# Embodiment in Design

# On the Embodied Foundations of Meaning and Experience in Product Design

Thomas van Rompay\*, Geke Ludden\*\*

\* University of Twente, t.j.l.vanrompay@utwente.nl \*\* University of Twente, g.d.s.ludden@utwente.nl

Ever since the introduction of the embodied cognition framework in cognitive and social psychology, numerous studies have demonstrated linkages between everyday bodily experiences and product evaluations reflecting meaning portrayal and affect. However, to date no comprehensive framework for understanding embodiment in relation to design has been developed. Hence, one goal of this article is to lay out a typology for understanding embodiment in relation to product appearance and interaction. A second goal consists in showing why insights in embodiment may be inspiring and useful to designers, and why understanding of the embodied dynamics underlying product experience may guide designers in creating meaningful objects. In order to substantiate these assumptions, we will present and illustrate the different types of embodiment most relevant in relation to design research. We will also elaborate on what design goals could underlie these different types, and we will suggest new avenues for design and design-research our findings point at.

Key words: Embodiment, Product Design, Symbolic Meaning, Product Appearance, Movement

## 1. Introduction

In the past three decades, it has become increasingly common in scholarly literature to explain human language use, evaluations of stimuli, and behaviors in terms of their embodied origins. For instance, a linguistic utterance such as *we're close friends* may be said to originate in the embodied, intimate experience of being physically close to another person [21] [22]. Perceiving an elongated vase as *impressive* is embodied in so far connotations of *heights* are grounded in everyday bodily interactions (e.g., climbing stairs and finding that this takes bodily strength). And intuitions that heavy, as opposed to lightweight, objects are more *important* or *serious* [17] are embodied in so far important objects usually are of great size or weight and thus require more bodily strength to handle. One may remember being critical or surprised upon finding electronic products such as mobile phones and USB sticks shrinking in size and weight constantly, wondering *Can we really trust these tiny, fragile devices with our personal memories and valuable documents*?

Although it is only with the rise of the embodied cognition framework within linguistics and the cognitive sciences that the topic has gained widespread attention [5] [16] [21] [11], the embodied bases of experiences in architecture and the arts were clearly articulated in the writings of John Dewey [10] and Rudolf Arnheim [3] in particular. For instance, in *Art as experience*, Dewey wrote: *Different lines and different relations of lines have become subconsciously charged with all the values that result from what they have done in our experience in our every contact with the world about us. The expressiveness of lines and space relations in painting cannot be understood upon any other basis* (p. 101). Similarly stressing the grounding of the symbolic in concrete bodily

experience, Arnheim argued that: *The symbolic endowment of architectural shape is compelling only because the humble daily experience of climbing stairs reverberates with the connotations of overcoming the weight of gravity and rising victoriously toward the heights* (p. 210). Such accounts thus seek to explain the meanings that people perceive in their environments and objects therein in terms of everyday bodily interactions and the experiential qualities that they bring.

Moving into the field of product design, embodiment generally brings to the fore still other types of conceptualizations and associations. At the most general level, for instance, products are material objects we physically interact with, and these interactions are constrained by our sensory and bodily characteristics. When talking about embodiment in the context of product design, however, such a generalized statement does not tell designers how embodied experiences can be designed for. On a more mundane level, embodiment may be associated with the common practice of imitating facial expressions in product appearance (e.g., a joyful face in an Alessi product). What these examples show is that, akin to how embodiment in cognitive science and the arts is used in relation to different types of phenomena [36], the same may be said in the context of product design. Furthermore, the examples presented so far suggest a distinction between more concrete (e.g., a direct translation of facial features to product appearance) and abstract (e.g., selecting specific materials to shape a product's character) types of embodiment in design. Hence, this article seeks to build a typology for understanding embodiment in relation to design, drawing both on conceptualizations from the social sciences, cognitive linguistics, and from current understanding of embodiment in design and design research.

This e ndeavor, however, only makes sense when the insights presented serve a design purpose. Hence, a second goal of this article is to show why insights in embodiment may be inspiring and useful to designers, and why understanding of the embodied dynamics underlying product experience may guide designers in creating meaningful objects designed for experience. Obviously, bodily actions and behaviors have always been a source of inspiration while designing, ranging from attempts to mimic subtle bodily behaviors in robotics, to a chair's design inspired by the shape of a woman's body. However, the embodiment cognition framework as originally developed in cognitive linguistics, we will argue, opens up additional avenues for going beyond mere copying or mimicry of bodily features or behaviors. Amongst others, such *new* insights allow designers to account for relationships between design features of their products (e.g., visual, material or interaction properties) and meanings that users perceive in them (e.g., perceiving an object as *serious, easygoing* or *warm*).

