conclusions on the tactual experience

The map 'conclusions' is provided to create an overview and summary of the descriptions of the different domains of the tactual experience as shown in Figure 5.2. Its purpose is to make people aware of the most important aspects in the previous maps, and to come to an overall conclusion about the tactual experience of the physical interaction with the object, about its body language in interaction. In addition, it is intended to assess the aesthetic aspects of the tactual experience: for each domain of the experience as well as for the experience as a whole.

#### 5.4.3 The use of words as means for descriptions

The structure of the tool implies that the user's descriptions of the different aspects of tactual experience are primarily verbal, occasionally illustrated with sketches or other visual expressions (Buzan & Buzan, 2000). Other means of expression such as sounds, colours, smells or tangible materials are more difficult to include in the map. This raises the question whether words should be the primary means for describing tactual experience, because the experience itself is non-verbal and because people consistently reported in the previous chapters that it is difficult to translate the tactual experience into words.

In his essay 'Why words are needed', Arnheim (1998) acknowledges and emphasizes that words cannot describe the wholeness of the experience of an object (in

his case a work of art), because the wholeness lies in the interaction, and in the bodily experience itself. But it is precisely this discrepancy between the wholeness and complexity of the experience and its verbal description that justify the use of words. According to Arnheim, the power of words lies in their capacity to abstract from the perceptual world and, thereby, to construct concepts that allow people to relate their different perceptual experiences to each other: to discover similarities and differences between their experiences. Words allow us to think about our perceptual experiences, thereby mediating between perceptual and cognitive learning, which was the scope of the present tool.

Arnheim's argument for the power of words motivates the choice of words as a means to describe the tactual experience. It is expected that encouraging people to put their experiences into words, supports people in their development of conceptual understanding of tactual experience. It is believed that other means, such as music, sounds, colours or other sensory expressions, do not possess the power of abstracting from the perceptual to the cognitive world and, therefore, are not likely to contribute to conceptual understanding. Nevertheless, the question is whether words are the appropriate means, or whether the verbal basis should be completed in the future with other means, such as visual, auditory or other sensory references.

#### 5.4.4 User Instructions

To fill in the guide, people need a general introduction to the conceptual framework on aesthetic tactual experience, as well as information on the specific aspects included in the maps. For the first version of the Tactual Experience Guide, the background information on the tool was provided:

- Verbally, through introductory lectures when the guide was handed out,
- Through an explanatory sheet for every specific map, containing a description of the specific aspects and of the possible descriptors to describe the aspect.

Additional information about the aspects on the maps was provided on separate sheets. From a usability point of view, this might not seem optimal: one has to switch back and forth between maps and explanation sheets. But from an experiential point of view, it was expected that this set up provides more creative space for users to find their own style, their own words, without being restricted by the descriptions proposed. After all, the explanations should be inspiring and not prescriptive.

## 5.5 User Evaluation of the Tactual Experience Guide

The tactual experience guide was handed out to design students to assess whether the tool was valuable and useable in the context of product design education.

### 5.5.1 Research approach for evaluation of the tool

The Tactual Experience Guide was introduced to 93 students in a course on product experience at the master program Design for Interaction (Dfi) at the Delft University of technology. Tactual Aesthetics was one of the topics of the course. The students were introduced to Tactual Aesthetics and to the use of the Tactual Experience Guide through a two hours lecture on the topic, presenting and illustrating the conceptual frame of the guide and its different aspects. During the lecture, the guide was handed out to the students. In addition, for the assignment on Tactual Aesthetics, the students had to use the guide for a specific object of their own choice.

The assignment to use the guide was part of a set of assignments related to the different topics of the course. Each student had to perform all assignments for one and the same object. The objects were chosen in the context of this larger set of assignments and not specifically for the assignment on tactual experience. Therefore, some objects may seem awkward in the context of tactual experiences, such as a dream catcher or a bus shelter. Nevertheless, this diversity was considered as an advantage in the evaluation of the Guide: it allowed to study whether it can be used for objects with which participants had minimal physical interactions as well.

The assignments of the students were to be assessed with a grade. This may have influenced the way students worked with the guide (trying to be complete) as well as the feedback of the students on the use of the guide (trying to please).

The assignment on tactual Aesthetics to the students was:

- To use the Tactual Experience Guide to explore their tactual experience of the object they chose for their assignments. Appendix 5.1 gives an overview of the products described.
- To reflect on the tactual experience with the object: its body language and its aesthetic aspects.
- To reflect on the use of the Tactual Experience Guide
- The analysis of the results is structured as follows:
  - Evaluation of the goal and of the value of the guide;
  - Evaluation of the structure of the guide;

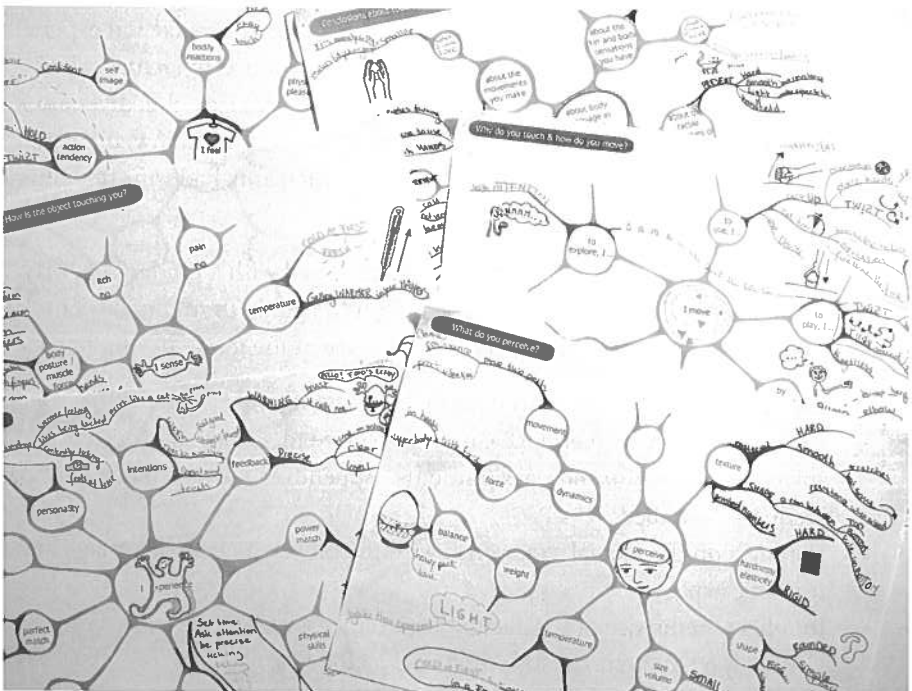
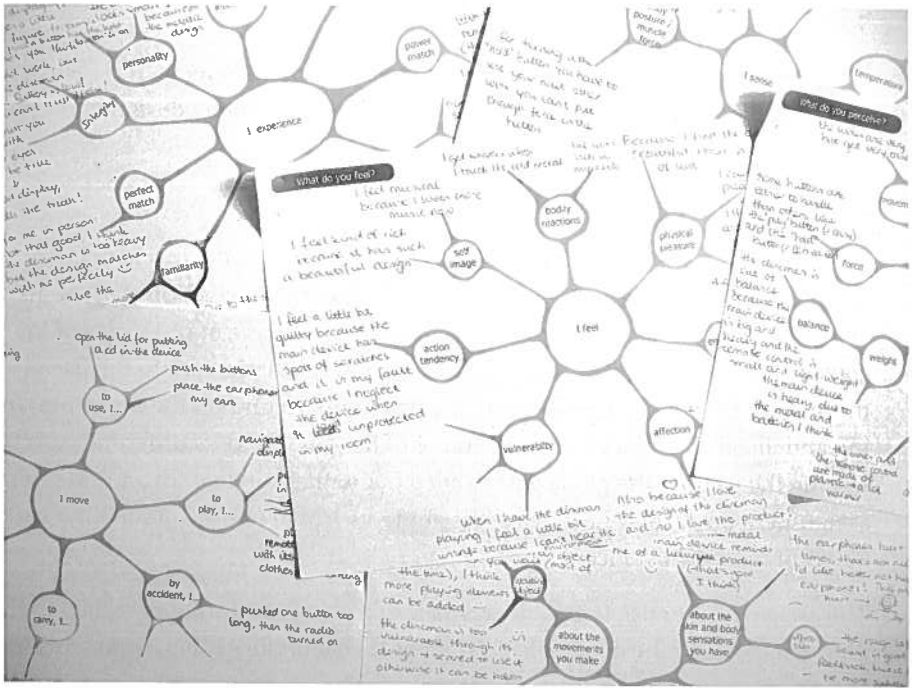


Figure 5.9  
Two examples of completed guides

- Evaluation of the content of the specific maps;
- Evaluation of the use of words to describe the tactual experience;
- Evaluation of the explanations provided to the user of the guide;

To analyse the assignments, the same procedure as in the previous studies was followed. For each of the above-mentioned aspects, the results and comments of the students were analysed for emerging aspects and general conclusions. These results are presented in the following paragraphs and illustrated with quotes of the students.

### 5.5.2 Evaluation of the goal and value of the Tactual Experience Guide

The evaluation and value of the guide is reported along the following themes:

- Overall appreciation
- Creating understanding of the tactual experience
- Creating awareness for tactual experience
- Personal versus general descriptions
- Applicability for different product types
- Tactual experience and the other senses

#### 5.5.2.1 Overall appreciation

The overall evaluation of the students was positive. Three students reported to have mixed feelings about the tool or to have initial resistance to use it: *'First I thought it was vague, but after using it, it proved powerful'*. One student seemed negative and commented that the use of the guide was *'The vaguest assignment I had to do since I had to redesign a birdcage inspired by a poem'*. But most comments were about the guide being *'Useful'*, *'Inspiring'*, and *'Fun to do'*. Also, several students reported that they would *'Use it again in the future'*.

It seemed that the resistance to use the guide was partly due to its complexity: *'At first, it looked a little too elaborate to me: so many subjects for just a simple object...'*. And although this elaborateness of the guide was generally acknowledged, there was no consensus on the ease of use of the Guide. The participants were equally divided between finding the Guide *'Easy to answer'* and *'Difficult'*. But as some described: *'It takes a lot of time to fill in the guide'*, which may be *'An obstacle to use it again'*.

The comments and the results of the students led to the overall conclusion that the first version of the Tactual Experience Guide is a fruitful basis for further development of the tool.



### 5.5.2.2 Understanding the tactual experience

The students seemed to accept the starting point that tactual experience can be understood as the body language of an animated object. Only one student reported that *'Talking about the personality and the affective behaviour of a guitar seems a bit weird'*. But overall, the students commented that the use of the guide did contribute to an understanding of the tactual experience: it *'Gives insight'*, *'Creates a higher level of understanding'*. According to the students, this is achieved by offering *'A different view'*, *'A new perspective'*. Moreover, several students particularly appreciated that the starting points for the Guide do not follow *'The usual way of thinking'*.

However, although the guide helped to unravel the different aspects of tactual experience, filling in the guide did not lead to an understanding of the links between the different aspects for a specific object, as a result of which the outcome may have seemed superficial to the participant: *'The guide does not give any information on why I feel the things I feel in relation to my product; it only summarizes information'*. Moreover, the guide did not offer enough support to create insight into the relative importance of the different aspects, leading to the conclusion that some students *'Couldn't see the essence of what they were feeling'*.

The appreciation of the usefulness of the guide seemed to relate above all to the fact that *'The guide creates a clear and complete overview of the tactual aspects'*. Nevertheless, as some commented, it should be kept in mind that *'It doesn't guarantee that the overview is complete'*. According to the students, users of the guide should take the guide as a starting point, and the guide should above all stimulate the students *'To explore more deeply the experience'*, an effect that most students actually acknowledged after using the guide.

The next version of the guide should emphasize that the tool is meant to get an overview of one's tactual experiences with a specific object and to describe the different aspects of these experiences. The guide should focus on the notions of broadening one's awareness for the different aspects, and deepening the descriptions of these aspects.

### 5.5.2.3 Creating awareness for Tactual Experience

Many students reported that the guide worked as an *'Eye-opener'*. It *'Stimulates you to go further than to say, "It feels good or bad"'*. According to the students, the guide did not open their eyes to a new world, but to a world of experience they already knew, but were not aware of: *'It explores the things you know but never*

thought of as being relevant'. And: 'I really love this product. Something I might have known unconsciously, but never acknowledged'. For example, as one of the students illustrated: 'I feel reassured that the Discman is still there because I can feel it in my pocket when I walk'. Before using the guide, the student was not aware that perceiving the Discman in his pocket while walking is a positive aspect of the interaction with the Discman. The power of the Guide partly seems to consist in making one aware of the unaware.

This aspect of creating awareness raised the question about the relevance of these aspects for the overall assessment of the experience, especially in the case where these aspects were negative. 'The conclusion may sometimes sound too dramatic: it highlights negative things that you would not have noticed', or, as some stated: 'There is no need to overreact to negative findings, the alarm clock is still OK'. Students tended to realize that negative aspects did not necessarily lead to rejection of the product. One student even commented: 'I found out that the negative aspects are actually making the experience more intense, they are the reason why I like this watch'. And through the overview, some students concluded that negative aspects seem to be all right because they 'fit' the function: 'It is OK the way it is. After all, an electric toothbrush is meant to be clean and hygienic, and this could require a certain level of clinical distant behaviour'.

Finally some students seemed to restrict the concept of experience itself to the pleasant affective aspects of the interaction with an object. In their perspective, 'experience' is a specific quality of interaction, to be considered apart from the functional aspects of the interaction. This different interpretation of the concept of experience was reflected in the comment: 'It is touched more in a practical way and for practical reasons, rather than for a tactual experience'. This interpretation conflicts with the concept of tactual experience as approached in the guide, which obviously needs better explanation in a next version.

#### 5.5.2.4 Personal versus general descriptions

Most descriptions were personal and concerned a lived subjective tactual experience. This reflects the use of the guide as intended: to research one's own experience, without concern for the general validity of what one describes. To describe a specific texture as sticky when other people experience it as slippery does not mean that either one is wrong (see also § 2.5.2 on physical subjectivity). The comments of the students suggest that this goal is not clear to all. Some students questioned 'The validity of the descriptions on the map', because it is 'Based on yourself as a starting point'. They seemed to strive for an objective description

(how it feels in general) and tried to describe how it would feel to other people as well (for example when bigger, weaker, older, etc). Obviously, the personal and subjective aspect of the description needs more explanation when the guide is introduced.

Several students commented on the guide's contribution to a personal development within design education, which fits well with the purpose of the Tactual Experience Guide: *'It offers good possibilities for personal development'* and *'It helps you to develop a personal framework you can work with'*. Moreover, *'As it is very personal, it also helps you to get to know yourself'*.

#### 5.5.2.5 Applicability for different product types

Using the tool raised the question whether the Tactual Experience Guide was suited for all kinds of products, and for what kind of products it was most appropriate. The students seemed to agree that the guide was especially appropriate for complex products. Several students commented that simple products, such as a plastic coffee cup, might not be that interesting to perform such an elaborate analysis on. But the observations of the descriptions on the maps did not lead to the conclusion that simple products lead to poor descriptions. For example, students were able to describe elaborately about the interaction with a hard cigarette box, or a nose clip. It seems that this comment was above all due to the discrepancy between the complexity of the guide and the apparent simplicity of some objects.

The students seemed to think that objects with *'Emotional aspects'* and with which people are *'In intimate contact with'* such as cars, shoes or guitars were more appropriate for the assessment of the tactual experience than other objects. In contrast, a number dispenser or a dream catcher seemed to be considered as objects that did not offer rich tactual experiences and, therefore, seemed inappropriate to study with the guide. This observation was in conflict with the goal of the Guide, which aims to be a general tool, mapping poor as well as rich experiences, without pretending to be an advocate for the one or the other. This statement should be pointed out in the explanations accompanying the subsequent version: a poor tactual experience is still a tactual experience.

#### 5.5.2.6 The tactual experience and the other senses

The structure of the guide is limited to the tactual aspects of the physical experience, which led to the comment that *'It is difficult to leave out the other senses'*:

*they are involved in the aspects as well*'. This led one student to actually expand the use of the guide *'To study the whole interaction, beyond the tactual properties only'*. But his attempt resulted in a loss of specific information on the tactual aspects. Obviously, it is too complex to include all senses elaborately at once. The results on the maps showed that these *'Other senses'* mostly concerned the visual senses. The next version of the guide should encourage people to limit the descriptions to the tactual aspects, for example by emphasizing that the guide is about the aspects that can be perceived physically with one's eyes closed.

### 5.5.3 Evaluation of the structure of the Tactual Experience Guide

The evaluation of the structure of the Tactual experience guide is reported along the following themes:

- The mind map structure
- Prescriptive versus free use

#### 5.5.3.1 The mind-map structure

Overall, students appreciated the mind-map structure. On the one hand because *'You don't have to be really tidy; you just write down and draw; you feel more free'*. And on the other hand because *'The different branches allow you to go into depth'*. The guide seemed to be appreciated by some because it actually offered a structure. *'It helps you to organize your feelings so it is easier to describe them'*. But to some, the structure of the guide and the way it should be used was not clear enough: *'The process was too open to give me support'*. Several people reported that they did not know how and where to start, and that they *'Had to go through the guide a few times before actually getting started'*. This support should get more attention in the explanation sheet, by providing information on how to create a mind-map.

Some students found the structure of the guide too complex: *'It is confusing that there are so many maps'*, *'It might be easier if the different maps can be seen together in the blink of an eye'*. The complexity of the guide cannot easily be reduced, because it is inherent to the complexity of the phenomenon of tactual experience. Nevertheless, this complexity should be addressed in future developments.

For now, it is concluded that the guide should remain a loose-leaf document, to give people the opportunity to choose their own sequence of maps, and to be able to display them all together.

Students complained about the space on the maps: *'I need bigger sheets!'*. The maps were meant as a template to write on, but the students seemed reluctant

to write over the grey words and graphics, they rather used the space around. Therefore, the new version should offer central maps as small as possible, providing more blank space.

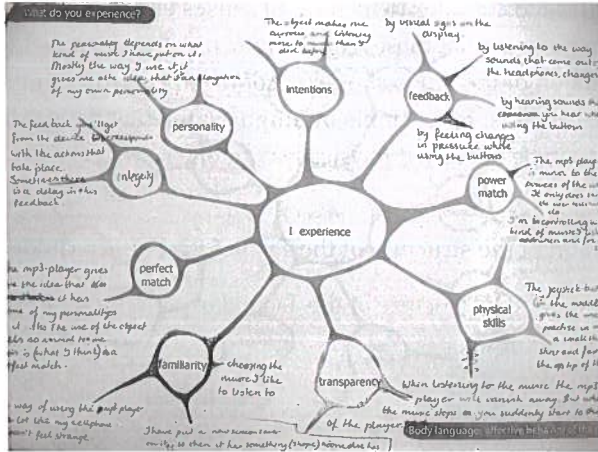


Figure 5.10 The maps are not used as templates, but as structures to complete

### 5.5.3.2 Prescriptive versus free use

The structure of the map should encourage a free and associative use, providing a structure without being strict about the process to follow when using the guide. Nevertheless, some comments were about how prescriptive the tool is, and how much creative space is left for the user. Students have different ideas about this topic.

On the one hand: *'When having a tool that is as prescriptive as this one (you have to follow a certain path to explore and find out the tactile experience of a product), I always get a bit allergic. Of course it can be very helpful, and I really see the use of it, but I'd rather have a piece of text about it...after reading the text I can see what points are relevant in the product I am facing. This saves room for creating my own vision on the product.'*

On the other hand, students who appreciated the use of the maps reported: *'It forces you to think of a lot of different aspects of the tactual experience without prescribing anything', 'You can go back to previous pages because of new thoughts', and 'You are free to use your own words.'*

An important misunderstanding about the use of the maps became evident from the comments of the students: people tend to think they *'Have to describe every-*

thing', which led to undesired situations: *'The format suggests that there is something to say for all the branches, so you start to make things up'*. Moreover, as one of the students reported: *'The more you cannot use, the more you get discouraged'*.

The goal of the guide is to support people to be as complete as possible about their personal experience. This does not imply that the guide itself should be completed. Rather, as one of the students concluded, the right procedure is that one *'Has to make a selection of aspects that are relevant for your product'* as the guide was meant to be used. Obviously, this was not clear to all, and needs more explanation in the instructions on how to use the guide.

The effect of getting demoralized was also attributed to the additional blank spaces around the centre of each map. These spaces are meant for people to add aspects of their own, but it seemed that *'To see the words helps you to come up with own words, but to see the empty spaces doesn't'*. Therefore, the blank spaces should be left out in future versions of the guide.

The results on the maps showed that many students mixed up the different domains, adding descriptions on maps that were not actually meant for it, for example describing personality traits on the map about sensations or perceptions on the map about feelings. Overall, one could argue that this is not a problem, as long as the different aspects are thought of. But mixing up different domains confuses the students and hinders a deeper understanding and description of the tactual experience. Moreover, not knowing where to put a description may lead to uncertainty about the use of the guide, as some students commented, and should be avoided in trying to be as specific as possible about the different aspects on the maps. Therefore, the structure should support a better use of the maps for their own purpose, and encourage the user to be conscientious about what aspects should be described on what map.

#### **5.5.4 Evaluation of the content of the specific maps**

The observations of the descriptions on the specific maps is analysed as follows:

- The frequency of the use of the aspects on the maps
- The introduction of new aspects on the maps
- The conclusions people formulated on their tactual experiences

##### **5.5.4.1 Frequency of use of aspects**

Some students were very elaborate in their descriptions on the different maps, but overall the descriptions on the different maps remained quite limited and

sometimes superficial. This led to the conclusion that the guide should encourage users to reflect more on what they are writing, to ask themselves questions about what they are writing, thus elaborating on their first descriptions.

The amount of descriptions sometimes differed between the aspects on one map, and between the different maps themselves. It is not clear whether these differences were due to unawareness for some aspects, or because they just don't play a role in the specific tactual experience. Nevertheless, these differences were not systematic: over all, all maps seemed used with the same intensity, despite the differences per case. Therefore, it is decided that in the next version the maps remain of equal size.

It is surprising to observe that the maps on sensations were well used and sometimes led to elaborate descriptions of the different bodily sensations. This supports the assumption that attention for tactual sensations is valuable in tactual experience, although one has to be made aware of this particular domain of experience.

#### 5.5.4.2 New aspects found

The completed guides were evaluated on the content of the descriptions. In the first place, the contents were used to refine the definition of the existing aspects, and their possible descriptors. Second, the maps were scanned for new aspects that could be added to the maps.

In general it can be concluded that the students did not add many new aspects to the existing ones. If it happened occasionally, this new aspect seemed to fit into the existing structure, giving it a slightly different nuance, rather than adding something completely new.

Overall, students related their descriptions to specific contexts of interaction. For example, an object may feel as a perfect match in summer, but not in winter times. A nose clip feels very different when clipped on a nose from how it feels when one is *'Trying to catch it under water!'*. Furthermore, the personal state of mind was mentioned as a relevant context. For example, when talking about the aspect of power and being in control: *'It is very different when being drunk'*. The explanations for the map on movements should therefore emphasize on the importance of the context of interaction, in all its aspects.

In addition, the following new aspects seem worthwhile to take into account:

### *On the map describing movements*

Some students explained that they made the movements as a response to a specific emotion: *'When I am angry, I hit it!*'. Nevertheless it was decided not to include this aspect on the map, because it was very similar to the aspect 'action tendency' on the map about feelings. It is therefore decided that in the explanation sheets, the aspect will be introduced on both maps, emphasizing that action tendency may lead to specific movements, that in turn influence the tactual experience.

