Surprise and humor in product design

Designing sensory metaphors in multiple modalities

GEKE D. S. LUDDEN, BARRY M. KUDROWITZ,
HENDRIK N. J. SCHIFFERSTEIN and PAUL HEKKERT

Abstract

When information from two or more sensory modalities conflicts, this can evoke a surprise reaction as well as feelings of amusement, interest, confusion or disappointment. In concurrence to joke theory, we argue that people appreciate and enjoy appropriate incongruities that can be related back to the product, whereas they are confused by and have negative opinions towards inappropriate incongruities.

This paper reports the design and the evaluation of products in two categories (rubber duckies and deodorants), with (in)appropriate sensory incongruities of three types: visual-tactual, visual-olfactory and visual-auditory. Participants evaluated the level of surprise felt and the intensity of resulting emotions. They also indicated their overall liking for the products.

Both appropriate and inappropriate incongruities were evaluated as surprising as well as confusing. As expected, appropriate incongruities evoked more amusement and were generally favored. Whereas products with visual-tactual incongruities showed large differences in ratings on liking and amusement between appropriate and inappropriate incongruities, these differences were smaller for products with visual-auditory and visual-olfactory incongruities. Possibly, the appropriateness of an incongruity is more conspicuous when it is brought about by a conflict between touch and vision than when olfaction or audition are involved.

Keywords: incongruity, senses, sensory metaphor, surprise, amusement, confusion, humor, product design, design.

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1. Introduction

Imagine that you are browsing in a design store, where you see a coffee cup that seems to be made out of stainless steel. However, when you pick it up, you are surprised and a smile appears on your face: the cup is flexible. It turned out that the cup was made out of a rubbery material. Apparently, in this kind of situation you create an expectation about what you will perceive through touch (an inflexible, cold material), based on what you perceived through vision (the color and texture of stainless steel). When the expectation is disconfirmed, you will be surprised. Sometimes designers intentionally design sensory incongruities in order to create more interesting products (Ludden et al. 2008b). In some cases, a surprise in a product evoked by sensory incongruity can be humorous.

Most theorists in the fields of emotion and humor agree that humor is a phenomenon that relies on incongruity (e.g., Berlyne 1971, 1972; Deckers and Salais 1983; Nerhardt 1976; Roseman et al. 1996; Rothbart 1976; Suls 1972; Wyer and Collins 1992). However, not all forms of incongruity lead to humor and/or amusement. Nerhardt (1976) gives some examples of studies where incongruity did not result in laughter or amusement. For example, he describes an experiment where he asked people to lift a suitcase varying in weight and to judge its heaviness by looking at the suitcase. The results showed that laughter and smiling did not increase as the weight of the suitcase diverged from expectations. However, in the setup of this experiment, the participants were forewarned that their expectations might be disconfirmed and thus could have anticipated perceiving an incongruity.

In their efforts to explain how and when incongruity leads to humor, researchers have focused on different topics. First of all, there has been some debate about the form of the relationship between incongruity and humor. Berlyne (1972) has described this relation as an inverted-U where humor reaches a maximum at a moderate level of incongruity. Deckers and Salais (1983) report several experiments in which support for the inverted-U relation was found. However, they argue that with incongruity varying within a single dimension (e.g., weight, as in the example above) a positive relationship between incongruity and humor will be found, for which the sizes of increments in humor become smaller with an increasing degree of incongruity. Secondly, others (e.g., Veale 2004) have indicated that incongruity alone is not a sufficient condition for amusement. Suls (1972) has proposed that next to perceived incongruity, it is essential for the experience of humor that this incongruity is resolved. Finally, Rothbart (1976) points out that there is a problem with the use of incongruity and its resolution as an explanatory principle for laughter, because unexpected

events may not always evoke amusement. Instead, she claims, they can also lead to fear, curiosity, problem solving or concept learning. In accordance with the latter study, our research on products with visual-tactual incongruities (Ludden et al. 2009a, 2012) suggested that the surprises these products evoked in some cases elicited feelings of amusement, interest or pleasure, but in other cases feelings of puzzlement, confusion or disappointment.

In this article, we test theories of incongruity, surprise and humor in the field of multisensory product design. Understanding why some surprises are amusing whereas others are confusing is valuable for designers. For a product designer, a surprise reaction can be beneficial, because something surprising attracts attention and stimulates word-of-mouth (Derbaix and Vanhamme 2003). Naturally, if the surprise is a pleasant experience for a product user, the product designer or developer will gain from the extra attention. For example, in our previous experiments (Ludden et al. 2009a) we presented participants with a vase ("Red and white vase" designed by Hella Jongerius). This vase has rough edges on its surface and seems to be made of papier mache. However, the vase is made of ceramics and therefore feels much heavier than one would expect. In our experiments, this vase evoked considerable interest. Participants were curious about how the vase was made, probably because they were surprised by the combination of form and material.

1.1. *(In)appropriate incongruities*

A sensory incongruity involves the comparison of information from two or more sensory modalities. Apart from sensory perceptions, this process usually involves making cognitive associations. For instance, when describing a particular sensory experience people often make metaphorical mappings between different sensory domains (Cazeaux 2002). Lakoff and Johnson (1980) describe the essence of metaphor as understanding and experiencing one kind of thing (target) in terms of another (source). Analogously, a sensory metaphor occurs when one kind of sensory characteristic is understood in terms of another sensory domain. For example, someone may describe the color of a product (visual) as "a bitter, lemon yellow" (gustatory), or the sound of a product (auditory) as "soft" or "sharp" (tactual). Cazeaux (2002) states that these metaphorical comparisons between sensory characteristics are basic to any organized experience in the same way as a lexicon of primary metaphors is used in language. Primary metaphors are so commonly used that we do no longer recognize them as metaphors. For example, in the statement "he undermined my

line of reasoning", the metaphor "argument is war" is used. Forceville (2006) states that a metaphor is multimodal if target and source are represented exclusively or predominantly in different modes. He proposes an example of a multimodal metaphor "cat is elephant" in an animation film: a cat that makes a trumpeting sound. In this case, the target is triggered visually and the source by means of sound.

