Types of Embodiment in Design: *The Embodied Foundations of Meaning and Affect in Product Design*

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Since the introduction of the embodied cognition framework in cognitive and social psychology, numerous studies have demonstrated links between everyday bodily experiences and product evaluations involving meaning portrayal and affect. To date, however, no comprehensive framework for understanding embodiment in relation to design experience has been developed. Hence, one goal of this article is to set out a typology for understanding embodiment in relation to multi-sensory product appearance and action. A second goal is showing why insights from 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. To substantiate these assumptions, we present the different types of embodiment most relevant in relation to design research accompanied by examples. We expand on the design goals that might underlie these different types, suggesting new avenues for design and design research based on our research propositions and findings.

Keywords **–** Embodiment, Product Experience, Product Appearance, Image Schemas, Product Expression.

Relevance to Design Practice **–** Designers communicate affective meanings through their designs. Many of these are grounded in bodily experience. Insights into the different types of embodiment involved facilitate 'design for experience' and open up new avenues for giving shape to human-product interaction.

Citation: Van Rompay, T. J. L., & Ludden, G. D. S. (2015). Types of embodiment in design: The embodied foundations of meaning and affect in product design. *International Journal of Design, 9*(1), 1-11.

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 (Bargh & Shalev, 2012; Lakoff & Johnson, 1980). Perceiving an elongated vase as impressive is embodied in as much as connotations of height are grounded in everyday bodily interactions, for example, climbing stairs and finding that this takes bodily strength (Van Rompay, Hekkert, Saakes, & Russo, 2005b). Such a perception is embodied in as much as it is grounded in intuitions that heavy objects are more important or serious than lightweight ones given that 'traditionally' important objects have had great size or weight and require more bodily strength to handle (Jostmann, Lakens, & Schubert, 2009). One may remember being critical or surprised to find electronic products such as mobile phones and USB sticks continually shrinking in size and weight, wondering 'Can we really trust these tiny, fragile devices with our personal memories and valuable documents?'

The rise of the embodied cognition framework within linguistics and the cognitive sciences has afforded this topic widespread attention (Barsalou, 1999; Gibbs, 1994; Johnson, 1987; Lakoff & Johnson, 1980), but the writings of John Dewey (1934) and Rudolf Arnheim (1977) clearly articulated the embodied bases of experiences in architecture and the arts. For instance, in *Art as experience*, Dewey (1934) 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 (1977) 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 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.

The foregoing indicates that embodiment has been used in relation to a wide diversity of phenomena, giving rise to more or less controversial claims (Wilson, 2002). For example, at the most

Received October 1, 2013; **Accepted** November 8, 2014; **Published** April 30, 2015.

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general level, various authors have used the term embodiment to emphasize that knowledge emerges from being in a world that is inseparable from our bodies and body-world interactions (Varela, Thompson, & Rosch, 1991). Most accounts of embodied cognition converge on the assumption that for an abstract concept (i.e., a symbolic meaning) to be embodied entails that the physical or bodily experience is part of the representation of that concept (e.g., Zhang & Li, 2012). At a more domain specific level, embodiment has been used to emphasize that specific meaning attributions, for example, perceiving an elongated pitcher as *proud*, can be traced to specific types of embodied interactions (i.e., interactions with objects or people in which relative height is a key feature; Van Rompay, de Vries, Bontekoe, & Tanja-Dijkstra, 2012). Next to these types, additional embodiment variants have been conceptualized (e.g., *organismoid embodiment* in Artificial Intelligence research; Sharkey & Ziemke, 2001).

Moving into the field of product design, embodiment triggers conceptualizations that are both generic and domain-specific. At the most generic level, for instance, products are material objects that 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 to design for embodied experiences. On a more domain-specific level, embodiment may be associated with the common practice of imitating facial expressions in product appearance, for example, a joyful face in an Alessi product. This shows that embodiment may be used in relation to different types of phenomena (cf. Wilson, 2002). 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 light or heavyweight materials to shape a product's 'character'; Janlert & Stolterman, 1997) types of embodiment in design. In response, this article offers a typology for understanding embodiment in relation to design experience, drawing on conceptualizations from the social sciences, cognitive linguistics and current understanding of embodiment in design and design research.

This endeavor, however, only makes sense when the insights presented serve a design purpose. A second goal of the 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 when 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 (Figure 1). We argue that the embodied cognition framework as originally developed in cognitive linguistics opens up avenues for going beyond mere copying or mimicry of bodily features or behaviors. For example, such new insights allow designers to account for relationships between the 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). In accounting for design-meaning relationships, we also discuss what embodied dynamics such meaning perceptions entail. Arguably, perceiving embodied meanings in design is not a static process in which users pick up meanings; it might rather involve bodily processes such as mimicry, embodied simulations, and perspective taking (Barsalou, 2008) although the extent to which these are involved in abstract meaning perception is open to debate (Zhang & Li, 2012).