### *On the map on sensations*

Sensations were often described as the physical effect of the interaction on the human body. For example, students described the occurrences of impressions on the skin, cramps, paralysis, bruises, blisters, or cuts due to interaction with the object. These aspects can be included in the explanation sheet, as a possible starting point to arrive at a description of the preceding or following sensation. For example, impressions are a result of pressure, pain a result of blisters, and so on.

### *On the map about affective behaviour*

For the descriptions of the intentions of the object, several students commented that some objects seem to have an intention of wanting to be touched or not, for example: *'It is almost begging to be touched!*'. This additional aspect will be included in the explanation sheet as a specific descriptor of the intentions of an object.

Several descriptions concerned the emotions the objects seemed to have. For example, objects could be experienced as feeling *'Lonely', 'Raged', 'Happy' or 'In need for comfort'*. Because this aspect seems to contribute to the understanding of the body language of the object, and in particular to the notion that the object is experienced as animated, it is decided that this new aspect 'emotion' is included on the map of the new version of the Guide.

The links made by students on the map about affective behaviour suggest that some aspects are related and could be grouped to make the map more insightful.

- Personality & intentions & emotions
- Integrity & transparency
- Power & skills
- Perfect Match & familiarity



### 5.5.4.3 The Conclusion Map

The concluding map was meant to summarize the findings on the previous maps by highlighting the most important aspects, assessing its aesthetic aspects and concluding on the experienced body language of the object. Some students understood the purpose of the map, as reflected in the way they filled in the map, and in the comments they gave on the use of the map: *'I think the conclusion mind map at the end is really good, because you can pick the most important things out of the other maps, and you can see the connection between the different maps'*. Or, as somebody else stated: *'To see the connections between the topics allows you to go deeper'*.

But it seemed difficult to formulate an overall conclusion. Some students seemed to merely repeat what was stated on the previous maps. The map did not help to formulate an overall assessment of the aesthetic aspects of the experience, and the concluding map did not offer specific aspects to help to conclude on an overall level. In sum, it seemed that the structure of the map elicited repetition instead of reflection.

To help people to reflect on the tactual experience with objects, the topics 'body language' and 'tactual aesthetics' should be explicitly mentioned on the conclusion map.

In addition, a new aspect was generated from the data found on the conclusion maps: the nature of the relationship with the object. This aspect was frequently mentioned as part of the reflection on the tactual experience and, therefore, seems a promising aspect to help people to understand and describe their tactual experiences with objects. Some examples of descriptions of the nature of the relationship are:

*'It's good company, I feel less alone...'*

*'It completes me'*.

*'It is like a close friend: it is there when you need it, but it does not ask for your attention when not desired for'*.

*'It is like an old friend with whom you have shared a lot of experiences'*.

*'It could be anybody's friend, not only mine... which is a bit sad, I would like our friendship to be more exclusive'*.

*'There seems to be a deal, or some kind of trade-off: I treat it well and it will give me fine music in return'*.

*'I feel harmony between me and my record player. We need each other and form a good team'*.

*'Like a mother, it wants to protect me'*.

*'I would like my sewing machine to be more involved with me: more personal, a closer relationship'*.

### 5.5.5 Evaluation of the use of words for the Tactual Experience Guide

In the Tactual Experience Guide, words are used as a means to research and describe experience. This raised the question among the student about how suitable words are for this goal. Observations of the maps show that students used different means when using the maps (Figure 5.8): keywords, short and long sentences, sketches, cartoons, pictures, smileys, and so on.

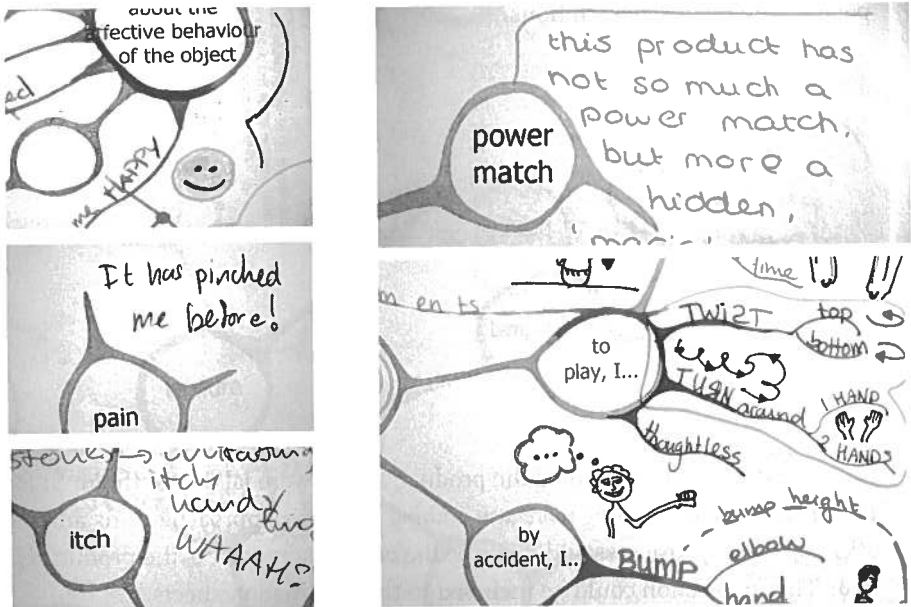


Figure 5.11  
Examples of different means used to complete the Tactual Experience Guide

All comments on the use of words stated that it was difficult to do so: *'It makes you use words to describe things there are no words for.* This led to undesired results: *'So sometimes you think 'well, this isn't right, but I don't know how else to put it'.* Some students preferred other means: *'I like to make drawings on the sheets',* or *'Too bad that in this shape, it doesn't leave any space for visual explanation'.* Like in the previous studies, students commented on the discrepancy between the subtlety of sensations and perceptions, and the poorness of the words to describe them.

When using words, some students used keywords, while others used a more narrative way to express their experience, telling stories. It is evident that students have their own style, and feel more comfortable in using the one than the other. But the results suggest that most keywords represent the first thing that came to one's mind, leading to superficial comments. It seems wise to encourage the user to deepen his insights by reflecting on the first descriptions that come to

mind, and to associatively add additional descriptions to them.

The results show that some aspects were interpreted as a yes or no question. 'Yes!' or 'No!' or 'Not so much', are frequent 'answers'. These comments do not contribute to a deepening description of the experience itself. Again, a first description in terms of 'yes' or 'no' seems a good start, especially because it is a strong statement, but the new version of the guide should stimulate addition personal qualitative descriptions.

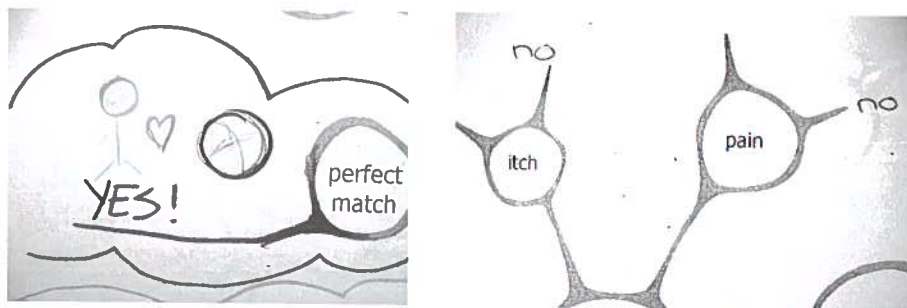


Figure 5.12  
Aspects 'answered' with yes or no.

Some students actually quoted the product, as if it were talking to them: *'It feels like saying: 'It's me, nothing more and nothing less'*. This approach seems another stimulating way to access and describe the experience: what is the product telling you? This suggestion could be included in the explanation sheets.

The English language was used in the assignments and in the guide. But English is not the native language for most students. The results show that this was an obstacle: the English was poor and contained many mistakes. *'I would like to be more productive in this field, but my English impedes me sometimes'*, and *'It is difficult to do this when it is not your native language'*. People should be encouraged to describe their experiences in the language they feel most comfortably with.

Finally, some students commented that it takes a long time to fill in the guide, and that one may get bored after working through all these guides providing verbal descriptions. This could be a valid argument to add other means to the guide (for example stickers with images or smileys to express feelings).

### 5.5.6 Evaluation of the instruction to the user

The Tactual Experience Guide was provided with explanation sheets with information on the content of the guide. In addition, the guide was introduced in a

lecture on Tactual Aesthetics, presenting many examples to illustrate the aspects of the maps, and giving instructions on how to use the guide. The question is whether the students were provided with enough information to use the guide as intended.

### 5.5.6.1 Interpretation of the aspects on the maps

Although the manual and the lecture seemed a valuable introduction to the guide, the students commented that they were not sufficient. The Guide including the explanatory sheets was evidently not self-explanatory, which made students insecure: *'You cannot do this wrong, can you?'*. Students asked that *'The topics should be defined more clearly'*, because *'Some words are still mysterious'*.

This confusion was reflected by the descriptions the students provided. The aspects on the different maps were often misinterpreted, leading to other descriptions than relevant for the tactual experience. Transparency, for example, was more than once explained as visual transparency. And it seemed hard to make a distinction between the tactual experience of the object and the other aspects of interaction (functionality, social, economical and ecological issues).

On the level of each map, the confusions led to the question whether the keywords are well chosen. In the case of transparency, 'tactual noise' might lead to less confusion. Likewise, the aspect 'self-image' is often interpreted in a visual manner, and related to the way people think that other people see them: *'It makes me look the way I want to'*. But this was not the purpose of the aspect: 'self-experience' seems a better descriptive keyword.

Overall, the confusion led to the conclusion that students need to be better introduced to the conceptual framework on tactual experience. Ideally, the concept should be introduced in relation to the other aspects of human-product interaction, to be able to discern what it includes and what it does not include.

Some aspects on the maps were experienced as related to each other. Some students had the feeling that they were occasionally repeating themselves, describing the same phenomenon from different perspectives, for example temperature. This added to the feeling of being insecure about the interpretation of the guide. The explanations accompanying the guide should emphasize that there are no strict limits between the different maps and that one should feel free about where to put one's descriptions.

The use of the guide does not seem smooth from the start. People reported

that they need experience in using the guide. They need to construct their own tactual vocabulary, which seems a creative process as well: *'I think that if I used it more often, I would become more creative in using it'*.

The students raised the question whether the explanation of the aspects should be included in the maps or stay separate. It seems practical to include them: *'You really need the explanation sheets, can they be included into the maps?'* because *'Having to scroll through the guide and the explanations of the keywords was not that desirable'*. But other students pointed out that: *'Explanations and examples are useful but may be restricting'*. *'It is good that the map and the lexicon are separated, so you can choose whether to look at them or not'*.

It is clear that the guide needs more elaborate descriptions, but it is decided not to add examples of objects, to avoid narrowing the aspects.

### 5.5.6.2 The instruction on how to use the guide

Besides examples that illustrate the aspects, students needed instructions on *how* to use the guide. *'Although I had the lecture before starting, I still miss an introduction to the guide'* and this lack of instruction *'Made me feel insecure'*. According to the students, these instructions should be included in the explanation sheets accompanying the guide. Moreover, students asked for examples of guides that were used and filled in. On the other hand, to let the guide function as an inspirational tool, the students commented that it should not be too strict about its own rules.

## 5.6 Conclusions for the Tactual Experience Guide version 2

The design of the Tactual Experience Guide can be improved on the following aspects:

The design and structure of the guide should (see § 5.4.3):

- Stay a loose-leaf document
- Leave out the empty circles meant for the adding of aspects on the maps
- Provide more writing space for each map
- Rearrange the aspects on the map to form logical groups
- Provide each map with an appropriate question that introduces the aspects on the maps.

The content of the different maps should be completed with the results from § 5.4.4.2;

- The sheets accompanying the map on movements should emphasize the importance of the physical context of use;
- The sheets accompanying the map on movements should include the suggestion that some movements are elicited as a reaction on emotions;
- The sheets accompanying the map on sensations should include the suggestion that sensations may include the physical effects of the interaction on the body;
- The sheets accompanying the map on affective behaviour should include the aspect that an object may express that it wants to be touched or not;
- The map on affective behaviour should present the aspects by grouping them into sets of related aspects;
- The conclusion map should be changed into a map that supports people to reflect on the tactual experience from an overall perspective: the body language of the object, its aesthetic aspects, and the nature of the relationship with the object.

The guide should provide a manual with an instruction on how to use the guide, including the following recommendations (based on § 5.4.2 to § 5.4.5):

- An instruction on the sequence of the maps: first the map on movements, followed by the maps on tactual properties, sensations, behaviour and feelings in random order and concluding with the conclusion map. The instructions should encourage a free flow of descriptions, going back and forth from one map to another.
- An instruction on how to use a mind-map
- The recommendation that the description concerns the personal and subjective experience: 'it is about you, don't worry about the others'.
- The comment that the map provides an overview of the different aspects of the experience, without pretending to unravel the underlying relations between these aspects.
- The comment that the guide is suited for all objects people physically interact with, whether complex or simple.
- The comment that the guide is only an empty structure. It is the user who provides the different aspects with embodied meaning, by exploring his world of experience.
- The recommendation to use a description style one is at ease with: key words, narrative, sketches, and so on, but emphasizing the use of words.
- The recommendation to leave out descriptions of the other senses, the guide

is only about touch.

- The recommendation to limit oneself to the aspects that are relevant, thus to avoid to make things up for the sake of being complete.
- The recommendation to add new aspects whenever appropriate: it is an open system.
- The recommendation to use the native language.

The evaluation of the first version of the Tactual Experience Guide resulted in a redesign of the guide and of the accompanying explanation sheets, presented respectively in Appendix 5.2 and 5.3.

### 5.7 Recommendations for further development and use

Students' evaluation of the Tactual Experience Guide show that the tool has the potential to achieve the goals it was developed for. The students are positive about the tool and value it for its contribution to understanding and describing tactual experience, to create awareness for it and to help them to develop themselves within the field of tactual experience. It is decided to further develop the tool, based on the results of the evaluation.

This chapter presented the final design of the Tactual Experience Guide in the context of this thesis. Further use of the guide will lead to further improvements, but it is expected that these improvements will not concern the core characteristics and nature of the Tactual Experience Guide. Rather, they will consist in deepening the guide and in providing cosmetic changes.

In addition, future developments should address the complexity of the guide. The present guide is based on the conceptual framework developed in this thesis, considering all aspects of equivalent value. Nevertheless, using the framework more extensively might lead to insight in the relative importance of the aspects and of possible overlaps. In the future, these insights may lead to an improvement of the clarity of the structure of the guide and thus of its accessibility.

The evaluation of the use of the Tactual Experience Guide shows that at start the guide remains difficult to use as a tool. Initially, it needs elaborate introduction and guidance: one has to become familiar with its concept. It is expected that this improvement can only partly be achieved by improving the information in the accompanying manual and explanation sheet. The tool aims to *learn to feel*, and to achieve this goal in its full right, the introduction should be embedded in a setting offering exemplary objects and materials to experience hands on, that

illustrate the different aspects introduced by the conceptual framework. Therefore, a toolbox offering a diverse pallet of tactual perception could be developed to illustrate the guide during its introduction.

Finally, the question about the assessment of the development of the students' tactual aesthetic sensitivity should be addressed. In the current evaluation, the assessment was done through introspection of the students themselves. And although most students were positive about their development, the results on the maps show that they were often confused about the concepts offered by the guides. Thus, although introspection seems a valuable means to assess the achievement of sensitivity, additional methods seem to be required to support students in their assessment.





## Appendix 5.1 Products described for the assignment

The objects reported by the students are categorized along the aspects that characterize the set of objects of the study reported in Chapter 3.

<b>Functional, Tool use</b>	<b>57</b>	<b>Leisure</b>	<b>27</b>
Mobile phone	5	Guitar	3
PDA	4	Sports shoe	2
Photo camera	3	Power ball	2
Alarm clock	3	Drum kit	1
Computer	2	Skiff	1
Scanner	1	Horse saddle	1
Remote control	2	Rocking chair	1
		Juggling balls	1
Coffee machine	7	Portable game	1
Bread toaster	3	Bicycle	1
Cooking timer	2	Discman	8
Water boiler	2	Gameboy	1
Water dispenser	1	Hi-Fi set	1
Sewing machine	1	TV set	1
Microwave oven	1	P5 Glove	1
Sandwich maker	1	Record player	1
Coffee cup plastic	2		
Thermos	2	<b>Personal care</b>	<b>6</b>
Water bottle	1	Electric toothbrush	1
Teapot	1	Lip balm (Labello)	1
		Package of cigarettes	1
Railway ticket machine	2	Nose clip	1
Traffic light pedestrians	1	Candy roll	1
Mail box	1	Dream catcher	1
Number dispenser	1		
Watch	3		
Pen	1		
Clock	1	<b>Total:</b>	<b>93</b>
Newspaper	1		
Counting machine	1		
Candle	1		
<b>Furniture (support/protection)</b>	<b>3</b>		
Bus shelter	1		
Elevator	1		
Couch	1		



## **Appendix 5.2 The Tactual Experience Guide, version 2.0**

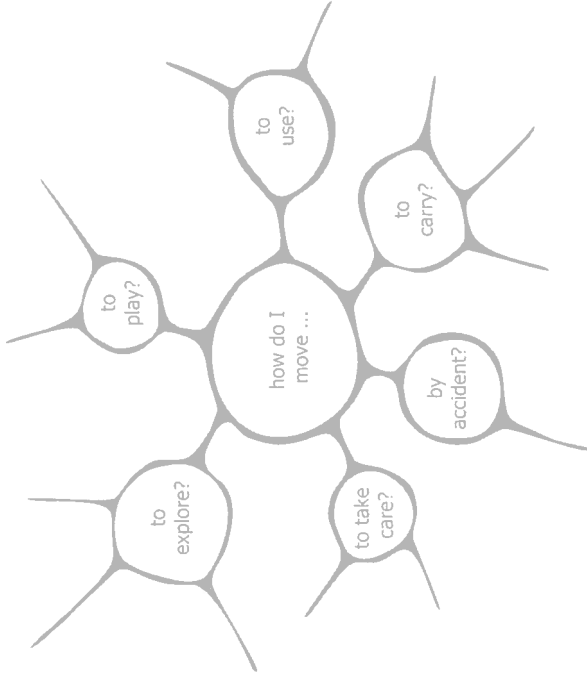
This appendix contains the maps and the accompanying user manual



# the tactual experience guide ©

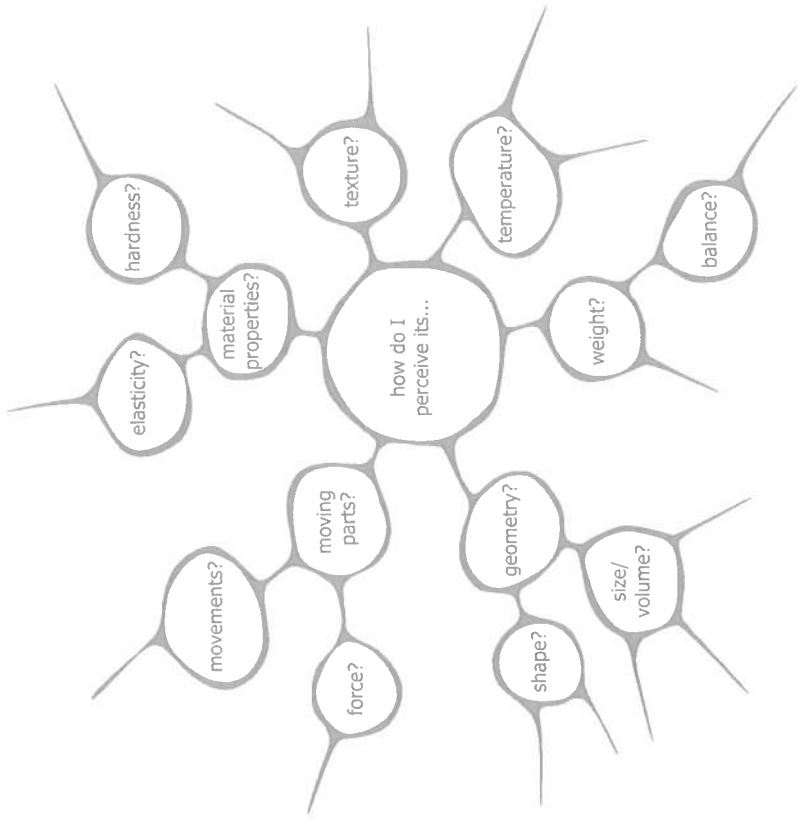
how do you experience touching and being touched?





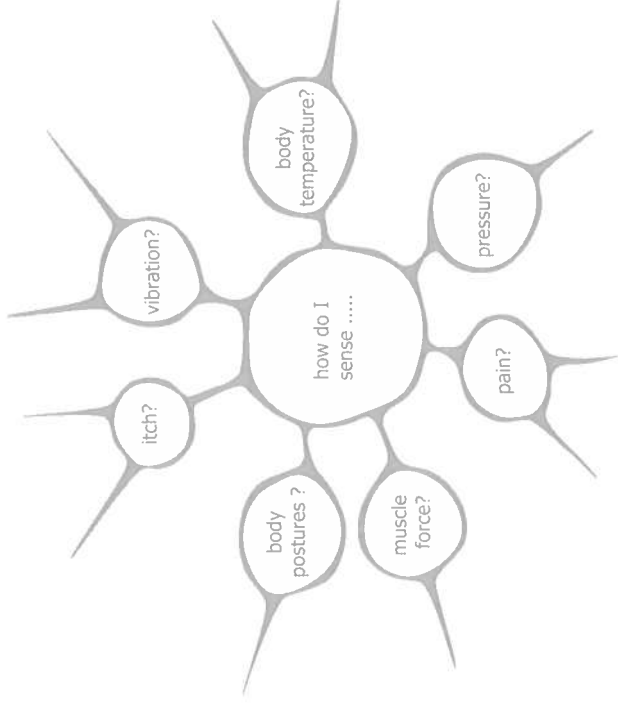






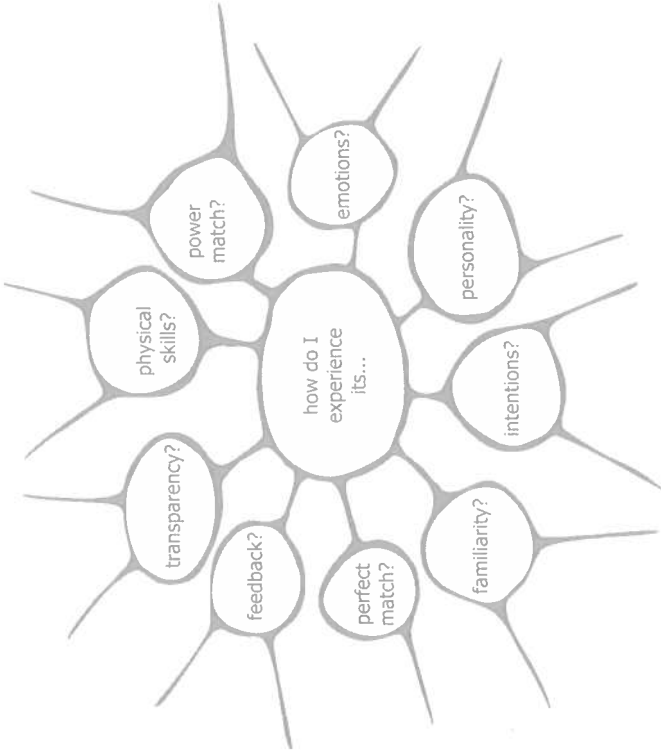
how do I perceive the objects tactual properties?