Sensory metaphors in products can be as simple as the examples mentioned above, but more complex associations can be made as well. As an example, in the US there is a cookie jar on the market that makes a cow sound when the user opens the lid. For a first time user, this cow sound may be surprising. The user will try to make sense of this incongruity. In Suls' (1972) terms, the user will try to resolve the incongruity. For Americans, there is a strong association between cookies and milk, and another strong association between milk and cows. A user who makes these associations will feel that the cow sound is somehow appropriate for the cookie jar. By making the associations, the user understands the incongruity and this leads to amusement.

We will use the term appropriate incongruity for incongruities that can be mapped back to other product characteristics and, oppositely, we will use the term inappropriate incongruity for incongruities that cannot be mapped (or are very difficult to map) back to other product characteristics. We expect that people appreciate and enjoy an appropriate incongruity, whereas they are confused by and have negative opinions towards an inappropriate incongruity, similar to jokes they either do or do not understand. In Suls' (1972) joke theory, if the receiver of a joke hears the punchline and either cannot make the connection back to the body of the joke or the punchline is obvious, then the joke will not be funny. Similarly, if the user of the product either cannot make the connection between the incongruent element and the product or if the incongruent element is obviously related to the product, the incongruity will not be amusing. One can view the product as the body of the joke. Someone perceiving a product makes assumptions about what to expect from the product through different modalities. Upon interaction, he or she comes across a sudden incongruity (a "physical punchline") and then attempts to connect the incongruity back to other aspects of the product.

1.2. *The present study*

People are capable of seeing objects from large distances and vision provides the most detailed information about a product within the shortest time frame

(Jones and O'Neil 1985; Schifferstein and Cleiren 2005). As a result, it is most likely that people will perceive an object through vision first and base their expectations for other modalities on the information they get from looking at a product. Therefore, in previous experiments, we have explored three types of incongruities that are most likely to occur in products: visual-tactual incongruity, visual-auditory incongruity and visual-olfactory incongruity (Ludden and Schifferstein 2007, 2009; Ludden et al. 2009). Analogously, a multimodal metaphor that uses the visual information of the product as the target is most likely easier to recognize than other forms of multimodal metaphors.

The results of our previous experiments suggest that creating surprise through visual-tactual incongruity is the most effective and direct strategy for generating both surprise and product appreciation. This type of incongruity can involve incongruent information about the same product characteristic in two sensory modalities and, therefore, does not always require associative mappings. We can, for example, both see and feel the size, shape, and material of a product. If a rubber cup looks like it is made out of metal, a person who sees the cup is likely to infer that its material will feel hard. As a consequence, that person will experience an intense surprise reaction immediately as he or she picks up the cup and feels that it is flexible. This is because the appearance of the cup's material generates a direct expectation of how the cup's material will feel. One could say that the cup looks hard, whereas upon touching it, it feels flexible.

Visual-olfactory and visual-auditory incongruities tend to be less direct than visual-tactual incongruities, and will often involve two different product characteristics. For instance, if a stuffed animal has a pink color, people are more likely to expect that it has a sweet, flowery smell rather than a grassy, leafy type of smell. In this case, the link between color and smell ("pink objects smell sweet") is based on learned associations and cultural conventions, rather than on lawful relationships (e.g., "metal feels hard and inflexible"). From a production point-of-view, the smell of the stuffed animal could have easily been changed. Therefore, the connection between the two sensory domains is less direct in the visual-olfactory case.

The results of previous experiments further suggest that the nature of the product in which the incongruity is perceived, is important for the evaluation of the surprise. For example, people may be more disturbed by and less appreciative of an incongruity in a tool than in a toy because tools are expected to function in a fully predictable manner. A surprise experience when using a tool may interfere with the user's functional aims and, therefore, decrease the user's appreciation for the product. On the other hand, toys are used in play, where an unexpected event could contribute to the user's enjoyment.

For the present study, we designed 12 products with various types of incongruities to investigate differences in people's reactions to (1) visual-tactual, visual-auditory and visual-olfactory incongruities; (2) appropriate incongruities and inappropriate incongruities; and (3) incongruities found in tools and incongruities found in toys. The first part of this paper discusses the design, selection, and creation of the products. The second part involves an experiment aimed at the evaluation and comparison of the created products. Finally, we discuss our results with reference to joke theory.

2. Design of products

To design the 12 products, several steps were taken. To ascertain that the final products were appropriate for our purposes, several test products were made during the design process. These test products were evaluated by designers working at the department of Industrial Design of Delft University of Technology. Below, we describe the design process in short.

2.1. *Step 1: Selecting products*

Surprise may result from an unexpected product characteristic alone rather than from an incongruity between sensory elements. Therefore, we aimed at selecting products that are familiar and that naturally produce information for all the senses. More specifically, the selected products should naturally produce an expected sound and an expected scent.

We selected one tool and one toy that are both often used in a bathroom environment. As a tool, we selected a roll-on deodorant. This product has a familiar feel, the moving parts ensure the production of a sound and because a deodorant comes in many scents, it is possible to change the scent to a reasonable degree without changing the functionality. For the toy, a rubber ducky was chosen. The rubber ducky is expected to have a light hollow rubber feel, a high-pitched squeak sound, and a rubber or plastic scent.

2.2. *Step 2: Searching for sources*

To search for sources to create sensory metaphors, a technique based on mind mapping (Buzan and Buzan 1994) was developed. A mind map is a non-linear

means of organizing, presenting, visualizing, and/or generating thoughts. It typically takes the form of a diagram that involves graphical and textual data that branch radially from a central idea or word. Mind maps are commonly used as a free form tool for study, organizing, brainstorming and problem solving. By analogy with mind mapping, we created "association maps". These association maps allow a designer to visualize the relationship between a product's attributes and seemingly unrelated objects and concepts.

