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CAN WE DESIGN PLEASURABLE PRODUCTS BY COMBINING PLEASURABLE SENSORY PROPERTIES?

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ABSTRACT

Sensory pleasure is an important component of product experience. Designing pleasurable products can enrich user satisfaction and contribute to the well-being of people and society. In this study we are wondering how sensory properties of products contribute to a pleasurable product experience. We manipulated stimuli of two sensory modalities and determined the correspondence between the pleasantness of these sensory properties and the pleasantness of products in which the two sensory properties were combined. In the first study we used colors and smells that differed in freshness. We designed products (softdrinks and dishwashing liquids) using fresh and non-fresh stimuli (colors and smells) in four different combinations and asked respondents how fresh and pleasant they find each product. In the second study, we designed alarm clocks and whistle kettles using noisy and calm stimuli (sounds and visual patterns) in four different combinations, and asked respondents how noisy and annoying they find each product. The correlations between noisiness and annoyance were found both for single stimuli and for the final products. However, the correlations between freshness and pleasantness were found only for single stimuli. There were no such correlations for the final products. Apparently, the combination of two pleasant stimuli does not guarantee the pleasantness of the final product.

Keywords: *sensory product experience, pleasantness, freshness, noisiness*

1. INTRODUCTION

Sensory pleasure is an important component of product experience [1]. Designing pleasurable products can enrich user satisfaction and contribute to the well-being of people

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and society. But how can we design pleasurable products? For instance, how do sensory properties of products contribute to a pleasurable product experience?

A study on table lamps and air fresheners [2] failed to demonstrate a correlation between the pleasantness of single modality stimuli (visual, tactual, auditory and olfactory) and the pleasantness of the multisensory final products. In the present study, we manipulated stimuli of two sensory modalities, and we determined the correspondence between the pleasantness of these sensory properties and the pleasantness of products in which the two sensory properties were combined.

Several studies have demonstrated that pleasantness is highly correlated with freshness [3; 4; 5; 6; 7]. Therefore, in our first study we used colors and smells that differed in freshness. We designed products (softdrinks and dishwashing liquids) using fresh and non-fresh stimuli (colors and smells) in four different combinations and asked respondents how fresh and pleasant they find each product.

In psychoacoustic literature, the terms "noisy" and "annoying" are almost used as synonyms [8; 9; 10; 11]. Therefore, in the second study, we designed alarm clocks and whistle kettles using noisy and calm stimuli (sounds and visual patterns) in four different combinations, and asked respondents how noisy and annoying they found each product.

2. ARE FRESH PRODUCTS PLEASANT?

2.1. Experiencing freshness

For many personal care products, cleaning products, beverages and food products it is important to evoke freshness. Freshness plays an important role in many everyday experiences, such as shaving, brushing teeth, taking a shower, and drinking soda.

Freshness is a multisensory product experience that includes visual, olfactory, tactile, and, in some cases, also gustatory and auditory components. According to the results of a questionnaire study in which respondents assessed the relative importance of different sensory modalities for various product experiences [12], the dominant modality for the experience of freshness was olfaction (mean rating 3.4 out of 4), followed by taste (3.1) and vision (2.9).

According foods or beverages studies, the most important characteristics of refreshing are temperature-related tactile attributes (cool, cold) [13]. The second important attribute of refreshing in food and beverage products is flavor. Orange and strawberry flavors were judged as the most refreshing for food and beverages [9], and mint odorants were scored as the most refreshing in oral care [5]. The gustatory sensation most often associated with a refreshing experience is high acidity [5; 7].

Color also affects the perceived freshness of beverages. Experimental data suggest that judgments on color freshness depend on the associations with particular products. For example, consumers expect clear and brown non-alcoholic beverages to satisfy their thirst more than other colors, because of their association with water and colas, respectively [6]. Of

the other colors, red and orange beverages were perceived as more thirst-quenching than green or purple ones [13].