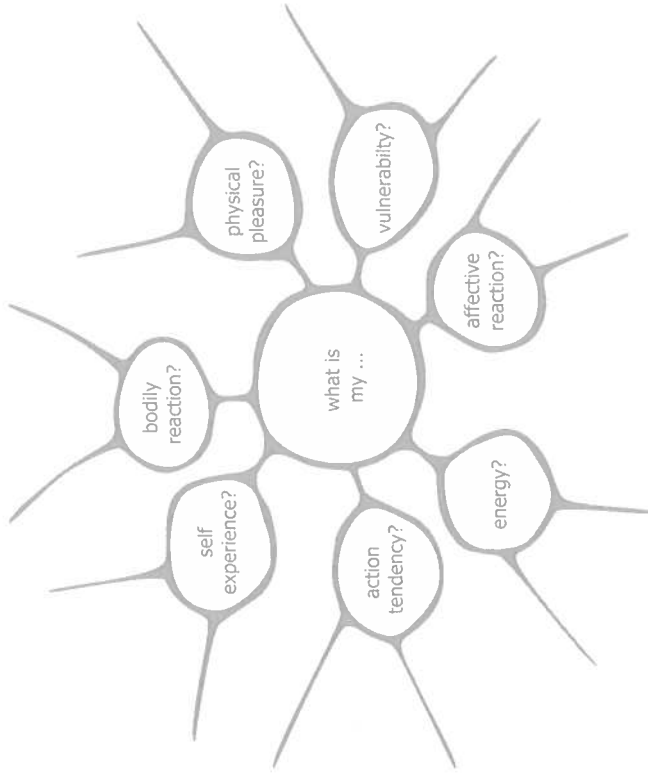
what do I sense in my body when touching the object?





how do I experience the object's affective behaviour?

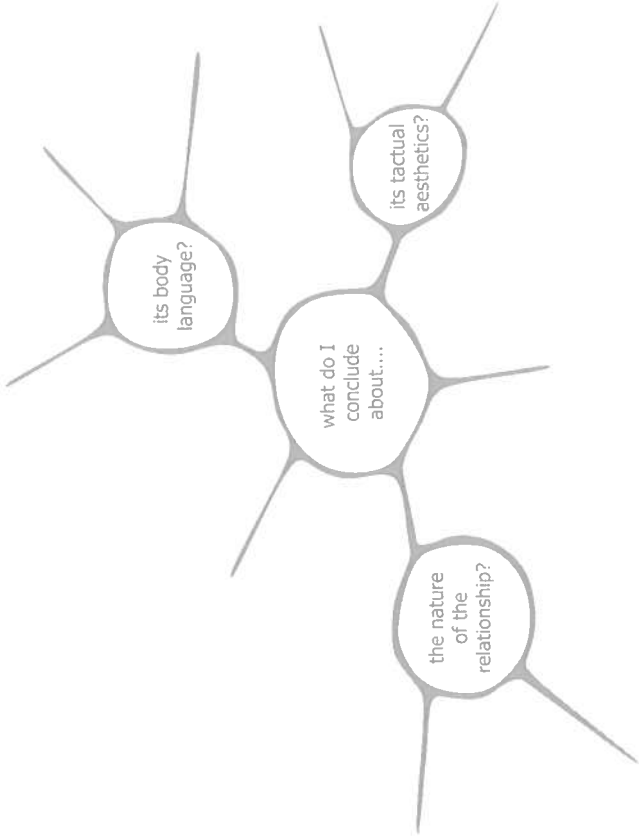




what feelings do I have when touching the object?







what do I conclude about my tactual experience with this object?



# User manual for the Tactual Experience Guide

The purpose of the Guide is to help you to describe your tactual experience with a specific object, and to assess its aesthetic aspects.

The tactual experience can be mapped along five different domains, as shown in the Figure 1.

These domains are:

- The movements you make with an object
- The objects' tactual properties you perceive
- The bodily sensations you have
- The objects' affective behaviour you experience
- The feelings you have

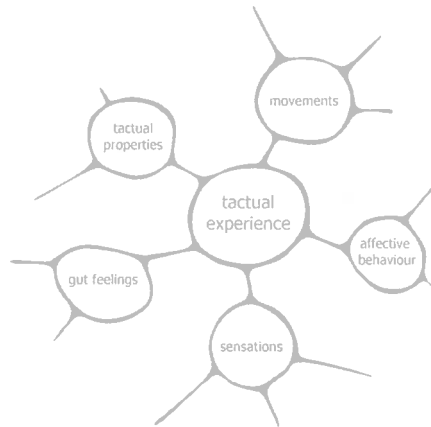


Figure 1.

The five domains that describe the tactual experience

## The structure of the Guide

The Guide consists of a specific mind-map for each domain. In addition, a concluding map helps you to assess the experience as a whole in the context of your relationship with the object.

You can use these mind-maps as a starting point to create your own mind-maps, describing the different aspects of this specific domain. This manual provides you with explanations of the different aspects for each domain, helping you to formulate your own descriptions.

### **Procedure to fill in the Guide**

Start with the map on movements, describe the different situations of interacting with the object, and consequently the movements you make with the object.

Continue with the maps on 'properties', 'sensations', 'affective behaviour' and 'feelings'. These maps can be used in random order; you may go back and forth between the maps, because some aspects make you think of aspects on the other maps.

Conclude with the map 'conclusions' on the tactual experience of the object, to assess the experience as a whole in the context of your relationship with the object.

### **Recommendations to use the guide**

To create a mind-map, you use the existing maps as a start to elaborate on, by providing descriptions for each branch on the map. Next, for each branch, you may enlarge the map by adding as much branches as appropriate for the specific aspect you are describing, for example:

You may describe each aspect on the map by providing:

- A qualitative description of the aspect (for example as adjective: 'soft', 'warm'; as action: 'it resist when I squeeze it', or as an association: 'like velvet');
- An additional quantifying description (for example 'very', 'a little', 'terribly');
- The changes in time of that particular aspect ('it becomes sticky after a while');
- The (un) pleasantness or indifference of that aspect.

The descriptions concern *your* subjective experience, don't worry about the universality or objectivity of what you are describing. It is your experience that gives meaning to the aspects included in the maps. Use your own world of experience to understand what the different aspects refer to.

Use a description style you feel at ease with: use keywords, sentences, little sto-

ries, sketches, images, or a mixture of these styles. Use your native language if you feel more at ease with it.

You don't have to describe *all* the aspects on the map: if a specific aspect does not seem relevant for your experience, then leave that space blank. The aspects on the map are meant as a *starting point* to help you to explore your experience of touching the object, so don't feel restricted to them. Add new aspects if you want to.

This guide is only about the tactual experience: what you experience with your eyes and ears closed. So leave out descriptions related to the other senses: this complicates your assessment of the object's tactual aspects.

# Explanations for the map on movements

What you sense, perceive and experience tactually depends on the movements you make with an object. Therefore, when considering tactual experiences, it is important to have an overview of these movements. In turn, these movements depend on the possible different reasons you have to interact with an object.

Relevant questions for this map:

- Why do you touch the object or is the object touching you?
- What movements do you make with the object in that situation?

Motivation for touching	Description of the aspect
To explore the object	To explore an object is to try to answer the questions: what is it? And what is it made of? You may want to explore the object when you see it for the first time, to get to know its physical properties. You may also want to explore a familiar object to check some of its physical characteristics before using it.
To play with the object	To play with an object is to interact with it for the sake and pleasure of the interaction itself, and not for its functional purpose. It can be considered as the non-functional interaction with an object. To play with an object is related to the question: what can I do with it? Physical play may be characterized by the type of movement made: swinging, squeezing, moving up and down, and so on.

<p>To use the object for functional purposes</p>	<p>The use of the object for functional purposes is characterized by the desired practical output of the interaction with the object. Note that you may use the object for practical purposes the object was not meant for originally.</p>
<p>To carry and displace the object</p>	<p>Objects are moved from one user situation to the other or carried around because they are portable. This carrying creates a specific physical interaction with the object.</p>
<p>To take care of yourself or of the object</p>	<p>A reason to interact with object may be to take care of the object, for example to clean it or to repair it. Also, you may use the object to take care of yourself or of other people in your surroundings.</p>
<p>By accident, you touch the object or the object touches you</p>	<p>Some physical interactions are unintended, they happen by accident.</p>



# Explanations for the map on tactual properties

The map on tactual properties is about the physical aspects of the object you perceive, when your attention is directed *towards* the object you are touching. Tactual properties are related to the physical behaviour of the object: how it reacts to your actions.

Relevant questions:

- What can you do with the object?
- How does the object react? What does the object do?

Tactual property	Description of the property	Possible Descriptors
Hardness	Hardness is perceived as the resistance of the material to being transformed.	Hard / soft
Elasticity	Elasticity is perceived as the capacity of the material to get back to its initial shape after being transformed.	Comes back to its original shape/ stays in its new shape  flexible/stiff
Temperature	Extreme temperatures are perceived at initial contact, subtle temperature changes after longer periods of contact.	Extreme hot / extreme cold Warm / cold

Weight	Weight is perceived when lifting and manipulating the object.	Heavy / light
Balance	Balance is perceived as reaction to swinging, to manipulation.	Balanced / unbalanced
Texture	Texture is perceived when stroking a surface, and through grip on a surface.	Rough / smooth Sticky / slippery Clean / dirty Wet / dry  Structure and pattern: Type of details (shape, size, layout) Location: local / overall Regular / irregular Direction
Shape, volume and size	Shape, volume and size are perceived in contact with the object, through holding and manipulating the object.	Size: Big or small Shape: Curved / flat, Rich / poor in contrasts, Complex / simple. Surface: Discontinuities (e.g. holes.) or not Edges: Sharp / rounded Orientation: horizontal / vertical
Moving parts	The dynamic aspects of moving parts of the object	Type of movement, activity Required force Development in time: Duration Speed Flow (rhythm, smoothness)

# Explanations for the map on bodily sensations

The map on bodily sensations is about what you sense on your skin and in your body when being in touch with the object. It is what you experience when your attention is directed towards your own body, instead of towards the object. It is about how you experience the object touching you.

Relevant questions:

- Where are you touched?
- What do you sense?
- What does the object do to you?

Tactual Sensations	Description of the sensation	Possible Descriptors
Pressure	Pressure is experienced as the force with which the object is pressed against your body. Pressure may result in impressions on the skin.	Light / intense. Large / small area of pressure
Vibration	Vibration is experienced when the experienced touch or pressure varies in time with a certain frequency.	Light / intense Rapid / slow Large / small area
Temperature	In interaction, the temperature of your own body parts may increase or decrease.	Warm / cold Large / small area

Pain	The touch of the object may result in the sensation of pain, due to too much pressure or stress on the skin, to high or low temperatures, or due to extreme mechanical impact on the skin.	Type of pain Light / intense Large / small area Physical effects (cut, bruises)
Itch, tickle	Itch and tickle may be the result of light touch, light vibration, or of a chemical reaction of the skin to the material the object is made of.	Light / intense
Body posture	In interaction, you may feel the movements your body makes, the postures of your different body parts. These postures may feel as neutral or extreme postures.	Extreme / neutral
Applied muscle force	In executing the different movements involved in physical interaction, you sense the forces you have to apply.	Strong / weak

# Explanations for the map on feelings

The feelings you have when physically interacting with an object can be described as basic, primordial feelings: gut feelings.

Relevant questions:

- How do you feel?
- What does it do to you?
- How do these aspects change in time?
- How (un) pleasant are these aspects?

Aspect of feelings	Description of the aspect	Possible Descriptors
Body reactions	Your emotional reaction to the interaction with the object may manifest itself in your physical reactions: your gut reactions.	Goose bumps Shivers Sweat Increased heart beat Increased respiration
Physical pleasure	The different sensations you described in the map on bodily sensation may be experienced as physical pleasure, or as physical disturbance. This may be related to the experience of lust, or disgust.	Pleasure / disturbance Lust / disgust

Affect	Your emotional reaction is related to the experienced affection in interaction. As polarities, you may feel accepted or rejected by the object, or you may feel loved or hated by the object. Your own affective reaction may be to love or hate the object.	To feel accepted / rejected To feel loved or hated To love / hate the object
Vulnerability	Physical interaction relates to the vulnerability of your own body: in interaction there is always a possibility to get hurt. Your emotional reaction may be related to the experienced vulnerability.	To feel protected / exposed To trust the object / or not
Energy	Physically interacting with objects has an impact on your energy. The impact may be positive: it excites you or relaxes you, or negative: it stresses you or causes an energy leak.	To feel excited To feel relaxed To feel stressed To feel an energy leak
Action tendency	Touching the object may elicit a (re) action tendency. You may want to let go immediately or may want to keep on touching the object, or experience these reactions simultaneously. Furthermore, the interaction may elicit affective behaviour of your side: taking care of the object or neglect it.	Approach / avoidance Hold / let go Take care / neglect
Self experience	The interaction with the object may contribute to the way you experience yourself.	Your self-experience: for example, feeling elegant or clumsy.

# Explanations for the map on affective behaviour

The physical behaviour of the object has an affective meaning to you, experienced as the affective behaviour of the object. This can be understood from the perspective of experiencing the object as if it was animated. To describe this affective behaviour, you can use the following aspects.

Relevant question:

- What is the object communicating through its physical behaviour?

Aspects of affective behaviour	Description of the aspect
Personality	<p>The object may seem to express its personality in the way it physically reacts to you.</p> <p>This personality may be literally related to its tactual properties (for example it can be experienced as a warm or cold, a flexible or stiff, rigid personality, and so on). The personality may also be described as character traits of living creatures such as people, animals or other living organisms (for example, it can be experienced as a mean, a friendly, a sneaky, a supporting or an impressive personality, and so on).</p> <p>In addition, the personality of an object may be described through associations with other objects (for example a weapon or a cuddle toy).</p> <p>Relevant question:</p> <ul style="list-style-type: none"><li>• What are the object's personality traits?</li><li>• What associations do you have with other objects?</li></ul>
Intention	<p>The object may seem to express its own intentions through its behaviour. These intentions reflect the personal motivations you have to interact and touch the object: it wants to be</p>

	<p>touched or not, to play with you or not, to cooperate with you or not, and so on.</p> <p>Relevant questions:</p> <ul style="list-style-type: none"> <li>• What are the object's intentions'?</li> <li>• What does it want?</li> </ul>
Emotion	<p>The object may seem to express its own feelings through its physical behaviour. It may seem sad, cheerful, proud, etc.</p> <p>Relevant question:</p> <ul style="list-style-type: none"> <li>• What feelings does the object express?</li> </ul>
Power match	<p>In physical interaction, there is a power match going on: the object may be experienced as stronger, weaker, or as an equal match. This power match engenders the experience of being in control or of being controlled. Furthermore, this power match is related to the aspect of dependency: you may depend on the object, or the object may depend on you.</p> <p>Relevant questions:</p> <ul style="list-style-type: none"> <li>• Who is the strongest?</li> <li>• Who is controlling whom?</li> <li>• Who depends on whom?</li> </ul>
Physical skills	<p>An object can challenge you to develop physical skills and to use them. The object may allow you to develop these skills in a very personal way, or impose its style on you.</p> <p>Relevant questions:</p> <ul style="list-style-type: none"> <li>• What physical skills does the object challenge you to develop?</li> <li>• Does it allow you to develop your own personal style?</li> </ul>
Perfect match	<p>In physical interaction, objects may form a perfect match with you, or not at all. This 'match' may be related to each of the different tactual properties of the object: its temperature, its hardness/elasticity, its size, its shape, etc. This 'matching' may exist at first touch, or develop in interaction, through adaptation of the object to your own physical characteristics.</p>



	<p>Relevant questions:</p> <ul style="list-style-type: none"> <li>• How does the object 'match' you?</li> <li>• Does it adapt itself to you physically?</li> </ul>
Familiarity	<p>An object may feel familiar, or strange, new. Also, it may feel natural or alien.</p> <p>This aspect of familiarity may be immediate or may be developed in time, through interaction with the object. Through interaction, the object can be recognized as 'mine' or 'not mine', because of little physical changes: adaptations to your body, little marks that remind you of your personal history, and so on.</p> <p>Relevant questions:</p> <ul style="list-style-type: none"> <li>• Does the object feel familiar?</li> <li>• Can you experience and recognize it as 'yours'?</li> </ul>
Feedback / Integrity	<p>The object may physically provide you with information about what is going on or not. If it does, it can be explicit and clear about it or provide you with feedback that is hard to understand. This aspect of providing feedback is related to the integrity of the object: it can be honest or dishonest (provide you with the wrong information).</p> <p>Relevant questions:</p> <ul style="list-style-type: none"> <li>• Does the object provide you with physical feedback about what is going on?</li> <li>• Is that information clear?</li> <li>• Can you trust that information?</li> </ul>
Transparency	<p>An object may continuously ask for your attention, or disappear in your awareness when you are interacting through it with other elements in your environment. In that case it becomes tactually transparent: you are able to incorporate it and 'feel through' it.</p> <p>Relevant questions:</p> <ul style="list-style-type: none"> <li>• Can the object disappear in your awareness?</li> <li>• Can you incorporate it and 'feel through' it?</li> </ul>

# Explanations for the map on conclusion

Once you have described the different aspects of the tactual experience with the object, you may assess the overall experience, and its (un) pleasantness.

Aspects to conclude on	Description of the aspect
Type of relationship	<p>Tactual experiences with objects evolve in time, thus creating a relationship with the object. This relationship may be characterized by its affective meaning, similar to relationships with other animated organisms (people, animals, and so on). For example, this relationship may be characterized as personal, intimate, professional, distant, and so on.</p> <p>Relevant question:</p> <ul style="list-style-type: none"><li>• How would you describe your relationship with the object?</li></ul>
Body language	<p>Together, the physical and affective behaviour of the object can be characterized as its body language. This non-verbal, physical way of communication, may be characterized by its style.</p> <p>Relevant question:</p> <ul style="list-style-type: none"><li>• What is the communication style of the object?</li></ul>

Aesthetic assessment

The different aspects of the tactual experience may have their (un) pleasant or indifferent qualities, as you have indicated on the separated maps. But the experience as a whole has an aesthetic quality of its own.

Relevant question:

- Overall, how would you characterize the tactual experience with the object?

notes



# Chapter 6

## Tactual Aesthetics in Design Education

### 6.1 Introduction

The challenge of this thesis is to develop a frame of thought for tactual aesthetics that is useful in a design context. To assure affinity with the practice of product design, the elective course ‘Tactility’ at the faculty of Industrial Design Engineering at the Delft University of Technology was set up and evaluated.

The goal of the course ‘Tactility’ was twofold. The first motivation comes from a research perspective, because part of the interpretation of data of the studies presented in these theses, of the development of the conceptual framework, and of the development of the Tactual Experience Guide was done in the context of this course and with this course as touchstone.

Next, the main motivation for the development of the course derived from an educational perspective, because it addresses the question whether the insights in tactual experience as developed in the previous chapters do support designers to deal with the tactual aspects of their design project. The course explores how the conceptual framework of the Tactual Experience Guide can be used in design education to develop the designer’s aesthetic sensitivity, as well as his design knowledge and design skills to design for the senses (see Figure 5.2).

The approach to the development of the course was exploratory. The course started with an open mind towards the question about how to integrate tactual aesthetics in the design process. At first, the course started with small groups of students and preliminary insights in tactual aesthetics. The general approach of the course was to explore tactual aesthetics as a team of students and teacher. The first version of the course included the different elements presented in this chapter in a rather unarticulated and unstructured setting. After several years, the course evolved through ‘learning by doing’ into the current structure, being a mix of lectures, hands-on experiences and design exercises.

This chapter presents the course Tactility in its current form. It reports and evaluates the different lectures and exercises that were developed, and concludes on general findings and recommendations for further development of the course Tactility in the design education curriculum.

## 6.2 Context of the course Tactility

The course Tactility was set out in the context of product design education to introduce students to designing for the tactual senses. As argued in Chapter 5, the starting point for this course was that to be able to design for the senses one should develop empathy for the world of experience of the people one is designing for. But to be able to be empathic one has to develop one's own personal aesthetic sensitivity. This development will therefore be a key issue addressed in the course Tactility. In addition, when designing for the senses, designers need to develop design knowledge to be able to use their sensitivity in the design process, referred to a 'a designerly way of knowing' by Cross (1982). The design knowledge addressed in the course Tactility has is twofold. First, the course develops the knowledge designers need *about* tactual experience in a specific domain (domain specific knowledge). Second, it develops the skills to design *for* tactual experience (Figure 5.2). This section discusses the different aspects of the acquisition of design knowledge and skills as the context for the set up of the course tactility.

### 6.2.1 Developing design knowledge in the domain of the tactual experience

An overview of the papers presented at the second international engineering and product design education conference (Lloyd, Roozenburg, McMahon, & Brodhurst, 2004) leads to the conclusion that the development of skills, is indisputably acquired *through* designing, from design experience (see for example Cross (2004)). In concordance, the acquisition of domain specific knowledge seems to shift from instructions through lectures, to an approach based on personal experience. This shift is inspired by constructivist theory (see for example Albers, Burkardt et al. (2004)), stating that knowledge is not learned as facts through lectures, but that it emerges as a (re)construct from personal interpretations of personal experiences.

Thus for the development of domain specific knowledge as well as of skills in designing, personal and biographical experience seem to play a key role, which fits well with the perceptual /cognitive learning process described in Chapter 5.

Besides addressing the question about *how* to achieve the desired design knowledge, design education addresses the different *stages* of the development process (Dorst & Reymen, 2004). These stages are not described (yet) for the development of sensitivity and skills in the domain of design aesthetics. Therefore, a model developed in the domain of aesthetic sensitivity in art creation will serve as a starting point. Haanstra (1994) observed the following stages:

- The naïve: when there is no frame of reference to guide the experience of art, art is approached with an un-prejudiced, open mind. One does not possess concepts to describe the experience. In creating art, the naïve operates in a genuine unstructured way, producing primitive art. Children are exemplary for naïve art perceivers and creators.
- The scholar: when one has acquired a frame of reference and has learned to use it when experiencing and producing art, one can use it to report about the experience. The key issue is that the scholar has learned how to experience and produce art according to established rules.
- The expert: when one has transformed the acquired frame of reference into a personal system, the expert does not experience and produce art according to rules, but creates his own rules, thereby creating new perceptions and experiences. Moreover, in communicating about his perceptions and creations, the expert contributes to the development of established rules on aesthetic experience.

Haanstra's model on aesthetic sensitivity seems to follow the same basic structure as the model Dorst and Reymen (2004) proposed to describe the different stages of the development of design *skills*, which are: the novice, the advanced beginner, the competent, the proficient, the expert, the master and the visionary. Again, these stages are characterised by the different ways of perceiving, interpreting, structuring and solving problems.

The domain of tactual aesthetics does not provide established rules yet, which leads to the conclusion that all students start at the level of the novice and the naïve. But the conceptual framework that is offered in this thesis could be seen as a starting structure to work with. From that perspective, the scholar could be discerned from the expert in the way he assimilated the framework, and created his own way of working with it.

Both models on expertise development share the insight that expertise is necessarily related to personal development. Experts do not design by standard rules and procedures. New insights are created and new worlds are disclosed. This involves the development of the designer's personal standpoints on his designs.



Dorst and Reymen (2004) point out that the different levels of expertise do not represent a linear process evolving in time. Different levels may be addressed and coexist within a single design project. According to Restrepo, Rodriguez et al. (2004) a design education curriculum should address these different levels simultaneously from the start, offering courses that support a student in *knowing to know* (scientific and methodological foundations), *knowing to do* (skills) and *knowing to be* (formation of the individual). Therefore, the course will not only focus on the development of the students' sensitivity towards tactual aesthetics, but also on the development of personal taste and attitude.