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Four Types of Embodiment in Product Design

In relation to design experience, there are four types of embodiment that can be deemed most relevant. These four types address embodiment in visual product perception [embodiment types 1 and 2], meaning attributions guided by non-visual product features such as material and sound [embodiment type 3] and perception of meaning in product action and movement [embodiment type 4]. The focus of the current undertaking is primarily on product appearance and product movement in relation to different facets of *product experience*. Our undertaking diverges from research on bodily dynamics in interaction design, where the focus is generally on human-product interaction and implications for 'product creation' rather than 'product experience' although these two foci are ultimately part of the same process. For a discussion of bodily dynamics in interaction design see Dourish (2001) and Klemmer, Hartmann, and Takayama (2006) who describe five themes for interaction design related to how we understand the world through our bodies and the actions they enable.

We selected the four types of embodiment discussed in the current undertaking for the following reasons: 1) their relatedness to sensory information and hence their relevance and potential with respect to the fact that people perceive the world around them and products therein through all their senses, 2) their explanatory power and potential to provide insights in difficult to understand facets of product experience, and 3) their relevance and pervasiveness in product experience as indicated by feedback from designers, design students and laypeople over the years. For instance, with respect to the latter criterion, anthropomorphism (type 1) was, among others, included because regardless of one's research intention or focus, participant feedback on design stimuli without exception reveals people's tendency to anthropomorphize (e.g., The contours of this vase resemble a female figure, or The configuration of this interface mimics a facial expression). Type 2,

centering on image schemas and symbolic meaning portrayal, both connects to the writings of design philosophers and provides a means to get a grip on the relationship between appearance and meaning, a relationship traditionally difficult to account for. Type 3 addresses a product's multi-sensory character and clearly connects to research on how people experience products through all of their senses. Findings from this type of research, fuelled by technological developments, are currently inspiring developments in smart product design. Finally, type 4 addresses meaning portrayal in action and movement, which is essential for understanding meanings issuing forth from a product's dynamic appearance.

In proposing directions for future research, we differentiate between the product level (how the insights can be applied in the design process) and the user level in which the social behavioral consequences of product use take center stage.

Type 1—Athropomorphism, Familiiarity and Literal Resemblances

From Vitra's 'Louis 20' chair (Figure 1, left panel) to Alessi's colorful designs, products imitating the human body or aspects thereof are numerous and common practice. Conversely, consumers' inclination to easily detect human features or traits in products comes just as natural, this being a tendency generally referred to as personification or anthropomorphism (Aggarwal & McGill, 2007; Guthrie, 1993).

One may, for instance, remember the childhood joy of watching clouds and discovering animal bodies, faces or facial features in them as they roll by. We also recognize these features in products where they are probably not specifically designed into their form, for example, discovering the face of an octopus in a coat hanger (see Figure 1, right panel), a type of 'accidental anthropomorphism' (Guthrie, 1993).

Apart from children engaged in perceptual discovery, the 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. 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. In a study on people's responses to a wide variety of products, Chang and Wu (2007) showed that people readily show interest and fascination for resemblances between products and human beings or animals. They further distinguish between three types of anthropomorphism in design: a concrete variant (i.e., a literal resemblance between a product and a human being or animal), a more abstract type described below and a variant involving similarities between products and living creatures in terms of movement or gestures (e.g., a copier displaying actions or movements resembling those of a hesitant or decisive human being; elaborated on in 'embodiment type 4').

To understand anthropomorphism on a more abstract level, think of designers who 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 while his 'spine' is erect all the way from bottom to top. Such visual-spatial features may resonate with users because of the implicit associations different postures carry in our daily social interactions (Dael, Mortillaro, & Scherer, 2012). For instance, the bodily features described may remind one of postures associated with interactions typified as serene, humble and non-intrusive.

