

Surprises elicited by products incorporating visual - tactual incongruities.

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Key conference themes: Emotion and design, Emotion and experience

# Surprises elicited by products incorporating visual - tactual incongruities.

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The perception of a product through one sense modality can create an expectation on what will be perceived through other sense modalities. However, the sensory information ultimately perceived may disconfirm the initial expectation, resulting in surprise.

By means of literature study and a study of contemporary design, types of surprises elicited by products incorporating visual-tactual incongruities are specified. These types are based on different design goals that can be reached by following different design strategies. Differences in the certainty about expectations on how a product will feel and the amount of surprise are important factors in the surprise types proposed. An explorative experiment in which responses to products incorporating visual-tactual incongruities are determined is carried out to verify the types of surprise. In this experiment, subjects could either 'see' or 'see and feel' several products. Although not all products fitted the surprise type they were selected for, the existence of the surprise types was supported.

Keywords: surprise, perception, experience, expectation, visual, tactual

## Introduction

In contemporary product design, attention is widening from creating functional products to creating interesting product experiences as well, as evidenced by the increasing focus on pleasure in products (Jordan and Green 2002) and product emotions (Desmet 2002; McDonagh, Hekkert, van Erp and Gyi 2004). For designers, one of the ways to create an experience is by focusing on the multiple sensory aspects of product design: when visual, tactual, auditory and olfactory aspects all contribute to the experience, together they create a rich form of user-product interaction (MacDonald 2001; Rashid 2003). New and smart(er) materials offer wide opportunities for designers to explore new sensory experiences (Verbücken 2003). An example of the use of a smart material is a water kettle made out of a thermochromic material that changes colour when its temperature rises. Through this material, the kettle 'warns' the user when it is hot.

Designing sensory experiences can be aimed at communicating a consistent message to all sensory channels, making this message a stronger one. This approach is often proclaimed by ergonomics, because it results in products that are easy to understand by consumers. Another, completely opposite approach, is designing a product in a way that incongruent information is provided to different senses. Designers use this approach to surprise consumers, to make

exploring the product more challenging, and to let them discover something new. The surprises such products elicit make them special. A surprise usually occurs when a perceiver's expectations are disconfirmed. This implies that experiencing surprise largely depends on what a user knows and expects.

For product designers, it is important to understand how surprises can be evoked. In short, a surprise-eliciting event occurs through the following four steps: first, an event is experienced as exceeding some threshold value of unexpectedness; second, a surprise experience occurs; third, ongoing activities and information processing are interrupted and attention is focussed on the unexpected event; finally, the unexpected event is analysed and evaluated and, if deemed necessary, stored knowledge is updated (Meyer, Niepel, Rudolph and Schutzwahl 1991; Meyer, Reizenzein and Schutzwahl 1997).

Designing products that can elicit a surprise reaction can be beneficial to both a designer and a user. The designer can make use of a surprise reaction because it captures attention to the product, leading to increased product recall and recognition, and to increased word-of-mouth (Derbaix and Vanhamme 2003; Vanhamme and Lindgreen 2001). The product user benefits because the product is more interesting to interact with and because it often involves learning something new about a product or product aspect.

The present research deals with a specific kind of surprise: surprise caused by incongruent information provided to different senses. Someone who perceives a product does not use all senses at the same time. Therefore, perceiving a product through one sense modality first can create an expectation on what will be perceived through other sense modalities. The sensory information perceived consecutively may disconfirm the expectation formed upon the initial perception, resulting in a surprise reaction.

Some senses are more likely to be used first than others. With the so called distance senses one can hear, see and smell products from distance, whereas with the proximity senses taste and touch, we can only perceive a product in interaction. Combined with the fact that several designers are currently experimenting with providing incongruent information to vision and touch, this led us to decide to study surprises elicited by visual - tactual incongruities in products.

### **Exploratory study of contemporary design**

Surprise reactions to products incorporating visual – tactual incongruities do not only occur when products are deliberately designed to evoke these reactions. According to Manzini (1989) more and more surprising products have gradually occurred on the market due to a ‘loss of recognition’ since the introduction of plastics. Many new plastic materials have emerged that possess unknown material characteristics. Upon seeing these materials, people experience uncertainty about their feel characteristics because they do not know them. Upon touching the materials they might be surprised by their feel. For example, the much lighter weight of many plastics combined with their strength relative to previously known materials like steel and wood surprised many people when plastics were first introduced. Further and faster developments of materials maintain this mechanism of surprise in products up to a point where designers start to create tactual surprises in their products deliberately.