### 6.2.2 Developing design skills: exploring design solutions in the tactual domain

Schon and Wiggins (1992) described the process of designing as a conversation with materials. They elaborated this insight from a visual perspective: the conversation takes place in the medium of drawing and depends to a large extent on the ways of seeing developed by the designer. Also, designers developed several skills to imagine and visually present products that do not exist as tangible artefacts, ranging from simple sketching techniques to complex digital 3D modelling. But these sketching and presentation techniques, also referred to as 'visualisation techniques', focus mainly on the *visual* aspects of a product.

Considering design as a conversation with materials seems to fit well with the tactual approach to product design. In the tactual domain, design takes place in the medium of *materials* and depends in a large part on the ways of touching and feeling developed by the designer. But in contrast to the diversity of visualisation techniques, design seems to lack the tools to support this tactual conversation in the different stages of design. 'Tactualisation techniques' seem to be quite primitive and underdeveloped. A specific goal of the course tactility will therefore be to explore how tactualisation techniques can support the design process in the context of tactual aesthetics. The course focuses on possibilities to develop techniques that allow designers to research, imagine and present the tactual aspects of a future product.

An important aspect of the design process consists in the formulation of the 'design domain': what is the designer setting out to solve? (Schon, 1983; Roozenburg & Eekels, 2001). The problem domain framed by the designer has an important impact on the domain of possible solutions, thus of the creative space of the designer (Hekkert, 2000). Therefore, the course Tactility will also focus on the contribution of the insights in tactual experience to the formulation and framing of design domains.

### 6.2.3 Communicating the tactual experience

Finally, throughout the design process, designers need to be able to communicate about the different stages of the process and, more specifically, about the experiential aspects of their design concepts. Tools to support the communication in the different stages are explored in several domains (Buchenau & Fulton Suri, 2000). Likewise, the course *Tactility* is set out to explore means to communicate about tactual aesthetics during the design process, directed towards fellow students and the teacher. The conceptual framework and the *Tactual Experience Guide* offer initial verbal means to express oneself, but they are unlikely to be sufficient in communicating the design concepts. Like for the visual domain, where one communicates through collages, mood boards, renderings and show-models, the tactual domain will need its own means to communicate the different stages of design concepts.

### 6.3 Educational objectives of the course *Tactility*

To achieve the objectives described in the previous section, the following educational goals were formulated. The course *Tactility* aims to develop:

- The students' design knowledge by offering insight in the concept of tactual aesthetics through personal experiences. This involves the development of the students' aesthetic sensitivity, personal preferences in matter of tactual aesthetics, and their personal position on how to design for this domain;
- The students' design skills by offering design exercises in which they practice the translation from design knowledge to tangible design solutions. This involves framing the problem domain, exploring design solutions, and communicating about these aspects in the different phases of the design process.

At the end of the course, the students are requested to write a report about the results of the different exercises, including an evaluation of the course. In addition, several material models are made for the different design exercises.

The assessment of the results is based on criteria that evolved throughout the different courses:

- The quality of the exploratory process for the different exercises: the originality of the questions the students formulated as starting points for their design exercises and the broadness and depth of their search to get material answers to these questions;

- The quality of the translation of the findings of their exploratory search into new 'tactual' concepts: the capacity to formulate abstract conclusions based on their material exploratory results, and to generate innovative and unexpected material designs based on these abstractions;
- The completeness and conscientiousness of the different presentation forms;
- The overall effort invested in the course.

#### 6.4 The course Tactility in Product Design

The course Tactility (ID5362) was presented as an elective for the master students at the Faculty of Industrial Design Engineering at the Delft University of Technology, from 2000 to 2006. In this period the elective, lasting eight weeks, was organized ten times. A maximum of 20 students participated in each course. The course was scheduled for two hours per week, complemented with two hours of homework per week.

##### 6.4.1 Structure of the course

Table 6.1 The time schedule of the course Tactility.

Week	Exercises	Lectures
Week 1	Awareness exercise 1 Introduction to Awareness exercise 2	The meaning of touch
Week 2	Presentation Awareness exercise 2 Introduction to Design exercise 1	The Tactual Senses
Week 3	Presentation Design exercise 1 Introduction to Design exercise 2	Tactual Aesthetics
Week 4	Presentation Design exercise 2	Communicating tactual experiences
Week 5	Individual coaching sessions	
Week 6	Individual coaching sessions	
Week 7	Individual coaching sessions	
Week 8	Final presentation Design exercise 2	

The content and structure of the course evolved throughout these years into a mix of lectures on the different aspects of tactual experience and of several short exercises, following the schedule presented in Table 6.1. This development was based on discussions with students on the content of the course and on the feedback the students provided at the end of each course through their evaluation reports.

#### 6.4.2 Lectures

The lectures in the course Tactility provide background information on the tactual senses and introduce the conceptual framework developed in this thesis. The lectures are based on the content of the first three chapters of this thesis.

During the lectures, the different topics are presented through a mix of a verbal introduction illustrated with visual images and a group discussion, asking the students to participate by providing possible illustrations of the theory from personal experiences. In addition, the theory in the lectures is illustrated with objects that are characteristic for specific aspects of tactual experience. These objects are handed out to provide hands-on experiences during the lectures. Goal of this mix of theory and hands-on experience is to present the theory right from the start as a structure to work with in a personalized and experiential way.

The lecture on the meaning of touch is based on the first chapter of this thesis (§ 1.2). The lecture starts with a question: ‘What does touch mean to people, according to you?’. This results in the generation of a collection of possible meanings and examples. In writing down these comments on the blackboard, the content of § 1.2 emerges. Eventually, if some aspects do not emerge from the comments of the students, they are added at the end of the lecture, to complete the overview.

The lecture about the tactual senses is based on Chapter 2 and the first part of Chapter 3, both introducing the tactual properties of objects: the physical aspects of the body language of objects. The lecture is presented through the first three maps of the Tactual Experience Guide: the maps on movements, on sensations and on tactual properties, which are handed out at the beginning of the lecture. The students are encouraged to take notes on the different maps, to become familiar with them.

The lecture on tactual aesthetics is based on the second half of chapter 3, concerning the affective meaning of the body language of objects and is presented

through the last three maps of the Tactual Experience Guide: the maps on affective behaviour, gut-feelings and on conclusions on the tactual experience. Again, these maps are handed out at the beginning of the lecture.

The lecture on communicating about tactual experience introduces the use of visual images as a possible means for communication in the design process. Starting point for this lecture is the principle that in some cases an image may be illustrative for an experience, and that the analysis of the image may create a starting point for refining the experience. For that purpose, the image has to show people in interaction with some kind of object, animal, or other human being. Images of people touching and holding other objects seem to communicate better about the tactual experience than images of objects alone, because images of touching people allow us to feel what they feel (Keyser, 2004). For example, to try to express and refine collaboration, an image of two acrobats flying in the air provides us with a different nuance than an image of two moving men carrying a couch.

The lecture uses visual advertisements to illustrate the power of images in communicating about tactual experiences (see also Figure 6.1). These advertisements are presented to inspire students to collect their own visual images that illustrate their own experiences, without pretending to offer a theory about this matter. It is emphasized that the image cannot replace the verbal description, it illustrates and accentuates it.



Figure 6.1. Examples of advertisements that use images of tactual experiences

### 6.4.3 Exercises

Two types of exercises are developed for this course. First of all, the students are presented with awareness and sensitivity creating exercises, meant to introduce the different aspects of tactual experience through personal, hands-on experiences and to enable students to discover personal preferences.

Second, the students are presented with design exercises, to learn how to shift from awareness and observation to creation, and to learn how to incorporate tactual aesthetics in the practice of product design. During the exercise, the students learn how to relate experience to tactual properties. For that purpose the student is first confronted with a short exercise as a starter, followed by a more elaborate design exercise of 4 weeks.

The following paragraphs present the different exercises, describing their goals, their procedures, and concluding with their results.

#### 6.4.3.1 Awareness exercise 1: Blindfolded tactual exploration

Goal of the first exercise is to introduce students to the world of touch without preliminary knowledge, as an open-minded encounter. The exercise is inspired by the study presented in Chapter 4, where blindfolded participants were confronted with unfamiliar material objects to explore their tactual properties. The results of that study showed that being blindfolded stimulates people to focus on the tactual senses and to discover the 'own-ness' of the tactual world by exploring the properties of objects and by imagining what could be done with the objects.



Figure 6.2.  
Examples of objects presented to the students in the first awareness exercise.

### *Stimuli*

For this exercise, a collection of different products is assembled, covering the different aspects of the tactual properties of objects, similar to the diversity of the stimuli offered in the study of chapter 4. In addition, the objects differ in shape, size and moving parts. The products are presumed to be unknown to the students, to stimulate them to tactually explore the objects for a longer period and in all their tactual properties. Fruitful sources of tactually interesting but unknown objects are pet shops, toyshops and health shops (massage attributes). Objects from nature are part of the collection as well, for example a large pinecone, and a large smooth river rock. These objects may not be unknown at first touch, but they are added deliberately because they evoke discussion on 'natural' versus 'artificial' materials and objects.

### *Procedure*

Students are seated and blindfolded. They each receive one object to explore. After having explored the object in its different aspects, the students pass the object to each other one by one, until they receive the object they started with. Overall, a set of about 20 objects is explored in about 30 minutes. To stimulate the students to explore the different tactual properties of the objects, they are asked to explore the movements the object elicits, to explore what you can do with it, and to explore what the object does. These instructions are based on the findings in chapter 3 and 4 showing that tactual perception is related to movement and is experienced as *physical behaviour* of the object. Moreover, the purpose of the instructions is to make students discover that the objects differ in their aesthetic potential: their capacity to elicit different types of movements and their capacity to elicit aesthetic experiences. During the explorations, the students are allowed to comment spontaneously on their experiences. After all objects have been explored, the blindfolds are taken off, and the students are allowed to explore the visual properties of the objects they have been touching. The exercise is concluded with a discussion on the different experiences during the exercise.

### *Results*

The comments of the students during and after the exercise show that the exercise is a vivid and probing introduction to tactual experience. The following topics seem to emerge:

- Students are enthusiastic about the exercise. Blindfolded experiencing of objects is surprising and fascinating. This way of tactually experiencing objects seems to have an exciting aesthetic value in its own right. Especially the fact

that the object presents itself immediately in a physical way without visual anticipation is thrilling and confrontational.

- Students discover that the tactual properties of the objects are related to the movements they make. Moreover, they become aware that some objects elicit many different movements and therefore are perceived in many different ways, whereas other objects do not. In addition, objects differ in the length of time they stimulate someone to move: some objects stimulate people to keep on moving, whereas other objects are put aside quite soon after receiving them. Nevertheless, there does not seem to be consensus about this effect for each object.
- The students are surprised by the differences between how the objects actually look and how they thought they would look while exploring them tactually. The comments suggest that these differences mostly concern the size of the object and its colour.
- The students are surprised by the fact that the aesthetic experience of these objects differs from person to person. The same object may feel pleasant for somebody, but disgusting for somebody else. Although we know this phenomenon from the visual domain ('tastes differ'), it leads to surprise when people discover it is also the case for tactual aesthetics. These differences do not seem to lead to discussion about who is right and who is wrong. Quite on the contrary, they lead to amusement.
- The students discover that intensely touching a set of objects may be exhausting. After a while, they become tired of touching and report that they cannot absorb any more and need a break. Experience with this exercise suggests that a set should not exceed a total amount of 20 objects.

#### 6.4.3.2 Awareness exercise 2: What is pleasant to touch?

Goal of the second exercise is to create awareness for the aesthetic aspects of the tactual properties of objects and to discover and develop personal preferences.

##### *Procedure*

Students are asked to bring different objects to the class: 3 objects that are appreciated for their tactual qualities, and 3 objects that are not. In class, each student puts his objects on the table, mixing the pleasant and unpleasant objects. The students walk around the different tables to explore the different objects, to explore their properties and to evaluate their pleasantness or unpleasantness to touch. Next, the students are asked to present their collection one by one, motivating their choice, and to reflect on what they discovered about their personal



preferences. The exercise concludes with a discussion on these findings.

This exercise provides an introduction to the lecture on tactual aesthetics and to the conceptual framework. During the lecture, the teacher illustrates the themes from the Tactual Experience Guide with examples that emerged from this exercise.

### *Results*

The results of the exercise reflect the comments on the first exercise, underscoring their relevance for the tactual experience.

- The students comment that it is difficult to find good examples of objects that feel good or bad. Overall, it seems easier to find examples of objects that feel good than objects that do not. Students report that they feel 'naïve', starting to explore a new domain without having a frame of reference about what is generally considered as a correct result. This creates insecurity: '*Am I doing it right?*', '*Can I bring this to class or will it be ridiculous?*'. This naiveté seems partly reflected in some of the objects that are brought to class: initially, soft cuddle toys and rough sand paper are over-represented in the collections. Throughout the course, students come with less obvious and more sophisticated examples, which leads the students to discover that, evidently, they have to go through these initial clichés to develop a more diverse and personal collection.
- Again, the students are surprised that it is difficult to recognize in each other's collections which objects are brought in because they feel good, and which are brought in for the opposite reason. The explanations of the students often reveal that movements are important: '*It doesn't feel good when you just hold it in your hand, but when you caress it in this direction it is really smooth*'. Notwithstanding these clarifications, the results underscore that tastes differ, also in the tactual domain.
- The reflection on students' individual preferences reveals that these preferences differ with respect to different aspects of the body language of objects. On the one hand, students report conclusions on the physical aspects of this body language, for example '*I like soft, flexible objects, and they have to have weight*'. On the other hand, students relate their preferences to the affective aspects of body language, for example: '*I don't like it when objects force me to be careful with them*', or '*I like objects that have aspects to discover, that challenge you*'.
- Again, students report that touching is intensive and tiring. As one of the students reported: '*At the end I couldn't stop touching anymore, I was aware of*

*touch all the time, I had to pick up everything to explore it. This exercise drove me crazy!'.*

### **6.4.3.3 Awareness exercise 2 (alternative): Material encounters**

An alternative second awareness exercise focuses especially on materials and their characteristics, and is meant to stimulate students to become aware of the use of different materials in the products that surround them, and to become aware of the effect of the properties of these materials on the tactual experience of these products.

Students are asked to explore during one week the encounters with a specific material of their choice from the following list of possible materials: wood, metal, textile, paper, glass, soft plastics, hard plastics, and ceramics. For each material, a group of two to three students comes together to share their findings, and to put together a 'portrait' of the material that characterizes the encounters with this material in daily life. If possible, the students are asked to bring some exemplary objects to the class when presenting their findings; followed by a group discussion.

The results of these material encounters show that materials consistently contribute to a specific kind of tactual experience, and that these experiences often seem to be double faced. For example, wood is experienced as comforting but offers dangerous experiences with splinters and may sometimes be somewhat filthy. Metal is experienced as distant but trustworthy and hygienic, and paper is experienced as weak but it may cut one's hand in a sneaky way.

The exercise does not seem to go beyond the clichés one can come up with by just sitting down and reflecting on these materials. It does not take the students through a phase of discovery of the unknown. Therefore, it is decided to remove this exercise from the program. It is expected that this exercise will gain more depth when it is followed up with a design exercise where the discovered material characteristics serve as a starting point for a product in a specific context. A starting question for the design exercise would be: where does such a personality and behaviour fit?

### **6.4.3.4 Design exercise 1a: Design of pleasant and unpleasant touch**

For this first design exercise, the students are asked to transform a wooden stick (30 cm, Ø 2.5 cm) into an object that feels pleasant on one side and unpleasant on the other side. The exercise is done at home. The students are allowed to use

any material and any creative technique they like. Again, the results of the exercise are presented to the other students in class. First the transformed sticks are passed to each other one by one. Next, the students motivate their choices and give a short comment on the exercise. The exercise concludes with a discussion on the different findings.

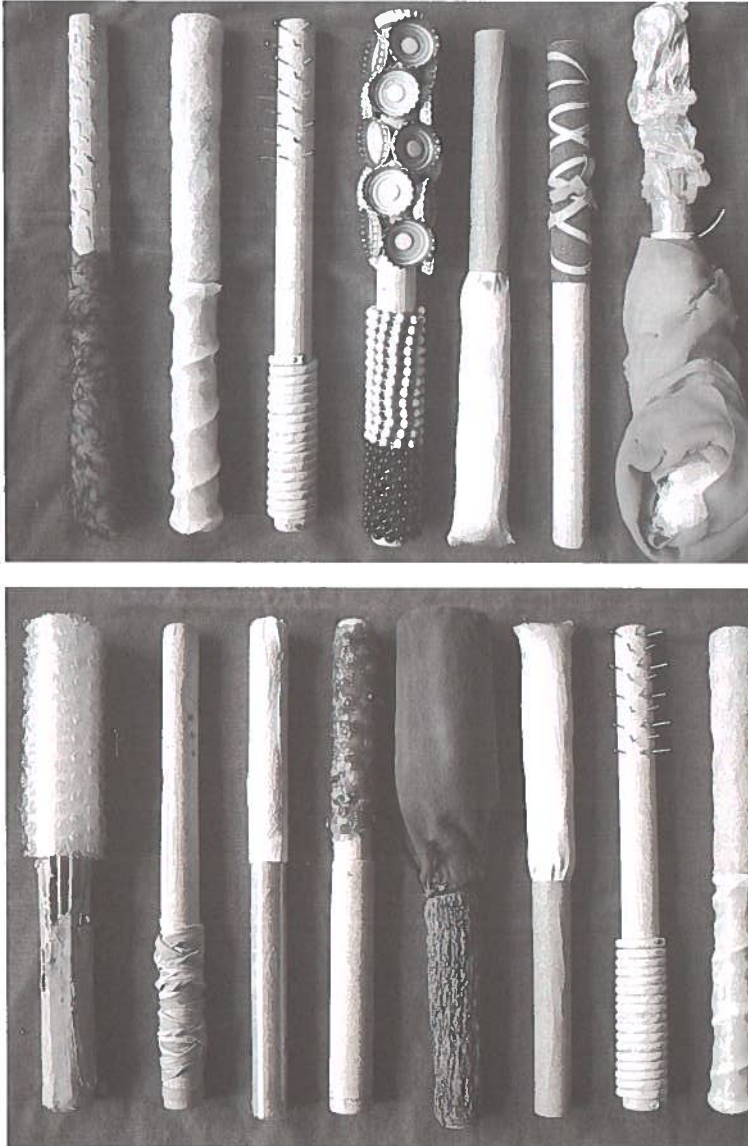


Figure 6.4. Examples of designs of products literally being pleasant on one side and unpleasant on the other side.

The results of the exercise and the comments of students lead to the following observations:

- The students report that the aesthetic aspects of the results are often different from what they expect. It is difficult to predict how a particular design solution will feel. It is only once something is actually made that one can evaluate how it really feels. Stearine wax is a good example of this phenomenon: students remember that it is nice to play with, but once they covered a broomstick with it, they were disappointed. The same thing holds for spikes: they are often applied initially because they are thought of as terrible to touch, but a broomstick with spikes in a particular pattern may actually feel good, *'You squeeze it, and you feel that it could hurt you, but it doesn't really hurt you because of the pattern. It is just the right amount of pleasant pain'*.
- In making the objects, students discover that the aesthetic aspects of touch are not clear concepts. Physical pleasure may imply tenderness as well as erotic aspects, whereas physical unpleasantness may imply pain, disgust or creepiness. Moreover, the exercise underscores that these two domains do not have clearly defined borders: physical pleasantness and unpleasantness are mixed phenomena and may vary in time: *'In the beginning it really felt good, but after a while it became irritating'*.
- Again, the solutions presented by the students have to be experienced through different movements. Some sticks are meant to be squeezed, others to be caressed, others to swing around with, and so on. The intended movements are not evident for all sticks, and need instructions to be able to experience the interaction in its full right.
- Finally, the exercise shows again that what may be experienced as pleasant to one, may not be pleasant to the other, often as a surprise to the students: *'You really like this!?'*. But it seems easily accepted that the tactual experience differs in its aesthetic value.

To conclude, the exercise proves to be valuable as a design exercise. In addition, the exercise deepens the exploration of personal preferences. Unfortunately the curriculum does not provide enough time for several short design exercises. Therefore, this exercise is not always part of the curriculum, but alternated with design exercise 1b.

#### 6.4.3.6 Design exercise 1b: Design for non-functional interaction, the 'Gris-gris'.

Goal of the exercise is to make students aware of aesthetic behaviour in physical interaction. This behaviour is related to the non-functional motivations to inter-

act with an object, especially the playing with the object (Chapter 3 and Chapter 4). Next, the goal of the exercise is to show that it is inspiring to make these affective aspects of non-functional interaction part of the design process, because they may lead to attractive and rich interactions.

Students are asked to observe themselves in the way they fiddle with objects just for the sake of the experience. The students have to characterize the movements they make, and try to pinpoint their 'stereotype' movements. In addition, the students are asked to formulate the possible affective benefits of the interactions.

Once the students found out what their characteristic non-functional movement is and what this movement means to them, they are asked to study what tactual properties an object needs to have, to offer an optimal interaction experience for that specific movement. The students are asked to design a small hand-held object that elicits these stereotype movements, offering a pleasant tactual experience. This object is referred to as a 'gris-gris', a French word for an object that one carries around in his pocket with no other reason than to play with it. The designs are realized and brought into the classroom to present to each other. First, everyone experiences how it is to play with these objects. Next, each student comments on the development of his/her object. Finally, the students reflect on possible applications of such interactions in functional objects, as additional features. These concepts are presented as sketches.

The exercise led to the following observations:

- The stereotypical movements students observe are often referred to as '*My nervous tic*', because these movements are strongly related to relieving stress or avoiding boredom. The purpose of this exercise is to show that this behaviour is normal, meaningful and longed for, and that it should not be referred to as a tic but as an aspect of physical interaction in its own right.
- Overall, students are excited when they discover their own stereotypical movement: '*I'm a real squeezer*', or '*I love to try to break down everything into as little pieces as possible*'. Also, when they discover that once they have made the 'perfect' object to do so, they cannot stop playing with it. In most cases, the exercise shows that this stereotypical and repeated playing with objects is relaxing for the one who is playing, but irritating for the surrounding people.
- Students discover that the way of playing with the gris-gris may evolve in time: at first, one plays with it the way it was intended to, but after a while one starts to discover new aspects, new ways of playing.
- The students report that the exercise inspires them to consider alternatives for 'pushing a button' in future interactions. However, to develop such alter-

natives, the translation into new interaction concepts should be a real design part of the exercise, and should be allowed more time than available in the present time-schedule.

Table 6.2

Results of design exercise 1b: design for non-functional interaction Summary of some stereotypical movements and possible benefits.

Examples of movement	Examples of interactions	Possible benefits and effects, reported by the students
Clicking	Clicking the mechanism of a pen, opening and closing one's mobile phone.	Makes me concentrate
Swinging	Swinging a key chain around one's finger.	Makes me daydreaming
Doing little tricks	Flipping a coin or turning a pen around one's finger	Pass time, Entertainment,
Destroying in as little pieces as possible	Tearing a coaster made of thick paper	Supports me in difficult conversations.
Caressing	Stroking the surface of one's mobile phone, stroking a particular piece of one's clothes.	Makes me feel safe, Calms me Makes me daydreaming
Exploring holes	Putting one's finger in the hole of a beer bottle.	Gives me physical pleasure, Thrilling
Building, putting together	Playing with a paper clip, adding other little objects to it	Pass time, Helps me in difficult conversations

Balancing	Making a pile of objects on the table, till they tumble over.	Pass time, Entertainment
Squeezing	Squeezing in a rubber ball	Calms me
Turning	Turning a ring around one's finger.	Makes me daydreaming, Helps me to concentrate
Tapping	Tapping with the fingers on a table, on one's leg. Tapping with the feet on the ground.	Stress relief
Chewing	Chewing on the back side of a pen or pencil.	Helps me to concentrate
Folding	Folding little pieces of paper from candy or chocolate bars as often as possible. Folding a table napkin, again and again	Helps in difficult conversations Pass time
Straightening the layout of objects on a surface, arranging them in relation to each other.	At a diner table, arranging the eating utensils, and positioning the wine glass according to the pattern of the table cloth. Putting objects in a specific order at a desk, before starting a new task.	Getting a clear mind before starting something. Helps in difficult conversations Pass time.



