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Experiencing the Elements – User Study with Natural Material Probes

Jonna Häkkilä¹, Yun He², Ashley Colley²

¹ Faculty of Art and Design, University of Lapland, Finland

jonna.hakkila@ulapland.fi

² CIE, University of Oulu, Oulu, Finland

{firstname.lastname}@cie.fi

Abstract. In this paper, we present the first systematic user study exploring the user experience and perceptions towards different natural materials – water, ice, stone, sand, fire, wind and soap bubbles. By trying out different materials, participants (n=16) expressed their associations and perceptions, rated different qualities of the materials, and described their impressions through product reaction cards. Our findings reveal for example that light weight and ease of movement are perceived as central qualities when inspiring and fun elements are sought for. This exploratory study shines light on user experiences with natural elements, and provides an experimental grounding for naturalistic tangible user interface design. Material qualities in tangible user interface design create a subtle, but critical part of the user experience.

Keywords: Material qualities · user experience · tangible user interfaces · design · user studies

1 INTRODUCTION

In [1], Hassenzahl defines user experience (UX) as “*a momentary, primarily evaluative feeling (good-bad) while interacting with a product or service*”. User experience consists of both utilitarian and a hedonic aspect [2]. Whereas the utilitarian side typically dominates in the overall motivation for application design, in constructing the user interface, hedonic aspects are important to consider in order to create pleasurable and engaging user experiences. When designing tangible user interfaces, material qualities are an integral part of the holistic experience.

Material qualities of physical objects have been thoroughly considered in areas such as art, industrial design and mechanics, but research on the material’s role in interactive systems has been quite sporadic, leaving much to explore. Especially, the use of natural materials has so far been little researched. As tangible user interfaces (TUIs) can make use of the human senses in a richer and more multidimensional way than conventional digital user interfaces (UIs) [3], it is of interest to explore the different qualities that are perceived and associated with different physical materials.

In this paper, we take steps towards systematic exploration of natural materials. We are especially interested of these because of the new possibilities they provide for the

design for tangible user interfaces, aesthetics and rich user experiences, and offer potential for user interfaces and application linked with, e.g., sustainable values or interactive environmental installations.

2 PRIOR ART AND POSITIONING OF OUR WORK

Prior art has demonstrated the use of different natural materials in different types of interactive systems, often designed for playful purposes or as part of a larger, monumental installation. Döring et al. have demonstrated interaction with soap bubbles [4], Virolainen et al. have shown touch screen interaction with an ice wall [5] whilst water based input and output has been used e.g. in [6, 7]. Heavy stone based input [8], and air based haptic feedback [9] have also been demonstrated. Rydarowski et al. [10] present an installation, where individually controlled CPU fans are used to move paper clips with air pressure.

The user experience findings reflect the curiosity [7], aesthetics [5], and playful nature of the interaction [5, 8]. With water related interactive systems, the pleasant sensation the cool water creates against the skin has been highlighted by users [7, 8], and spilling water has been reported to offer a more powerful UI feedback than a virtual one [6].

Whereas examples of the use of natural materials in TUIs exist, differing from us, the earlier research has reported the user perceptions focusing each time on a single system without a systematic comparison between different tangible elements. Moreover, the focus of the prior art has been more on the proof-of-concept level installations rather than on explicit investigation of the user experience aspects. A few explorations of different material qualities exist, as in [11] in the context of fashion, fabric and shape-change, but to the best of our knowledge, not in the domain of natural materials.

3 STUDY METHODOLOGY

3.1 Material Probes

In our user study, we applied the material probes method introduced in [12]. Material probes for seven (7) natural materials were created. The materials were selected to have as wide a range of physical properties as possible, in order to elicit a full range of perceptions from our test participants when interacting with the probes. The material probes are shown in **Fig. 1** and consisted of:

- *Water*, contained in a small bowl.
- *Stone* in the form of 3 smooth rocks.
- *Soap bubbles*, created as required from a soap solution container and wand.
- *Ice*, in the form of a tennis ball sized block.
- *Sand*, as a small pile on a plate.
- *Wind*, created as needed from a small desk fan.
- *Fire*, in the form of a candle flame.



Fig. 1. User study set-up.

3.2 User Study Procedure

Our user study included an open think-aloud method, subjective rating of qualities and two tasks that required users to associate the materials with objects or activities. Additionally we utilized the product reaction cards method adapted from [13]. Each study session lasted for approximately 60 minutes and the study procedure was as follows:

- Completing a background questionnaire.
- Interacting with each material probe in turn and giving a free form description of ideas, thoughts and associations the material created.
- Selection of a favorite material (see **Fig. 2**)
- Rating the materials on a 7-point Likert scale against the criteria: *Controllable*, *Calm*, *Inspiring* and *Overall preference*.
- Connecting each material with digital artifacts, e.g. such as an alarm clock. Here, multiple artifacts could be connected with each material, and participants could leave some material unused (see **Fig. 5**).
- Connecting each material with activities and thoughts, e.g. such as organizing files. Again, multiple activities could be connected with each material, and participants could leave some material unused (see **Fig. 6**).
- For each material, selecting 3 adjectives from a list of 20 that best describe the material. Here following a Product Reaction Cards (PRC) based methodology [13]. Table 1 contains the adjectives that were available.