Stressing the links between bodily postures and symbolic connotations, Carney, Cuddy, and Yap (2010) demonstrate a relationship between the expansiveness of bodily posture and experienced 'power'. Interestingly, they showed that an expansive, as opposed to a contracted, bodily posture made people feel more powerful and 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. Such findings are embodied in so far as we intuitively and automatically take on specific bodily postures that a situation calls for (Dael et al., 2012). For instance, when willing to face or confront challenges posed by people or forceful events such as a fierce wind blowing, taking an open, expansive posture comes naturally. Evasive behaviors and submission to forceful events

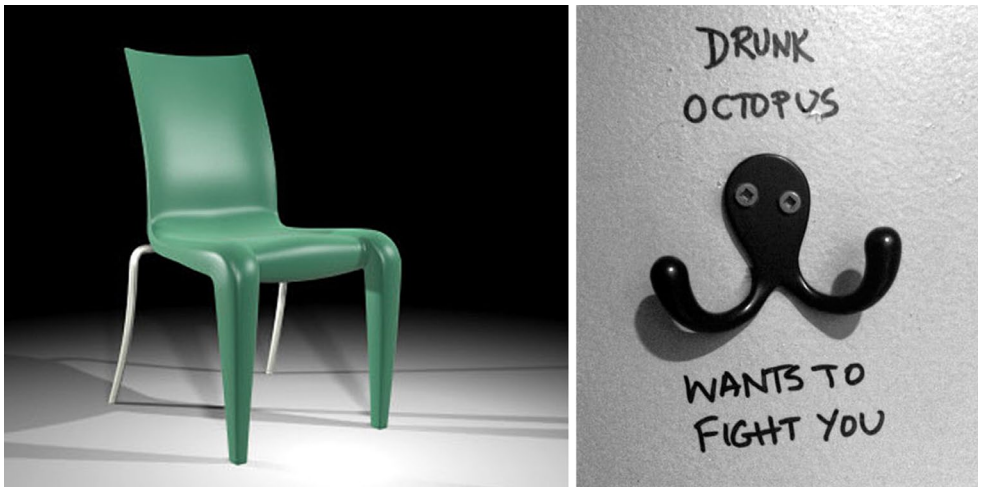

Figure 1. Louis 20 chair by Vitra (left) **and Octopus coat hanger** (right)**.**

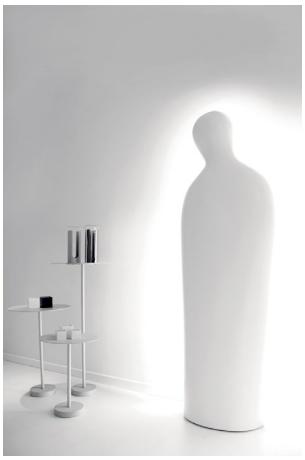

Figure 2. Dulcinea lamp by Mimmo Paladino.

induce contracted postures. Through such couplings of bodily postures and affective states in everyday interactions, we come to experience such affective qualities in ourselves when taking in a specific posture and recognize those very same qualities in other people and products.

Embodied simulations involving mimicry facilitate part of this recognition process (an automatic process involving imitation of the perceived expression, e.g., Niedenthal, 2007). Mimicry allows for feelings of empathy as it activates the same muscles and neural pathways involved in our own affective experiences. Arguably, this might also apply to products exemplifying facial expressions or bodily postures such as the Dulcinea lamp, which we perceive as expressive of mental states or emotional qualities. Hence, anthropomorphism in design might not only involve embodiment in so far as product designs may resemble bodily features. It may also be conceived as embodied in so far as the perceptual process itself is grounded in bodily enactments or, on a more subtle level, motor activity.

Having discussed the examples presented, the next natural question to address is the question 'what for'? Why do designers imitate or use bodily parts, features or postures in their work and why do consumers appreciate such endeavors? Perceiving familiar facial features in design may be amusing and thus 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. Seeing the familiar may be reassuring or comforting (DiSalvo & Gemperle, 2003; Guthrie, 1993) as shown by classic studies in the social sciences (Reber, Schwarz, & Winkielman, 2004; Zajonc, 1968, 2011) and healthcare research (Ulrich, 1991).

Apart from bringing joy, amusement or comfort and related emotional experiences involving elements of happiness or contentment, seeing the familiar in an unexpected context, for example, a human face in inorganic matter, may also trigger surprise and interest, emotions resulting from unexpectedness or ambiguity (Ludden, Schifferstein, & Hekkert, 2008; Silvia, 2006), especially when the resemblance is not immediately apparent. In addition to inducing emotional or affective experiences, the examples presented also indicate that meaning attributions, that is, cognitive rather than affective dimensions of product experience, may be involved. In many cases, such meanings will reflect human characteristics or personality attributions, for example, describing aforementioned Dulcinea lamp as serene or modest. Finally, anthropomorphized products may facilitate product-user interactions (e.g., a domestic robot seducing users to interact with it through its humanlike appearance) as their humanized features suggest that interactions are likewise 'humane', familiar and cooperative (DiSalvo & Gemperle, 2003; Fink, 2012). Based on this, the following research topics emerge as directions particularly worthy of exploration in the context of product design:

Research propositions:

- Product level: Is there an optimal level of anthropomorphism in design, one that strikes the right balance between abstractness and hence interestingness, and familiarity and hence recognizability?
- User experience level: Can design with recognizable, anthropomorphic features soothe and/or relieve people in stressful situations and settings such as the waiting rooms of healthcare services, during social gatherings and at business meetings?