We created association maps for a rubber ducky (Figure 1) and for a roll-on deodorant (Figure 2). These association maps formed the basis of the sensory metaphors we designed in our products. We started by branching outward from a product and by making associations with the product's attributes. Because we were searching for sensory metaphors, "feels", "scents" and "sounds" were selected as most important attributes. Next to these, we included four attributes

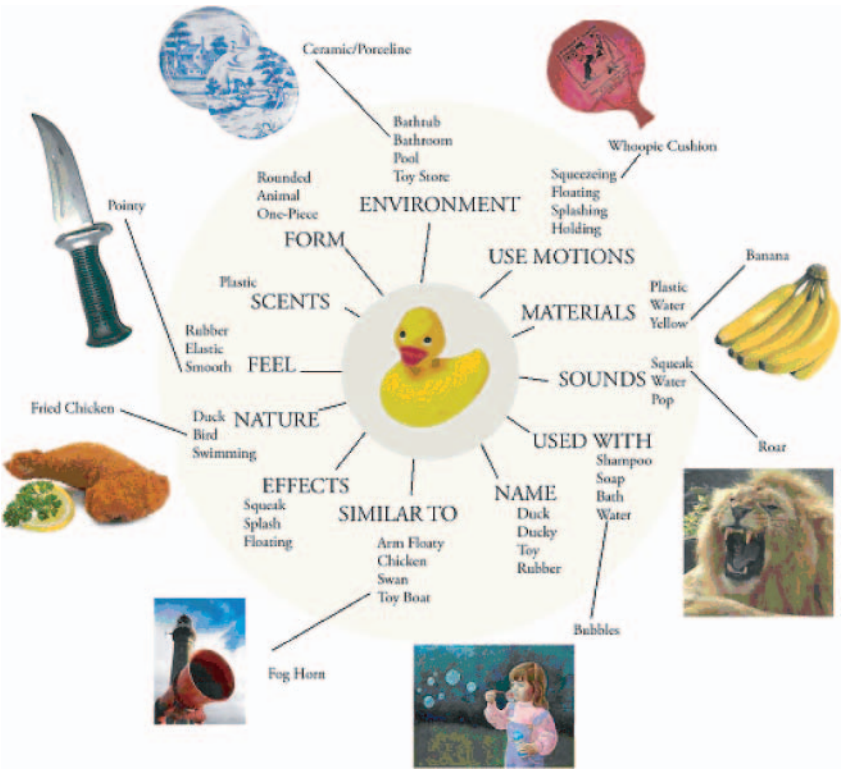

Figure 1. *Association map for a rubber ducky.*

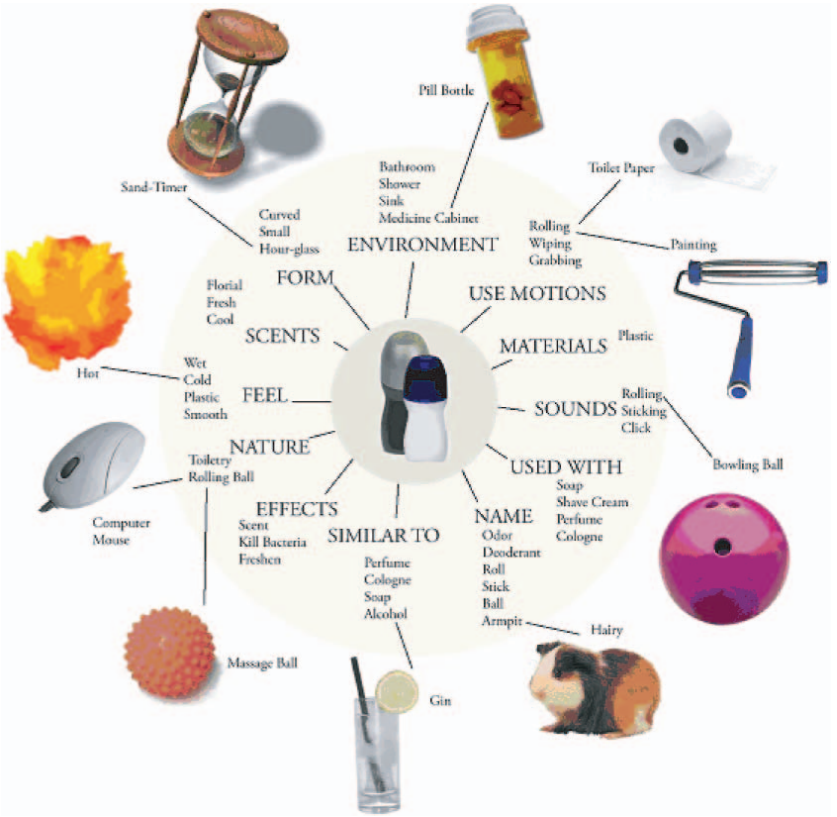

Figure 2. *Association map for a deodorant.*

that can directly influence the first three attributes: “form”, “material”, “use motions” and “effects”. Furthermore, we included two attributes describing the product itself: “nature” and “name”, and three attributes describing the product’s relation to other products: “environment”, “used with” and “similar to”.

The first branching lists items and concepts directly related to the product. This branching will not contain any possibilities for incongruity. When branching out to additional layers, further associations will be made that are less obviously related to the product. If the designer can incorporate properties of one of these distant associations into the product, the result will be an *appropriate* incongruity that can be related back to the product. This incongruity could then be amusing to the user, assuming the incongruity is not too obvious and the user is able to make the connection.

To make *inappropriate* incongruities, a designer must find sources of associations that are not on the association map (or for which the number of association steps is high enough) so that they cannot be related back to the product (target). This will result in surprise and most likely confusion.

2.3. *Step 3: Choosing incongruities*

Multiple sources of associations were identified using the maps. Looking at these maps, one can see how some of the connections could lead to surprising (and possibly amusing) product concepts. In the ducky association map, for example, one can see a connection between a rubber ducky and a whoopie cushion. A whoopie cushion is an inflated rubber bag that you can place on a chair. If someone sits on the chair the air is pushed out, which makes a flatulent sound. Although the connection between a rubber ducky and a whoopie cushion is relatively uncommon, both products involve a squeezing use-motion. Similarly, in the deodorant map, one can see a connection between a roll-on deodorant and a massage ball. Again, the two products are not directly related, but they are similar in nature because both products contain a rolling ball. The whoopie cushion and the massage ball can therefore serve as possible sources for appropriate incongruities for the rubber ducky and the roll-on deodorant, respectively.