To explore the occurrence of surprise in product design, we analysed designs in five issues of The International Design Yearbook (1999 - 2003) and counted the number of designs that incorporated a (deliberately or undeliberately designed) visual - tactual incongruity (de Lucchi and Hudson 2001; Lovegrove and Hudson 2002; Maurer and Andrew 2000; Morrison, Horsham and Hudson 1999; Rashid 2003). Table 1 shows that the number and percentage of products that incorporate a visual – tactual incongruity increased over time. This increase may be considered small, suggesting that this is a short-term design trend. Nevertheless, the call for creating new sensory experiences by many designers and the many new developments in materials discussed earlier, suggest that this is an interesting design issue.

| <b>Year</b> | <b># Designs in book</b> | <b># Visual-tactile incongruities</b> | <b>%</b> |
|-------------|--------------------------|---------------------------------------|----------|
| 1999        | 232                      | 5                                     | 2,2      |
| 2000        | 435                      | 5                                     | 1,1      |
| 2001        | 504                      | 7                                     | 1,4      |
| 2002        | 182                      | 11                                    | 6        |
| 2003        | 242                      | 11                                    | 4,5      |

Table 1, Analysis of International Design Yearbooks.

## Design strategies

The examination of the products with visual-tactual incongruities in the international design yearbooks revealed several ways to design a product with visual – tactual incongruities. These design strategies seem to be based on two different design goals and result in two different types of products. Both evoke a surprise reaction, although the mechanisms that underlie these reactions are different. Therefore, we propose two surprise types called ‘Visible Novelty’ (VN) and ‘Hidden Novelty’ (HN). Figure 1 summarizes the relationships between design goals, design strategies and surprise types.

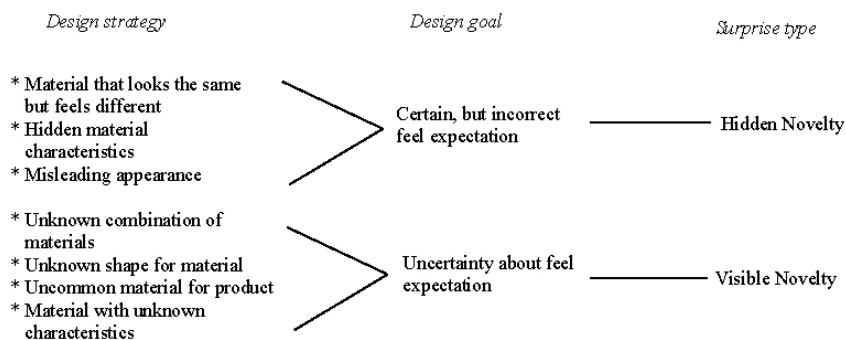


Figure 1, Relationships between design strategies, design goals and surprise types.

The distinction between the two design goals is based on the eventual sensory expectations the user forms. Expectations can be based on different sources of information. Oliver and Winer (1987) mention three sources for expectations as conceptualised by Tolman (1932): ‘memories of actual experiences, perceptions of current stimuli, and inferences drawn from related experiences such as trial of other objects’. This implies that expectations about how a product will feel, taste, smell or sound can be based on how a person sees a product, on his/her previous experiences with that product, or on experiences with similar products.

Oliver and Winer (1987) also state that the concept of an expectation involves uncertainty and an association with a point in the future. In our case, the uncertainty about a following perception is likely to depend on the source of the expectation. When the expectation is based on a memory of an actual experience, the level of uncertainty is likely to be lower than when it is based on inferences drawn from related experiences. In the latter case, the perceiver can not be sure that the current experience is fully comparable to the related experiences and will thus be more uncertain about what to expect.

The sources for expectations and their uncertainty differ between the two design goals. The design goal for VN products leads to products that seem unfamiliar to the perceiver. Consequently, the perceiver is not able to form an expectation based on previous experiences with the product. The perceiver forms an expectation about how the product will feel based on resemblances with other products in, for example, shape or material. A high degree of uncertainty will accompany this expectation. A surprise is experienced whenever the uncertain expectation is disconfirmed. A VN product can, for example, be made out of a new material that the perceiver vaguely associates with a material he/she knows. An expectation could then be based on experiences with the known material, but the new material can have very different tactual properties.