Figure 6.5a  
Overview of Gris-gris.



Figure 6.5b  
Gris-gris with a hole and with surfaces to caress

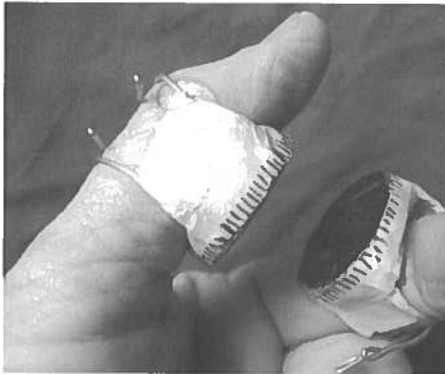


Figure 6.5c  
A gris-gris consisting of two magnet rings, to click with

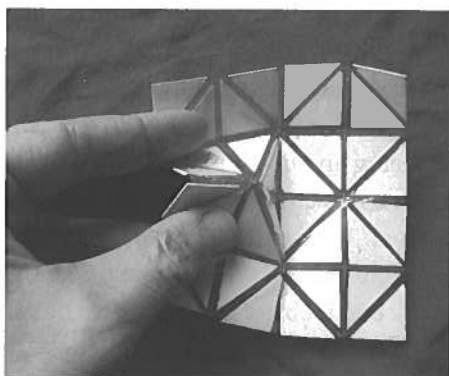
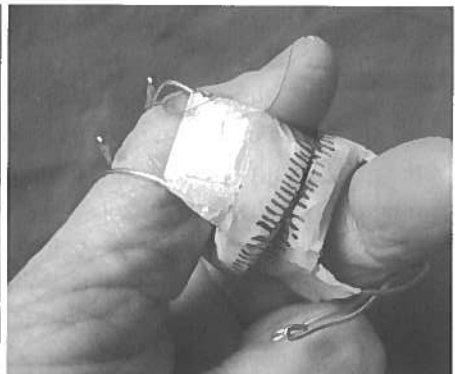


Figure 6.5d  
A Gris-gris to fold in many different ways.



Figure 6.5e  
A gris-gris to caress and to be caressed

Figure 6.5  
Results of designs of a gris-gris for playful interaction



### 6.4.3.7 Design exercise 2: Design of a product with a personal touch

Goal of this last design exercise is to bring together the lessons learned from the previous exercises in one final product design exercise, within a specific context, using the Tactual Experience Guide. The students are asked to redesign a product in such a way that the interaction with the device becomes a pleasant tactual experience for themselves.

The exercise has three phases:

In the first phase the students explore their tactual experiences with the existing product, using the Tactual Experience Guide. This exploration results in insight in the object's body language and the relation to the aesthetic aspects of the experience. In the second phase, the students formulate the desired behaviour of the object through words and collages of visual images, again using the Tactual Experience Guide as a frame of reference. Third, the students redesign the new product in 'tactual' sketches and 3D models. To support the design process, a specific procedure was developed throughout the different courses development of the course, also referred to as 'designing by touch', or 'designing from the guts'. To find new design solutions, students were asked to tactually explore other objects that have the desired behaviour, to analyse their tactual properties as a source of inspiration for their design. Their results were presented twice to the group: once after the first two phases, and once after the final design is finished. In between the plenary sessions, the students are coached in pairs, each coaching session lasting 20 minutes.

This exercise is alternately given in two different set ups. In the first set up, all students have to work on the same object. In the second set up, the students are allowed to choose their own object to redesign, with the only requirement that the student should have a personal relationship with the object and in some way experience it as unpleasant. Both set-ups have advantages. In the first set up, the students inspire and learn from each other in the plenary sessions, because they are able to share their experiences. Seeing and hearing how other people experience the same kind of objects creates a rich and fruitful overall insight in the experience of a particular kind of product. The disadvantage of the first set up is that some people have to work on a topic that does not inspire them. In the second set up, students are allowed to work on an object that fascinates them, but they miss the sharing of the experiences and the resulting discussions.

Examples of objects that are chosen during this exercise as a pre-given are: handheld game computers (Gameboy's), remote controls, mobile phones, and bunches of keys. In the second set up, students come up with diverse objects such as juggling sticks, kitchen utensils, tools, wallets, backpacks, CD boxes, watches, and so on.

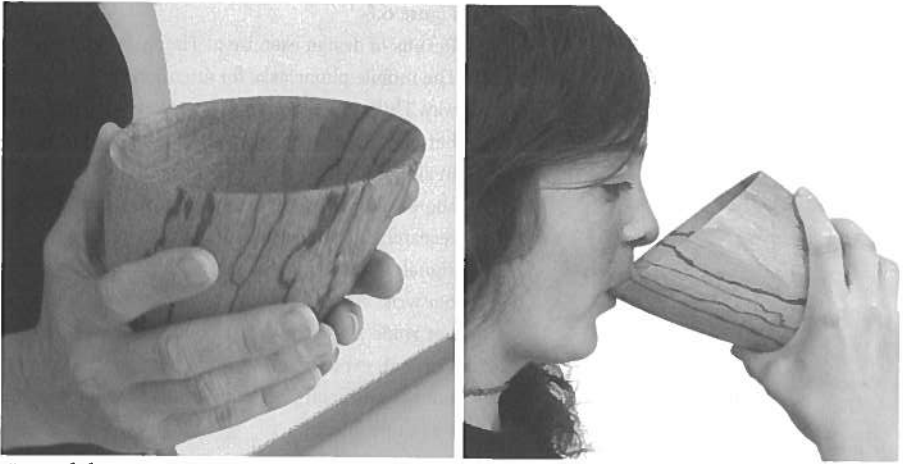


Figure 6.6

#### Results of design exercise 2: The coffee mug

The current metal and plastic coffee mug of this student was distant and cool on the outside. The experience of holding the mug did not match the cosiness and the feeling of having a relaxing moment. The student wanted to experience her the mug as 'sharing the special moment', and as offering a cosy support. This was achieved by the texture and warmth of the material, the size and the shape that allows a special relaxed grip without pouring the coffee over, and that does not cover your face when you drink from it.

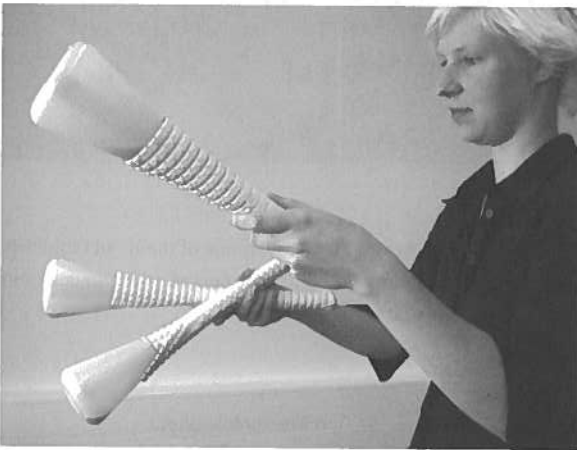


Figure 6.7

#### Results of design exercise 2: The juggling cones

The current juggling cones of this student were not cooperative in the learning phase, and did not 'participate' in the movement. They were indifferent to whether or not she was juggling with them. In addition, due to their shape and hard material, they hurt her when she caught them. The cones she designed are filled with water. When played with, the movement of the water slightly slows down the movement on the right moment, giving the feeling that the juggle cones are considerate and enjoy to participate. In addition, the cones are wrapped with a soft rubber material filled with air, to allow for a gentle touch with a firm grip when being caught.

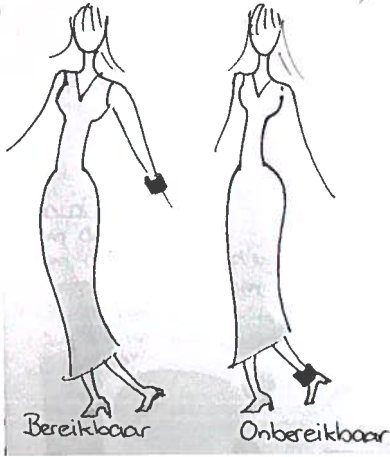


Figure 6.8

Results of design exercise 2: The mobile phone.

The mobile phone asks for attention in a pertinent way. This student did not feel at ease with her phone in her pocket, because, it felt too close and intimate. Also in situations where she did not want to be disturbed she would feel the phone buzzing for attention. She researched what body parts are less sensitive for these signals. She designed a phone that is carried around her wrist when she wants to be reachable, and around her ankle when she does not want to be disturbed. Through experimenting, she found out that she did not have difficulty neglecting the call when the phone was more 'distant'.

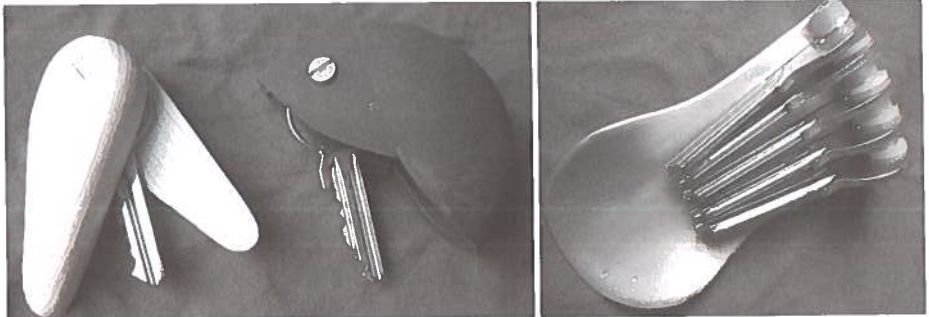


Figure 6.9

Results of design exercise 2: The bunch of keys

Keys are chaotic, hysterical and try to escape whenever you try to catch one of them out of the whole bunch. In addition, keys hurt you when you carry them around in your pocket, trying to poke you in the leg. These designs are examples of attempts to 'tame' these keys.



Figure 6.10 The mobile phone

The current mobile phone of this student did not create a world of its own in which one could escape from the outside world to communicate with somebody in an other space. The redesign allowed her to experience the 'outside' of the phone different from the 'inside'. The outside complies with the shape and texture of her hand, whereas the interaction with the smooth and simple inside allows for a gentle transition into the 'other space'.

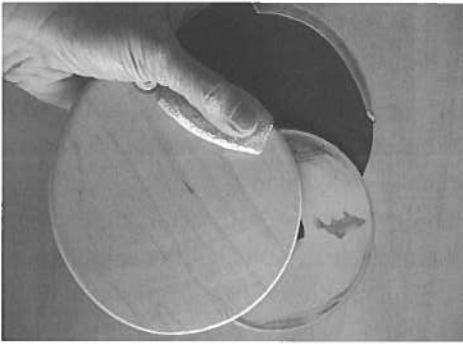


Figure 6.11

The CD box. This student experiences a CD box as an object that does not want to be opened, and once it is, it does not want to let the CD go, it seems to struggle to keep it in. The student designed a CD box with the opposite behaviour: opening the box is a pleasant and delicate movement, like a dance: one slides the two halves of the box over each other to open it. In this opening, the box offers the CD like a waiter offers you your plate.

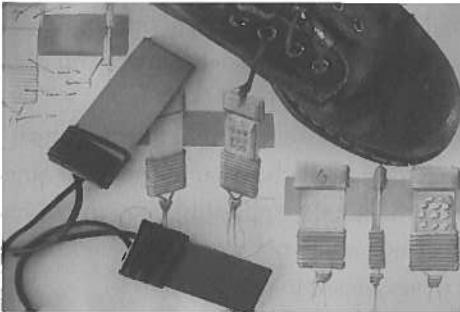


Figure 6.12.

The mobile phone.

In use, mobile phones do not become 'yours', they do not adapt themselves to you. This student explored the possibilities to experience a phone as familiar as an old shoe. The redesign with a leather lace that one can play with by wrapping and unwrapping it during the telephone conversations allows for such a personalisation.

The comments of the students show that this exercise introduces two new perspectives on product design: designing through the senses, and designing from a personal world of experience:

- First, to incorporate awareness for the tactual senses in the design process seems to be experienced as a new way of designing. Although the exercise was not meant as such, it is an intriguing observation that designing for the tactual senses sheds a new light on product design as a whole. The core of this new approach seems to be the shift from thinking in products in interaction to thinking in product behaviour in interaction. This is strengthened with the insight that to design for tactual experience is to design from and through tactual experience. This new approach becomes particularly explicit in the fact that most students do not make sketches during this design exercise, but directly design with 3D models and materials.
- Next, the exercise confronts students with the experience of designing for themselves. Initially, this approach elicited some strong discussions, raising the question about the value of such a personal design process. For example as one student pointed out: *'I'm not here to learn about myself, I want to learn*

*how to design for others*’, or as another student asked more timidly: ‘Are you sure we are allowed in this University to design for ourselves?’.

Throughout the years, the insight was developed that the exercise has the educational goal to help students to develop their own ‘database’ of tactual experiences to work from, and that one needs this self-knowledge to be able to empathically understand other people. These arguments seem satisfactory to motivate students to go on with designing for themselves. Eventually, after completing the exercise, most students report that to design for themselves is a strong positive experience, sometimes even referred to as a relief. As one student formulated: ‘*This was liberating! finally I can do what I want, and make something exactly the way I like it*’.

However, designing for oneself eventually raises the question about how to design for the other. From the discussions among the students at the end of the exercises, the following general consensus seems to emerge:

Although one may set out to design for experience, one cannot force affective meaning on people. Designers may try to design the body language of an object, but they do not know whether the object will get the opportunity to express itself in the interaction with others, because designers do not control whether the user will experience this language the way it was meant to be.

However, to design from personal experience seems to add to the designed objects a specific kind of inspiration, which is recognized by the students as an authentic quality regardless of the aesthetic value it may represent for an anonymous user. It seems that this authenticity leads to objects with a high tactual aesthetic *potential* (see § 4.8.2), because whatever the reaction of the other students is, the design results are not likely to elicit indifference. In other words, the value of designing for personal touch leads to tactually *expressive* objects, regardless of *what* they are expressing.

## 6.5 Evaluation of the course

The evaluation of teaching tactual aesthetics and of the different elements of the course after each session led to the following conclusions about its approach and content.

### 6.5.1 Development of insight in and sensitivity for tactual aesthetics

A primary goal of the course is to develop a student’s sensitivity for tactual aesthetics. The results of the course show that this development fits the stages

of the expertise development process, as observed by Haanstra (1994) when studying aesthetic sensitivity in art (creation). It seems that the course presents all three stages in a nutshell. The stage of being naïve is recognized by students when they start the exploration of tactual experience: they become aware that they have no frame of reference to work from. The second stage seems reflected by the fact that some tacit clichés seem to exist about tactual aesthetics: pleasantness is easily associated with a soft, fluffy world with friendly rounded shapes. And unpleasantness is at first associated with harsh, hard and cold materials. The expert level seems reflected in that it is often only after these first possibilities are explored and assimilated, that students explore the less obvious. It is therefore that some students refer to their work as ‘tactual discoveries’, touching the stage of the expert, where new experiences are created. In addition, the stage of the expert seems reflected by students who, rather than merely adopting the vocabulary offered by the Tactual Experience Guide, add new themes to the conceptual framework and transform some concepts into their own words. Thus, not only the way its concepts are used in design, but also the customisation of the framework to personal insights is a sign of the development of expertise.

Throughout the different exercises, the students present the results to each other, which proves to be a fruitful means to deepen insight into their own experiences. The differences in experiences of physical interactions help the students to articulate and reflect on their own likings and disliking. The fact that these experiences are presented as personal instead of general, leads to a pleasant meeting and sharing atmosphere. It is not a matter of convincing each other, but of being inspired by each other. The comments ‘*Yes, I know that feeling!*’ and ‘*Really? I feel completely the opposite*’ are both frequently expressed during the group-meetings. These group discussions should be acknowledged for their value in the development of tactual aesthetic sensitivity, and form a substantive part of the course.

The course set out for a personal development of the students in matters of tactual aesthetics. The group discussions about personal preferences proved to be a fruitful contribution to one’s insights in one’s personality and to be able to be explicit about it.

The evaluation of the course introduced the question on how to assess its different educational goals. The design exercises are assessed along the standard criteria developed in design education projects: assessment of product, process, and presentation. But how to assess the development of aesthetic sensitivity? How to assess personal development in aesthetic preferences and standpoints? So far, in the context of the course Tactility, this development was assessed based on the acquired use of the conceptual framework provided in the Tactual Experience

Guide, and through assessment of the subtlety and originality of the findings in using that framework. But it is recommended that aesthetic tactual sensitivity and, following, personal development in that domain, is assessed through more systematic and insightful methods, which will have to be developed in the future.

### **6.5.2 Exploration and communication**

The use of the vocabulary offered by the Tactual Experience Guide confirms the results of the studies described in the previous chapters: words are useful to reflect on experience, but they often lack nuances and subtlety. The design context makes clear that especially the tactual properties of objects are difficult to describe in the different stages of design. The following section discusses the different means to explore and communicate tactual concepts throughout the different stages of the design process.

#### **6.5.2.1 Framing the design domain**

In the last design exercise, students had to formulate the starting points for the redesign of a personal object that is unpleasant to touch. The aesthetic assessment was done for each specific theme of each specific map in the Tactual Experience Guide, followed by an overall conclusion on the body language of the object. This overall conclusion is crucial for the formulation of fruitful starting points for redesign, which have to be formulated on that same level as well. Students report that the added value of the guide is to elaborate on and to give depth to the statement 'it has to feel good'. But some students tend to translate unpleasant tactual properties of the current object directly into more pleasant properties for the new design. For example, when an object is experienced as too rough, a direct translation would be: it should be softer. Or starting points for an object that is unbalanced, are formulated as: it should have a better balance. This tends to lead to superficial or obvious improvements: the object should be lighter, softer, more balanced, and so on.

The results of the exercise show that a more innovative and creative approach to (re)design is to formulate the conclusion about the actual and the desired tactual experience of the objects on the meta level of the actual and desired body language of the object. The desired behaviour then needs to be translated into tactual characteristics for the different dimensions of the tactual experience (Figure 6.13). For example, further analysis of the unbalanced object might lead to the conclusion that it is not very willing to cooperate, but that it has a playful side

as well. Formulation of a desired behaviour might lead to the conclusion that being unbalanced fits the desired body language of a playful object that has to be tamed. Likewise, roughness might fit the starting point of designing a ‘rough diamond’. Redesign would then not exclude the roughness, but explore what kind of roughness ‘fits’ the rough diamond that has a soft spot as well.

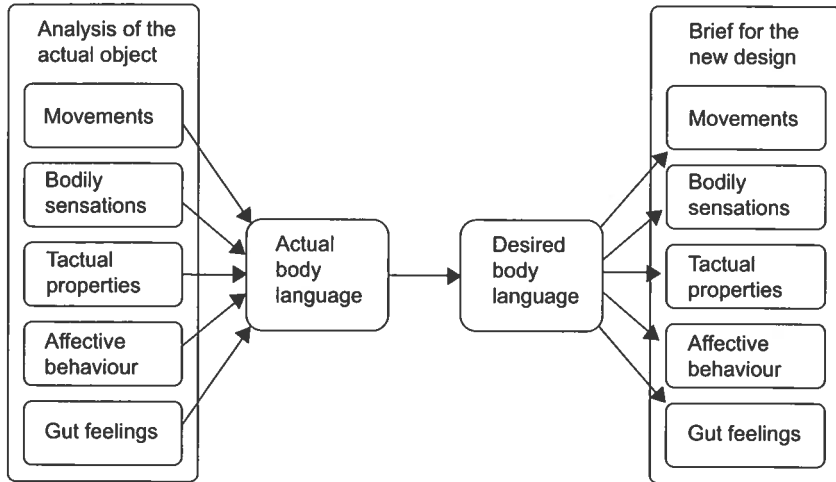


Figure 6.13. Schematic representation of the formulation of design starting points that lead to creative tactual designing.

To conclude, to formulate the starting points for the redesign on the meta level of body language opens up the possibilities of making tactual discoveries and, more importantly, lead to a more consistent overall design. Although the exercises in the course did not involve innovative design projects without precedents, it is expected that such design projects will benefit from the same insight: formulating overall starting points on the level of body language and desired behaviour in the context of a desired kind of relationship with the object, will presumably lead to more authentic and innovative tactual concepts.

### 6.5.2.2 Exploring collages of visual images

In the last design exercise students use collages of visual images to explore and express the desired behaviour of the object (Figure 6.14). These visual means proved to be powerful in communication, as well as in exploring the nuances of the desired experience.



The comments and results of the student suggest that the word 'collage' may be initially confusing. The concept of making collages is often associated with a visual tool to explore the *visual characteristics* of the domain one is designing for (Muller, 2001). These visual collages are meaningful and communicative and speak for themselves. But collages created to explore and communicate *human experience* have a different character: they do not concern the visual expression per se, but they help people to describe and express their experiences through visual means. Also, a collage in that context does not 'speak for itself', it needs the comments of the one who created it to become meaningful and communicative (Sleeswijk Visser, Stappers, Van der Lugt, & Sanders, 2005).

Thus, the collages made during the exercise did not speak for themselves, the students needed to comment on them to make their meaning explicit. Also, rather than creating an assembled collage, students made a loose collection of different visual images, each telling a part of the story. Some students turned their collage into a booklet, each page illustrating an aspect of the object's properties and behaviour, completed with verbal descriptions. The collected images are often found by browsing through different image banks on the Internet and in printed journals. In addition, students make their own pictures, when they have the image 'in mind', but do not find it ready made.



Figure 6.14

Examples of visual collages. The first collage pictures the different tactual properties of the design, the second visualizes the different aspect of the affective aspects of the experience.

The course was too concise to allow for exploration of the use of video and animation films. But it is expected that future exploration of these moving images may contribute to the set of tools appropriate for the exploration of tactual experience in interaction (Klooster, 2004).

### 6.5.2.3 Exploring collections of 3D objects

The course emphasized that designers evidently lack ‘tactical sketching tools’ while designing.

Visual sketching tools do not explore and communicate the domain that is addressed in tactual aesthetics. In general, students leave the visualisation techniques aside during the design exercises. Moreover, it seems that students who keep using visualisation techniques have difficulties in grasping the essence of tactual aesthetics. These students need encouragement to get beyond paper and screen to reach out to explore and discover the real world as a source for inspiration and to make tactual discoveries.

To explore possible design solutions, the students collect 3D objects and materials that illustrate the desired affective behaviour, thus offering insight in possible tactual properties of the new design (Figure 6.15). The results show that initially, students mainly search for man-made materials and shapes, but, when encouraged to do so, they use the whole pallet of available objects around them as sources of inspiration, such as the texture of fruit or the feeling of sand slipping between one’s fingers. Nevertheless, the students often reach high levels of frustration during the design phase, because they do not find the means to express the experience they have in mind. It seems quite impossible to ‘tactualize’ an object, that is, to represent it tactually without the object *being* the real object.