The order in which participants interacted with the materials was counterbalanced to avoid any effects due to the presentation order.

Table 1. Adjectives used in product reaction card method. Participants selected three (3) that best described each material.

Fast	Slow	Inconsistent	Consistent
Responsive	Rigid	Uncontrollable	Controllable
Fun	Serious	Unpleasant	Pleasant
Restful	Stressful	Boring	Exciting
Approachable	Unapproachable	Frustrating	Inspiring

Altogether 16 participants (5 female, 11 male) took part in the study. The age range of the participants was 18-24:13%, 25-29:37%, 30-39:44% and 40-49:6%. The participants were recruited through advertising on university email lists, and through personal networks. Although participants predominantly represented university students, they came from various backgrounds with several different nationalities being represented. No UX professionals or UI designers were included.

4 RESULTS - PERCEPTIONS OF DIFFERENT MATERIALS

4.1 Favourite Material

The materials the participants selected as favorite are shown in **Fig. 2**. Water was clearly the favorite material with almost half of the participants (7/16) selecting it as their favorite. Here, many of the participants highlighted the relaxing nature of water, for example, “*Water is comfortable and controllable to interact with. I can do it for a long time, just like swimming.*” (User #3).

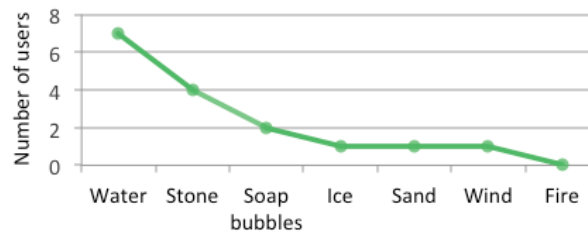


Fig. 2. Number of users preferring each material (n=16)

4.2 Subjective ratings and Product Reaction Cards

When asked to subjectively rate their perceptions of the materials (**Fig. 3**), users considered fire to be the least controllable and least calm material. Several users commented on the danger of fire, “*It is hot and untouchable. It hurts the hand. It is difficult to control and use.*” (User #9). Water and Ice were perceived as two of the calmest and most inspiring elements. For both materials issues related to cleanliness and transparency were voiced e.g. “*Transparent and clean*” (User #9, water), “*Cold, beautiful and transparent*” (User #10, ice).

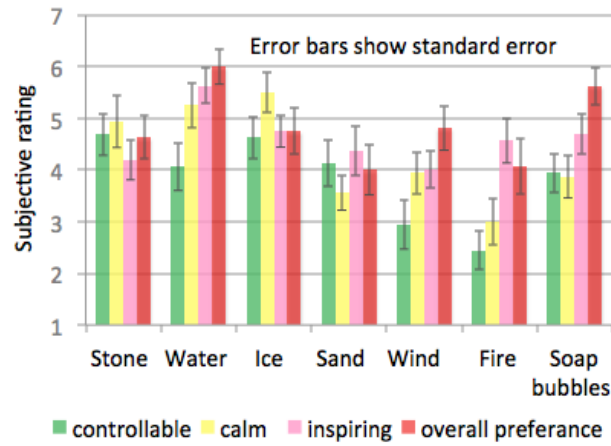


Fig. 3. Subjective ratings for each material

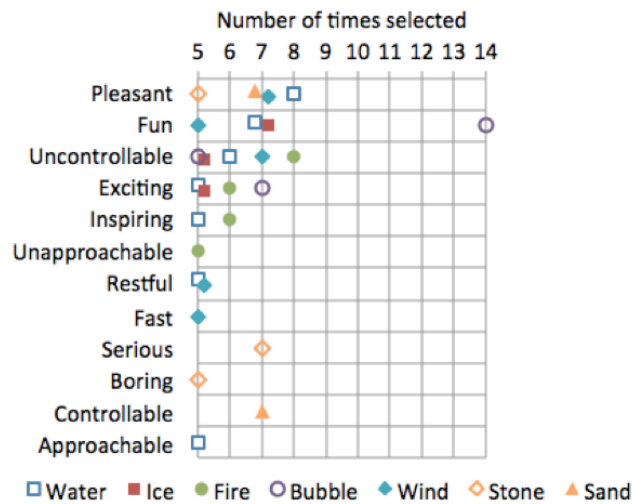


Fig. 4. Most frequently chosen adjectives for describing each material from Product Reaction Cards (N = 16 with 3 word selections per user).