The design goal for HN products leads to products that do seem familiar to the perceiver. In this case, the expectation about how the product feels is based on previous experiences with a similar product. The perceiver is quite certain about his/her expectation. A surprise is elicited because the apparent familiarity is proven wrong by touching the product, disconfirming the expectation: the visual perception is misleading or the product has hidden characteristics that prohibit the perceiver from forming a correct expectation. An example of a HN product is a plastic bowl that looks like a crystal bowl. Upon seeing this product, the perceiver thinks that the product will be heavy. Upon touching or lifting the product, however, the perceiver is surprised about the much lower weight of the bowl.

Design strategies leading to the two surprise types can be further explored. The examination of the design yearbooks revealed that a surprise in the VN type can be obtained by using a new material or shape for a product, by using an unknown combination of materials, or by using a new material with unknown material characteristics. A surprise in the HN type can be obtained by combining a known visual image with a new tactual perception, for example by substituting a new material, that looks the same but feels different, for a common material, or by hiding certain product characteristics from visual perception. Another possibility is to mislead visual perception by reproducing fake shadows or reflections. (Figure 1.)

### **Surprise types**

Table 2 shows an overview of the most important properties of the two surprise types. Type NN (No Novelty), which represents products without visual-tactual incongruities, is added for comparison. The terms ‘Visible Novelty’ and ‘Hidden Novelty’ directly relate to the mechanisms behind the surprise types. In the VN type, a novelty is visible to the user

immediately. Thus, the VN product does not seem familiar to the perceiver, resulting in a high degree of uncertainty about expectations, and eventually in a surprise reaction. In the HN type, the novelty is hidden, it can not be seen immediately. The HN product seems familiar to the perceiver, thus resulting in a low degree of uncertainty about expectations. However, upon touching the product the hidden novelty is perceived, resulting in surprise.

|                    | <b>VN</b>      | <b>HN</b> | <b>NN</b> |
|--------------------|----------------|-----------|-----------|
| <b>Familiarity</b> | small          | large     | large     |
| <b>Uncertainty</b> | large          | small     | small     |
| <b>Surprise</b>    | normal - large | large     | small     |

Table 2, Properties of surprise types.

User responses to products evoking the different surprise types may differ strongly. For example, products of the VN type may be appreciated more because they offer the opportunity to explore and to discover something new, whereas products in the HN type may cause an unpleasant surprise or disappointment because the user feels misled. In addition, products in the HN type may result in a stronger surprise reaction, because users were quite certain about their initial expectation.

## **Experiment**

To verify the surprise types described above, to evaluate whether a number of products belonged to the surprise type they were selected for, and to explore differences between the surprise types we conducted an experiment. We separated responses based on vision alone from those based on both vision and touch. Responses based on vision alone provided information about the perceived familiarity of the products and about feel-expectations. Responses based on both vision and touch provided information about discrepancies between expected and actual experiences and about surprise. Commercially available products were used to ensure a real-life surprise reaction and to be able to relate the research directly to the current design practice.

## Method

### Respondents

A total of 60 respondents participated in the experiment, 33 female and 27 male. Respondents were Dutch bachelor students in Industrial Design aged 18-30 (mean 20.3). Respondents were paid for their participation.

### Stimuli

18 products were used in 6 product categories (Figure 2). Within each product category, a VN product and a HN product were selected based on the criteria for the surprise types: familiarity with the product and uncertainty of expectation. This led to a total of twelve products incorporating visual – tactual incongruities. In addition, 6 products without these incongruities (NN) were used as controls. All products can be found in a home environment. The product categories were ‘vase’, ‘tile’, ‘cup’, ‘bench’, ‘table cloth’ and ‘lamp’. The 18 products varied on price, design style and quality.