## 2. Four Types of Embodiment in Product Design

Next, the four types of embodiment will be discussed that are deemed most relevant in relation to design research. These four types address embodied dynamics figuring in visual product perception, meaning attributions guided by material selection, and perception of meaning in product action and movement. Hence, the focus of current undertaking is primarily on product appearance and product movement (as opposed to meaning attributions issuing forth from behavioral or social consequences of human-product interactions).

#### 2.1 Literal Resemblances: Products Endowed with Human Features.

From Vitra's 'Louis 20' chair (Figure 1, left panel), to Henry's vacuum cleaner (Figure 1, right panel); products imitating the human body or aspects thereof are numerous and common practice among designers. Reversely,

consumers' inclination to easily detect human features or traits in products comes just as natural; a tendency generally referred to as personification or anthropomorphism [2] [13].



Figure 1. Louis 20 chair by Vitra (left) and Henry vacuum cleaner (right)

One may, for instance, remember the childhood joy of watching clouds and discovering (animal) bodies, faces or facial features in them as they roll on by. But we also recognize these features in products where they are (probably) not specifically designed; a type of 'accidental anthropomorphism' [13].

Apart from children engaged in perceptual discovery, language we use in discourse about products likewise testifies to this tendency. For instance, the fact that we readily talk about a chair's 'legs' indicates that we are apt to experience products as if endowed with human characteristics. Seen from this perspective, designers may be said to capitalize on this natural tendency by making explicit, enhancing, or creating such resemblances. Hence, a designer further spelling out a resemblance between two types of legs in a chair's appearance may be said to explicate a pre-existing connotation.

On a somewhat more abstract level, designers may also endow their products with global, gestalt-like bodily features such as postures. For instance, the Dulcinea lamp (Figure 2) adopts a retreating posture; his back is turned towards the user, the position of his head slightly lowered, but at the same time his spine is erect all the way from bottom to top.



Figure 2. Dulcinea by Mimmo Paladino

Such visual-spatial features may resonate with users because of implicit associations different postures carry in our daily (social) interactions [9]. For instance, the bodily features described may remind one of postures associated with interactions typified as *serene*, *humble*, and *non-intrusive*.

Stressing linkages between bodily postures and symbolic connotations, Carney, Cuddy, and Yap [7] demonstrated a relationship between expansiveness of bodily posture and experienced 'power'. Interestingly, they showed that an expansive (as opposed to a contracted) bodily posture did not only make people feel more powerful, it also affected behavioral choice by enhancing risk taking (in the experiment, participants adopting an expansive posture were more likely to risk losing their 2\$ reward for participation in the experiment by rolling a dice to earn 4\$). Again, such findings are embodied in so far we intuitively and automatically take in specific bodily postures that a situation calls for [9]. For instance, when willing to face or confront challenges posed (e.g., by people or forceful events such as a fierce wind blowing), taking in an open, expansive posture comes natural, whereas evasive behaviors and submission to forceful events rather induce contracted postures. Through such couplings between bodily postures and affective states in everyday interactions, we come to experience such affective qualities in ourselves when taking in a specific posture or recognize those very same qualities in other people and products.

Having discussed and looked at the examples presented, a natural question to address next is the question *what for*? Why do designers imitate or use bodily parts, features or postures on the one hand, and why do consumers appreciate such endeavors on the other? First of all, perceiving familiar facial features in design may be amusing, and thus may be linked to positive affect. Whether it is a short-lived smile on one's face or a source of enduring fun (in part based on the previously discussed tendency to derive pleasure from discovering human characteristics in non-living things), many objects in this category seem to be designed with this purpose in mind. In addition, seeing the familiar may be reassuring or comforting [13] as also shown by classic studies in the social sciences [25] [37] [38]. Hence, the tendency to depict concrete or familiar objects in stressful settings such as hospitals [30]. Apart from bringing joy, amusement or comfort (and related emotional experiences involving elements of happiness or contentment), seeing the familiar in an unexpected context (i.e., a human face in inorganic matter) may also trigger surprise and interest; emotions resulting from unexpectedness or ambiguity [23] [28], especially so when the resemblance is not immediately apparent. In addition to inducing emotional or affective experiences, the examples presented also indicate that meaning attributions (i.e., cognitive rather than affective dimensions of product experience) may be involved. In many cases, such meanings will reflect human characteristics or personality attributions (i.e., describing aforementioned Dulcinea lamp as *serene* or *modest*).