Examining the results from the Product Reaction Cards method (Fig. 4) provides congruent findings e.g. with fire and wind being considered uncontrollable by many users. Clearly soap bubbles are considered as fun, with all but 2 users (14/16) selecting this adjective.

4.3 Material Associations

The test participants associations between the materials and digital artifacts and activities are presented in Fig. 5 and Fig. 6 respectively. Whilst some of the strong as-

sociations are obvious, e.g. the association between the pairs ice - fridge and water - coffee maker, other such as stone - mobile phone are less easily explained. Overall the high selection frequency of stone and low frequency of sand may be interesting to explore further.

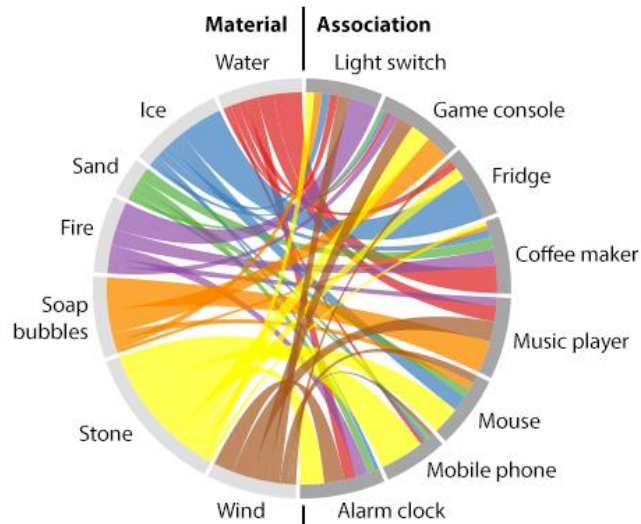


Fig. 5. Association between materials and digital artifacts. (The thickness of the base of each connection represents the number of users selecting that association).

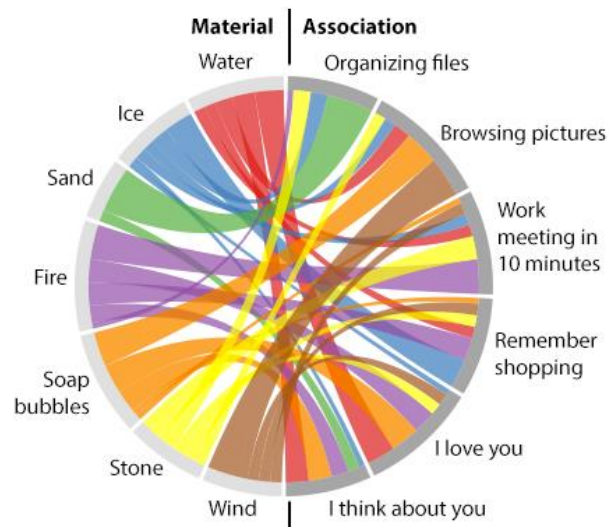


Fig. 6. Association between materials and activities/thoughts

In general the association of the given activities with materials is rather even, with most activities being associated to some extent with all of the materials. One clear

exception is that of sand, which was almost exclusively associated with organizing files

5 DISCUSSION AND CONCLUSIONS

5.1 Perceiving Materials

In this paper, we have reported the first user study seeking to systematically explore the user experiences perceived with different natural materials, investigated by using material probes. Based on the PRC results, it seems that lucid and light materials – water, wind and bubbles - are perceived as generally more playful, pleasant and fun. These materials also gained the highest ratings when the participants assessed in numerical scale how much they liked each material. Their light weight and ease of movement are perceived as central qualities when inspiring and fun elements are sought for. Although inspiring, fire was perceived uncontrollable and, based on the observations and comments, provoking reactions of respect and even fear.

Solid materials – stone, sand and ice – were perceived as more controllable and mostly pleasant. These were also the only materials that were associated with the task of ‘organizing’ (see **Fig. 4**). Whereas these associations are somewhat unsurprising, they confirm how materials that are quantifiable and behave less erratically are more easily associated with tasks that require control. This aligns with the findings reported by [8], where it is concluded that metaphors and interaction styles that match the physical characteristics of the interaction control should be utilized.

5.2 Limitations of the Study and Methodological Observations

In our study, we generally observed that people paid a lot of attention to each material - many spent a long time interacting with the materials in the tasks, and sometimes also came back to them. The test sessions generally took more time than we had first expected.

We acknowledge that our study is limited by the small sample size of participants. However, we believe that our research is valuable in its attempt to conduct a comparable study on different user experience qualities of natural materials. The laboratory type context was disconnected from any specific domains or use cases, and hence we believe provided a good environment for obtaining baseline results.

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