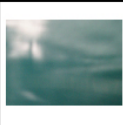













|          | Vase  | Tile  | Cup   | Bench   | Tablecloth   | Lamp  |
|----------|---|---|---|---|--|---|
| VN       |  |  |  |  |  |  |
| Name     | Red and white vase  | Tactiles  | Styrene   | Shrunken furniture  | No name  | Konko   |
| Material | porcelain   | ceramics  | porcelain   | polystyrene, wax  | polyamide, viscose   | polyamide   |
| HN       |  |  |  |  |  |  |
| Name     | No name   | Droptiles   | My way  | Ordinary furniture  | No name  | Softlamp  |
| Material | polycarbonate   | stoneware, glass  | porcelain   | recycled plastic  | polyethylene   | soft polycarbonate  |
| NN       |  |  |  |  |  |  |
| Name     | Vasen   | No name   | No name   | Oddvar  | No name  | Foto  |
| Material | glass   | stoneware   | stoneware   | wood  | polyamide, viscose   | aluminium   |

Figure 2, Pictures and characteristics of stimuli used for experiment.

The products were all placed in a room in the way they would normally be used at home. So the lamps were hung, the benches were placed on the floor, the tablecloths were placed over tables, and the cups and vases were placed on tables. The only exceptions were the tiles that were placed on a low cupboard. All products were covered. The 18 products were divided



over three sets. Each set consisted of six products: one from each different product category, two from each surprise type.

### *Procedure*

Each respondent was presented with two product sets. The first set was only inspected from a distance. This condition was called the ‘see’ condition. The second set was explored from nearby and in interaction. This condition was called the ‘see and feel’ condition.

Upon entering the room, subjects first signed a consent form. Then they performed the ‘see’ task. They sat down in a chair placed at 2 m distance from the product. Subsequently, the experimenter uncovered the product for approximately 5 s and covered it again. When the experimenter uncovered a product, she did not touch the product and, therefore, no sounds were generated that could give the subject a clue about its material properties.

The respondent then filled in a questionnaire concerning the product’s familiarity, expectations with regard to how the product would feel and the certainty of this expectation. One of the questions about the certainty of the expectation was directly related to a question about the material of the product (Table 3). Finally, respondents rated the product on 14 bipolar scales (not stylish – stylish, beautiful – ugly, weak – strong, expensive – cheap, funny – lame, extraordinary – normal, common – exclusive, not interesting – interesting, contemporary – old fashioned, not durable - durable, exciting – boring, pleasant – irritating, not original - original, unattractive – attractive). All responses were recorded on 9-point scales, except for the question about the material of the product, for which subjects chose from a list of possible materials.

After evaluating 6 products from a distance, the second task began. Again, respondents sat down at 2 m distance from the product before it was uncovered. After 2 s the respondent was instructed to stand up and approach the product, touch it and lift it. Subjects could explore the product at their own pace. The product was covered again after the respondent placed it back. Subsequently, subjects filled in a questionnaire about surprise and about the certainty of their initial expectation upon seeing the product, but this time after touching the product. Also, they rated the differences between what they had felt and what they had expected to feel (Table 4). The questionnaire also included the 14 bipolar scales used in the ‘see’ questionnaire. All responses were recorded on 9-point scales.

| <b>Scale</b>               | <b>Question</b>   | <b>Responses</b>  |
|----------------------------|---|---|
| familiarity                | ‘I have seen this product before’<br>‘This product looks familiar’<br>‘I know things that resemble this product’  | do not agree at all -<br>agree completely<br>"<br>"   |
| certainty                  | ‘I am certain about how it feels’<br>‘I am curious about how it feels’  | "<br>"  |
| material                   | ‘This product is made of ...’   | list of possible<br>materials   |
| certainty                  | ‘How certain are you that you answered the<br>question about the product’s material right?’   | very uncertain - very<br>certain  |
| expectations about<br>feel | ‘When I rub its surface I expect it to feel ...’<br><br>‘When I rub I expect to feel a ... texture’<br>‘I expect it to feel ... when I pick it up’<br>‘I expect it to feel ... when I push on it’ | soft - hard<br>smooth - rough<br>very sticky - not at all<br>sticky<br>smooth - rough<br>light - heavy<br>flexible - hard |

Table 3, ‘See’ questionnaire.

| <b>Scale</b>                                | <b>Question</b>  | <b>Responses</b>  |
|---|--|---|
| surprise                                    | ‘It felt exactly as I expected’<br><br>‘I am amazed about how it feels’<br>‘I am surprised about how it feels’   | do not agree at all -<br>agree completely<br>"<br>"   |
| certainty                                   | ‘When I saw it, I was certain about how<br>it would feel’<br>‘When I saw it, I was curious about how<br>it would feel’   | ,"<br>"   |
| differences between<br>feel and expectation | ‘When I rubbed its surface it felt ... than<br>expected’<br><br>‘When I rubbed its surface I felt a ...<br>texture than I expected’<br>‘When I lifted it, it felt ... than I<br>expected’<br>‘When I pushed on it, it felt ... than I<br>expected’ | less soft - softer<br>rougher - smoother<br>less sticky - more<br>sticky<br>smoother - rougher<br>lighter - heavier<br>more flexible - harder |

Table 4, ‘See and feel’ questionnaire.