2.2. Present study

We used an experimental approach to determine the relationships between freshness and pleasantness in product experience. In the pre-study we asked respondents to assess the freshness and pleasantness of sensory stimuli (colors and smells) on a 9-point scale. In the main study we created products using fresh and non-fresh stimuli of both modalities in four different combinations: 1) fresh color + fresh smell, 2) fresh color + non-fresh smell, 3) non-fresh color + fresh smell and 4) non-fresh color + non-fresh smell. We asked respondents to assess the freshness and pleasantness of each product on a 9-point scale.

2.3. Pre-study

The participants were 40 students and staff members of the Faculty of Industrial Design Engineering, Delft University of Technology. Their ages ranged from 18 to 52 years; mean age was 26.0 years.

Two products were selected for which 'freshness' is likely to be an important characteristic: a soft drink and a dishwashing liquid. For each product 10 olfactory and 11 visual stimuli were prepared (odors and colors). The smells and the colors for each product were evaluated separately. All stimuli were randomized between respondents. Each sample was assessed on 9-point scales for fresh, colorful, natural and pleasant from "not at all" to "very".

2.3.1. Statistical analysis

For each product, repeated measures ANOVAs on freshness and pleasantness ratings were performed with smell or color as within-subjects factor. Post-hoc analyses with Bonferroni adjustment were performed to test the significance of the differences between means.

2.3.2. Results

The analysis showed significant main effects of both smell and color on the freshness ratings for both products ($p<0.01$). The main effects of color and smell on the pleasantness ratings were also significant ($p<0.02$).

Pleasantness was highly correlated with freshness. The Pearson correlations between freshness and pleasantness of colors were 0.78 for a dishwashing liquid, and 0.61 for a soft drink. The correlations between freshness and pleasantness of smells were 0.72 for a dishwashing liquid, and 0.75 for a soft drink. All correlations were significant at the 0.01 level (two-tailed).

2.4. Main study

Two groups of 20 respondents participated in the main study. In the first group ages ranged from 18 to 28 years, mean age was 22, and 62% were women. In the second group the ages ranged from 18 to 32 years, mean age was 23, and 60% were women.

For both products 4 variants were created combining fresh and non-fresh visual and olfactory stimuli according to the full factorial (2x2) design. Participants evaluated the products with respect to their freshness, pleasantness, colorfulness, and naturalness on 9-point scales (from "not at all" to "very").

2.4.1. Results

The combination of fresh stimuli rated higher than the combination of non-fresh stimuli for both soft drinks and dishwashing liquids ($p<0.01$). The ratings of soft drinks and dishwashing liquids with fresh smell and non-fresh color were significantly higher than the ratings of products with fresh color and non-fresh smell ($p<0.01$). This indicates that smell was important for the overall experience of freshness in both soft drinks and dishwashing liquids and that color did not seem to contribute to freshness for these two products (Figure 1).

