Factors contributing to product experience: The cases of 'warmth' and 'freshness'

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Abstract

Designers can manipulate physical properties of a product: they can change its colour, texture and smell. But can we also predict people's product experiences such as 'freshness' and 'warmth'? We collected 10 smells and 10 colours for freshness, and 10 textures and 10 colours for warmth. Participants evaluated the freshness of 20 stimuli for a softdrink and a dishwashing liquid, and the warmth of 20 stimuli for a scarf and a tray. The results showed that sensory experiences (freshness and warmth) include affective components (pleasantness and comfort) and depend on the product. Our findings imply that 'freshness' and 'warmth' are complex product experiences that integrate sensory, affective, and semantic components. To predict users' reactions to products we need to take into account all three components of these experiences.

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Introduction

Product experience can be defined as "the awareness of the psychological effects elicited by the interaction with a product, including the degree to which all our senses are stimulated, the meanings and values we attach to the product, and the feelings and emotions that are elicited" (Hekkert & Schifferstein, 2008, p.2). Emotions and personal meanings people attach to products are difficult to predict, and even more difficult to control. However, the sensory component of product experience appears more regular and easier to understand. On the one hand, designers can control physical attributes of products that directly affect sensory experiences: they can change colour, texture and smell of a product. On the other hand, sensory perception is probably the most thoroughly investigated and best understood psychological process. Our senses usually give us straightforward, reasonably accurate information about the world around us and the things in it.

It is important for designers to understand how people experience sensory properties of the products they create. A lot of work has been done to measure people's reactions to separate sensory properties of products, such as colour, shape, texture, smell, and sound. Many properties are perceived by more than one sensory modality. For example, shape and texture of the product can be experienced visually as well as tactually. Even 'purely visual' properties like colours have strong associations with other modalities. It is quite common to speak about 'warm' and 'cold' colours, 'heavy' and 'light' colours, 'loud' and 'quiet' colours.

The aim of this research is to understand the product experiences of 'freshness' and 'warmth'. To what extent do these experiences rely on the physical properties of products? The results of previous questionnaire research (Fenko, Schifferstein, Otten, Hekkert, submitted) demonstrated that two sensory modalities are important for these experiences: one clearly dominant sensory modality (olfaction for 'fresh', touch for 'warm') and a secondary modality, which is also relatively important (vision for both experiences). We are interested in the factors that influence people's judgements on 'fresh' and 'warm' for products. Which smells do people experience as fresh? Which materials feel warm? Are there any differences between products? For instance, is the evaluation of what constitutes a fresh smell and a fresh colour for a softdrink the same as for a dishwashing liquid?

Experiencing warmth through touch

Objects made out of different materials feel thermally different. For instance, wood generally feels warmer than metal, even though both materials are at room temperature. This effect is caused by differences in the thermal properties of these materials. An object feels cold if it extracts warmth from the skin. Examples of such materials are glass and metal (Ashby & Johnson, 2002). Materials with high temperature resistance, such as wood or plastics, generally feel 'warm' even if their temperature is below body temperature. When the material is hotter than the observer's hand, the effect is reversed. For example, a copper sample that feels colder than a wood sample at room temperature, will feel warmer than the same wood sample at a high temperature. The geometry of the object also plays an important role: a thick bar can conduct heat away from the finger more easily than a thin foil (Bergmann Tiest & Kappers, 2008).

Experiencing freshness through olfaction

Studies on olfactory 'freshness' have mainly been performed in the areas of food and dental care. According to Labbe et al. (2007), sensory determinants of complex perceptions such as refreshing, fresh or natural generally involve multiple modalities, including olfaction, taste and texture perception.

Westerink and Kozlov (2003) investigated the concept of 'oral freshness' in the context of tooth care. The authors identified 6 attributes: wateriness, coldness, taste (menthol), cleanness, smell, and energy (texture and touch). The "freshness" construct correlated most closely with the constructs related to "cleanness", "coldness" and "pleasantness".

A study by Zellner and Durlach (2002) showed that respondents most frequently listed water when asked to list ten foods or beverages they found refreshing (90% of respondents). The participants were also asked to list ten characteristics of refreshing foods or beverages. Results showed that temperature-related attributes (cool, cold) were most commonly reported (92% of respondents). The flavour most often regarded as refreshing was orange, with strawberry a close second. The flavour most commonly listed as not refreshing was chocolate.