Please note that we specifically did not choose properties of sources that were similar to properties of the target to create incongruities. For example, the whoopee cushion serves as a source for the rubber ducky because of their resemblance in use-motion, but the use-motion is not used to create a metaphor. To create recognizable metaphors, we chose a salient (Ortony 1993) and, therefore, easily recognizable property of the source. For instance, for the whoopie cushion we chose to implement its sound in the rubber ducky, because it is its most salient property. Using the sound of the whoopie cushion is more likely to result in a recognizable metaphor than, for example, its smell.

To determine the appropriateness or inappropriateness of an incongruity, we selected a number of promising incongruities for each modality from the maps. For these incongruities, we visualized their relation to the product using connection maps similar to the ones presented in Figure 3. Connections are denoted as weak (1 line), strong (2 lines) or very strong (3 lines). The strength of each connection was determined in discussion with two designers. Using these maps, we identified which sensory incongruities had strong associations with the product and could thus be easily related back to the product. At the same

time, we also identified sensory incongruities that had little to no associations and are thus very difficult to relate back to the product.

2.4. *Step 4: Designing the final products*

At this stage, we determined the stimulus manipulations needed to incorporate the selected incongruities in the products. We tried to avoid using manipulations that would cause changes in functionality of the product because they would, in essence, change the product. An important focus point in the design of the final products was the intensity of the incongruities. The intensity describes the subtlety or non-subtlety of the incongruent element. A very subtle incongruity may go unnoticed and an extreme incongruity (i.e., very sharp, very loud, very odorous) may be unpleasant (or surprising) solely for its intensity. Therefore, the intensity of incongruity should be at a moderate level for all types of incongruity.

Other researchers have performed studies trying to equate the intensities of specific product attributes across the senses (e.g., Schifferstein et al. 2010). To perform a similar study prior to the present experiment would require an elaborate study calibrating all attributes to be manipulated. Instead, we tried to control the intensity of the incongruities as much as possible by asking a team of six designers to analyse the concepts for level of incongruity prior to testing. Design alterations were made to maintain consistency of incongruity. Finally, six test variants were created for both the rubber ducky and the roll-on deodorant.

To determine which were the best manipulations to use in our experiment, the test products were evaluated in a pre-test by a group of eight designers. They determined if the test products were effective in (1) surprising potential users and (2) providing either an appropriate or inappropriate surprise. Table 1 describes the original test products and the final products used in the main study.

In the pre-test, we found that none of the eight participants were able to recognize the scent of baby lotion on the rubber ducky. For this reason we decided that the next best option, banana scent, would be a better choice for an appropriate olfactory incongruity. The designers agreed that all other choices for incongruities in the rubber ducky were effective, but we did make some changes to the ways in which the incongruities were implemented. For example, in creating the flatulent rubber ducky, we originally attached reeds to the air intake hole. This worked well, but was too visible. To better hide the

Table 1. *Description of test and final products*

	Modality	A/IA*	Test Product	Final Product	Final Manipulation	Effect of manipulation on sensory characteristics
Ducky	Tactual	IA	Hard body	Same	Filled with high-density foam	Ducky feels inflexible when squeezed
	Tactual	A	Vibrating	Same	Reed switch and motor in body, magnet under table	Ducky vibrates when lifted
	Auditory	IA	Metal clank	Same	Metal cymbals are installed in body	Clank from touching cymbals is heard when ducky is squeezed
	Auditory	A	Farting	Same	Whoopie Cushion is installed in body	Whoopee Cushion sound is heard when ducky is squeezed
	Olfactory	IA	Wood	Same	Ducky is sprayed with wood fragrance	Ducky smells of wood
	Olfactory	A	Baby lotion	Banana	Ducky is sprayed with banana fragrance	Ducky smells of banana
Deodorant	Tactual	IA	Off-balanced	Heavy	A steel weight is inserted in bottom	Deodorant feels very heavy
	Tactual	A	Massage ball	Vibrating	Reed switch and motor are installed in bottom, magnet placed in the cap	Deodorant applicator vibrates when cap is removed
	Auditory	IA	Bell	Same	A small bell is installed in bottom	The sound of the bell is heard when the deodorant is moved/shaken
	Auditory	A	Maraca	Same	Body of deodorant is filled with dry rice	A maraca sound is heard when the deodorant is moved/shaken
	Olfactory	IA	Almond	Honey	Deodorant is filled with pure honey	Deodorant smells of honey
	Olfactory	A	Mint	Same	Deodorant is filled with mint fragrance	Deodorant smells of mint

* A/IA stands for appropriate (A) or inappropriate (IA) incongruity

alteration, a small whoopie cushion was installed inside the body of the duck in lieu of the reeds. This provided the desired sound in an inconspicuous manner. In the metal clank ducky, small metal disks were attached loosely to the inner body (top and bottom). When the ducky was squeezed, the metal disks would make contact and produce a chime. In the pre-test, we found that the body of the duck somewhat muffled this chime sound and thus a larger opening in the bottom was made to allow the high pitch sound to be audible.

For the deodorants, an off-balanced ball as a roller was too subtle to be recognized and so we decided to use the second best option for inappropriate tactual incongruity: a heavy deodorant container. For an appropriate tactual incongruity, we first tested a roller ball with rubber dimples. However, this roller was a visual surprise rather than a tactual surprise. We then decided to pursue a vibrating deodorant as the appropriate tactual incongruity. The original inappropriate scent of almond cookies was mistaken for toilet cleaner and so we decided to use honey scent instead. All other incongruities for the deodorant were deemed effective. In designing the maraca deodorant, several filler materials were tested, including dry rice, small metal beads and chocolate sprinkles. The dry rice was found to produce the most realistic maraca sound. In designing the bell deodorant, the most pleasant bell sound was made by suspending a single jingle bell in cotton inside the body of the deodorant.