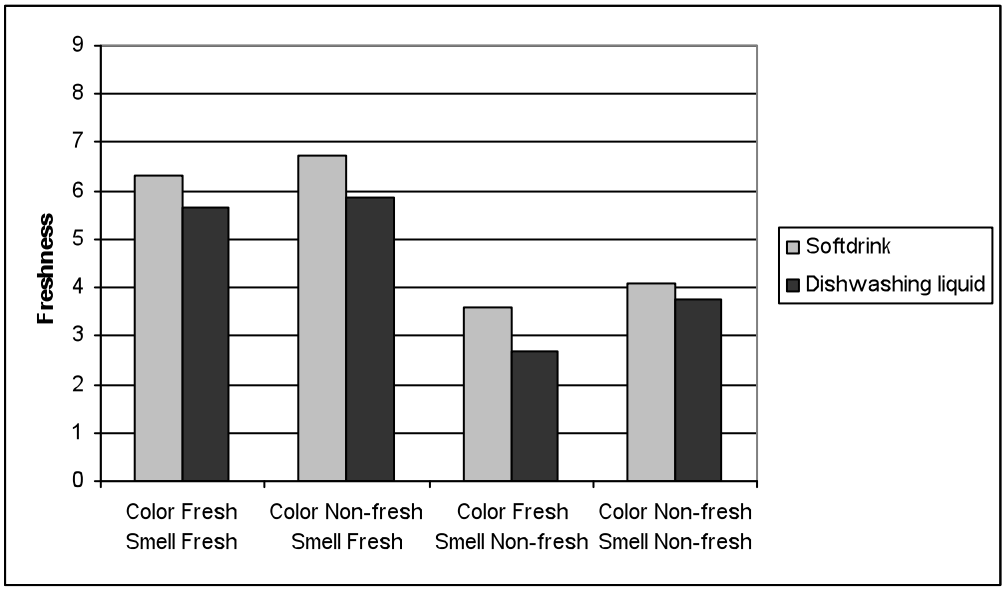

Figure 1: Freshness rating for softdrink and dishwashing liquid

However, the pleasantness ratings of both products did not match the freshness ratings. The combination of fresh stimuli did not differ in pleasantness from the combination of the non-fresh stimuli for both products ($p>0.10$). For both soft drinks and dishwashing liquids, the combination of fresh color and non-fresh smell was considered as the least pleasant by our respondents (Figure 2).

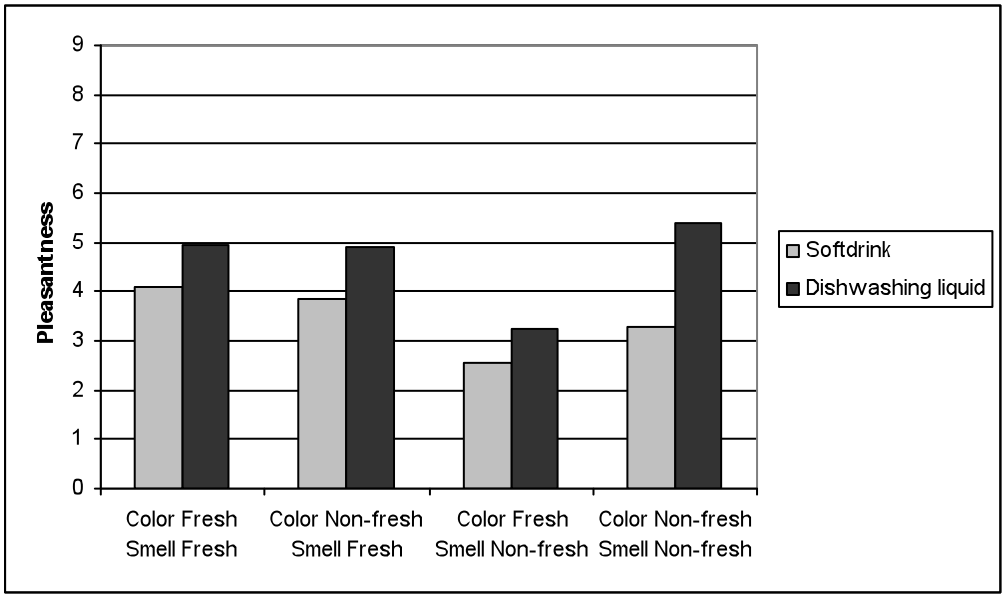

Figure 2: Pleasantness rating for softdrink and dishwashing liquid

3. ARE NOISY PRODUCTS ANNOYING?

3.1. Experiencing noisiness

From the physical point of view, any complex sound may be completely described as the combination of a number of pure tones of various amplitudes, frequencies and phases relative to each other. Some musical tones contain only a few components, for which the frequencies and phases have simple relations. More complex sounds contain many components, which may not be systematically related in frequency and phase. The ultimate complexity is "white noise" that contains all frequencies; the sound from a water-spray or a jet of air is an approximation of white noise [14].

The loudness of a sound does not correspond with its subjective noisiness. The subjective rating of "noisiness" usually increases as 1) the pitch of a sound is raised; 2) the complexity of the spectrum is increased; and 3) the duration is increased beyond 200 milliseconds [8].