The order in which the products were presented was randomised and differed between subjects. For every product, 20 respondents performed the ‘see’ task and another 20 respondents performed the ‘see and feel’ task. Performing the total task took approximately 45 minutes.

### *Data analysis*

All responses on scales were coded 1-9. Principal components analysis (PCA) was used to reduce the number of variables for further analysis and to check whether items measured the same construct. Consistency of the resulting scales was evaluated using Cronbach’s  $\alpha$ .

## **Results**

### *Visual-tactual incongruities*

To check for visual-tactual incongruities in the selected products, we analysed the data in the ‘see – feel’ condition about perceived differences between expected and actual experience.

| <b>Product</b> | <b>Soft-<br/>ness</b> | <b>Smooth<br/>-ness</b> | <b>Sticky-<br/>ness</b> | <b>Textured<br/>-ness</b> | <b>weight</b> | <b>flexibility</b> | <b># per<br/>type</b> |
|----------------|-----------------------|-------------------------|-------------------------|---------------------------|---------------|--------------------|-----------------------|
| <b>VN</b>      |                       |                         |                         |                           |               |                    |                       |
| Vase           |                       |                         | ×                       |                           | ×             |                    |                       |
| Tile           |                       |                         |                         |                           | ×             | ×                  |                       |
| Cup            | ×                     | ×                       | ×                       | ×                         | ×             |                    | <b>20</b>             |
| Bench          | ×                     |                         |                         | ×                         |               | ×                  |                       |
| Tablecloth     |                       |                         |                         |                           | ×             | ×                  |                       |
| Lamp           | ×                     | ×                       | ×                       | ×                         | ×             | ×                  |                       |
| <b>HN</b>      |                       |                         |                         |                           |               |                    |                       |
| Vase           |                       |                         |                         | ×                         | ×             | ×                  |                       |
| Tile           |                       |                         |                         |                           |               | ×                  |                       |
| Cup            | ×                     | ×                       | ×                       |                           |               | ×                  | <b>16</b>             |
| Bench          |                       |                         |                         |                           | ×             |                    |                       |
| Tablecloth     |                       |                         | ×                       |                           | ×             |                    |                       |
| Lamp           | ×                     |                         | ×                       | ×                         | ×             | ×                  |                       |
| <b>NN</b>      |                       |                         |                         |                           |               |                    |                       |
| Vase           |                       |                         |                         |                           |               |                    |                       |
| Tile           |                       | ×                       |                         |                           |               | ×                  |                       |
| Cup            |                       |                         |                         |                           |               |                    | <b>5</b>              |
| Bench          |                       | ×                       |                         |                           |               |                    |                       |
| Tablecloth     |                       |                         |                         |                           |               | ×                  |                       |
| Lamp           |                       |                         |                         |                           | ×             |                    |                       |

Table 5, Visual – tactual incongruities per product.

Table 5 shows on which feel aspects the products differed significantly from respondents' expectation (two-tailed t-test,  $p < 0.05$ ). The number of crosses per product suggests that products in the VN and HN groups had more visual-tactual incongruities than products in the NN group. Products in the HN and VN groups showed these incongruities on more than one feel aspect and always on at least one aspect. Four of the products in the NN group also show incongruities on one (3 products) or two (1 product) aspects.

### *Surprise types*

For the 'see' questionnaire, we obtained two variables that measured the familiarity of a product (3 items,  $\alpha = 0.83$ ) and the degree of certainty with which the assessment was made (3 items,  $\alpha = 0.77$ ). From the 'see and feel' questionnaire, two variables that measured the degree of surprise with the product (3 items,  $\alpha = 0.94$ ) and the certainty of the original expectation (2 items,  $\alpha = 0.76$ ) were obtained.