In Figure 3 the mappings of the appropriate incongruities are visualized for both the ducky and the deodorant. The strength of the associations across modalities can thus be compared. These maps start with the product in the centre and branch outward, similar to the association maps. The maps show the path(s) along which the desired incongruity can be related to the product. All appropriate incongruities have at least one strong connection to the product through an abstract attribute. It might be important to note here that these connections are not necessarily universal and different cultures may make different connections. However, as long as designers are selling or testing their products within their own culture, the intended product users will be able to make the appropriate connections.

3. Experiment

The products described in Table 1 were created as working prototypes. Including a control product without manipulations, there are seven versions of each product (deodorant and ducky) that all look the same, but sound, feel and smell

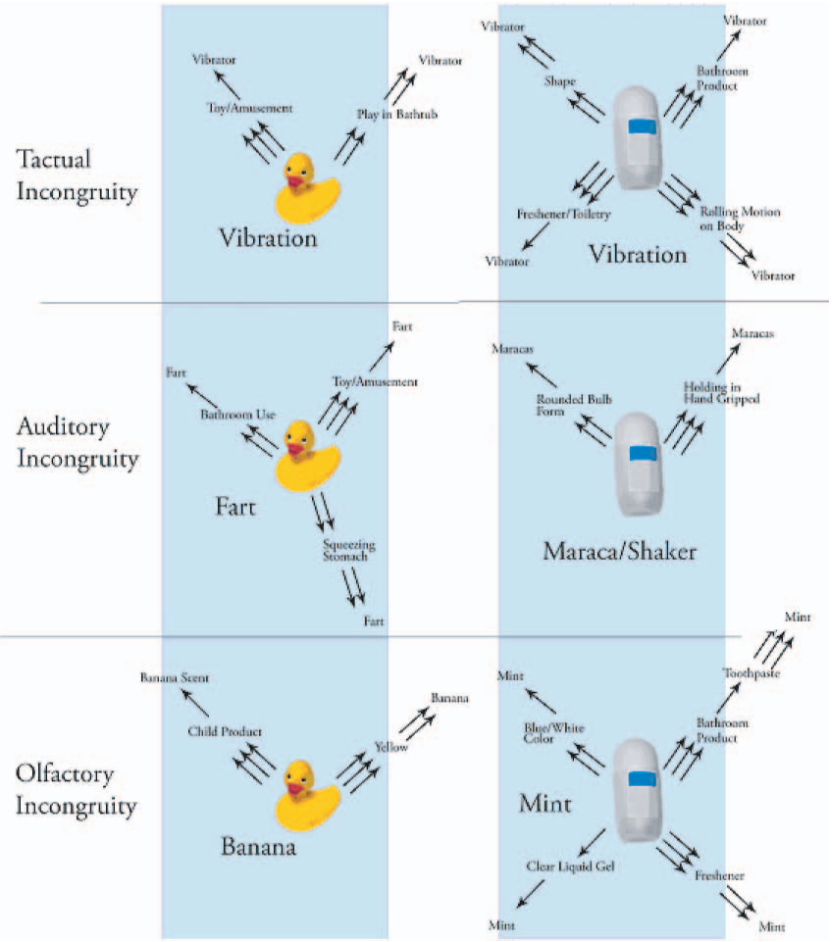

Figure 3. *Strength of connections of selected appropriate incongruities for ducky and deodorant with the original products.*

differently. We added one extra control product to each product set to prevent participants from expecting only surprises when evaluating the products.

The products were evaluated in six focus groups of eight participants each. Using focus groups in the evaluation of products ensured a lively discussion about the products after the evaluation process. With this method, we expected to gain more insight into participants' thoughts and opinions about the different types of products. However, by using focus groups participants were able to see all of the products and the reactions of other participants during the evaluation

process. To minimize the effect this may have had on their judgements, participants were explicitly instructed not to talk to each other before the start of the discussion.

Participants were 48 students and employees (22 female and 26 male, aged 18–57 years old, mean 25.6) of the faculty of Industrial Design Engineering of Delft University of Technology. The participants of three focus groups were presented with all eight duckies and the participants of the other three focus groups were presented with all eight deodorants. All products were presented without brand labels.

3.1. *Method*

Each focus group sat at a table with eight chairs. There was one product in front of each seat. Each product was placed on a placeholder with a letter code. Participants were instructed to examine the product in front of them. They were allowed to pick up the product, interact with it, and explore it through their senses, but they were not allowed to take the product apart. For each product, they filled out a questionnaire.

The questions for each product were similar, but differed slightly (see below). They concerned the level of surprise felt ("This ducky/deodorant is surprising"), deviations from expectation for each sensory modality ("The ducky/deodorant felt/sounded/smelled exactly how I thought it would"), intensity of resulting emotion(s) ("This ducky/deodorant is confusing"; "This ducky/deodorant is amusing"), their overall opinion of the product ("I like this ducky/deodorant"), and of its specific sensory characteristics ("I like the scent/feel/sound of this ducky/deodorant"). This last question differed per type of stimulus: we only asked about the manipulated sensory characteristic. For example, for the products manipulated on sound we asked about the pleasantness of the sound. For one of the control products we asked about sound and for the other one we asked about scent and feel. All questions were rated on a seven-point Likert scale with end points "disagree strongly" to "agree strongly". The order of the questions differed between products within each questionnaire.

After two minutes during which they filled out the questionnaire, participants placed the product back onto its placeholder, and changed seats to examine the next product. This repeated until all participants experienced all eight products. In each focus group products were presented in a different order.

After the group reviewed the set of products, they discussed the entire set. The experimenter led the discussion on the basis of the following questions:

"Which product did you like the most?"; "Which product did you like the least?"; "Which product was most surprising?"; "What would be surprising in this type of product?"; "Do you like surprises in products in general? Can you mention examples?" While the products were examined, the focus group sessions were videotaped to record (surprise) reactions as well as reactions and opinions during the discussion.

3.1.1. *Data analysis.* Separate analyses were carried out for duckies and deodorants throughout the study.

Responses to the questions asking about deviations from sensory expectation were used to check our manipulations. We expected the products with appropriate or inappropriate tactual/auditory/olfactory incongruities to differ from expectations on the corresponding response scales. One-tailed t-tests were used to test whether product means were significantly lower than the centre of the scale (see Section 3.2.1).