The capacity of noise to induce annoyance depends on many acoustical and non-acoustical factors [11; 15]. Few sounds are intrinsically unpleasant. They become so if they are able to distract listeners from their activities. This requires that the sounds have some special character, usually denoting a specific activity. Speech sounds are particularly troublesome if they are intelligible or nearly so. Sudden impacts, startling or alarming sounds, and sounds with marked pitch or rhythm (for example, a dripping faucet) are particularly distracting and therefore annoying. Similarly, a single identifiable source of noise is more troublesome than the same level produced by a random assortment of many noises from many sources [14].

According to people's self-reports [12], audition is the dominant (mean rating 3.9 out of 4), but not the only sensory modality responsible for the perception of noisiness. The second important modality is vision (mean rating 2.1). Visual noisiness is closely related to visual complexity, which has been reported to influence aesthetic pleasure [16; 17; 18; 19]. A

number of experiments show that medium levels of complexity, whether of visual or auditory stimuli, are liked the most, while low and high levels are liked the least [17].

Visual complexity depends on the quantity of objects, clutter, openness, symmetry, organization, and variety of colors [20]. Textures with repetitive and uniformly oriented patterns are judged less complex than disorganized patterns [21]. The results of perceptual grouping show that regularities (e.g., symmetry, repetition, similarity) simplify a visual pattern, making it less noisy [22; 23].

3.2. Present study

In the present study we manipulated products' auditory and visual noisiness. In the pre-study we asked respondents to assess the noisiness, pleasantness and annoyance of various sounds and visual patterns on a 10-point scale. In the main study we created products using noisy and calm stimuli of both modalities in four different combinations: 1) noisy sound + noisy visual pattern, 2) noisy sound + calm visual pattern, 3) calm sound + noisy visual pattern and 4) calm sound + calm visual pattern. Participants indicated how noisy, pleasant and annoying they found these products on a 10-point scale.

3.3. Pre-study

We have chosen two products for which noisiness is a necessary characteristic: a whistle kettle and an alarm clock.

Two groups of participants took part in the pre-study. The first group (9 men and 12 women, aged between 18 and 54 years, mean age 29) assessed the sounds of alarm clocks and kettles, and the second group (24 men and 16 women, ages ranged from 20 to 60, mean age 33) assessed the pictures of the two products with applied visual patterns of various noisiness. All stimuli were randomized between participants and assessed on 10-point scales for noisy, loud, pleasant and annoying.

3.3.1. Results

The analysis showed significant main effects of both sound and visual pattern on the noisiness for both products ($p<0.01$). The main effects of sound and visual pattern on the ratings of pleasantness and annoyance were also significant ($p<0.01$).

Annoyance was positively correlated with noisiness both for sound (Pearson correlation 0.64 for alarm clocks and 0.48 for kettles) and for visual pattern (0.71 for alarm clocks and 0.69 for kettles). The correlations between pleasantness and noisiness were negative both for sound (-0.62 for alarm clocks, -0.60 for kettles) and for visual patterns (-0.64 for alarm clocks, -0.60 for kettles). The correlations between pleasantness and annoyance were also negative both for sound (-0.78 for alarm clocks, -0.71 for kettles) and for visual patterns (-0.84 for alarm clocks, -0.73 for kettles). All correlations were significant at the 0.05 level (two-tailed t-test).

3.4. Main study

The participants were 40 students of TU Delft (45% women), ages ranged from 18 to 51 years, mean age was 24.

Computer video clips of the experimental products were created combining two noisy and two calm stimuli according to a full factorial (2x2) design. In the videos, the products were presented in their natural environment (alarm clocks in the bedroom, kettles in the kitchen). Participants saw the products and heard the product sounds for 10 seconds. They filled in a computer questionnaire assessing the noisiness, annoyance and pleasantness of the four products on a 10-point scale. The sequence of products was randomized between participants.