Because the questions about certainty of expectation in both questionnaires intended to measure the same expectation at different moments in the evaluation process (before or after touching the product), we checked whether these were similar. Indeed, the two questions were highly correlated: 0.93 over product means.

Figure 3 shows the rated familiarity with the product plotted against the certainty of the expectation in the 'see' questionnaire. Figure 4 shows the degree of surprise plotted against the certainty of the initial expectation and represents data gathered in the 'see and feel' questionnaire. Because the questions about certainty of expectation in both questionnaires yielded highly similar outcomes, the horizontal axes in these two graphs can be regarded equivalent. In both graphs, the expected location for each surprise type as described in Table 2, is indicated by the marks 'HN', 'VN' and 'NN'.

The three groups can be distinguished based on the attributes used in the suggested surprise types. Most products selected for the three groups belong to the group they were selected for, but three exceptions can be observed. The products 'tile HN' and 'cup HN' seem not to belong to the HN group but to the VN group. The product 'bench HN' did not result in a surprise reaction and is, therefore, similar to items in the 'NN' group.

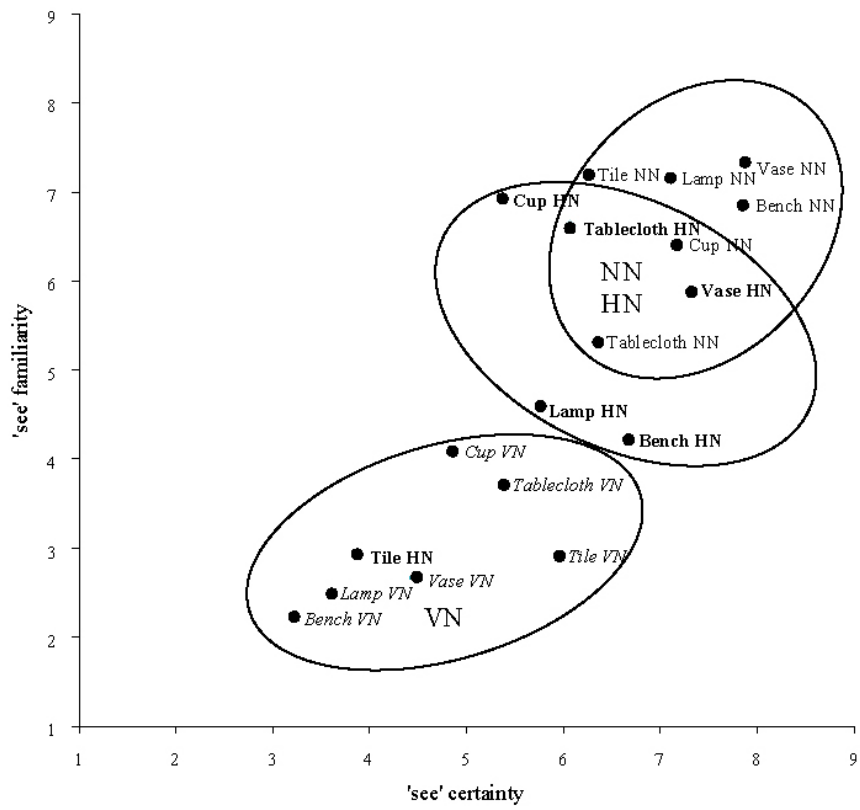


Figure 3, Product scores on certainty and familiarity.