To study the mutual effects of sensory modality and (in)appropriateness, the questions about overall liking, surprise, amusement and confusion were subjected to analyses of variance (ANOVAs) with Manipulated sensory modality (3 levels: touch, smell and sound) and (In)appropriateness (2 levels: appropriate and inappropriate) as within-participants factors (see Section 3.2.2). Through these ANOVAs, we can determine whether the observed variance in a dependent variable is due to differences between the three sensory modalities, to differences between appropriate versus inappropriate incongruities, or to both sources of variance simultaneously. The data for control products were not included in these ANOVAs.

To compare the effects of appropriate and inappropriate incongruities with control conditions (no incongruity), separate ANOVAs were performed with (In)appropriateness (3 levels) as the single within-participants factor (see Section 3.2.3). Differences between appropriate, inappropriate and control products were examined in paired comparisons with Bonferroni adjustment of confidence levels for multiple comparisons (Stevens, 1978). For each manipulated sensory characteristic (smell, touch, audition) we performed an ANOVA on the liking ratings for that specific sensory characteristic ("I like the scent/feel/sound of this ducky/deodorant") with (In)appropriateness (3 levels: appropriate, inappropriate and control) as within-participants factor (see Section 3.2.2).

Finally, we analyzed the content of the opinions and remarks expressed during the group discussions in order to illustrate the results from the questionnaires (see Section 3.2.4).

Table 2. *Means for deviation from expectation*

	feels as expected	sounds as expected	smells as expected
Ducky			
Control	5.8	5.3	5.2
Tactual Appropriate	**2.3***	1.8*	5.2
Tactual Inappropriate	**1.7***	1.8*	5.2
Auditory Appropriate	4.4	**1.9***	5.0
Auditory Inappropriate	4.4	**1.8***	4.9
Olfactory Appropriate	5.5	5.2	**1.8***
Olfactory Inappropriate	5.6	5.8	**2.7***
Deodorant			
Control	5.0	5.7	5.1
Tactual Appropriate	**1.7***	2.0*	4.7
Tactual Inappropriate	**2.0***	5.6	4.7
Auditory Appropriate	4.4	**2.5***	4.9
Auditory Inappropriate	4.0	**2.5***	4.9
Olfactory Appropriate	4.6	5.6	**1.8***
Olfactory Inappropriate	4.9	5.5	**1.5***

Means in bold: deliberately manipulated characteristics
* significantly lower than centre of scale (= 4), one-tailed t-test, $p < 0.05$.
N = 24 for (in)appropriate products and N = 48 for control products.

3.2. *Results*

Results will be discussed in four sections. The first section discusses the manipulation check. The subsequent two sections focus on differences in people's reactions to (1) visual-tactual, visual-auditory and visual-olfactory incongruities; and (2) appropriate incongruities and inappropriate incongruities. The last section discusses people's opinions as expressed in the discussion part of the focus group sessions.

3.2.1. *Manipulation check.* One-tailed t-tests were carried out on the questions asking about deviations from expectations in order to test whether mean ratings were significantly lower than the centre of the scale. Generally, Table 2 shows that we succeeded in manipulating the desired sensory characteristics (the ratings in bold). However, for some products, the manipulation in one sensory characteristic caused unanticipated experiences towards other sensory characteristics. Specifically, manipulations in tactual characteristics sometimes changed the auditory characteristics. We see this for the tactual appropriate and the tactual inappropriate ducky and for the tactual appropriate deodorant.

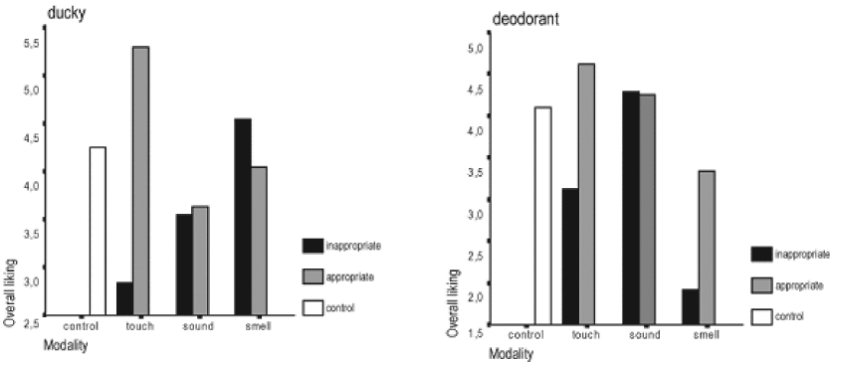

Figure 4. *Mean ratings on overall liking per Manipulated sensory incongruity and per (In)appropriateness for duckies and deodorants.*

Changes in tactual characteristics generally imply a change in material characteristics, which can also affect sound properties. Furthermore, the vibrations that were used in the tactual manipulations naturally produced a sound. As our results will show later on, these unanticipated changes in sound properties for tactually manipulated products did not directly interfere with our other analyses.

3.2.2. *Interactions between sensory modalities and (in)appropriateness.* For both the duckies and the deodorants, the ANOVAs with surprise, overall liking, amusement or confusion as dependent variables, and Manipulated sensory modality and (In)appropriateness as factors showed interaction effects for overall liking ($F[2,276] = 13.9$ and $F[2,274] = 3.5$, all $p < 0.05$) and amusement ($F[2,276] = 11.8$ and $F[2,274] = 10.6$, all $p < 0.05$), but not for surprise and confusion ($p > 0.20$). Figure 4 shows the interaction effect we found for overall liking. The interaction effect we found for amusement follows a similar pattern (data not shown). In Figure 4 we see that differences in mean liking ratings between products with appropriate and inappropriate incongruities are larger in size for the products that were manipulated in touch and (to a lesser extent) smell, than for the products that were manipulated in sound.