Type 2—Relational properties: *Image schemas and Symbolic Meaning*

At a more abstract or fundamental level, we not only perceive concrete things with recognizable features, for example, products with a human-like face. We also 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 object 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 (Johnson, 1987; Lakoff & Johnson, 1980; Lakoff & Johnson, 1999).

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 is apparent from phrases such as *we made it to the top* and *looking up to someone*. Not only is this relationship language-independent, it has also been shown to apply to non-linguistic stimuli such as products and visual displays (Van Rompay et al., 2005a, 2005b; Van Rompay, 2008). For instance, in one of their studies, Van Rompay et al. (2005b) show that products are more readily perceived as impressive, proud and dominant the higher they tower over their surroundings. Following a similar line of reasoning, Schubert (2005) shows that power perceptions also relate to location of elements in the vertical plane, demonstrating that otherwise identical animals are perceived as more powerful when presented in the upper part of a computer screen rather than the lower part. 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).

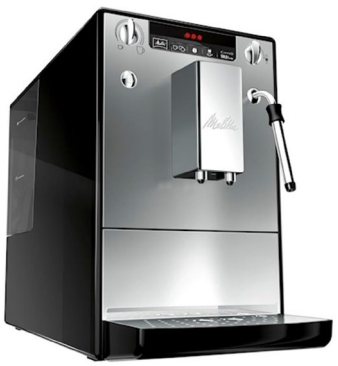

Figure 3. Melitta Espresso Machine.

Similarly, containment in everyday life, for example, 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, containers limit our freedom of movement and block our view to what is outside the container. Hence, containment is also associated with expressive qualities such as constraint and suffocation. In line with this argument, Van Rompay et al. (2005b) showed that a closed jug with a narrow opening is more readily perceived as secure and constraining compared to an open jug. Figure 4 presents another example of how containment, or the lack thereof, can be used in design to suggest a sense of restricted intimacy (left panel) or rather a sense of unprotected freedom (right panel).

Think also of everyday social interactions between people. Generally, verbal communication comes more naturally at close quarters (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 (2008) show 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). Where 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 Tango iPhone sound dock rather conveys a sense of cool distance by having the two visually salient product features positioned far apart (right panel). Such attributions of meaning may also impact product interactions. For instance, a distant or cool appearance may literally keep consumers at a distance and inhibit tactual interactions for which close proximity is required. As a resultant, product-consumer relationship formation, characterized by bonding, attachment and perceptions of the product as part of the self (i.e., extended self, Belk, 1988), might be affected as well.

It is also worth briefly exploring the embodied processes that image schemas might instigate. Rather than revolving around cognitive associations induced by image schemas, we recently set out to explore the hypothesis that image schemas induce perspective taking (Van Rompay, Veltkamp, & Pruyn, 2014). For instance, when confronted with a container-contained relationship, for example, a vase containing a marble, part of the process through which people come to experience the vase as *secure* or *restraining* arguably involves a process in which the perceiver takes the perspective of the contained object and comes to 'feel' whether the containment provided by the vase is tight,