#### 2.2 Relational properties in visual appearance: Image schemas and Symbolic Meaning

At a more abstract or fundamental level, we not only perceive concrete things with recognizable features (e.g., products with a human-like face), we also (or foremost) perceive relationships between people and objects in our world; people may be *close* or *far away* from each other, bus shelters may or may not *provide shelter* to people waiting inside, and a building may *tower above* houses on the other side of the street. In other words, we perceive our world in terms of visual-spatial relationships such as *distance* (e.g., between objects), *containment* (e.g., provided by an object to another) and *verticality* (e.g., relative height of one objects versus another). Such visual-

spatial patterns are referred to as image schemas and are at the basis of the embodiment perspective as originally developed in cognitive linguistics [16] [22].

Of interest in this context are couplings between such image schemas and expressive qualities connoted by design. The verticality schema, for instance, is generally used in language to talk about power-related qualities such as *dominance*, *pride* and *success*, as apparent from phrases such as *we made it to the top* and *looking up to someone*. Not only is this relationship language-independent [22], it has also been shown to apply to non-linguistic stimuli such as products [32] [33]. For instance, in one of their studies, Van Rompay et al. [33] showed that products are more readily perceived as *impressive*, *proud* and *dominant* the higher they tower above their surroundings. Following a similar line of reasoning, Schubert [27] showed that power perceptions also relate to location of elements in the vertical plane, showing that (otherwise identical) animals are perceived as more powerful when presented in the upper part (as opposed to the lower part) of a computer screen. In the context of product design, perceptions of *prestige*, *luxury* or *power* may likewise be conveyed by a top-heavy element positioned up high, perceptually conveying the impression of *overcoming* or *transcending* (Figure 3).



Figure 3. Melitta Espresso Machine

In a similar fashion, containment in everyday life (e.g., being inside a closed space such as one's office, house or car) is generally correlated with experiencing *security* and *room for personal expression*. At the same time, however, containers limit our freedom of movement and block our view over what is on the outside of the container. Hence, containment is also associated with expressive qualities such as *constraint* and *suffocation*. In line with this argument, Van Rompay et al. [33] showed that an everyday container (i.e., jug) providing higher degrees of enclosure to its contents (i.e., a closed jug), is more readily perceived as *secure* and *constraining* compared to a container providing lower degrees of containment (i.e., an open jug). Figure 4 presents another example of how containment (or the lack thereof) may be used in design to suggest a sense of *restricted intimacy* (left panel) or rather a sense of *unprotected freedom* (right panel).



Figure 4. JBL iPod docks

Apart from these examples, think also of everyday social interactions between people. Generally, we will find that verbal communication comes more naturally at a close distance (e.g., at a large distance, it takes a higher volume of speech to make oneself heard), and may also strike a more intimate note. Because of such associations tied to everyday (social) interactions, we may intuitively associate close distances with *intimacy* and vice versa. Williams and Bargh [35] showed that even (seemingly) trivial distance cues may influence evaluations of intimacy-related constructs. For instance, in one of their studies, participants were primed with either spatial closeness or spatial distance by plotting an assigned set of points on a Cartesian coordinate plane. When primed with distance, participants reported weaker levels of emotional attachment to family members and hometowns. Although not studied in the context of design, depending on distances between product features or elements within a product gestalt, perceptions of product *warmth, coziness* or *involvement* are likely to vary (Figure 5). Whereas the Philips/Alessi coffee-tea machine may be said to express *warmth* or *coziness* because of the close proximity between the two containers (left panel), the sound dock rather conveys a sense of *cool distance* by having the two (visually) salient product features positioned far apart (right panel).



Figure 5. Philips-Alessi Coffee/Tea Machine (left) and Tango iPhone Dock (right)

Taken together, these findings and intuitions suggest that part of a product's expression resides in the perception of relational properties constituted by a design's product features. Hence, in terms of design goals, insights on this level foremost facilitate the articulation of a product's expression or character.