Martin et al. (2005) found that citrus and peach were often reported as fruit aromas associated with refreshing. Labbe et al. (2007) demonstrated that mint odorants were scored

as the most refreshing. The second sensory driver of a refreshing sensation was high acidity. This is in line with McEwan and Colwill (1996), who showed that a carbonated lemon drink was more refreshing than orange juice > orange squash > cola > isotonic > sparkling water > diet cola > strawberry milk, mainly due to its high acidity.

Experiencing warmth and freshness through vision

It is a widespread belief that certain colours are experienced as warm and others as cool (Arnheim, 1954; Itten, 1961; Ross, 1938). Most psychological research has supported the conclusion that red and yellow are perceived as warmer than green and blue. For example, Lewinski (1938) and Ross (1938) found that projected red colours were rated warmer than blue ones, and Tinker (1938) and Newhall (1941) found that surface reds were consistently described as warmer than surface blues. Wright (1962) and Wright and Rainwater (1962) demonstrated that there is a well-defined effect of hue on judgments of the apparent warmth of coloured squares, independent of brightness and saturation. They also demonstrated that darker and more saturated colours tended to be viewed as warmer.

In colour-meaning research that used 5 objects painted in 6 different colours (Osgood et al., 1957) consistent colour effects were found for warmth, e.g. all objects appearing in red were consistently rated warmer than those in other colours. Similar findings were reported by Taft (1997).

Little work has been done to determine if colour affects the perceived freshness of solutions. Clydesdale et al. (1992) found that consumers expected brown and clear non-alcoholic beverages to satisfy their thirst more than other colours, probably because of their association with colas and water. Of the other colours, red and orange beverages were expected to be more thirst-quenching than green or purple.

Zellner and Durlach (2002) asked 86 students if particular flavours, foods, and beverages were perceived as more refreshing than others and which sensory characteristics are important in making something refreshing. Colour was mentioned as an important sensory characteristic of refreshing foods/beverages by only 24% of respondents. However, when asked specifically about colour, most respondents (77%) thought that refreshing foods/beverages would have specific colours. The colour most frequently associated with refreshing foods/beverages was “clear”, followed by red. The most unlikely colour for a refreshing food/beverage was black, followed by brown.

In a study on colour-flavour interaction, Zellner and Durlach (2003) found that clear beverages of every flavour were perceived as the most refreshing. Brown versions of lemon and mint beverages were perceived as being less refreshing. However, in the case of vanilla, where brown is an appropriate colour (vanilla extract is brown), brown was not perceived as being any more or less refreshing than any other colour. The authors conclude that brown colas and vanilla drinks can be refreshing because we consider brown the appropriate colour, whereas brown lemon and mint drinks are inappropriate and, therefore, not refreshing.

The present study

We will determine the extent to which people experience 'warmth' and 'freshness' for different sets of sensory stimuli (tactual, visual, or olfactory) for different product groups (scarf, breakfast table, softdrink, or dishwashing liquid).

Method

Participants

Participants were recruited among students of the Faculty of Industrial Design Ingeneering, Delft University of Technology. The ages ranged from 17 to 28 years, 50% of the respondents were women. Two groups of 20 students were used: the first group assessed the warmth of the stimuli; the second group assessed the freshness of the stimuli.

Materials

Two products were chosen for which 'warmth' is an important characteristic: a scarf and a tray (a breakfast table). For each product two sets of stimuli were prepared: 10 fabrics and 10 colour chips for a scarf, and 10 hard materials and 10 colour chips for a tray.

Softdrink and dishwashing liquid were chosen as products for which 'freshness' is an important property. For these products we prepared 10 colour chips and 10 smells. For olfactory stimuli we used 10 standard smells produced by *International Flavors &Fragrances* (*IFF*). The same set of smells was used for softdrink and dishwashing liquid. The same set of colour chips was used for all four products.

Procedure

For the assessment of warmth, tactile stimuli were presented to the participants in a closed box, so they could explore them by touch without seeing them. The sequence of the stimuli varied for each respondent. The warmth was evaluated on a 10-point scale. Visual stimuli were presented all at once and participants were asked to assess the warmth of each colour on a 10-point scale. In addition, spontaneous comments made by participants during the experiments were recorded by the experimenters.

For the assessment of freshness, smells were presented to the participants in clear plastic containers. Participants opened containers one by one and assessed the freshness of the smells on the 10-point scale. Two groups of respondents assessed the freshness of smells for two different products. One group was asked to assess smells of a softdrink and another of a dishwashing liquid. The sequence of stimuli differed between participants. Participants were asked to smell their wrist between the trials in order to get rid of the previous smell. Visual stimuli were presented all at once, and participants were asked to assess the freshness of each colour on a 10-point scale.