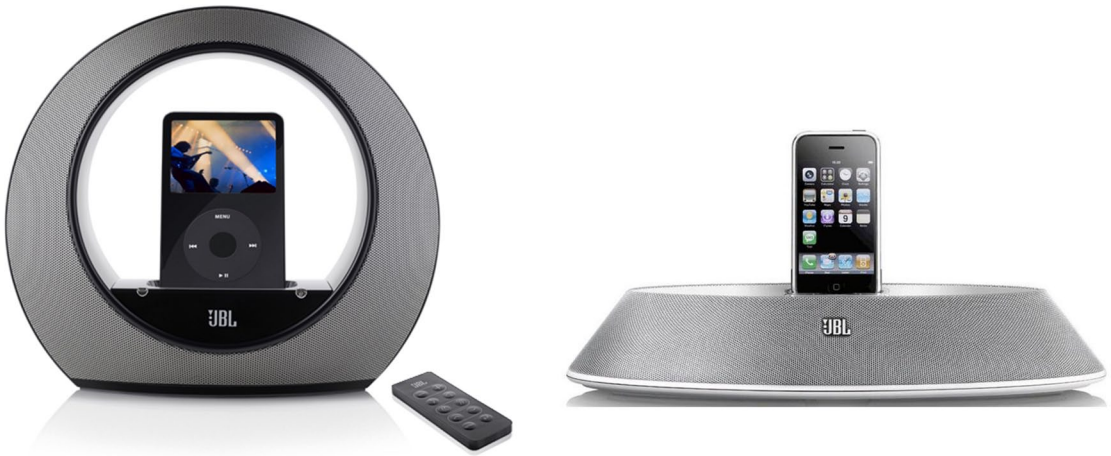

Figure 4. JBL iPod docks.

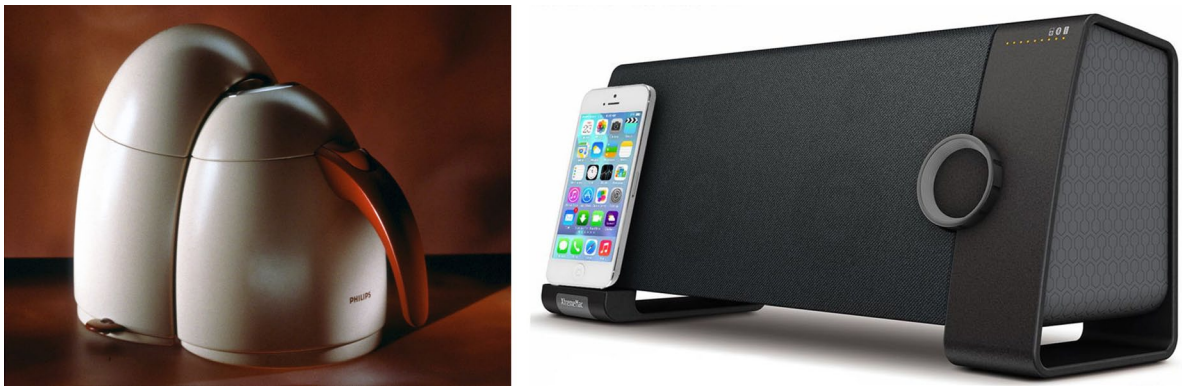

Figure 5. Philips-Alessi Coffee-Tea Machine (left) **and Tango iPhone Dock** (right)**.**

loose, restraining, etc. Such embodied simulations (Barsalou, 2008) might only arise under specific circumstances, for example, when contemplating aesthetics or symbolic meaning portrayal as opposed to everyday object perception, similar to how we might sometimes get a sense of an environmental setting by imagining what it must be like inside that space (see for instance Schön & Wiggins, 1992, discussing how architects project themselves inside their sketches to get a feel for the experiential qualities of their buildings).

In design research, the applicability of image schemas in interface design and human-computer interaction has been explored (Hurtienne, 2011; Hurtienne et al., 2010). Hurtienne (2010) show that participants holding a handheld device intuitively understand the connection between positive abstract concepts such as familiarity and liking, and gestures 'towards', as opposed to 'away from' the body. Due to their embodied nature, these relationships do not require cognitive processes to be learned. Even target groups with little or no experience with interactive products intuitively understand relationships between abstract concepts and image schema-based gestures.

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. In terms of design goals, insights on this level primarily facilitate the articulation of a product's expression or character. As for design research, the following themes are particularly worth exploring:

Research propositions:

- Product level: How can designers implement image schemas across salient product elements, such as the different containers in Figure 5? In other words, how do image schemas find expression in different product configurations?
- User experience level: Can image-schema based expressions influence how people approach and interact with products. For instance, do products expressing 'involvement' invite approach behaviors and stimulate close interactions where products expressing distance render people more hesitant in their behaviors towards products?

Type 3—Meaningful Sensorial Experiences

Apart from the visual domain, designers can also draw on multisensory product experiences to bring about an envisioned product expression. For instance, designers have at their disposal a large repertoire of materials that both influence a product's visual appearance and its tactile feel. In recent years, sustained attention to couplings between tactile impressions and product evaluations has spurred a considerable body of research also relevant to the design context (Ackerman, Nocera, & Bargh, 2010; Bargh & Shalev, 2012; Jostmann et al., 2009; Sonneveld, 2007; Zhang & Li, 2012).