#### 2.3 Meaningful sensorial experiences

Apart from the visual domain, designers can also draw on multisensory product experiences in order to bring about an envisioned product expression. For instance, designers have at their disposal a large repertoire of materials that not only influence a product's visual appearance but also its tactile feel. In recent years, sustained attention for couplings between tactile impressions and product evaluations has spurred a considerable body of research also relevant to the design context [1] [4] [17].

For instance, Jostmann et al. [17] proposed that people tend to equate heaviness with importance (a coupling also apparent in language use; e.g., *a weighty issue* or *an issue not to be taken lightheartedly*). To this end, they had participants provide judgments of importance while they either held a heavy or a light clipboard. Holding a heavy clipboard increased, among other things, judgments of monetary value. Such findings nicely concur with the previously discussed skepticism people may feel when holding lightweight (technologically advanced) gadgets or devices (e.g., a mobile phone). Specifically, such skepticism may relate to associations (e.g., *cheapness, flimsiness* or *vulnerability*) triggered by a (literal) lack of substance. Such relationships are embodied because they are grounded in correlations between object weight and value judgments in our physical interactions with the environment and objects therein (with objects of greater weight generally being more important and valuable).

In a similar vein, Bargh and Shalev [4] showed that sensations of physical warmth affect evaluations of social warmth (an association likewise apparent in language use; e.g., *a cold person*). Again, such associations make sense when we consider that person perceptions may indeed follow from sensations triggered by, for instance, the environments in which people reside [12], such that when waiting for a relative stranger, a cold living room may lead us to expect a not so warmhearted, but rather coldblooded, person. Interestingly, Zhong and Leonardelli [39] showed that people who were instructed to think of an episode in which they felt socially excluded gave lower estimates of room temperature compared to participants who recalled an inclusion episode in which they were socially involved with others. The embodied basis of such findings can be traced to (early-life) social interactions (e.g., a mother holding her newborn close to her own body) in which physical warmth is equated with intimacy and belongingness.

A final example related to material selection follows from research from Ackerman et al. [1]. Interested in relationships between tactile sensations and ease of social interactions, they showed that (texture-wise) rough objects (a hard wooden chair versus a soft cushioned chair) rendered social interactions more difficult, amongst others transpiring in a lowered willingness to seek compromise in a negotiation task. Again, such couplings are rooted in object interactions in which we find that objects (e.g., balls) move less speedily or smoothly on rough surfaces. Similarity, in interacting with objects of different material substance, we find that some materials yield to bodily force or pressure (e.g., textiles, wood), whereas others do not (glass, iron, etc.). Because of this embodied grounding, we intuitively understand the meaning of common (or in some cases novel) linguistic phrases such as *an iron heart* or *a soft personality*.

Needless to say, decisions on product weight, material conductivity, and texture selection are common aspects of design processes. Hence, knowledge on how such design decisions not only influence usability and ergonomics, but also the constitution of a product's expression or character are important when designing for experience [18]. For instance, selecting a material with low heat conductivity, feeling relatively warm at average room temperature, could inspire sensations of social, psychological warmth amongst users. Acknowledging the embodied basis of

material experience, Karana [18] likewise explored relationships between particular material features and meaning attributions (e.g., *shiny hard* materials connoting *professionalism*), at the same time acknowledging cultural, personal and product category-specific determinants of material experience.

Apart from vision and touch, product sound may also be considered an important vehicle for establishing a product's character [20] [24] [29]. For instance, focusing on luxury perceptions, Lageat, Czellar, and Laurent [20] had people rate different flip-top lighter sounds. Results revealed (at least for a large segment of consumers) a relationship between luxury perceptions and sounds characterized as 'matte', 'even', and 'low-pitch'. When considering the embodied basis of such results, it is worthwhile to reconsider aforementioned relationship between weight and value. That is, in our daily interactions, we find that objects varying in weight carry distinct acoustic properties. For instance, dropping a heavy-weight object on the ground makes for a more full-bodied, low-pitch sound compared to a lightweight object. Hence, from an embodied line of reasoning, this might explain why consumers associate luxury with a full-bodied, low-pitch product sound. As illustrated by the examples presented in this section, material and sound selection may play an important role in shaping a product's expression.