3.4.1. Results

The products consisting of two noisy stimuli rated higher than the products consisting of two calm stimuli for both alarm clocks and whistle kettles ($p<0.01$). The noisiness ratings of products with a noisy sound and a calm visual pattern were significantly higher than the ratings of products with a calm sound and a noisy visual pattern ($p<0.01$). This indicates that sound dominated the overall experience of noisiness in both alarm clocks and whistle kettles, and that visual pattern did not contribute to noisiness for these products (Figure 3).

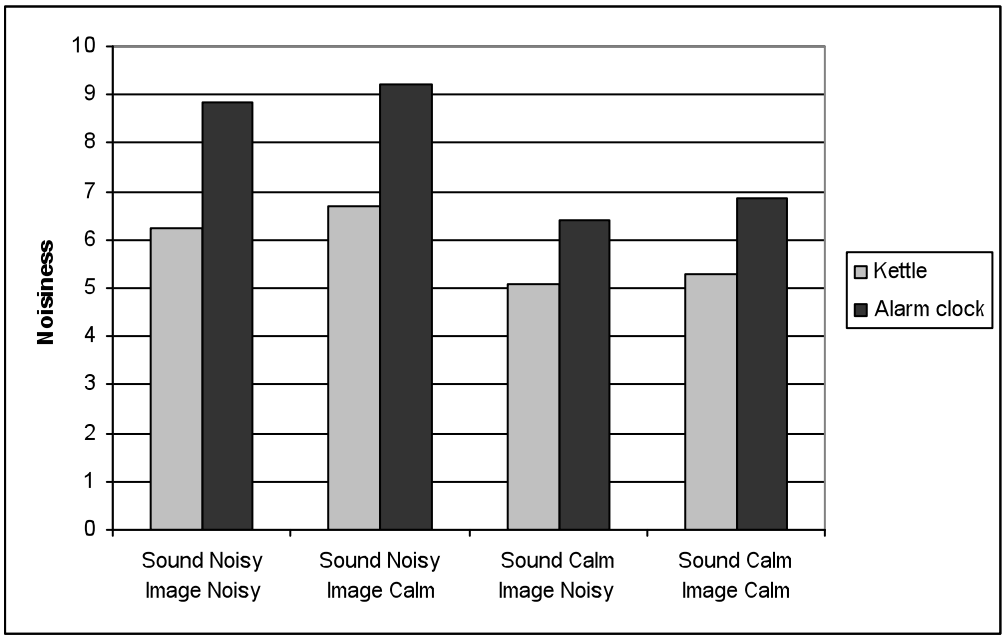

Figure 3: The noisiness ratings for kettles and alarm clocks

The response pattern for annoyance ratings largely matched pattern for the noisiness ratings (Figure 4). The products with noisy sound scored significantly higher on annoyance than the products with the calm sound, and the visual pattern did seem not to contribute to the annoyance level. The pleasantness ratings showed the reversed pattern: the products with calm sounds had significantly higher pleasantness ratings than the products with noisy sounds (data not shown).