We further compared responses to tactual, auditory and olfactory incongruities by evaluating the liking ratings for specific sensory characteristics ("I like the scent/feel/sound of this product") (see Table 3). While designing our products, we focused on creating the same average level of pleasantness for all manipulations. For both duckies and deodorants, the control products (the unaltered products) rated average (3–5) on all three sensory characteristics. However, our analyses showed some interesting deviations for the manipulated

Table 3. *Means for perceived liking per manipulated sensory characteristic (N = 24)*

	like feel	like sound	like smell
Ducky			
Control stimuli	4.9[a]	4.5[a]	3.5
Appropriate stimuli	4.8[a]	2.8[b]	4.5
Inappropriate stimuli	2.4[b]	2.8[b]	3.8
Deodorant			
Control stimuli	4.4[a]	3.4	4.1[a]
Appropriate stimuli	4.2[a]	4.7	3.7[a]
Inappropriate stimuli	2.7[b]	4.5	1.7[b]

[a,b] Means with different superscripts were significantly different in vertical comparisons, $p < 0.05$.

stimuli. ANOVAs showed main effects of (In)appropriateness on the perceived liking of the feel of the products ($F[2,69] = 29.5$ and $F[2,69] = 9.1$, both $p < 0.001$). This indicates that the appropriateness of the incongruity influenced the degree to which participants liked what they experienced. For both product categories, the feel of the tactually inappropriate stimulus was perceived as significantly less pleasant than the feel of both the appropriate and the control stimulus. We found a similar effect of (In)appropriateness on the perceived liking of the scents of deodorants ($F[2,69] = 13.7$, $p < 0.001$). Finally, we also found a main effect of (In)appropriateness on the perceived liking of the sounds of duckies ($F[2,69] = 8.5$, $p < 0.001$). Both manipulated sounds for the ducky were evaluated as significantly less pleasant than its original sound.

The mean ratings on overall product liking presented in Figure 4 show roughly similar differences between appropriate and inappropriate incongruities as those found for the liking ratings for specific sensory characteristics in Table 3. Although not significant in all cases, ratings on liking for products incorporating tactual and olfactory inappropriate incongruities are typically lower than those for appropriate incongruities.

3.2.3. *Main effects of (in)appropriateness.* In ANOVAs with (In)appropriateness as factor and the questions about surprise, overall liking, amusement and confusion as dependent variables, we expected to find that both appropriate and inappropriate incongruities were surprising, that appropriate incongruities were more amusing and better liked than inappropriate incongruities and that inappropriate incongruities were more confusing than appropriate incongruities. Overall, the results for duckies and deodorants were similar and the majority supported our hypotheses. We found significant main effects of (In)appropriateness on all four variables (see Table 4). As expected, products

Table 4. *Mean ratings (averaged over sensory conditions) and F-values for surprise, confusion, amusement and overall liking per type of product incongruity.*

	Control N = 48	Inappropriate N = 72	Appropriate N = 72	F-value
Ducky				
Surprise	2.5[a]	4.6[b]	4.4[b]	26.7**
Confusion	2.1[a]	3.6[b]	3.6[b]	16.4**
Amusement	3.9[ab]	3.6[a]	4.4[b]	4.5*
Overall liking	4.3[b]	3.6[a]	4.3[b]	4.2*
Deodorant				
Surprise	2.5[a]	4.4[b]	5.2[c]	35.7**
Confusion	2.3[a]	3.8[b]	4.1[b]	16.7**
Amusement	2.3[a]	3.1[b]	4.5[c]	25.7**
Overall liking	4.1[a]	3.1[b]	4.1[a]	7.5**

[a,b,c] ratings with different superscripts were significantly different in horizontal comparisons ($p < .05$).
* significant main effect at the .05 level, ** at the 0.01 level.

with both appropriate and inappropriate incongruities rated higher on surprise than the control versions. As for overall liking and amusement, ratings for appropriate versions were higher than those for inappropriate versions of products. However, unexpectedly, all implemented incongruities were judged to be both surprising and confusing.

3.2.4. *Group discussions.* We analyzed transcripts from the group discussions to identify similarities in remarks that were made and issues that were raised. Here, we discuss issues that were often mentioned ($N > 10$ remarks) and/or remarks that further illustrate the results presented above.

Participants were generally concerned about surprises that altered the function of the product ($N = 23$). Even though one of our products was a toy (the rubber ducky), participants designated play as its function and, therefore, this concern applied to both products. Participants expressed that surprises could be fun in new and unfamiliar products as long as the surprise did not alter or interfere with the functionality of the product.

When describing what they liked about the products or what they would like to encounter in a surprising product, many participants ($N = 15$) favored tactual surprises. The other types of sensory incongruity were not mentioned very often ($N < 5$). A considerable part of the discussion was devoted to participants' personal preferences for smell ($N = 21$), and, to a lesser extent, sound ($N = 7$). Liking or disliking a smell was in some cases mentioned in connection with an

association of the memory elicited by the scent (N = 4). Opinions on the pleasantness of smells seemed to vary between participants.

Some participants expressed their concern about the long-term effects of surprise (N = 10). It was often mentioned that although surprise is fun, it is a one-time-only experience. Participants suggested that experiencing surprise over and over again, was bound to become boring. However, several other participants mentioned that they liked a certain product solely because it was surprising (N = 8). Possibly, these participants valued the surprise factor of the products, because they thought they could amuse or impress others with the surprise.

4. Discussion

The present study had a somewhat explorative character. Although our manipulation check shows that we succeeded in manipulating the desired characteristics in the creation of products, we did not in all cases succeed to completely separate manipulations between the senses. Consequently, some of the results need to be interpreted with caution. Nonetheless, our approach shows how designers can systematically design surprising products that evoke amusement: using association maps allows designers to explore less obvious routes to create amusing incongruities.

4.1. *Differences between product categories*

Comparing the results for duckies and deodorants shows some interesting differences between the two product categories.

Results for overall liking and amusement mostly follow a similar pattern for the two product categories. However, the ratings for the control products in Table 4 show considerable differences between overall liking and amusement. Whereas the control ducky rates high both on overall liking and amusement, the control deodorant rates high on overall liking but low on amusement. This is in line with our intuitive expectation that for a tool the relationship between overall liking and amusement is less strong than for a toy.

Furthermore, it seems that the olfactory manipulations for deodorants caused stronger effects than those for the duckies (see Table 3). This can be explained by the fact that the scent of a deodorant forms a substantive part of its function-

ality. Therefore, manipulations on this element are likely to cause stronger effects.