Results

Experience of warmth

Fleece and wool were found the warmest and viscose and nylon the coldest fabrics for the scarf (see Table 1). The thick woollen scarf with a lot of holes in it was assessed as the second most warm, while the three coldest fabrics had a dense structure. These results suggest that the tactile experience of warmth in scarves was dominated by the material and to a less extent by the structure of the fabric. According to respondents' comments, the comfort of wearing a scarf was important in their assessments of warmth. For example, denim was often assessed as the least warm because of its stiffness, and fleece was judged as warmer than wool because it is very soft and does not irritate the skin.

All samples of wood and plastic, both rough and smooth, were found warmer than the plates of metal for a tray (see Table 2). At the same time, the smooth plate of steel was found colder than the plate of rough aluminium. This suggests that tactile perception of warmth in a tray depends on a combination of the material and the surface pattern.

The perception of warm colours in scarves was dominated by two factors: hue and lightness. The warmest colours for a scarf were both dark and reddish (see Table 3). According to colour theory (Arnheim, 1954; Itten, 1961; Ross, 1938), dark green is not a warm colour; nevertheless, it was considered as warm as magenta, probably because of its darkness. On the other hand, yellow is a warm colour, but respondents found it too bright for a warm scarf. Cyan was the least warm colour for a scarf, because it is both cold and light.

The colours that were perceived as warm for a breakfast table tended to be reddish and yellow (see Table 4). In contrast to the results for a scarf, they were more bright and "sunny". Blue colours were experienced as the least warm for a breakfast table and green colours as medium warm. These results correspond to the "warm-cold" colour theory.

Table 1. Mean ratings for warm fabrics (scarf)

	Mean
Viscose	2.00
Nylon	3.30
Denim	4.20
Yarn	4.50
Rumpled cotton	4.70
Thin cotton	5.55
Wool	6.75
Thick wool	6.80
Fleece	7.90

Table 2. Mean ratings for warm materials (tray)

	Mean
Steel	1.90
Aluminium	3.80
Marble	4.60
Tile	4.70
Hairy wood	4.85
Plastic	5.05
Pressed wood	5.50
Ripple wood	7.55
Polystyrene	7.90
Rubber	9.15

Table 3. Mean ratings for warm colours (scarf)

	Mean
Cyan	2.65
Yellow	2.75
Light green	4.10
Dark blue	4.50
Green blue	5.90
Dark green	6.35
Magenta	6.40
Orange	6.65
Red	7.30
Purple	8.40

Table 4. Mean ratings for warm colours (tray)

	Mean
Dark blue	3.40
Cyan	3.90
Green blue	4.45
Dark green	4.60
Light green	4.80
Magenta	5.50
Yellow	6.25
Purple	6.65
Red	7.50
Orange	7.95

Experience of freshness

Fruity and citrus smells were perceived as the most fresh for a softdrink (see Table 5). This could suggest that the choice of a fresh smell for a softdrink is based on associations. Even though apple and pear were often described as “too sweet”, they were also considered as “suitable for a softdrink”. Cedar wood, lily of the valley (often described as too soapy), menthol (described as too strong and medical) and jasmine were not usually associated with softdrinks. Patchouli was perceived as the least fresh and very unpleasant.

Lily of the valley and bergamot were perceived as the freshest smells for a dishwashing liquid (see Table 6). Surprisingly, the lemon smell was assessed as significantly less fresh than the smell of bergamot. This can be explained by the strength of the smell: in their comments participants described bergamot as stronger and less sweet than lemon. Lily of the valley was also described as a strong smell. Even when respondents disliked the particular smell, they sometimes considered it suitable for a dishwashing liquid. They described those smells as strong, heavy and soapy. These smells seem to convince people that the dishwashing liquid will be able to clean their dishes.

The judgments about the freshness of the colours for a softdrink were based on the associations between the colour and the taste of a softdrink. The colours perceived as most fresh were yellow, orange, cyan and dark blue (see Table 7). Yellow and orange were associated with existing drinks (*Fanta*, for example) and fruits (orange and lemon). Blue was often associated with water. Purple, magenta and red were sometimes associated with berry drinks, which can be sour and thus fresh, but can also be sweet (strawberry).

The results for a dishwashing liquid were in full agreement with the "warm-cold" colour theory: cold colours were perceived as fresher than warm colours (see Table 8). Also light colours were perceived as fresher than dark colours (for example, yellow was perceived as fresher than dark green, and cyan as fresher than dark blue). There were few associations between colours and existing washing liquid brands, except for the occasional associations of magenta with *Vanish*.