For instance, Jostmann et al. (2009) propose that people tend to equate heaviness with importance, a coupling also apparent in language use, for example, *a weighty issue* or *an issue not to be taken lightheartedly*. 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 such as a mobile phone. Specifically, such skepticism may relate to associations such as cheapness, flimsiness or vulnerability, triggered by a literal lack of substance. Of additional relevance to the design context, is a recent study (Van Rompay, Verdenius, Okken, & Pruyn, 2014) that shows that excessively lightweight mobile phones might harm value perceptions and, consequently, lower price expectations. 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 (2012) showed that sensations of physical warmth affect evaluations of social warmth, an association likewise apparent in language use, for example, *a cold person*. 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 (Gosling, Ko, Mannarelli, & Morris, 2002) such that when waiting for a relative stranger, a cold living room may lead us to expect a cold rather than warmhearted person. Interestingly, Zhong and Leonardelli (2008) 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 in which physical warmth is equated with intimacy and belongingness, for example, a mother holding her newborn close to her own body.

A final example related to material selection follows from research from Ackerman et al. (2010). 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, transpiring in a lowered willingness to seek compromise in a negotiation task among other effects. Again, such couplings are rooted in object interactions in which we find that objects such as 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, for example, textiles and wood where others such as iron and glass do not. Because of this embodied grounding, we intuitively understand the meaning of both common and novel linguistic phrases such as *an iron heart* or *a soft personality*.

Decisions on product weight, material conductivity and texture selection are common aspects of design processes. Knowledge about how such design decisions influence usability and ergonomics and also the constitution of a product's expression or character are important when designing for experience (Janlert & Stolterman, 1997; Karana, 2009). For instance, in selecting a

material with low heat conductivity, feeling relatively warm at average room temperature could inspire sensations of social, psychological warmth among users. Acknowledging the embodied basis of material experience, Karana (2009) explored relationships between particular material features and meaning attributions, for example, 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 can also be considered an important vehicle for establishing a product's character (Lageat, Czellar, & Laurent, 2003; Ludden & Schifferstein, 2007; Özcan & Van Egmond, 2012; Spence & Zampini, 2006). Ludden and Schifferstein (2007) explored congruencies between products' visual appearances and their sounds, for example, the look and sound of dust busters and citrus juicers, showing that different sounds impact a product's perceived expression differentially. Focusing on luxury perceptions, Lageat et al., (2003) had people rate different flip-top lighter sounds. Their results revealed that for a large segment of consumers, a relationship between luxury perceptions and sounds was characterized as 'matte', 'even' and 'low-pitch'. When considering the embodied basis of the results from the latter study, it is worthwhile reconsidering the aforementioned relationship between weight and value. That is, in our daily interactions, we find that objects of varying weight carry distinct acoustic properties. For instance, dropping a heavy object on the ground makes a more full-bodied, low-pitch sound compared to a lightweight object. From an embodied line of reasoning, this might explain why consumers associate luxury with a full-bodied, low-pitch product sound.

The examples presented in this section illustrate that material and sound selection may play an important role in shaping a product's expressiveness, as with a product's visual appearance, and may consequently impact social interactions. However, research attention for these topics has been scarce within design research, hence:

Research propositions:

- Product level: Design researchers could further explore how material and sound characteristics in product design connote symbolic meanings of different types and how these meanings interact with those connoted by visual appearances.
- User experience level: Can material expressions influence the extent to which consumers feel connected to others, at ease and self-confident? Secondly, can material expressions influence ease of social interactions in particular settings, for example, focus groups, group therapy and creative sessions?

Type 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 (Dourish, 2001). 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, for example, 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 (see, for instance, Djajadiningrat, Wensveen, Frens, & Overbeeke, 2004) and also within consumer electronics, anonymous, black boxes have slowly paved 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 and postures carry meaning. However, 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 (1993) showed that arm movements towards the body as opposed to away from the body made by having participants push or pull a joystick on presentation of stimuli enhanced liking for arbitrary stimuli, for example, Chinese characters, meaningless stimuli to Western respondents. Such findings are embodied from early childhood on; liking of people and stimuli such as a baby's mother, play toys or candy are equated with bodily approach whereas dislike of stimuli such as scary dogs, frightening people and noisy dust blowers elicits bodily avoidance. Interestingly, a recent study in the retailing context (Van den Bergh, Schmitt, & Warlop, 2011) showed that arm flexion, that is, shoppers carrying a basket such that bodily action is directed toward the body, versus arm extension, that is, 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 such as 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 (cf. Wiers, Rinck, Kordts, Houben, & Strack, 2010).