#### 2.4 Embodiment in product movement and action

The final type of embodiment is arguably the most familiar among design researchers interested in interaction design, as it touches on notions central to design disciplines focusing on new media interaction, tangible design and interaction design in general [8]. The basic premise of such endeavors holds that many existing (technologically advanced) products do not exploit people's rich repertoire of physical skills, but rather tax people's limited information processing capacities (e.g., memorization of multiple functions and 'if-then' rules tucked away under one and the same function key). In response to such mismatches, product designs that do rely on users' physical skills have been proposed, and also within consumer electronics, anonymous, black boxes slowly pave the way for more intuitive, user-friendly designs.

Additionally, new media and interactive games such as PlayStation Move and Wii provide increasing opportunities to stimulate movement and full-body action. Such developments, however, require more insights into how such actions, movements or postures carry meaning. Thus although drawing on bodily skills and repertoires is one thing, knowing how specific bodily actions can be exploited to design for particular experiences is quite another.

Starting at the most basic level, research indicates that even the most mundane movements carry their own meanings. For instance, research by Cacioppo, Priester, and Berntson [6] showed that arm movements *towards*, as opposed to *away from*, the body (effectuated by having participants push or pull a joystick upon presentation of stimuli) enhanced liking for arbitrary stimuli (i.e., Chinese characters, meaningless stimuli to Western respondents). Such findings are embodied in so far from early childhood on, liking of people and stimuli (e.g., a baby's mother, play toys or candy) is equated with bodily approach whereas dislike of stimuli (e.g., scary dogs, frightening people and noisy dust blowers) transpires in bodily avoidance. Interestingly, a recent study in the retailing context [31] showed that arm flexion (i.e., shoppers carrying a basket such that bodily action is directed toward the body) versus arm extension (i.e., shoppers pushing a cart such that bodily action is directed away from the body) increased the likelihood of purchasing 'vice' products associated with hedonic gratification (e.g., chocolate bars or candy). In line with the foregoing, the authors explain their findings by arguing that arm flexion

has been repeatedly associated with acquiring desired objects, while arm extension has been repeatedly associated with rejecting undesired objects [31] [34].

In addition to direction of movement, various authors have explored connotations of movement characteristics such as speed and force. For instance, Sawada, Suda, and Ishii [26] studied relationships between arm-movement characteristics and emotional expression, based on Laban's classification of movement in terms of time, weight, space, and flow [19]. They showed that dancers' expressions of anger, for instance, are reflected in arm movements fast in velocity and strong in force, as opposed to slower and weaker arm movements indicative of sadness and joy.

Clearly, these findings may guide designers in creating an envisioned expression through movement characteristics. For instance, Bruynzeel's kitchen drawers (Figure 6) adopt a steady, smooth but at the same time decisive movement repertoire (accentuated by a slowing down of the drawer near the end of the closing process, followed by a 'click' upon full closure), suggestive of *calm, confidence,* and *purposeful activity*.



Figure 6. Bruynzeel Kitchen Drawer with Blue Motion System

Likewise conveying affective qualities through movement characteristics (forcefulness of movement), the copier presented in Figure 7 was conceived based on the metaphor *Interacting with a machine is a dance* [14]. One aspect of a dance is that the participants feel and respond to each other's moves, an aspect labeled 'resonance'. The designers mapped this aspect onto the copier by reconsidering the (traditional) ways in which copiers react to user behavior. Agitated movements, for instance, cause this copier to offer more resistance in handling its different parts, whereas smooth movements evoke less resistance. Doing so ensures a linkage between the emotional state of the user and expressiveness of the product, either experienced as a *forceful, decisive* agent or a *smooth, sensitive* partner.



Figure 7. Copier (from Hekkert et al., 2003)

Apart from users perceiving such qualities in product movement, users are also stimulated to adjust their own motor movements accordingly (e.g., figuring out how much force and speed to apply in order to achieve a smooth pattern of interaction). A similar argument can be made for aforementioned interactive gaming appliances (e.g., Wii). For instance, a basic game setup may consist of users replicating movements of shapes moving in different directions and speeds on screen. In addition to perceiving meanings in the shapes' movements (e.g., *indecisive* or *confident*), through imitating such movements using arm gestures, for instance, users may also experience these very same qualities as they 'play' along (e.g., users learning that specific postures or arm movements indeed inspire feelings of confidence). What foregoing shows is that design goals may vary from creating a desired expression through product movement to transforming affective user experiences by directly influencing bodily actions or gestures.