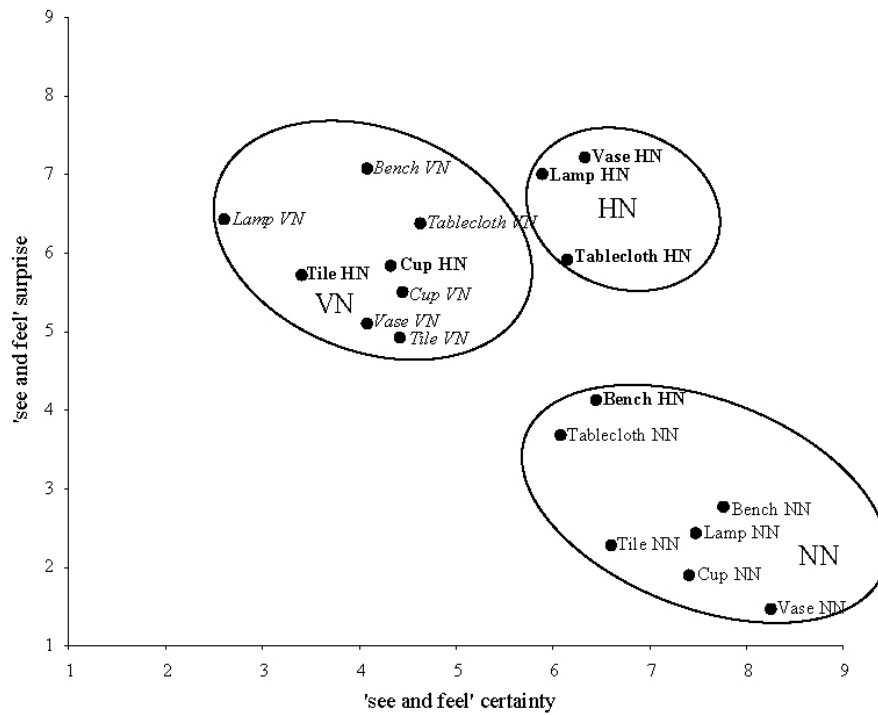


Figure 4, Product scores on certainty and surprise.

### *Evaluation of products*

PCA with oblimin rotation was used to reduce the number of product evaluation scales in both questionnaires. This led to three factors, describing the extent to which a product was perceived as normal or mainstream versus original (7 items,  $\alpha = 0.91$ ), beautiful or ugly (5 items,  $\alpha = 0.86$ ) and durable versus not durable (2 items,  $\alpha = 0.74$ ).

We explored the relationship between the factors familiarity, certainty and surprise on the one hand and the evaluation factors 'original', 'beautiful' and 'durable' on the other hand. This analysis showed that the original factor was correlated with all four other factors (correlation with certainty 'see' = -0.80, with familiarity = -0.89, with certainty 'see and feel' = -0.90 and with surprise = 0.58). The factor 'durable' was only correlated with the factor certainty 'see and feel' (0.54). The factor 'beautiful' was not correlated with any of the other factors. This shows that the aesthetic evaluation (beautiful factor) is not related to surprises elicited by these products.

### **Discussion**

Although the different types of surprises seem to exist, not all products selected for the three groups VN, HN and NN match the group they were selected for. In particular, the HN group seems to incorporate some difficulties. In this group, 50% of the products do not fit: one because the product is not surprising ('bench HN') and two because respondents are uncertain about their feel expectation for these products ('tile HN' and 'cup HN'). The following explanations can be given for these deviations.

For HN products, it is important to completely hide the characteristics that evoke the surprise reaction. When the characteristics are not completely hidden, the user will immediately be alarmed and begin to feel uncertain about what he/she sees. This is the case for the 'cup HN': the shape of the porcelain cup matches a plastic cup exactly, but the shininess of the surface is slightly different. For the 'tile HN' the same effect may occur. In addition, context may affect the evaluation for this product. The 'tile HN' is meant to be used on bathroom floors, which are more likely to be wet than a tile in an experimental setting on a cupboard. Therefore, we think that the 'tile HN' might still belong to the HN group when used in the bathroom context.

In the case of the 'bench HN' the deficiency is somewhat different; the bench did not surprise respondents. The actual feel experience of the bench was not different from the expected feel experience; the bench was only perceived as significantly heavier than expected but this did not result in a surprise reaction. An explanation might be that respondents who thought the bench was made out of wood did not discover their mistake, implying that the surprise was hidden too well! At the same time, 33% of the respondents in the 'see' condition correctly identified the material as plastic and thus were not surprised that the bench was not made out of wood.

The unexpected shifting from some of the products selected for the HN type into the VN and NN types point at difficulties in predicting individual perceiver reactions to HN products. The experiment nevertheless shows that designers are able to design these surprising products when the design strategies discussed are followed consequently.

### **Acknowledgements**

The authors would like to thank the following persons and companies for enabling us to use their products in our experiment: Koninklijke Tichelaar; Artismonline, Willeke Evenhuis and Alex Gabriel; VIVID, centre for design; Ineke Hans; Bertjan Pot. This research was supported by grant number 452-02-028 of the Netherlands Organization for Scientific Research (N.W.O.) awarded to H.N.J. Schifferstein.

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