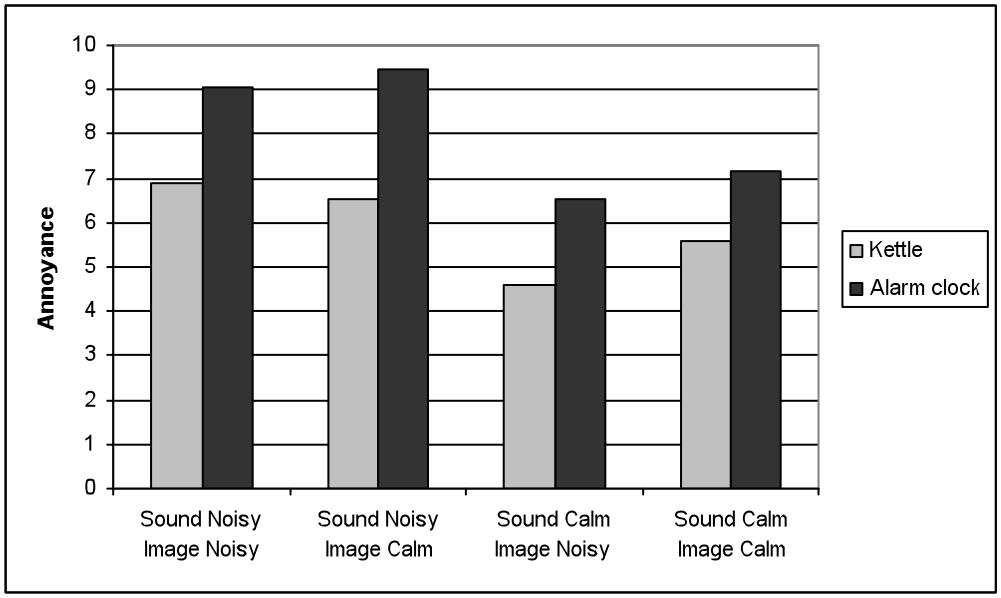

Figure 4: Annoyance rating for kettles and alarm clocks

4. DISCUSSION

Previous research has found that pleasantness is strongly related to freshness [4; 5; 6; 7]. Analogously, our pre-study found that pleasantness ratings correlated significantly with freshness ratings of single modality stimuli. Despite these correlations found for single, component stimuli, a comparison of the product means shows that there was no correlation between freshness and pleasantness for the final products. When specific smells were combined with specific colors, the freshness of the combinations could be predicted on the basis of the freshness of the separate stimuli (Figure 1), but the pleasantness of the combinations could not (Figure 2). The most pleasant dishwashing liquid had both a non-fresh smell and a non-fresh color. These outcomes are in line with those obtained by Schifferstein and colleagues [2], who also failed to demonstrate the link between the pleasantness ratings of single stimuli and the overall pleasantness of the products. In their study, the pleasantness of visual, tactual, auditory, and olfactory unisensory stimuli was determined for two test products (a portable air purifier and a table lamp).

Pleasantness has been suggested as an odor's most salient attribute [24] and a lot of data indicate the strong link between the sense of smell and affective reactions [25; 26]. Based on the extensive literature on the affective character of olfactory perception, we would expect smell to have more influence on the pleasantness rating than color, but our results only partly confirm this assumption. The most unpleasant samples of both soft drink and dishwashing liquid were those with fresh color and non-fresh smell. These outcomes indicate that negative affective reactions might be due to the inconsistent combinations of olfactory and visual stimuli rather than by the unpleasant smell as such. Probably, evaluations of pleasantness are more dependent on the combinations of stimuli used and their degree of (in)congruence than evaluations of freshness [27]. For instance, the least fresh combination of color (purple) and smell (vanilla) was assessed as the most pleasant for the dishwashing liquid, probably

because the dishwashing liquid is a boring product, and users appreciate some newness and surprise in it.

The results of the study on noisiness demonstrate that noisiness and annoyance were highly correlated both for single stimuli and for the final products. Sound dominated the experience of noisiness and annoyance for the final products, while the contribution of visual patterns to the overall experience was not significant. These results are consistent with our previous conclusions that the dominant modality for a specific experience depends on the function of a product [28]. Auditory properties are functional for both alarm clocks and whistle kettles and, therefore, the auditory modality dominates the overall experience.

5. CONCLUSION

For noisiness we found similar interaction patterns between sound and vision as for annoyance. In both cases, these patterns could be related to the noisiness or annoyance ratings of the single stimuli. However, the correlations between freshness and pleasantness were found only for single stimuli. There were no such correlations for the final products. Although the freshness of the complex products could be related to the freshness of single stimuli, the pleasantness data did not follow any similar or related pattern. Therefore, we conclude that the pleasantness of complex products cannot be predicted by the perceived pleasantness of the products' components but may depend on other variables, such as the degree of congruence between the various stimulus components.

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