#### 3. Conclusions

In this article, various type of embodiment in design were discussed by integrating findings from cognitive linguistics, social psychology and design research. Whereas some of these notions already are common practice in design (e.g., imitation of bodily features), others clearly require more reflection and exploration in the design context. For instance, with respect to the image schemas discussed, design research could further explore how spatial constructs such as verticality and distance can be used in different dimensions of product appearance (i.e., not only in overall shape but also in interface design and layout, amongst others). In that sense, the insights presented are foremost important in so far they create awareness of (and sensitivity for) the bodily basis of product experience. How designers subsequently move from visual-spatial constructs to product appearance and action is, obviously, a creative challenge by no means limited (but rather fuelled) by this awareness.

One specific topic worthy of further exploration is how to facilitate the study of bodily interactions underlying specific affective experiences. For instance, in exploratory workshops, design students were instructed to reenact interactions in which they felt *involved* with another person, analyze these interactions afterwards in terms of the image schemas discussed (e.g., *distance*: moving *closer* or *backing away* from person; *containment*: *providing shelter* or *openness*), and, finally, use these visual-spatial parameters in sketches for a product expressing *involvement* towards users (i.e., involvement in product appearance), or creating involvement amongst users (i.e., involvement in user interactions). Such design exercises not only create awareness for the bodily bases of product expressing on, and analyzing, situations encountered, they also facilitate the transition from idea to form via the image schemas discussed. That is, because image schemas are of a visual-spatial nature, characterizing experiential qualities in terms of them is like creating a bridge between the abstract (e.g., an idea as to what a product should express) and the concrete (e.g., product shape and materials).

Finally, with new media such as tablets providing increased opportunities for bodily actions (e.g., *dragging*, *pinching*, or *swiping* objects on an iPad), future research could explore to what extent parameters such as force, direction, and expansiveness of such (finger/hand) movements can trigger subtle affective qualities that may enhance specific *states of mind* (i.e., open-mindedness, creativity or self-confidence) deemed desirable in the context of, for instance, e-learning. As such, the insights presented not only allow one to explain (seemingly)

obvious relationships between visual-spatial features and meaning portrayal encountered in language, the arts, and design, they may also open up avenues for creating (and reflecting on) new types of human-product interaction.

### 4. References

- Ackerman, J. M., Nocera, C. C., and Bargh, J. A. (2010). Incidental haptic sensations influence social judgments and decisions. Science, 328(5986), 1712-1715.
- [2] Aggarwal, P., and McGill, A. L. (2007). Is that car smiling at me? Schema congruity as a basis for evaluating anthropomorphized products. Journal of Consumer Research, 34, 468-479.
- [3] Arnheim, R. (1977). The dynamics of architectural form. Berkeley and Los Angeles: University of California Press.
- [4] Bargh J. A., and Shalev, I. (2012). The substitutability of physical and social warmth in daily life. Emotion, 12(1), 154-162.
- [5] Barsalou, L. W. (1999). Perceptual symbol systems. Behavioral and Brain Sciences, 22(4), 577-609.
- [6] Cacioppo, J. T., Priester, J. R., and Berntson, G. G. (1993). Rudimentary determinants of attitudes II: Arm flexion and extension have differential effects on attitudes. Journal of Personality and Social Psychology, 65, 5-17.
- [7] Carney, D., Cuddy, A. J. C., and Yap, A. (2010). Power posing: Brief nonverbal displays affect neuroendocrine levels and risk tolerance. Psychological Science, 1363-1368.
- [8] Dourish, P. (2001). Where the action is: The foundations of embodied interaction. Cambridge, MA: MIT Press.
- [9] Dael, N., Mortillaro, M., and Scherer, K. (2012) Emotion expression in body action and posture. Emotion, 12(5), 1085-1101.
- [10] Dewey, J. (1934). Art as experience. New York: Berkley Publishing Group.
- [11] Gibbs, R.W. (1994). The poetics of mind: Figurative thought, language, and understanding. New York: Cambridge University Press.
- [12] Gosling, S. D., Ko, S. J., Mannarelli, T., and Morris, M. E. (2002). A Room with a cue: Judgments of personality based on offices and bedrooms. Journal of Personality and Social Psychology, 82, 379-398.
- [13] Guthrie, S. (1993). Faces in the Clouds: A New Theory of Religion. New York: Oxford University Press.
- [14] Hekkert, P., Mostert, M., and Stompff, G. (2003). Dancing with a machine: A case of experience-driven design. Proceedings of the 2003 International Conference on Designing Pleasurable Products and Interfaces, Pittsburgh (pp. 114-119).
- [15] Janlert, L. E., and Stolterman, E. (1997). The character of things. Design Studies, 18, 297-314.
- [16] Johnson, M. (1987). The body in the mind. Chicago: Chicago University Press.
- [17] Jostmann, N. B., Lakens, D., and Schubert, T. W. (2009). Weight as an embodiment of importance. Psychological Science, 9, 1169-1174.
- [18] Karana, E. (2009). Meanings of materials. Dissertation (PhD), Delft University of Technology, The Netherlands.
- [19] Laban, M. (1988). The mastery of movement. Plymouth, MA: Northcote House.