In addition to direction of movement, various authors have explored the connotations of movement characteristics such as speed and force. For instance, Sawada, Suda, and Ishii (2003) studied relationships between arm-movement characteristics and emotional expression based on Laban's classification of movement (von Laban & Ullmann, 1988) in terms of time, weight, space and flow. They showed that dancers' expressions of anger, for instance, are reflected in arm movements that are fast in velocity and strong in force as opposed to slower and weaker arm movements, which are indicative of sadness or joy. Design researchers have repeatedly shown interest for qualities of dance and have studied dance characteristics and patterns emerging from interactions between dancers to explore options for movement in product

interaction (see for instance Ross & Wensveen, 2010; Hummels, Overbeeke, & Klooster, 2007). By copying or applying emotion-laden human movements in product design, designers can create an envisioned expression through movement characteristics. For instance, Bruynzeel's kitchen drawers 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, suggesting calm, confidence and purposeful activity.

Likewise conveying affective qualities through movement characteristics (forcefulness of movement), Hekkert, Mostert, and Stompff (2003) designed a copier based on the metaphor *Interacting with a machine is a dance* (Hekkert, Mostert, & Stompff, 2003). 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 links the emotional state of the user and the expressiveness of the product, either experienced as a forceful, decisive agent or a smooth, sensitive partner.

Apart from users perceiving such qualities in product movement, users are also stimulated to adjust their own motor movements accordingly, for example, 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 interactive gaming appliances, for example, Wii. 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, users may also experience these very same qualities as they play along, for example, users learning that specific postures or arm movements indeed inspire feelings of confidence. What this 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. Hence:

Research propositions:

- Product level: How do certain movement characteristics such as force, speed and direction influence the expressiveness of products?
- User experience level: How do movement characteristics influence how people feel and interact with products, for example, an agitated versus smooth interaction style?

Conclusions

This article has discussed four types of embodiment in design by integrating findings from cognitive linguistics, social psychology and design research. Where some of these notions are already common practice in design, for example, 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, that is, not only in overall shape, but also in interface design and layout among others. In this sense, the insights presented are most important in so far as they create awareness of and sensitivity for the bodily basis of product experience.

The article has highlighted different facets of product experience to hint at the design goals that could underlie applications of the insights presented. In all types discussed, creating a desired product expression through appearance and/or product movement takes center stage (i.e., is the primary consequence of applying the insights presented), but discussion of each type revealed additional implications for user experience. For instance, both with respect to embodiment type 1 (literal resemblances) and type 3 (meaningful sensorial experiences), elicitations of specific emotions may be involved. Designing for surprise or interest, for instance, may revolve around a perceived incongruence or mismatch between cross-sensorial input (Ludden et al., 2008) such that symbolic impressions gathered from 'seeing' a product, for example, perceiving a vase's shape as stately and dignified, may conflict with impressions gathered from 'touching' a product, for example, subsequently picking up the vase and finding it is made out of lightweight plastics, rather inspiring the impression of a playful, casual product. Depending on one's concerns—what one desires to 'see' in a product—such a perceived incongruence may lead to positive emotions such as interest or pleasant surprise or to disappointment or unpleasant surprise.

Likewise, surprise and interest may be elicited on unexcitingly perceiving a familiar element such as a face-like contour in an otherwise unfamiliar product. As the resemblance becomes more explicit, surprise and interest may wane and feelings of familiarity and recognition may take over. As hinted at, the latter may be particularly important in environmental settings where anxiety is high. For instance, comparisons between different types of art in psychiatric wards suggest that ambiguity and incongruities may elicit negative affect and behaviors, where recognizable, familiar scenes may soothe and pleasantly distract (Ulrich, 1991).

With respect to embodiment type 4 in particular (embodiment in movement and action), behavioral facets of product experience also take center stage. For instance, in the examples presented, movement characteristics such as force, smoothness and abruptness not only co-create the product's expressiveness, they also call for specific types of user movements. Bruynzeel's 'blue-motion' kitchen drawers, for instance, set the stage for a smooth, continuous product-user interaction, directly influencing user behaviors. Alternatively, the copier discussed (Hekkert et al., 2003) adjusts to user movement characteristics, thereby aiming to be non-disruptive and non-prescriptive, but with user dynamics in mind all the same.