Table 5. Mean ratings for fresh smell (softdrink)

Smell	Mean
Patchouli	1.7
Jasmine	2.4
Menthol	2.5
Lily of the valley	2.9
Cedar wood	3.0
Amber	4.1
Bergamot	5.7
Lemon	5.8
Pear	5.8
Apple	6.0

Table 6. Mean ratings for fresh smell (dishwashing liquid)

Smell	Mean
Patchouli	2.4
Cedar wood	3.2
Jasmine	3.6
Menthol	3.7
Amber	4.6
Apple	4.9
Pear	5.0
Lemon	5.0
Bergamot	6.4
Lily of the valley	6.5

Table 7. Mean ratings for fresh colours (softdrink)

	Mean
Dark green	3.70
Purple	3.70
Green blue	4.70
Magenta	4.75
Red	5.15
Light green	6.15
Cyan	6.45
Dark blue	6.60
Yellow	6.80
Orange	7.00

Table 8. Mean ratings for fresh colours (dishwashing liquid)

	Mean
Red	3.75
Purple	3.80
Orange	4.15
Magenta	5.05
Dark green	5.10
Yellow	5.60
Green blue	6.00
Dark blue	6.80
Light green	7.25
Cyan	7.50

Discussion

The results suggest that sensory product experiences (freshness and warmth) have strong affective components (pleasantness and comfort). For example, we had expected minty and citrus smells to score higher on the scale of 'freshness' than fruity and floral smells. Instead, fruity smells were chosen more often as 'fresh' for a softdrink, and the floral smell was judged as the most 'fresh' for a dishwashing liquid. Respondents commented that fruit smells seemed more 'nice' and 'suitable for a softdrink', while the floral smell was 'strong' and 'pleasant' and suitable for a dishwashing liquid. Similarly, fleece scored higher than wool on the scale of 'warmth' for a scarf, because 'it does not irritate your skin'.

Similar results were mentioned in previous studies on the perception of refreshing colours. They can be related to the strong correlation between hedonic ratings and refreshment ratings (McEwan & Colwill, 1996). Zellner and Durlach (2003) argue that some confusion of the two qualities ('fresh' and 'pleasant') might be occurring during experiments. For example, when asked to name refreshing foods or drinks, most people named beverages (water, iced tea) and ice cream. However, some people indicated that items such as chicken and pizza were refreshing. "Although subjects probably do find these items hedonically

positive, it is hard to imagine what about them would be refreshing", the authors conclude (Zellner & Durlach, 2003, p. 645).

Possibly, the participants in our experiment relied on holistic perception. Psychological theory holds that people are capable of two types of perception: holistic and analytical. Analytical processing involves treating the stimulus in terms of its properties – comparing stimuli by their values on independent dimensions that may be selectively attended. Holistic processing, by contrast, implies treating the stimulus as an integral whole or 'blob'(Lockhead, 1972) – comparing stimuli in terms of their overall similarity rather than according to their values on independent dimensions (Smith, 1989). Smith and Kelmer Nelson (1984) have shown that people can change their usual analytical classification to holistic perception of similarities when speed is emphasized, when a concurrent cognitive task is given to them, or when they allow themselves to be guided by their first impressions. The last has probably happened in our experiment.

The type of product was another important factor that influenced sensory experience of warmness and freshness. For example, yellow and orange (so-called warm colours) rated higher on the scale of 'freshness' for a softdrink because of the associations with fruits and existing softdrinks. These results correspond to the findings of Clydesdale et al. (1992), who suggested that clear and brown beverages were perceived as thirst-quenching because of their association with water and colas.

Similar results were reported for colour and smell preferences. A study by Holmes and Buchanan (1984) showed that although people's favourite colour was blue, this was not the case for a sofa, walls, a carpet, or a chair. Yet for some items (skirt, dress, shirt, and slacks) the favourite colour was also blue. Köster (2005) showed that unidentified lavender is normally disliked, whereas people who identify it like it. He concludes that odours are linked to personal situations and the same odour may be pleasant in one situation and unpleasant in another. According to Köster, we deal with odours very differently from visual or verbal stimuli, because odours are notoriously hard to describe, classify and identify. Nevertheless, our results show that judgements on visual and tactile stimuli also depend on the situation. Therefore, we can conclude that any sensory experience is influenced by the semantic context and the product usage situation.

Conclusion

Our findings imply that the product experiences of ‘warmth’ and ‘freshness’ do not only depend on physical properties of the products. They are complex product experiences that integrate sensory, affective and semantic components. Hence, to create an experience of ‘warm’ or ‘fresh’ products designers need to take into account all three components of product experience.

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