- [20] Lageat, T., Czellar, S., and Laurent, G. (2003). Engineering hedonic attributes to generate perceptions of luxury: Consumer perception of an everyday sound. Marketing Letters, 14(2), 97-109.
- [21] Lakoff, G., and Johnson, M. (1980). Metaphors we live by. Chicago: Chicago University Press.
- [22] Lakoff, G., and Johnson, M. (1999). Philosophy in the flesh. New York: Basic Books.
- [23] Ludden, G. D. S., Schifferstein, H. N. J., and Hekkert, P. (2008). Surprise as a design strategy. Design Issues, 24(2), 28-38.
- [24] Özcan, E., and Van Egmond, R. (2010). Basic semantics of product sound. International Journal of Design, 6(2), 41-54.
- [25] Reber, R., Schwarz, N., and Winkielman, P. (2004). Processing fluency and aesthetic pleasure: Is beauty in the perceiver's processing experience? Personality and Social Psychology Review, 8(4), 364-382.
- [26] Sawada, M., Suda, K., and Ishii, M. (2003). Expression of emotions in dance: Relation between arm movement characteristics and emotion. Perceptual and Motor Skills, 97, 697-708.
- [27] Schubert, T. W. (2005). Your Highness: Vertical positions as perceptual symbols of power. Journal of Personality and Social Psychology, 89, 1–21.
- [28] Silvia, P. (2006). What is interesting? Exploring the appraisal structure of interest. Emotion, 5(1), 89-102.
- [29] Spence, C., and Zampini, M. (2006). Auditory contributions to multisensory product perception. Acta Acustica united with Acustica, 92(6), 1009-1025.
- [30] Ulrich, R. S. (1991). Effects of health facility interior design on wellness: Theory and recent scientific research. Journal of Health Care Design, 3, 97-109.
- [31] Van den Bergh, B., Schmitt, J., and Warlop, L. (2011). Embodied myopia. Journal of Marketing Research, 48(6), 1033-1044.
- [32] Van Rompay, T. J. L., Hekkert, P., & Muller, W. (2005). The bodily basis of product experience. Design Studies, 26(4), 359-377.
- [33] Van Rompay, T. J. L., Hekkert, P., Saakes, D., and Russo, B. (2005) Grounding abstract object characteristics in embodied interactions. Acta Psychologica, 119(3), 315-351.
- [34] Wiers, R. W., Rinck, M., Kordts, R., Houben, K., and Strack, F. (2010). Retraining automatic actiontendencies to approach alcohol in hazardous drinkers. Addiction, 105(2), 279-287.
- [35] Williams, L. E., and Bargh, J. A. (2008). Keeping one's distance: The influence of spatial distance cues on affect and evaluation. Psychological Science, 19(3), 302-308.
- [36] Wilson, M. (2002). Six views of embodied cognition. Psychonomic Bulletin and Review, 9, 625-636.
- [37] Zajonc, R. B. (1968). The Attitudinal Effects of Mere Exposure. Journal of Personality and Social Psychology, 9,1-27.
- [38] Zajonc, R. B. (2011). Mere exposure: A gateway to the subliminal? Current Directions in Psychological Science, 10(6), 224-228.
- [39] Zhong C. B., and Leonardelli, G. J. (2008). Cold and lonely: Does social exclusion literally feel cold? Psychological Science, 19(9), 838-842.