Regardless of the embodiment type discussed, links between cognition (e.g., meaning attributions guided by image schematic structures), affect (e.g., a design eliciting self-confidence) and behavior (e.g., a smooth surface facilitating social interactions) became apparent, making it hard and unwarranted to draw firm lines

separating the cognitive, affective and connotative. In line with Dewey's (1934) notions, a (product) experience always involves shades of all three components, with one's focus dictating which component stands out at a specific time. Consider the following episode of a man perceiving a chair. What may strike him first is the chair's expressive quality, perhaps best described as inviting and cautious or as a cautious invitingness. Such meaning perceptions may be said to be foremost cognitive or intellectual. However, further reflection on the embodied bases of these constructs makes it clear that they are laden with emotional qualities at the same time; an invitation is never affectively neutral, it is always qualified by one or more emotional overtones, for example, an invitation may be said to be joyful, hesitant, indifferent, painful, cautious, etc.. At the same time, an invitation suggests a call for action, whether it is a joyful acceptance surfacing in approach or silent retreat. Hence, as far as the embodied basis of a product's expressiveness is concerned—something in the first instance perhaps readily referred to as 'cognitive'—it cannot be demarcated from the affective and action-oriented realms. The studies discussed in this context, most of them conducted in recent years, indeed testify to this interwovenness of cognition (e.g., understanding of a texture-wise hard product as rough), affect (feeling oneself toughen up to others) and action (unwilling to seek compromise in a negotiation task).

As suggested in the introduction section, the selection of the four embodiment types discussed in this paper was driven both by product-design specific considerations, for example, anthropomorphism or creating resemblances between products and familiar, concrete things as is common practice in design, and by a focus on the product as the unit of analysis, that is, product appearance and action. Focusing on smart products or interactive media would have implied additional types, for example, embodied intelligence. Hence, the categorization presented in this paper is not intended to be exhaustive. Embodiment is obviously not the only explanatory framework for describing and analyzing product expression. For instance, within semiotics, a distinction is made between cases where signifier (the product) and signified (the concept referred to) literally resemble each other, for example, the body of a vacuum cleaner resembling a human face and where signifier and signified are bound by cultural convention, for example, a product expressing innocence through its white color. The former example fits Type 1 embodiment ('Anthropomorphism, familiarity, and literal resemblances'), whereas the latter connects to our Type 3 ('Meaningful sensorial experiences') category.

Within semiotics, however, the arbitrary nature of the relationship between signifier and signified is emphasized (e.g., Eco, 1976; de Saussure, 1983) and stress is put on cultural convention and learned meanings. In Eco's definition, a sign is "Everything that on the grounds of a previously established convention can be taken as something standing for something else" (p. 16). What renders the embodiment framework of particular relevance to the design context is that it provides an embodied explanation for relationships between objects on the one hand and the meanings they connote on the other. As such, it not only allows for description or categorization of such relationships after the fact, it also allows designers to account for relationships between design features and symbolic meanings beforehand. It is in this sense that the embodiment framework holds great potential; it makes difficult or seemingly arbitrary relationships between object and meaning insightful, thereby guiding designers to translate ideas about what a product should express into shape, materials and product action.

Future Directions

Throughout this article, we have sought to show that the insights presented about awareness of the embodied bases of product experience should by no means be considered prescriptive or as somehow narrowing the creative scope of the design process. In other words, how designers move from, for instance, visual-spatial constructs (image schemas) to product appearance and product movement is a creative challenge not limited by, 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, to analyze these interactions afterwards in terms of the image schemas discussed (e.g., distance: moving closer or backing away from the person interacted with; containment: providing shelter or openness) and finally to use these visual-spatial parameters in sketches for a product expressing involvement towards users (i.e., involvement in product appearance) or creating involvement among users (i.e., involvement in user interactions). Such design exercises not only create awareness of the bodily bases of product experience by reflecting 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).

It is also here that open-ended rather than narrow aspects of image schemas come to the fore. Starting from a particular image schema and its embodied basis (e.g., distance), shape considerations (e.g., a close distance between salient product features; Figure 5) and reflections on color and material selection are facilitated (e.g., compare color use in Figure 5). In this sense, image schemas are abstract enough to serve as a starting point for multiple product features and are also sufficiently tangible due to their visual-spatial nature and are actionable by being grounded in our 'own' bodily experiences.

Finally, with new media such as tablets providing increasing opportunities for bodily actions, for example, dragging, pinching or swiping objects on an iPad, future research could explore the extent to which parameters such as the force, direction and expansiveness of finger and hand movements can trigger subtle affective qualities that may enhance specific states

of mind such as open-mindedness, creativity or self-confidence deemed desirable in the context of e-learning for instance. Smart products might also detect user mood and adjust feedback and interaction style accordingly as in the copier example. This line of research is steadily growing in the field of human-computer interaction. Paying attention to such previously ignored aspects of interaction design and reflecting on how interactions with 'old' and 'new' products alike connect to people's daily experiences paves the way for extending meaning beyond the physical artifact to include bodily action and engagement.

In sum, the insights presented in this article 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.

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