It should be noted that, irrespective of its intended functionality, people may use a product as a toy in some situations and as a tool in other situations. For example, people may play with their pens during meetings while they are not using them to make notes. Therefore, rather than differentiating between toys and tools in future experiments it may be more useful to distinguish between the "usage modes" people are in while using the product (Hassenzahl 2008). Hassenzahl proposes two usage modes: a "goal-oriented" mode, where task fulfillment is important and an "activity-oriented" mode, where the focus is on the activity itself. In future studies, this distinction could be used by presenting participants with different tasks for the same product. For example, we could present a pen and ask participants to explore the pen (activity-oriented mode) or to write their name and address with the pen (goal-oriented mode). A pen is a logical product choice in this case, because people use pens both to play and to perform tasks with.

4.2. *Different types of sensory incongruities*

In terms of generating surprise, both the results from our questionnaire and the discussions with participants suggest that manipulations involving visual–tactual incongruities are the most successful of the types tested here. Ratings on surprise were highest for products that were manipulated on touch and in the discussions many participants mentioned that they liked and would like to encounter tactual surprises. Furthermore, overall liking ratings in Figure 4 show the largest difference between appropriate and inappropriate products for the stimuli that were manipulated on tactual characteristics. Possibly, the appropriateness of an incongruity is more conspicuous when it is brought about by a conflict between touch and vision than when olfaction or audition are involved.

As one participant brought to our attention, perhaps we should differentiate between instant surprises and discovery surprises. The surprises that the tactual incongruities in these products evoke can be thought of as "instant surprises", because they do not require additional exploration, they tend to be perceived immediately. To experience auditory or olfactory incongruities, the user typically explores the product further to receive additional stimulation (i.e., squeezing, bringing near to face, shaking, lifting). If an unexpected sound or smell is

perceived, the user tends to verify whether the unexpected stimulus is indeed produced by the product. Therefore, surprises evoked by auditory and olfactory incongruities are less direct and can be thought of as "discovery surprises". It is arguable that tactual surprises were mentioned more often in the discussions, because they are easier to think of and understand, as they can be perceived in one and the same product attribute. On the other hand, discovery surprises might be more rewarding to the user in the long term.

In three cases with inappropriate incongruities of tactual and olfactory stimuli, the perceived pleasantness of the products decreased (Figure 4 and Table 3). Possibly, the differences in perceived pleasantness of sensory stimuli are brought about by the inappropriateness of the stimuli. In other words, the inappropriate sensory stimuli can be perceived as less pleasant *because* they are inappropriate (e.g., Schifferstein and Verlegh 1996). In contrast, we did not find differences in perceived pleasantness between appropriate and inappropriate stimuli for sounds. Probably, this difference is related to the different ways in which sensory stimuli are processed. Whereas scents and tactual perceptions are more directly related to a perceiver's emotional experience, product sounds may be processed in a more cognitive manner (Schifferstein and Desmet 2007).

As for olfactory stimuli, context can play an important role in the perceived pleasantness. Dubois (2000) states that odours cannot be considered as isolated stimuli and that their context must always be taken into consideration. As an example, some participants mentioned in the discussion that they liked the scent of the olfactory inappropriate deodorant (honey). However, in the context of a deodorant, the sweet smell was perceived as unpleasant. Perhaps any uncommon scent in a deodorant would have been perceived as unfavourable (Herz and Schooler 2002). Given that there are soaps with honey-scent on the market, some manufacturers think that honey is an appropriate smell for a body-care product. Perhaps, smells reflect more idiosyncratic preferences and dislikes than other sensory stimuli.

4.3. *Differences between appropriate and inappropriate incongruities*

This study also tested whether the emotional reactions to appropriate and inappropriate incongruities differ as predicted based on joke theory. Both the products with appropriate incongruities and those with inappropriate incongruities were found surprising. Although based on Suls's (1972) model, we expected that inappropriate incongruities would be perceived as more confus-

ing, our results show that both appropriate and inappropriate incongruities were found to be confusing. Nevertheless, those products with appropriate incongruities were appreciated (liked) more and were perceived as more amusing than those with inappropriate incongruities. Perhaps our results indicate a limitation of Suls's two-stage model. In their review of humor theory, Wyer and Collins (1992) state that Suls's model is primarily applicable to the comprehension of jokes, cartoons, or other stimuli of which perceivers believe a priori that they will be funny. However, for most products users do not expect to encounter a humor-eliciting aspect. This may evoke the simultaneous experience of confusion and amusement upon perceiving products with appropriate incongruities.

Alternatively, Silvia's (2005) theory on the sequential processing of emotions suggests that upon encountering an incongruity, participants experience both surprise and confusion. For the inappropriate incongruities, the sequence may end here, or participants may experience another emotion that we did not measure in this experiment. For example, it is not unlikely that participants have experienced disappointment in reaction to inappropriate incongruities. For the products with appropriate incongruities, our results show that amusement may be experienced after the incongruity is resolved.

In future research it would be interesting to test if and how different types of (in)appropriate incongruities can evoke other emotions as well. Again, humor theory could be used to build predictions. We have suggested earlier that in the same way that jokes with an obvious punchline are not funny, a product with an incongruent element that is too easily related back to the product will not be experienced as amusing. People may experience indignation when they perceive these types of incongruities.

Participants expressed their concern about the long-term effect of surprising (and amusing) products. Nevertheless, in his discussion of the repeated exposure to humor, Suls (1972) states that some forms of humor can be appreciated more than once. He suggests multiple reasons for a repetitive experience of humor. Two of these seem readily applicable to products. The first is the possibility that the humorous event is associated with the positive emotional response the perceiver had during the first encounter. The other is the possibility that humorous events may become more enjoyable upon repeated exposure, because familiarity with the humorous event may lessen the tension aroused by novel stimuli. In fact, a study where we presented participants with the same surprising products at three different points in time showed that even after the third evaluation people experienced the emotions interest, fascination and confusion (Ludden et al. 2012).

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Corresponding author: Geke Ludden (g.d.s.ludden@utwente.nl)

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