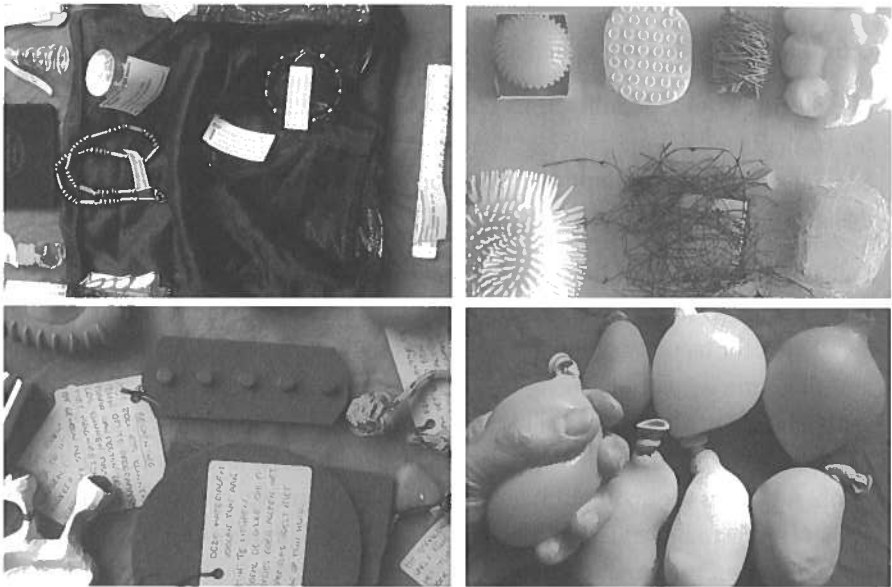


Figure 6.15  
Examples of 3D objects, collected to explore the desired tactual properties of the design.

From a tactual perspective, the 3D collection technique seems promising, because it offers insight in the tactual properties relevant for the desired behaviour, without actually having to make the objects. But in addition, 'true touch' models seem a must in the design process to research the tactual experience. Clay, foam and wood seem to be the students' preferred materials for this sketching phase, but the models made with these materials seem to lack the subtlety of what one would like to explore and express. Part of the frustration seems to derive from the students' lack of skills to work with these materials. It is recommended that, like for the visualisation techniques, the use of these 3D sketching skills becomes part of the design education curriculum, for example in creating workshops 'sketching in clay' or 'sketching in foam'.

## 6.6 Recommendations for further development

The results and evaluation of the course Tactility leads to the conclusion that the course meets the goals it was set out for: students gain insight in tactual aesthetics and develop skills to design for the tactual senses. To further improve the course and its role in the curriculum of design education, the following general recommendations for further development of tactual aesthetics in product design education are formulated.

### 6.6.1 Elective versus integrated approach

The elective course Tactility in its current specialised form offers a strong basis for students to become aware of tactual aesthetics and to learn to design for it. Several students commented that the topic should get attention earlier in the design education curriculum.

Following the model of the development of the different levels of expertise in design skills (Dorst & Reymen, 2004; Haanstra, 1994), it could be argued that awareness for tactual aesthetics should be an integral part of all design exercises, and therefore be part of a design education curriculum throughout the different years instead of an elective for students enrolled in a Master program. But in defence of the existence of a specific, dedicated elective, it is argued that tactual aesthetics *needs* the spotlight it gets through this elective, because otherwise the subject tends to be neglected. The course Tactility will therefore stay as a specialised part of the curriculum of the Master Design for Interaction of the education Industrial Design Engineering. In addition, integration of the topic into the

curriculum of Delft Industrial Design Engineering is gradually obtained through participation in other courses such as Product Use, Understanding and Experience and Exploring Interactions, through the elective Multi-Sensory Design and through guest lectures in the Bachelor design projects.

### **6.6.2 Tactual materials for hands-on experiences**

The experiences with the course Tactility confirm the starting point that hands-on experiences should be the core of the course. Words and theory are appropriate to give people a frame of thought for experience, but the experience itself is needed to give the frame of thought embodied meaning. Constructivism emphasizes the importance of personal biographical experiences (Albers et al., 2004); therefore, students bring their own objects to the classes. However, these objects may not provide a broad pallet of tactual properties. There is a need for illustrative material examples to start with during the course. To ensure the effect of encounters with unknown objects and to make sure the collection covers the entire pallet of tactual sensations and perceptions, it is recommended to develop a standard tool-kit with example-objects that are developed specifically for the purpose of the course. For future use during the course Tactility, these objects should be gathered through a systematic approach, using the Tactual Experience Guide as a basis.

### **6.6.3 Design research through design education, design education through design research**

To teach tactual aesthetics proves to be a fruitful basis for the development of theory and the gain of insight on tactual experience. The course Tactility could be further developed as such. Design projects include an exploratory phase where students explore the translation of formulated goals and starting points into material objects. From that perspective, design exercises can be considered as small exploratory research projects, contributing to the students' personal body of design knowledge on tactual aesthetics. The students formulate a specific research question on tactual aesthetics and start to explore possible answers in their own world of experience. The results of these personal, applied research projects are often experienced as 'tactual discoveries'. But besides the value for the growth of personal insights, these discoveries could be considered as valuable contributions to a more general body of design knowledge on tactual aesthetics as well, and should be acknowledged as such. For example, some themes seem to

emerge repeatedly in the exploratory phases: how does an object express that it wants to cooperate, or to tease, or that it wants to be humble in interaction? How does an object elicit the feeling of coming home when using it? As discussed before (§ 6.4.1), the results of these small scale and individual exploratory research projects inspire other students to reflect on during the course, and this effect could be taken to a broader level. The results of the different courses could serve as inspiration and soundboard on a more general level for other students as well. To achieve such a pragmatic body of design knowledge on tactual aesthetics, the results of the different design exercises could be analysed and presented to a broader public. This could be done through an interactive website on tactual aesthetics or through annual publications of the design results that include the exploratory phases.





# Chapter 7

## Concluding remarks

### 7.1 Introduction

The tactual senses are underestimated in product design education and seem to play a minor role in the design profession. This may lead to a product milieu where the tactual senses are poorly addressed and, where interaction itself becomes disembodied, remote and button based. The present thesis is therefore a plea to give the tactual senses the full attention they deserve in the design process.

The tactual domain is complex and, more importantly, it is a tacit domain, difficult to access through observation and reflection (Polanyi, 1967). However, to design for the tactual senses demands for the development of design knowledge and design skills on tactual aesthetics.

This thesis contributes to the development of design knowledge and design skills by offering a conceptual framework that describes the different aspects of tactual experiences. The framework offers designers access, and thereby insight in, the tactual experience because it offers a language to make these experiences explicit. The framework is made accessible and practicable for designers through the development of the Tactual Experience Guide, a design tool that supports the development of designers' tactual sensitivity and tactual design knowledge.

The content of the conceptual framework describing tactual experience and the use of the Tactual Experience Guide in design education are presented and assessed in the previous chapters. The results lead to the conclusion that both, framework and tool, form a fruitful basis to support the development of future awareness for tactual aesthetics in product design.

This final chapter discusses the value of the results for further research on tactual aesthetics in human-product interaction. First, the chapter describes pos-



sible research directions to deepen insights in tactual aesthetics, generated by the suggestion that products and people can be considered as two social entities in physical interaction. Second, the chapter describes two possible perspectives on aesthetic experience, both relevant as possible research directions for further research in tactual aesthetics. Next, the role of movement and sensation in tactual aesthetics are discussed and, finally, the possibility to research the existence of good 'tactual gestalts'.

In addition, this chapter addresses the relevance of the results for further developments in designing for the tactual senses. First, this topic is related to the broader perspective of designing for all the senses and next, to designing for human-product interaction as a whole, from a human-centred perspective.

Finally, the chapter concludes with a reflection on the implications of the verbal approach to the understanding of aesthetic tactual experience: did this approach only *describe* the phenomenon, or did the framework partly create the tactual experience through the concepts it has generated?

## 7.2 The body language of two social identities

From a physical perspective, people and objects can be considered as equivalent entities in human-product interaction, because they are both physical bodies moving in contact with each other. People's movements are intentional and motivated and, therefore, they are experienced by themselves and by others as meaningful: people 'understand' body language through their own body. These messages are conveyed in a personal, expressive way. People express themselves through their movements: their body language reflects their personality (North, 1971). This could be characterized as people 'speaking' with their body.

This capacity of people to 'speak' and 'understand' body language is the basis of the concept of tactual aesthetic in human-product interaction developed in this thesis. And because it is a language, in touch people experience the object's movements and the way the object touches them as meaningful affective behaviour. Objects are experienced through movements, and the way people move is grounded in their personality (North, 1971). Thus, in interaction, it is through their own expressive body language that people experience the body language of objects. This leads to the suggestion that the subjectivity of tactual experience is not only grounded in people's physicality, as suggested in Chapter 2, but also in their personality, the basis of their physical movements. This suggestion could

be an inspiring starting question for further research on the relation between user personality and product personality.

Body language is a *social* language. Therefore, in addition to the observation that people and objects can be considered as two equal entities in physical interaction, we can add the conclusion that in tactual *experience*, people and objects can both be considered as two equal social *identities*, intimately communicating with each other.

To postulate that objects are experienced as social identities is not a new perspective in human-product interaction. Animism, that is, experiencing objects as alive and animated, was suggested as a basis to understand the way people relate to their physical surroundings by anthropologists such as Herbert Mead (Doyle McCarthy, 1984) and by philosophers such as Merleau-Ponty (Abram, 1996). By now, researchers in the field of product design or material culture have taken up this perspective to approach human experiences with objects, focussing on the personality expressed through an object's (mostly) visual appearance (Crozier, 1994; Govers, 2004; Jordan, 2002; Kalviainen, 2005).

The contribution of this thesis is that it developed this animistic perspective for the intimate domain of bodily interaction, and showed that animism is grounded in an intimate bodily interaction with people's surroundings. The results of this thesis suggest that the way people bodily 'understand' themselves and other people's body language may be used as a basis to describe the way people tactually experience objects. In addition, the conceptual framework developed in this thesis made this tacit structure explicit, and thus accessible for designers.

It is assumed that the insights obtained through the development of the conceptual framework form a solid basis for future research. Insight in *inter-human* behaviour and relationships may inspire researchers as well as designers to formulate further hypotheses about the behaviour of objects and the relationships between people and *objects*. Possible sources of inspiration are insights in body language (Mehrabian, 1972), attachment (Mugge et al., 2005), personality studies (Govers, 2004), (Totton & Jacobs, 2001), haptonomics (Veldman, 1996) and well-being (Ryan & Deci, 2001).

For example, in their review on well-being, Ryan and Deci (2001) concluded that well-being in a relationship between two people is dependent on three factors: one should feel understood, feel competent and have fun. It is intriguing to translate these findings into requirements for well-being in human-product-relationships and to research their implications. Likewise, according to Veldman,

the experience of integrity of the other and trusting the other forms a necessary and solid base for an exchange of affection. Again, this offers interesting hypotheses for human-product-relationships that could lead to new insights in product design.

And to conclude this brief overview of possibilities, Totton and Jacons (2001) observed in their study on personality and character type that we all need to feel understood and accepted by other human beings. Likewise, we could hypothesize by paraphrasing that people all need to feel understood and accepted by at least some of the objects that surround them.

### 7.3 Two perspectives on aesthetic experience

Physiological aspects of the senses suggest new starting points for understanding the social and aesthetic value of interactions with objects. From a physiological perspective, organisms are considered as searching for pleasant stimulations, and avoiding unpleasant stimulations (such as pain) (Klopf, 1982). This immediate gratification of the sense could be considered as the hedonic aspects of aesthetic experience (Ryan & Deci, 2001). But the senses tend to adapt themselves to pleasant situations, banishing the sensory experience altogether from attention and awareness. Thus, to strive exclusively for immediate and omnipresent pleasant experiences is eventually to strive for a numbed sensory system. The senses need to be stimulated in all their possibilities to ensure their functioning. Thus, there is more to pleasant experience than an immediate gratification of the senses, it is also about a special *kind* of experience, related to a specific *way* of experiencing. To illustrate this point of view, I refer to Dewey's thoughts on aesthetic experience. For Dewey (Dewey, 1934), the basis of aesthetic experience lies in the conditions of organic life itself. More precisely, the basis of aesthetic experiences lies in unexpected, possibly unpleasant experiences:

*Life itself consists of phases in which the organism falls out of step with the march of surrounding things and then recovers unison with it – either through effort or by some happy chance. Life grows when a temporary falling out is a transition to a more extensive balance of the energies of the organism with those of the conditions under which it lives. p 14.*

*Because the world, that in which we live, is a combination of movement and culmination, of breaks and re-unions, the experience of a living creature is capable of aesthetic quality. The moment of passage from disturbance into harmony is that of intensest life. p.17.*

These experiences are aesthetic in the sense that they *awake* the senses, and stimulate a person to discover a new perception of the world *through* the senses. To Dewey, this attempt to recover to a state of harmony necessarily involves some kind of freedom of thought or act. Likewise, in inter-human relationships, it could be suggested that friction and fights are sometimes needed to wake up the relationship and to avoid the routine that makes people's attention drift away. These frictions can be the basis for growth of the relationship provided that people are allowed freedom of thought and act to recover. In contrast to the hedonic, thus the immediate gratification of the senses, this kind of experience is related to the eudaimonic aspects of well-being (Ryan & Deci, 2001): being challenged and exerting effort.

Translating this perspective to the domain of human-product relations, suggests that people all need at least some objects around them that awake and shake their bodily senses, simultaneously challenging and allowing them to discover a sense of harmony again. These objects contribute to people's personal development and allow them to struggle for a deepened relationship with their surroundings. An example of such an object is found in the way cellist Quirine Viersen describes her cello Guarnerius: *'This Guarnerius demands much of its player. It is an obstinate cello, which has to be conquered. It will only start to sing when you give your utmost. But once it gives in, it suddenly turns out to be capable of anything and magnificent sounds emerge. As soon as your concentration wanes a bit, it will begin to resist and get contrary again. It is all or nothing.'* (Savenije, 2003)

#### 7.4 Affective movements and sensations

The thesis set out for an understanding of tactual aesthetic behaviour and attitude in physical interaction. This question will be reflected on from the perspective of movement and sensations.

Lederman and Klatzky (1985) documented the movements people make to *explore* the tactual properties of an object and concluded that these movements are stereotypical for each tactual property. These movements are intentional from a cognitive perspective: they are deliberately made to understand what the object is and what it is made of.

The present study suggests that this observation can be mirrored in the affective domain: people have stereotype *affective movements* to express and experience affective meaning. For example, in the inter-personal domain, people caress,

shake hands, tap shoulders, slam faces, and so on to express their feelings. Thus, analogous to the existing overview of 'Exploring movements' as developed by Lederman and Klatzky (1985) (see Figure 2.4), future research could focus on a typology of 'affective movements' in human product interaction, as a strategy to describe body language in human-product interactions more systematically.

Vice versa, people interpret the *sensations* elicited by *being touched* as having affective meaning: being caressed, being taped, pinched or slammed and so on. Chapter 2 concluded with the supposition that the pallet of tactual sensations, such as light touch, vibrations, light and deep pressure, warmth, coldness, itch and pain may play an important role in tactual aesthetics. The explorations in this thesis suggest that these sensations may be characterised along their affective meaning. Thus, analogous to the typology of human touch developed by Fagan (1998), the sensations derived from being touched by objects could be characterised along a *typology of object touch* including for example: affective touch, erotic touch, hostile touch, distant touch, energetic touch, and so on. Further research should focus on a systematic development of such a typology of tactual sensations, because it could be a useful addition to the concepts developed in the Tactual Experience Guide.

The notion of affordances could be used to further develop the notion of tactual aesthetics. The present study made clear that objects are tactually explored and assessed for the possibilities of actions and reactions they offer. 'What can I do with it, what does it do?' seems to be the question people have in mind when physically exploring objects. This relates to Gibson's notion of affordances in *perception*: people perceive possibilities for physical behaviour. For example, an object is *manipulable*, *changeable*, *foldable*, *squeezable*, *controllable*, *transportable*, and so on (Carello, 2004). The results in this thesis suggest that this notion of affordances is not restricted to the perceptive domain, but belongs to the affective domain of experience as well. An object offers possibilities to experience affect: it is *lovable*, *hateable*, *trustable*, and so on. In future research, to support an aesthetic attitude in exploring aesthetic interaction, the appropriate mindset in terms of perceptual and affective affordances could therefore be: what does it *enable*?

To conclude, affective movements, the related sensations and the affective response they afford, because they play a key role in tactual aesthetics, could be systematically approached to create a typology for each of these domains. It is expected that such typologies will support people to understand and describe tactual experiences in the future.

From this perspective, the affective movement of *caressing* asks for a special attention in exploring tactual experience. In Dutch, tactual attractiveness is often characterized as having a high 'aaibaarheids-factor', that is, a high 'caressability-factor'. According to Lederman and Klatzky (1985), lateral motion on a surface (the objective description of the caress), is related to the perception of the texture of an object. Thus, although speculative, it could be concluded that the texture of an object may play an important role in its attractiveness, because it determines its 'caressability'. This might explain why texture seems to emerge as most described and salient property throughout the different studies in this thesis: it represents one of people's characteristic affective movements, the caress. These suggestions may form a basis for further research aimed at deepening the understanding of the aesthetic aspects of tactual experience.

## 7.5 Principles of good 'tactual Gestalts'

The present thesis described the tactual experiences, but it did not give insight in the underlying relationships between the different domains of tactual aesthetics, nor between the different aspects in these domains. But during the design exercises, it became clear that designers need insight in these relations, more specifically between the tactual properties of an object (its physical behaviour) and its affective behaviour.

Designers shape materials into objects, therefore, the tactual properties of objects is their material design domain. So far, the design students formulated their own research questions during the design exercises to explore the implications of desired affective behaviour for their material designs.

It is expected that, like for the visual domain, relations between the physical properties of an object and its aesthetic experience are systematic, following certain principles (Hekkert, 2006).

For example, analogous to the formulation of principles of good gestalts for the visual domain (Kreitler & Kreitler, 1972), it may be possible to conceive of principles of good 'tactual gestalts'. These tactual gestalts will then represent the relationships between different tactual properties of an object that characterize the pleasantness of the object as a whole. The appealing aspect of the concept of good gestalts lies in the fact that gestalts consider the material object as a whole and not as the sum of its parts, which fits well the tactual perception of objects. The physicality of objects is perceived through its behaviour as a whole, and not as the sum of its parts.

Nevertheless, it is unlikely, and from a creative point of view even undesirable, that it is possible to formulate a *prescriptive* set of unequivocal relations as design guidelines for aesthetic tactual experiences, because such prescriptive guidelines do not exist in other areas of design aesthetics either. Thus the insights we are looking for should not be formulated on a deterministic level trying to find out what kind of properties are related to what kind of affective meaning. Rather, on a meta-level, research should be focussed on the understanding of *how* these different aspects of the tactual experience influence each other. It is expected that such research attempts, provided that they are not deterministic in nature, enrich the framework with meta-concepts, and thus deepen our understanding of tactual aesthetics.

## 7.6 Designing for the tactual senses

The practice and education of Product Design was the context for the present exploration of tactual experiences in human-product interactions. Bringing the insights in tactual aesthetics and the tactual experience guide into the domain of 'designing for the tactual senses' leads to the following overall reflections on further deepening of the insights and on the integration of the findings in the broader context of product design.

### 7.6.1 Multisensory Design

So far, tactual experience was explored as a phenomenon on its own. One could argue that it has been a rather 'blind and deaf' approach, because it did not take the other senses into account. This seems conflicting with the starting point that objects are experienced as a whole, and not as the sum of their different aspects. Although the choice for a deaf and blind exploration proved to be valuable because it generated useable insights in the world of touch in human product interaction, it also made explicit its weakness. The participants in the different studies as well as the student in the different courses reported that it is difficult to keep the other senses out of the different descriptions and design solutions. Thus, although the approach was fruitful as starting point, Tactual Aesthetics should not remain a research field on its own. It should find its relations with the other senses, to result in a conceptual framework of multisensory aesthetics of objects, where the senses are considered as an integrated system (Schiffenstein, 2007). Nevertheless, *in* the context of this multisensory domain, Tactual Aesthetics should be developed as a full research area in its own right, exploring the research directions set out in the previous paragraphs.

## 7.6.2 Researching experience in human centred design

The Tactual Experience Guide was used to explore the designer's *personal* tactual experiences and the design exercises are aimed at creating pleasant experiences for the design students *themselves*. This seems to be far removed from the practice of human-centred design, where the experiences of the people one is designing for are researched and taken as a starting point for design.

The choice for such a personal oriented approach is motivated by the goal of developing the tactual sensitivity and personal taste of the designer, and of supporting the development of his personal attitude towards tactual aesthetics in product design. It is assumed that one needs to have developed these sensitivities, tastes and attitudes *from* personal experience to be able to develop empathic design skills to design for others.

However, to develop tactual aesthetics in product design in its full right, a next step is to develop tools and methods that support the designer to research the experience of the people in the context of human-product interaction.

The current conceptual framework and the derived Tactual Experience Guide are developed to support people to *learn to feel*, and is therefore elaborate. But when researching users' experiences, the question is whether the user needs to go through this elaborate process to be able to generate useful data for the researcher. As stated by MacDonald (2001), all people possess aesthetic intelligence, but most people use it without being aware if it. Design research on human experience often taps into this non-explicit, associative domain of existing experiences and of possible dreams and latent needs, using a creative, playful approach to the development of research tools (Sanders & Dandavate, 1999, Sleeswijk Visser, Stappers, Van der Lugt, & Sanders, 2005). The approach of the current tactual Experience Guide may be too elaborate and complex to support unprepared users to express themselves. However, it is expected that it forms a solid basis to inspire design researchers to develop new simplified tools that can be used by relatively naïve consumers to express themselves through words, images, and other creative means.

## 7.7 Reflection

In this thesis a conceptual framework was developed with the assumption that its concepts could help people to become aware of their experience, and help them to put their experiences into words. In other words, a verbal language is



proposed to *reflect* on tactual experience. This approach leads to an interplay between cognitive and perceptual learning: the richer the set of concepts to describe a phenomenon, the richer the perception is (Chollet, Valentin, & Abdi, 2004). In that sense, the perception is made possible *by* the acquired language. But from an experiential point of view, the question could be raised whether an acquired language supports and deepens the *awareness* of the experience, or whether it actually *creates* the experience. This linguistic relativity is referred to as the Whorfian hypothesis: language influences thought (Hunt & Agnoli, 1991). In the case of tactual experience, the Whorfian theory leads to the presumption that the proposed conceptual framework is helpful for people to describe their experiences, not because it *matches* the experience, but because it actually creates it. One could argue that people experience objects as animated, and with a specific affective behaviour, *because* the framework proposed them to think about it that way.

Hunt and Agnoli argued that the Whorfian theory is not absolute, nor should it be completely rejected. The experiences so far with the Tactual Experience Guide underscore this position: on the one hand, people claimed that the guide made them aware of things they already knew, but did not know they knew. On the other hand, people claimed that the Guide made them think about tactual experiences in a totally new way, which they experienced as inspiring and refreshing.

From a designer's point of view, I believe that this double-sided stance is a fruitful one for further developments in tactual aesthetics, because it allows designers to think about the proposed set of concepts not as *the* framework to think about aesthetic experience, but as *a* possible framework. It opens up possibilities for other design researchers to develop other languages, that will engender other ways of experiencing, thus enriching the domain of tactual aesthetics as a whole.





# References

- Abram, D. (1996). *The spell of the sensuous*. New York: Random House.
- Albers, A., Burkardt, N., & Ohmer, M. (2004). The constructivist aspect of design education in the Karlsruhe education model for industrial product development in Kalep. Paper presented at the The changing face of design education, Delft.
- Amazeen, E. L. (1997). The effect of volume on perceived heaviness by dynamic touch: with and without vision. *Ecological psychology*, 9(4), 245-263.
- Appelle, S., Gravetter, F. J., & Davidson, P. W. (1980). Proportion judgements in haptic and visual form perception. *Canadian Journal of Psychology*, 34, 161-174.
- Armstrong, J. (2000). *The intimate philosophy of art*. London: Penguin Books.
- Arnheim, R. (1998). Why words are needed. *Journal of Aesthetic Education*, 32(2), 21-25.
- Arnheim, R. (1990). Perceptual Aspects of art for the blind. *Journal of Aesthetic Education*, 24(3), 57-65.
- Ashby, M., & Johnson, K. (2002). *Materials and design: the art and science of material selection in product design*. Oxford, UK: Butterworth - Heine-mann.
- Bakker, R. (1975). *Merleau-Ponty, Filosoof van het niet-wetend weten*. Baarn: Wereldvenster.
- Bergsma, J. (1987). *Identiteit, lichamelijke verstoring en autonomie*. Lochem: uitgeversmaatschappij De Tijdstroom.
- Berla, E. P., & Butterfield, L. H. (1977). Tactual distinctive features analysis: training blind students in shape recognition and in locating shapes on a map. *The Journal of Special Education*, 11(3), 335-346.
- Bermudez, J. L., Marcel, A., & Eilan, N. (1995). *The body and the self*. London: The MIT Press.
- Bobjer, O., Johansson, S.-E., & Piguët, S. (1993). Friction between hand and handle. Effects of oil and lard on textured and non-textured surfaces; perception of discomfort. *Applied Ergonomics*, 24(3), 190-202.
- Bolanowski, S. J. (2003). Passive, active and intra-active (self) touch. *Behavioural Brain Research*.
- Brochet, F., & Dubourdieu, D. (2001). Wine descriptive language supports cognitive specificity of chemical senses. *Brain and Language*, 77, 187-196.

- Brown, D. E. (1991). *Human Universals*. Boston: McGraw-Hill.
- Buchenau, M., & Suri, J. F. (2000). Experience prototyping. Paper presented at the DIS2000, Brooklyn, New York.
- Buchholz, B., Frederick, L. J., & Armstrong, T. J. (1988). An investigation of human palmar skin friction and the effects of materials, pinch force and moisture. *Ergonomics*, 31(3), 317-325.
- Burton, G. (1993). Non-neural extensions of haptic sensitivity. *Ecological Psychology*, 5(2), 105-124.
- Buzan, T., & Buzan, B. (2000). *The mind map book*. London: BBC Worldwide Limited.
- Cacioppo, J. T., & Berntston, G. G. (1999). 1999. Current Directions in Psychological Science, 8(5), 133-137.
- Caranfa, A. (2001). Art and science: The aesthetic education of the emotions and Reason. *Journal of Art and Design Education*, 20(2), 151-160.
- Carello, C. (2004). Perceiving affordances by dynamic touch: hints from the control of movement. *Ecological psychology*, 16(1), 31-36.
- Chollet, S., Valentin, D., & Abdi, H. (2004). Do trained assessors generalize their knowledge to new stimuli? *Food Quality and Preference*.
- Classen, C. E. (2005). *The book of Touch*. Oxford, New York: Berg.
- Craig, J. C. (1988). The role of experience in tactual pattern perception: a preliminary report. *Int. Journal of Rehabilitation Research*, 11(2), 167-183.
- Craig, J. C., & Rollman, G. B. (1999). Somesthetis. *Annual Review of Psychology*, 50, 305-331.
- Cross, N. (1982). Designerly ways of knowing. *Design Studies*, 3(4), 221-227.
- Crozier, R. (1994). *Manufactured Pleasures. Psychological responses to design*. Manchester & New York: Manchester University Press.
- Csikszentmihalyi, M. (1990). *Flow. The psychology of optimal experiences*: HarperCollinsPublishers.
- Daly, E. M., Lancee, W. J., & Polivy, J. (1983). A conical model of the taxonomy of emotional experience. *Journal of personalty and social psychology*, 45(2), 443-457.
- Damasio, A. R. (1999). *The feeling of what happens. Body and emotion in the making of consciousness*. New York: Harcourt Brace & Company.
- Davidson, P. W. (1985). Functions of haptic perceptual activity in persons with visual and developmental disabilities. *applied research in mental retardation*, 6, 349-360.
- De Mendoza, J.-L. J. (1979). Demonstration of an aftereffect occuring in the tactile-kinesthetic domain., 415-422.

- Demir, E., Desmet, P. M. A., & Hekkert, P. (2006). *Experiential concepts in Design Research*.
- Desmet, P. M. A. (2002). *Designing emotions*. Unpublished PhD dissertation, Delft University of Technology, Delft.
- Dewey, J. (1980 (1934)). *Art as experience*. New York: Perigee Books.
- Dewey, J. (1997 (1916)). *Democracy and Education*. New York: The free press.
- Dewey, J. (1997 (1938)). *Experience and education*. New York: Touchstone.
- Dirken, H. (1997). *Productergonomie*. Delft: Delft University Press.
- Djajadiningrat, T., Wensveen, S. A. G., Frens, J., & Overbeeke, C. J. (2004). *Tangible products: redressing the balance between appearance and action*. *Personal Ubiquitous Computing*(8), 294-309.
- Dorst, K., & Reymen, I. (2004). *Levels of expertise in design education*. Paper presented at the *The changing face of design education*, Delft.
- Dourish, P. (2001). *Where the action is*. Cambridge: The MIT Press.
- Doyle McCarthy, E. (1984). *Toward a sociology of the physical world*. *Studies in symbolic Interaction*, 5, 105-121.
- Duijne, F. H. (2005). *Risk perception in product use*. Delft University of Technology, Delft.
- Eaton, M. M., & Moore, R. (2002). *Aesthetic experience: its revival and its relevance to aesthetic education*. *Journal of Aesthetic Education*, 36(2), 9-23.
- Ellis, R. R., & Lederman, S. J. (1999). *The material-weight illusion revisited*. *Perception & Psychophysics*, 61(8), 1564-1576.
- Essinck, G. K., James, A., & McGlone, F. P. (1999). *Psychophysical assessment of the affective components of non-painful touch*. *NeuroReport*, 10(10), 2083-2087.
- Fagan, J. (1998). *Thoughts on using touch in psychotherapy*. In E. W. L. Smith, P. R.
- Clance & S. Imes (Eds.), *Touch in psychotherapy*. New York: The Guilford Press.
- Fields, T. (2003). *Touch*. London, England: The MIT Press.
- Finnegan, R. (2002). *Communicating. The multiple modes of human interconnection*.  
London, New York: Routledge, Taylor & Francis Group.
- Flanagan, J. R., Wing, A. M., Allison, S., & Spenceley, A. (1995). *Effects of surface texture on weight perception when lifting objects with a precision grip*. *Perception & Psychophysics*, 57(3), 282-290.
- Forlizzi, J., & Ford, S. (2000). *The building blocks of experience: an early framework for interaction designers*. Paper presented at the *DIS2000*.
- Franzen, O., & Lindblom, U. (1976). *Tactile intensity functions in patients with*

- sutured peripheral nerve. In Y. Zotterman (Ed.), *Sensory functions of the skin with special reference to man*. Oxford: Pergamon Press.
- Frens, J. (2006). *Designing for rich interaction: integrating form, interaction and function*. Eindhoven University of technology, Eindhoven.
- Frijda, N. H. (1986). *The emotions*. Cambridge: Cambridge University Press.
- Fulton Suri, J. (2003). *The Experience Evolution: Developments in Design Practice*. *The Design Journal*, 6(2), 39-48.
- Fulton Suri, J. (2000a). *Communicating with designers: the role of empathy, evidence and inspiration*. Paper presented at the IEA 2000 / HFES 2000 Congress.
- Fulton Suri, J. (2000b). *Inclusive design through individual insight*. Paper presented at the IEA 2000 / HFES 2000 Congress.
- Ganong, W. F. (2001). *Review of medical physiology: Lange Medical Books/McGraw-Hill Medical Publishing Division*.
- Gerritse, T. A. C. M. (2000). *Over kleine dingen. Een inleiding in de haptonomie*. Maarssen: Elsevier Gezondheidszorg.
- Gershensfeld, N. (1999). *When things start to think*. New York: Henry Holt and Company.
- Giboreau, A., Navarro, S., Faye, P., & Dumortier, J. (2001). *Sensory evaluation of automotive fabrics: the contribution of categorization tasks and non-verbal information to set-up a descriptive method of tactile properties*. *Food Quality and Preference*, 12, 311-322.
- Gibson, E. J. (1988). *Exploratory behaviour in the development of perceiving, acting, and the acquiring of knowledge*. *Annual Review of Psychology*, 39(1-41).
- Gibson, J. J. (1962). *Observations on active touch*. *Psychological Review*, 69(6), 477-491.
- Gibson, J. J. (1963). *The useful dimensions of sensitivity*. *American Psychologist*, 18, 1-15.
- Glaser, B. G. (1967). *The discovery of grounded theory*. Hawthorne, New York: Aldine de Gruyter.
- Glaser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory: Strategies for qualitative research*. New York: Aldine de Gruyter.
- Goldstein, E. B. (2002). *Sensation and perception (6th ed.)*. Pacific Grove: Wardsworth.
- Goodnow, J. J. (1969). *Eye and hand: differential sampling of form and orientation properties*. *Neuropsychologia*, 7, 365-373.
- Goodnow, J. J., Baum, B., & Davidson, P. (1971). *A haptic error: skew in sym-*

- metrical curve. *Perception & Psychophysics*, 10(4a), 253-256.
- Govers, P. (2004). *Product personality*. Delft University of Technology, Delft.
- Haanstra, F. (1994). Effects of art education on visual-spatial ability and aesthetic perception: two meta-analyses. *Rijksuniversiteit Groningen*, Groningen.
- Hanninen, K. A. (1972). Review of the educational potential of texture and tactually discriminable patterns. *The Journal of Special Education*, 5(2), 133-141.
- Hassenzahl, M., & Tractinsky, N. (2006). User experience - a research agenda. *Behaviour & Information technology*, 25(2, march - april), 91-97.
- Hekkert, P. (1995). *Artful Judgements*. Delft University of Technology, Delft.
- Hekkert, P. (2000). Designing from context: foundations and applications of the ViP approach. Paper presented at the Designing in Context: Design Thinking Research Symposium 5, Delft.
- Hekkert, P. (2006). Design aesthetics: principles of pleasure in design. *Psychology Science*, 48(2157-172).
- Hekkert, P., Moster, M., & Stomppff, G. (2000). Dancing with a machine: a case of experience-driven design. Paper presented at the ACM2000.
- Highley, D. R. (1977). Frictional properties of the skin. *The journal of Investigative Dermatology*, 69, 303-305.
- Hodgson, J. (2001). *Mastering Movement*. New York: Routledge.
- Hollins, M., Bensmaia, S., Karlof, K., & Young, F. (2000). Individual differences in perceptual space for tactile textures: evidence from multidimensional scaling. *Perception & Psychophysics*, 62, 1534-1544.
- Hollins, M., Faldowski, R., Rao, S., & Young, F. (1993). Perceptual dimensions of tactile surface texture: a multidimensional scaling analysis. *Perception & Psychophysics*, 54, 697-705.
- Hunt, E., & Agnoli, F. (1991). The Whorfian hypothesis: a cognitive psychology perspective. *Psychological Review*, 98(3), 377-389.
- Jordan, P. (2002). The personalities of products. In *Pleasure with products: beyond usability*. London & New York: Taylor & Francis.
- Kalviainen, M. (2005). Action, movement and bodily relationships in products. Paper presented at the Design and semantics of form and movement.
- Keysers, C., Wicker, B., Gazzola, V., Anton, J.L., Fogassi, L., Gallese, V. (2004). A touching sight: SII/pv activation during the observation and experience of touch. *Neuron*, 42(2), 335-346.
- Klatzky, R. L., Lederman, S. J., & Metzger, V. A. (1985). Identifying objects by touch: an "expert system". *Perception & Psychophysics*, 37, 299-302.
- Klatzky, R. L., Lederman, S. J., & Reed, C. (1987). There's more to touch than meets the eye: the salience of object attributes for haptics with and without vision. *Journal of Experimental Psychology: General*, 116, 356-369.



- Klooster, S. (2003). *Ontwerpen beweegt*. Delft.
- Klooster, S., & Overbeeke, C. J. (2005). Designing products as an integral part of choreography of interaction: the product's form as an integral part of movement. Paper presented at the DeSForm 2005, Newcastle upon Tyne.
- Klopf, A. H. (1982). *The hedonistic neuron. A theory of memory, learning and intelligence*. New York: Hemisphere Publishing Corporation.
- Kreifeldt, J. G. (2001). Designing 'feel' into a product. Paper presented at the International conference on affective human factors design.
- Kreitler, H., & Kreitler, S. (1972). *Psychology of the arts*. Durham, NC: Duke University Press.
- Kruger, L. (1996). *Pain and touch*. San Diego: Academic Press.
- Kuiper, W., & Scheepens, J. (2000). *tactiliteit in producten: toeval?* Delft: Delft University of Technology.
- Lakoff, G., & Johnson, M. (1999). *Philosophy in the flesh: the embodied mind and its challenge to western thought*. New York: Basic books.
- LaMar, J. (1997). *Tasting wine: a sensory user's manual*.
- Lamme, V. (2003). Why visual attention and awareness are different. *Trends in cognitive science*, 7(1, january), 12-18.
- Lederman, S. J. (1974). Tactile roughness of grooved surfaces: the touching process and effects of macro- and microsurface structure. *Perception & Psychophysics*, 16(2), 385-395.
- Lederman, S. J. (1981). The perception of surface roughness by active and passive touch. *Bulletin of the Psychonomic Society*, 18, 253-255.
- Lederman, S. J., & Klatzky, R. L. (1987). Hand movements: a window into haptic object recognition. *Cognitive Psychology*, 19, 342-368.
- Lederman, S. J., & Klatzky, R. L. (1993). Extracting object properties through haptic exploration. *Acta Psychologica*, 84, 29-40.
- Lederman, S. J., & Klatzky, R. L. (1998). The hand as a perceptual system. In K. J. Connolly (Ed.), *The psychobiology of the hand*. London: Mac Keith Press.
- Lederman, S. J., & Klatzky, R. L. (1999). Sensing and displaying spatially distributed fingertip forces in haptic interfaces for teleoperator and virtual environment systems. *Presence*, 8(1), 86-103.
- Lederman, S. J., & Klatzky, R. L. (2003). Multisensory texture perception.
- Lloyd, P., Roozenburg, N., McMahon, C., & Brodhurst, L. (2004). *The changing face of design education*, Delft.
- Loomis, J. M., & Lederman, S. J. (1986). Tactual perception. In K. R. Boff, L. Kaufman & J. Thomas (Eds.), *Handbook of Human Perception and Performance* (pp. 1-41). New York: Wiley.

- MacDonald, A. S. (2000). Aesthetic Intelligence Assists Inclusive Design. Paper presented at the IEA/HFES 2000.
- MacDonald, A. S. (2001). Aesthetic intelligence: optimizing user-centred design. *Journal of Engineering Design*, 12(1), 37-45.
- MacDonald, A. S. (2002). The scenario of sensory encounter: cultural factors in sensory-aesthetic experience. In W. S. Green & P. W. Jordan (Eds.), *Pleasure with products: beyond usability* (pp. 113-123). London: Taylor & Francis.
- MacKenzie, C. L., & Iberall, T. (1994). *The grasping hand*. Amsterdam: North Holland.
- Manen, M. (1990). *Researching the lived experience*. Ontario: The Athlouse Press.
- Margolin, V. (1997). Getting to know the user. *Design Studies*(18), 227-236.
- Mattelmaki, T. (2005). Applying probes-from inspirational notes to collaborative insights. *CoDesign: International journal of Cocreation in Design and the Arts.*, 1(2).
- Mattelmaki, T., & Batterbee, K. (2002). Empathy Probes. Paper presented at the PDC2002, Malmo.
- Matthews, P. B. C. (1982). Where does Sherrington's "muscular sense" originate? Muscles, joints, corollary discharges? *Annual Review of Neuroscience*(5), 189-218.
- Mehrabian. (1972). *Non-verbal communication*. Chicago, Illinois: Aldine-Atherton.
- Melzack, R. (1975). The McGill questionnaire: major properties and scoring methods. *Pain*(1), 277-299.
- Michotte, A. (1963). *The perception of causality*. London: Methuen.
- Moen, J. (2005). Towards people based movement interaction and kinaesthetic interaction experiences. Paper presented at the AARHUS2005.
- Montagu, A. (1971). *Touching*. New York: Columbia University Press.
- Mugge, R., Schifferstein, H.N.J., & Schoormans, J.P.L. (2005). Product Attachment and Product lifetime: the role of personality congruity and fashion. In *European advances in consumer research*, 7. Goteborg: Association for Consumers.
- Muller, W. (2001). *Order and meaning in design*. Utrecht: Lemma Publishers.
- Restrepo, J., Rodrigez, A., & Martinez, J. F. (2004). The axiological and epistemological foundations of a PDE program. Paper presented at the *The changing face of design education*, Delft.
- Murray, D. J., Ellis, R. R., Bandomir, C. A., & Ross, H. E. (1999). Charpentier (1891) on the size-weight illusion. *Perception & psychophysics*, 61(8), 1681-1685.

- Norman, D. A. (2002). Emotion & design: attractive things work better. *Interactions*(July), 36-42.
- Norman, D. A. (2003). *Emotional Design. Why we love (or hate) everyday things.* New York: Basic Books.
- North, M. (1971). *Personality Assessment through movement.* Plymouth: Northcote House.
- Olausson, H., Lamarre, Y., Backlund, H., Morin, C., Wallin, B. G., Starck, G., et al. (2002). Unmyelinated tactile afferents signal touch and project to insular cortex. *Nature Neuroscience*, 5(9), 900-904.
- O'Meara, D. M., & Smith, R. M. (2001). Static friction between human palmar skin and five grabrail materials. *Ergonomics*, 44(11), 973-988.
- Overbeeke, C. J. (1999). *Educating the senses: design, science, aesthetics and ethics.* Unpublished manuscript.
- Picard, D., Dacremont, C., Valentin, D., & Giboreau, A. (2003). Perceptual dimensions of tactile textures. *Acta Psychologica*, 114, 165-184.
- Polanyi, M. (1967). *The tacit dimension.* Garden City, New York: Doubleday.
- Pratorius, B., Kimmeskamp, S., & Milani, T. L. (2003). The sensitivity of the sole of the foot in patients with Morbus Parkinson. *Neuroscience letters*, 346(3), 173-176.
- Redstrom, J. (2006). Towards user design? On the shift from object to user as the subject of design. *Design Studies*, 27, 123-139.
- Revesz, G. (1950). *Psychology and the art of the blind* (H. A. Wolff, Trans.). London: Longmans Green.
- Rompay, T. (2005). *Expressions.* Delft University of Technology, Delft.
- Roozenburg, N. F. M., & Eekels, J. (2001). *Productontwerpen, structuur en methoden* (2nd ed.). Utrecht: Lemma.
- Ross, H. E., & Murray, D. J. (1996a). *E.H. Weber on the Tactile Senses.* Erlbaum, UK.: Taylor & Francis.
- Ross, H. E., & Murray, D. J. (1996b). *E.H. Weber on the tactile senses.* Erlbaum: Taylor&Francis.
- Rozendaal, M. C., Keyson, D. V., & De Ridder, H. (2006). Interactivity, vividness and richness in user interfaces.
- Ryan, R. M., & Deci, E. L. (2001). On happiness and human potentials: a review of research on hedonic and eudaimonic well being. *Annual Review of Psychology*, 52, 141-166.
- Sacks, O. (1984). *A leg to stand on.* London: Picador.
- Sacks, O. (1987). *The man who mistook his wife for a hat and other clinical tales.* New York: Harper & Row Publishers.

- Saladin, K. S. (2001). *Anatomy & Physiology: the unity of form and function*. New York: McGraw-Hill Higher Education.
- Sanders, E. B.-N. (2001). *Virtuosos of the experience domain*. Paper presented at the IDSA Education Conference.
- Sanders, E. B.-N., & Dandavate, U. (1999). *Design for experience: new tools*. Paper presented at the Design & Emotion, Delft.
- Savenije, W. (2003). Een goed instrument. *NRC Handelsblad*(May, 12 th.).
- Schifferstein, H. N. J. (2007). *Multisensory product design*. In preparation.
- Schon, D. A., & Wiggins, G. (1992). Kinds of seeing and their functions in designing. *Design Studies*, 13(2), 135-156.
- Schon, D. A. (1983). *The reflective practitioner*. New York: Basic Books.
- Sekuler, R., & Blake, R. (1994). *Perception* (3rd ed.). New York: McGraw-Hill.
- Sherrick, & Cholewiak, R. (1986). *Cutaneous Sensitivity*. In K. R. Boff (Ed.), *Handbook of Perception and Performance*. New York: Wiley and Sons.
- Shusterman, R. (1999). *Somaesthetics: a disciplinary proposal*. *Journal of Aesthetics and Art Criticism*, 57.
- Sleeswijk Visser, F., Stappers, P. J., Van der Lugt, R., & Sanders, E. B.-N. (2005). *Contextmapping: experiences from practice*. *CoDesign: International journal of Cocreation in Design and the Arts*, 1(2), 119-149.
- Sorri, M. (1994). The body has reasons: tacit knowledge in thinking and making. *Journal of Aesthetic Education*, 28(2), 15-26.
- Stevens, J. C. (1980). Thermal intensification of touch sensation: further extensions of the Weber phenomenon. *Sensory Processes*, 3, 240-248.
- Stevens, J. C. (1990). Perceived roughness as a function of body locus. *Perception and psychophysics*, 47(3), 298-304.
- Stevens, J. C., & Choo, K. K. (1996). Spatial acuity of the body surface over the life span. *Somatosensory and motor research*, 13(2), 153-166.
- Stolnitz, J. (1960). The aesthetic attitude. In *Aesthetics and philosophy of Art criticism, a critical introduction*. Boston: Houghton Mifflin Co.
- Teghtsoonian, R., & Teghtsoonian, M. (1970). Two varieties of perceived length. *Perception & Psychophysics*, 8, 389-392.
- Thayer, S. (1982). *social touching*. In W. Schiff & E. Foulke (Eds.), *Tactual Perception: a sourcebook*. Cambridge: Cambridge University press.
- Tiemersma, D. (1988). *La Chair. Het vlees van de wereld. Merleau-Ponty over Cezanne*. In H. F. A. P. Oosterling, A.W. (Ed.), *La Chair. Het vlees in filosofie en kunst*. Rotterdam: Faculteit der Wijsbegeerte van de Erasmus Universiteit Rotterdam.
- Totton, N., & Jacobs, M. (2001). *Character and personality types*. Buckingham. Philadelphia: Open University Press.

- Tritsch, M. F. (1988). The veridical perception of object temperature with varying skin temperature. *Perception & Psychophysics*, 43(6), 531-540.
- Tsakiris, M., & Haggard, P. (2005). The rubber hand illusion revisited: visuotactile integration and self-attribution. *Journal of Experimental Psychology*, 31(1), 80-91.
- Turvey, M. T. (1996). Dynamic touch. *American Psychologist*, 51, 1134-1152.
- Vander, A. J., Sherman, J., & Luciano, D. (2001). *Human Physiology. The mechanisms of body functions*. New York: McGrawHill.
- Veenhoven, R. (2006). *Healthy Happiness. Exploratory study for ZonMw, the Netherlands' organisation for health research and development*. Rotterdam: Erasmus Universiteit Rotterdam.
- Veldman, F. (1996). *Haptonomie. Wetenschap van de affectiviteit*. Utrecht: Uitgeverij Erven J.Bijleveld.
- Vink, P. (2005). *Comfort and design - Principles and good practice*. Boca Raton: CRC Press.
- Visser, A. (1986). *Hardop kijken*. Nijmegen: SUN.
- Vogels, I. M. L. C., Kappers, A. M. L., & Koenderink, J. J. (2001). Haptic after-effect of successively touched curved surfaces. *Acta Psychologica*, 106(247-263).
- Wensveen, S. A. G. (2005). *A tangible approach to affective interaction*. Delft University of technology, Delft.
- Winnicott, D. W. (1964). *The Child, The Family and the Outside World*. Middlesex, England: Penguin Books Ltd.





# Samenvatting

Vanaf onze geboorte worden we omringd, aangeraakt, ondersteund, beschermd, belaagd en toegerust met objecten die door mensen zijn gemaakt. Toch is de tactiele ervaring van mens-product interacties een veronachtzaamd onderwerp in ontwerppopleidingen en onderzoek. Dit proefschrift wil bijdragen aan een onderzoeksgebied dat deze leemte in mens-product interactie op wil vullen: Tactiele Esthetiek in product ontwerpen. Het streven van dit proefschrift is productontwerpers bewust te maken van de tactiele ervaring en vat op dit onderwerp te krijgen door er een begrippenkader voor te ontwikkelen. Daarnaast beschrijft dit proefschrift hoe studenten productontwerpen hun sensitiviteit voor de esthetiek van de tactiele ervaring kunnen ontwikkelen en de aandacht voor de tactiele ervaring kunnen betrekken in hun ontwerpprojecten.

De esthetische ervaring wordt in dit proefschrift fenomenologisch benaderd. De tactiele ervaring zelf wordt beschouwd als het bewustzijn van wat er gebeurt in de mens-product interactie: hoe men beweegt, wat men gewaarwordt, wat gedacht en wat gevoeld wordt. Een ervaring wordt beschouwd als een gebeurtenis, een proces voortvloeiend uit voorgaande gebeurtenissen en aanleiding gevend tot volgende gebeurtenissen. De esthetische aspecten van de tactiele ervaring zijn gedefinieerd als de ervaren (on)plezierigheid van de mens-product interactie.

Hoofdstuk 1 geeft een overzicht van de betekenis van de aanraking en beschrijft vanuit verschillende invalshoeken de noodzaak om aan te raken en aangeraakt te worden.

Ten eerste draagt aanraken en aangeraakt worden bij tot het bewustzijn van het zelf. Fysieke interactie beperkt zich niet alleen tot de handen, maar betreft het hele lichaam. De aanraking maakt mensen bewust dat ze een fysiek lichaam *zijn*, en de wereld delen met andere fysieke objecten. De tastzin laat mensen daarbij ervaren wat de grenzen zijn tussen zichzelf en de buitenwereld. Tegelijkertijd kan men door de tastzin deze grenzen met de buitenwereld verleggen. Wanneer



men de wereld door een object heen voelt, bijvoorbeeld door een stuk gereedschap, wordt dit object als 'ingelijfd' ervaren.

Ten tweede staat de tastzin aan de basis van kennis over de materiele wereld, omdat we via de tastzin grip krijgen op haar fysieke eigenschappen. Dit is kennis 'uit ervaring'. Deze kennis wordt zelden onder woorden gebracht en is vaak ook moeilijk te vatten in taal.

Daarnaast is fysiek contact ook de basis voor het *gevoel* dat men in contact is. De tastzin is daarom de basis voor de ontwikkeling van gevoelens van affectie en intimiteit. Aanraken en aangeraakt worden is in die zin onontbeerlijk, mensen die het gebruik van hun tastzin wordt ontzegd, kwijnen weg.

Als laatste is de tastzin ons meest sociale zintuig. In tegenstelling tot onze afstandszintuigen, zoals zien en horen, is de tastzin een nabijheidzintuig en is daardoor de basis voor het communiceren van affectie. In de aanraking ervaren we of we veilig zijn, verzorgd en gewaardeerd worden. De tast kan gezien worden als een taal met een specifieke vocabulaire en grammatica. Het is essentieel voor het emotioneel welbevinden van mensen deze taal te spreken.

Hoofdstuk 2 toont een overzicht van de psychofysische aspecten van de tastzin. Aanraken en aangeraakt worden is een complex proces waarbij verschillende zintuiglijke systemen zijn betrokken: de huidzintuigen, proprioceptie en de zintuigen voor temperatuur en pijn. Daarnaast, en hierin verschilt de tastzin van de andere zintuigen, kan de tastzin beschouwd worden als een interactief fenomeen: aanraken is op hetzelfde moment aangeraakt worden.

De basis voor tactiele gewaarwordingen en percepties is beweging. Door te bewegen, zoals optillen, strelen, knijpen en rekken, nemen we de tactiele eigenschappen van een object waar, zoals gewicht, textuur, hardheid en elasticiteit. De perceptie van deze tactiele eigenschappen wordt niet uitsluitend bepaald door de bewegingen die men maakt, maar ook door de omstandigheden van de mens-product interactie. Wanneer bijvoorbeeld een object wordt aangeraakt kort na een ander object, dan wordt de perceptie van de temperatuur van het tweede object beïnvloed door de temperatuur van het eerste. Verder wordt de tactiele ervaring beïnvloed door de lichamelijke eigenschappen van de waarnemer zelf. De subjectiviteit van de tactiele waarneming is daarmee gegrond in de lichamelijkheid van de waarnemer. Bijvoorbeeld, de beoordeling of iets groot voelt hangt af van hoe groot men zelf is.

Tenslotte hangt de tactiele perceptie af van de tactiele sensitiviteit van de waarnemer: het vermogen om te voelen *of* men aangeraakt wordt, waar, hoe lang en met welke intensiteit. Tactiele sensitiviteit is niet gelijk over het hele lichaam. Zo zijn de vingertoppen en lippen gevoeliger dan de rug of de kuit. De tactiele sensi-

tiviteit zelf kan niet worden verhoogd door oefening, maar de tactiele perceptie wel. Zo kunnen mensen die blind zijn geworden hun tactiele herkenning van objecten verbeteren.

Om een conceptueel begrippenkader te creëren voor het beschrijven van de tactiele ervaring in mens-product interacties is een kwalitatief onderzoek gedaan. Hierbij werden via een schriftelijke vragenlijst beschrijvingen verzameld van tactiele ervaringen (Hoofdstuk 3). De analyse van de data is gebaseerd op de methode van 'grounded theory': vanuit de data worden thema's gegenereerd die het fenomeen beschrijven. Deze thema's vormen vervolgens het conceptuele begrippenkader.

De resultaten hebben geleid tot een begrippenkader dat in de tactiele ervaring vijf gebieden onderscheidt:

- de **bewegingen** die met een object gemaakt worden. Deze zijn gegrond in de verschillende beweegredenen om met het object om te gaan: onderzoeken, spelen, functioneel gebruiken, verzorgen, dragen of onbedoelde bewegingen;
- de **tactiele sensaties** en de lichaamsdelen die betrokken zijn bij de interactie;
- de **tactiele eigenschappen** van het object; deze worden ervaren als het fysieke gedrag van het object: hardheid, elasticiteit en flexibiliteit, grootte en vorm, textuur van het oppervlak, temperatuur, gewicht, evenwicht en de eigenschappen van de bewegende delen;
- de **expressie** van het object; deze expressie wordt ervaren als het affectieve gedrag van het object en wordt beschreven worden aan de hand van de thema's: persoonlijkheid, intentie, integriteit in tactiele terugkoppeling, het 'precies goed' zijn, vertrouwdheid, machtsspel, uitdagen van de fysieke vaardigheden en tactiele transparantie;
- de **gevoelens** van de deelnemers; de affectieve respons van de deelnemers kan in de volgende thema's worden gevat: fysieke (on)aangenaamheid (lust en pijn of afschuw), affectie (liefde en haat), kwetsbaarheid (vertrouwen en angst), energie (spanning en ontspanning), handelingsbereidheid (toenadering en vermijding) en de manier waarop men zichzelf ervaart;

Deze gebieden en hun verschillende thema's kunnen gevat worden in het overkoepelende begrip van de lichaamstaal van een object: het affectieve gedrag gegrond in het fysieke gedrag van het object tijdens de interactie.

Dit proefschrift beperkt zich niet tot het zoeken naar thema's die de tactiele ervaring beschrijven. In taal hebben mensen naast vocabulaire ook een structuur nodig om hun ervaringen te beschrijven. In Hoofdstuk 4 wordt de bruikbaarheid van de thema's uitgewerkt die in Hoofdstuk 3 zijn bepaald. Daarnaast richt de

studie in Hoofdstuk 4 zich op de *structuur* van de beschrijvingen van tactiele ervaringen. *Hoe* beschrijft men deze verschillende aspecten?

Geblinddoekte deelnemers verkenden 15 balletjes van verschillende materialen, zoals kristal, hout, polystyreen schuim, kurk, suède, gel en metaal. Het explorerende gedrag van de deelnemers suggereert dat de stimuli verschillen in de manier waarop ze de mensen uitdagen om met de stimuli om te gaan (zowel in het soort beweging als in de tijd die gebruikt wordt om de stimuli te verkennen). Dit kan worden beschreven als het esthetische potentieel van een object: het vermogen om mensen aan te zetten tot het ontdekken van interactiemogelijkheden en om (on)plezierige ervaringen op te roepen.

De resultaten van het onderzoek laten zien dat beschrijvingen van tactiele ervaringen als volgt gestructureerd kunnen worden:

- een **kwalitatieve** beschrijving van een aspect (bijvoorbeeld 'een *ruwe* textuur');
- een **kwantitatieve** beschrijving van een aspect (bijvoorbeeld 'een *redelijk* ruwe textuur');
- de **veranderingen in de tijd** van een aspect (bijvoorbeeld 'eerst was het glad, maar na verschillende keren gebruiken werd het plakkerig').

De opmerkingen van de proefpersonen over de esthetische aspecten van de interactie met de verschillende balletjes leiden tot het inzicht dat naast plezierige en onplezierige ervaringen, de deelnemers "onverschilligheid" beschrijven als een specifiek onderdeel van de esthetiek.

De resultaten van de eerste hoofdstukken vormen de basis voor een instrument om deze resultaten toegankelijk te maken voor productontwerpers: De Tactual Experience Guide (Hoofdstuk 5). Het doel van deze gids is ontwerpers te helpen inzicht te krijgen in de esthetische aspecten van de tactiele ervaring. Dit door hun eigen tactiele ervaringen in kaart te brengen. De veronderstelling is dat bewustwording en sensitiviteit voor de tactiele ervaring bereikt worden door het samenspel van cognitief en zintuiglijk leren: leren door fysiek te ervaren.

Om dit doel te bereiken moet de Tactual Experience Guide een overzicht geven van de verschillende gebieden van de tactiele ervaring, dat ruimte laat voor persoonlijke invulling en interpretatie. Daarnaast moet de structuur van de gids de gelegenheid bieden voor associatief denken. De 'mind map' is hiervoor een geschikt middel. De Tactual Experience Guide bestaat uit zes mind maps: een mind map voor elk gebied van de tactiele ervaring en een extra mind map voor de esthetische aspecten van de ervaring. Het gebruik van de Tactual Experience Guide is geëvalueerd met ontwerpstudenten, resulterend in een definitieve versie ervan en een gebruikershandleiding, beide gepresenteerd in Appendix 5.2. De tactiele

ervaring wordt in de Tactual Experience Guide beschreven door middel van woorden. Evaluatie van deze beschrijvingen leidt tot het inzicht dat aanvullende mogelijkheden voor persoonlijke expressie wenselijk zijn, zoals foto's, geluiden en tastbare materiaalvoorbeelden.

Om voor de tastzintuigen te leren ontwerpen is het keuzevak Tactiliteit ontwikkeld. Dit keuzevak is geëvalueerd door studenten van de afdeling Industrieel Ontwerpen van de Technische Universiteit Delft (Hoofdstuk 6). Het vak bestaat uit colleges en ontwerp oefeningen. Het uitgangspunt hierbij is dat een ontwerper zijn eigen ervaringswereld moet kennen om met empathie voor de ervaringswereld van de eindgebruiker te kunnen ontwerpen. De nadruk van de bewustwordings- en ontwerp oefeningen ligt daarom op de persoonlijke ervaringswereld van de student: de studenten ontwerpen voor tactiele ervaringen die ze zelf als plezierig ervaren. Verder onderzoekt het vak de communicatiemogelijkheden voor de tactiele ervaring, met name door het verzamelen van beelden en 3D objecten die het soort lichaamstaal illustreren waarnaar gestreefd wordt in het ontwerp.

Hoofdstuk 7 besluit dit proefschrift met een overzicht van de bijdrage aan het onderzoeksgebied van de Tactiele Esthetiek in het Product Ontwerpen en met aanbevelingen voor verdere ontwikkelingen. Het inzicht dat tactiele ervaringen in mens-product interactie gezien kunnen worden als de lichaamstaal van twee sociale entiteiten, biedt de mogelijkheid om tactiele esthetiek te verkennen alsof het intermenselijk gedrag betreft. Voorts worden twee perspectieven voorgesteld voor de benadering van esthetische aspecten van de ervaring. Ontwerpers kunnen kiezen voor een hedonische aanpak, strevend naar het directe plezier van de zintuigen. Daarnaast kunnen ze een eudemonische aanpak nastreven, die zich richt op esthetische ervaringen als basis voor zelfontwikkeling. Vanuit deze zienswijze kan de ontwerper enige initiële ongemakken of weerstand in de mens-product interactie overwegen, als dit uiteindelijk leidt tot het plezier van het beheersen van het product. Muziekinstrumenten en sportattributen zijn voorbeelden van producten die dergelijke ervaringen kunnen bieden.



# Summary

From the moment we are born, we are surrounded, touched, supported, protected, attacked and equipped by man-made objects. We are continuously in physical interaction with this man-made world. Yet tactual experience in human-product interaction is a neglected domain in product design education and research. This thesis contributes to a design research field addressing this blind spot in human-product interaction: *Tactual Aesthetics in Product Design*. Goal of this thesis is to contribute to designers' awareness for the tactual experience and to make this phenomenon accessible by creating a conceptual framework to describe it. In addition, the thesis describes how design students can be educated to develop aesthetic sensitivity for tactual experience, and to incorporate awareness for the tactual senses in their design projects.

The approach to aesthetic experience in this thesis is phenomenological. The tactual experience itself is considered as the awareness of what is happening in human-product interaction: how one is moving and what one is sensing, thinking and feeling. An experience is an event, a process grounded in previous experiences and giving input to future experiences. The aesthetic aspects of tactual experience are defined as the experience of the (un)pleasantness of the human-product interaction.

The overview of the literature presented in Chapter 1 addresses the meaning of touch, and the need for touching and being touched from different perspectives. First, touching and being touched contribute to the awareness of oneself. Physical interaction is not limited to the hands, it involves the whole body, and thereby makes people aware of *being* a physical body themselves, sharing the physical world with other physical bodies. Touch allows people to experience the borders between the self and the outside world. Simultaneously, touch questions these borders because one is able to incorporate objects and to perceive the surrounding world through them.

Second, touch is the foundation for knowledge of the material world, because it is through touch that we learn about the properties and characteristics of the

world's physicality. It is the kind of knowledge one refers to as 'from experience'. This knowledge is hardly ever made explicit, and often hard to make explicit.

Next, touch is the basis of the *feeling* of being in contact. Touch forms a foundation for feelings of affection and intimacy. Touch is primordial, a person withers if the need for touching and being touched is not satisfied.

Finally, touch is our most social sense. In contrast to the 'distant' senses such as seeing and hearing, touching implies physical contact, and embodies a communication channel for affection. Touch tells us whether we are safe, cared for and have value. Touch may be considered as a language with a specific vocabulary and a specific grammar, and it is essential for people's emotional well-being to speak that language.

Chapter 2 presents a literature overview addressing the psycho-physiological aspects of the tactual senses. Touching and being touched is a complex process. It involves different sensory systems: the skin senses, proprioception and the senses of temperature and pain. In addition, and in contrast to the other senses, touch can be considered an interactive phenomenon: to touch is to be touched simultaneously.

Tactual sensations and perception are grounded in movement. It is through movements such as lifting, caressing, squeezing and stretching, that we perceive an object's tactual properties such as weight, texture, hardness and elasticity. The perception of these tactual properties depends not only on the movements one makes, but also on the circumstances preceding the interaction. For example, when two objects are touched one after the other, the perception of the temperature of the second object is influenced by the temperature of the first. In addition, tactual perception depends on the material properties of one's own body and is therefore physically subjective. For example, the perception of size (small or large) depends on one's own size.

Finally, tactual perception depends on one's tactual sensitivity: the capacity to sense *if* one is touched, where one is touched, for how long and with what intensity. Tactual sensitivity varies between the different body parts. For example, finger tips and lips are more sensitive than the back or the calf. This *physical* sensitivity can not be altered by training, but we are able to improve tactual *perception* through training. For example, people who become blind can improve their tactual recognition of objects.

To create a conceptual framework describing tactual experience in human-product interaction, a qualitative study was carried out, collecting people's descriptions of tactual experiences through a written questionnaire (Chapter 3). The

analysis of the data is based on grounded theory: generating themes that describe the phenomenon from the data, and combining them into a conceptual map.

The resulting map consists of five domains of tactual experience:

- the **movements** made in interaction; these movements are based on the different motivations to interact with the object: to explore, to play with, for functional use, to take care, to carry or by accident;
- the **sensations** and body parts involved in interaction.
- the **tactual properties** of the object; these properties are related to the way the object behaves physically: hardness, elasticity and flexibility, size and shape, surface texture, temperature, weight and balance, and the properties of moving parts.
- the **expression** of the object; this expression is related to the affective behaviour of the object, and can be described along the themes: personality, intention, integrity in tactual feedback, being a perfect match, familiarity, challenging a power match, challenging physical skills and tactual transparency.
- the **feelings** of the participants; the affective response of the participants can be characterized by the themes: physical (un)pleasure (lust, pain & disgust), affection (love & hate), vulnerability (trust & fear), energy (tension & relaxation), action tendency (approach & avoid), and self experience.

These domains and their different themes can be characterised by the umbrella concept of the body language of an object: its affective behaviour grounded in its physical behaviour in interaction.

The exploration this thesis set out for, is not limited to finding a set of themes characteristic for the tactual experience. In language, in addition to a vocabulary, people also need a structure to describe their experiences. Besides addressing the appropriateness of the themes developed in Chapter 3, the study in Chapter 4 addresses the *structure* of the descriptions people give: *How do people actually describe these different aspects?*

Blindfolded participants explored 15 balls made of different materials such as crystal, wood, polystyrene foam, cork, suede, gel and metal. The participants' exploratory behaviour suggests that the stimuli differ in the way they challenge people to interact with them (in type of movement as well as in time spent to explore the stimulus). This can be characterised as the aesthetic potential of the object: its capacity to stimulate people to discover interaction possibilities and to elicit experiences of (un)pleasantness.

The results of the study show that descriptions of tactual experience can be structured along:



- a **qualitative** description of a specific aspect (for example: a *rough* texture);
- a **quantitative** description of the aspect (for example: a *slightly* rough texture);
- the **changes over time** of the aspect (for example: first it was smooth, but after using it for several times it became sticky).

The comments on the aesthetic aspects of the interaction with the different balls lead to the insight that in addition to pleasant and unpleasant experiences, people describe indifference as a specific aspect of the aesthetics.

The results of the first chapters form the basis of a tool making these findings accessible for product designers: the Tactual Experience Guide (Chapter 5). Goal of this tool is to support designers to develop insight in the aesthetic aspects of tactual experience, by describing their own world of tactual experience. The assumption is that awareness and sensitivity for the tactual experience is achieved through the interplay between cognitive and perceptual learning: learning by experience.

To achieve this goal, the tactual experience guide offers an overview of the different domains of tactual experience in a way that allows room for personal interpretation. In addition, the structure of the tool supports free associative thinking. The mind map is an appropriate means to meet these requirements.

The Tactual Experience Guide consists of six mind maps: one mind map for each domain of tactual experience and an additional map to conclude on the aesthetic aspects of the experience. The use of the tool is evaluated with design students, resulting in a final version of the Tactual Experience Guide and a user manual, both presented in Appendix 5.2. The Tactual Experience Guide relies on words to describe the tactual experience. Nevertheless, using the guide leads to the insight that it is beneficial to explore additional means for personal expression, such as photographic images, sounds and material samples.

In order to design for the tactual senses, designers need to develop awareness and sensitivity for the aesthetic aspects of tactual experience. To achieve this goal, the elective course Tactility was developed and evaluated at the department of Industrial Design at the Delft University of Technology (Chapter 6). The course consists of a mixture of lectures and design exercises. Starting point is the assumption that to be an empathic designer, one needs to explore and know one's own world of experience. Therefore, the focus of the awareness and design exercises is on the students' personal worlds of experience: the students design for tactual experiences that they themselves perceive as pleasant. In addition, the course explores means to communicate about the tactual experience, especially through collecting images and 3D objects that illustrate the type of body lan-

guage one is aiming for in the design.

Chapter 7 concludes this thesis with an overview of the contribution of this thesis to the field of Tactual Aesthetics in Product Design, and with recommendations for further developments. The insight that tactual experiences in human-product interaction can be regarded as elements of the body language of two social entities, opens up the possibility to explore the aesthetics of tactual experience as if it concerned inter-human behaviour. Furthermore, two different perspectives are proposed to consider the aesthetic aspects of experience. Designers may use a hedonic approach, striving for immediate gratification of the senses. From an eudemonic perspective, they may approach aesthetic experience as a basis for personal development. From the latter perspective, a designer may accept some initial unpleasantness or resistance in the human-product interaction, if this struggle eventually leads to the pleasure of being able to master the product. Musical instruments and sports equipment are examples of products that offer such experiences.



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Marieke Sonneveld. Rotterdam, March 2007



# About the author

Marieke Sonneveld was born in Holland in 1962 and grew up in Lebanon, Egypt and Italy. She completed her secondary school {education} in 1981, at the Lycee Chateaubriand in Rome with a baccalaureat scientifique, and subsequently started her studies at the Delft University of Technology, department of Industrial Design. Her main focus became the ergonomic aspects of human-product interaction. Her graduation project was the design of a support that allows women to squat during the final stage of labour, in order to facilitate a natural childbirth. She received her Master's degree in 1989. After completing her studies, she started a Design Studio with three fellow product designers, specializing in usability research in the context of product innovation.

In 1992 Marieke Sonneveld started her own research bureau Nomos. Projects varied from analysing the use of airport terminals, toothpaste tubes, to that of toilet seats and kitchen tools. Her research was done from the Design for All perspective. This implied (designing with) an empathic mind-set and awareness of who is included in pleasant interaction with a specific product in a specific context of use. It is from this practice in applied design research that her desire grew to gain insight in the experiential aspects of human-product interaction, especially related to touch. Marieke Sonneveld's research on Tactual Aesthetics started in 1999 at the Delft University of Technology, resulting in the present thesis. Based on the findings of her research she initiated a course on Tactual Aesthetics for the curriculum of Design Education in Delft.

Next to her research activities Marieke Sonneveld teaches Human Factors in Design at the Design Academy Eindhoven, from 1995 up to the present. Her drive is to show design students that researching human-product interaction is a source of inspiration for product design. In addition to Delft and Eindhoven, Marieke Sonneveld has also taught at other design schools in the Netherlands for shorter periods of time.

Marieke Sonneveld lives in Rotterdam with product designer Claas Westerhof and their three children, Nicolaas, Stijn and Lena.







