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VIEWPOINT DYNAMICS AND VERBAL FEATURES: AN INVESTIGATION OF USER PREFERENCES FOR AND IMPRESSIONS OF PRODUCTS

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Abstract: In this study, we attempt to understand the mechanism of user preferences for and impressions of products, and how they are related, by focusing on viewpoint dynamics and verbal features. The notion of viewpoint dynamics here involves the changes between "still viewpoints" and "moving viewpoints," while the notion of verbal features involves the quantitative characteristics of verbalizations. A "still viewpoint" here is the specific time period during the generation of product impressions when there are no shifts in the ways in which the products are viewed, while a "moving viewpoint" is the time period when there are such shifts. With respect to verbal features, in addition to including the number of words from different parts of speech, the quantitative characteristics include the number of repeated and unique words. We consider that user preference is affected by users' viewpoint dynamics and verbal features while viewing a given product. The findings show that viewpoint dynamics are indeed related to the verbal features, including the number of unique words used.

Keywords: *viewpoints on product, user impressions, user preferences, viewpoint dynamics, verbal protocol analysis, human behaviour in design*

1. Introduction

The impressions of a designed product—particularly the way in which it connects with innate human feelings—may fundamentally influence its design, use, and overall success. Products that have such qualities also influence the design, use, and success of future products. Such products expand the human feelings and further motivate people to design creative products (Taura & Nagai, 2012).

We consider that **user preference** for and impressions of a product are connected with the way in which those impressions are generated. User preferences are observed through user **ratings**. Preference is seen as fundamental for the aptitude towards the product; further, it is related to imagination about the product and creativity—especially to idea generation (ideas about new products). To address how an impression formed from a given product, we examined how products are viewed with a focus on viewpoint dynamics.

In this study, we introduce a *definition* of **viewpoint dynamics** that involves shifts between "still viewpoints" and "moving viewpoints." We also introduce a *definition* of **verbal features** that involves quantitative characteristics of verbalizations. Here, "**still viewpoint**" is *defined* as the specific time period during product observation when there are no shifts in the ways products are viewed. This time

period is the opposite of "**moving viewpoint**," which is *defined* as the time period when there are shifts in the ways in which products are viewed. The **purpose** of this study is to investigate the mechanism of user preferences for and impressions of products by focusing on viewpoint dynamics and verbal features. Our **hypothesis** is that there will be a positive correlation between user preferences, viewpoint dynamics, and verbal features. Our consideration is that the users will have more *still viewpoints* and *moving viewpoints* (viewpoint dynamics), as well as more verbalizations (verbal features), regarding products they prefer.
Preferred products may trigger imagination and creativity; such products would trigger more viewpoint dynamics and verbal features. We consider the products in a broader view to design into the pre-design stage that occurs prior to the starting point of the actual design process. That is to say, we focus on how existing products further influence the pre-design stage, where design creativity is fundamental.

2. Capturing viewpoint dynamics, verbal features, and preferences

During the generation of product impressions, we captured and analyzed users' (1) viewpoint dynamics, (2) verbal features, and (3) preferences, as well as the relationship between the three, as part of a methodology to investigate the mechanism of user preferences for and impressions of designed products (Figure 1).

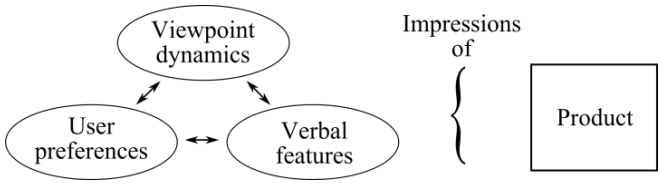

Figure 1. Viewpoint dynamics, verbal features, and user preferences during the generation of product impressions

Users' attitudes toward products have been investigated on the basis of different features exhibited during the generation of user impressions. For example, the movements and fixations of subjects' eyes are indicative of issues with usability (Poole and Ball, 2006). However, such movements and fixations are difficult to capture continuously and, consequently, to analyze. "Still viewpoints" and "moving viewpoints"—the terms defined in this paper and discussed in the study method below—allow for a simplified framework for the analysis of user preferences for and impressions of a product.
On the other hand, verbalizations can be considered related to the generation of impressions and ideas. In addition to regarding verbalizations as a fundamental means of analyzing the design process (Chakrabarti et al., 2004), verbalizations are also deemed a means of information for concluding on the perception in case of eye-tracking investigations (Ruckpaul et al., 2014). Furthermore, verbalizations are used to analyze users' feelings and impressions (Taura et al., 2010; Junaidy & Nagai, 2013). Additionally, explicit scale ratings are a common method by which to examine users' product preferences (Taura et al., 2010).
To investigate the mechanism of users' preferences and impressions, we propose the following method of capturing and analyzing viewpoint dynamics and free, unrestricted verbalizations during the generation of impressions of 3D product models.

3. Method

3.1. Identification of "still viewpoints" and "moving viewpoints"

To capture subjects' "still viewpoints" and "moving viewpoints," we proposed a method whereby we analysed subjects' movement of a *3D product model* using *mouse operation*. The model was presented with 3D viewing software on a computer screen. This allowed subjects to look at the model from different angles by turning it using the left mouse button with mouse movement. They were also able to view the product from up close and far away by zooming in and out using the mouse's scroll function. A "**still viewpoint**" was identified as the time period in which the subject did not operate the

left mouse button with mouse movement, and a "**moving viewpoint**" was identified as the time period in which the subject did do so (Figure 2). In practical terms, "still viewpoints"—the time periods between when the subject stopped and resumed moving the model—were determined using screen video recording with one-second precision.

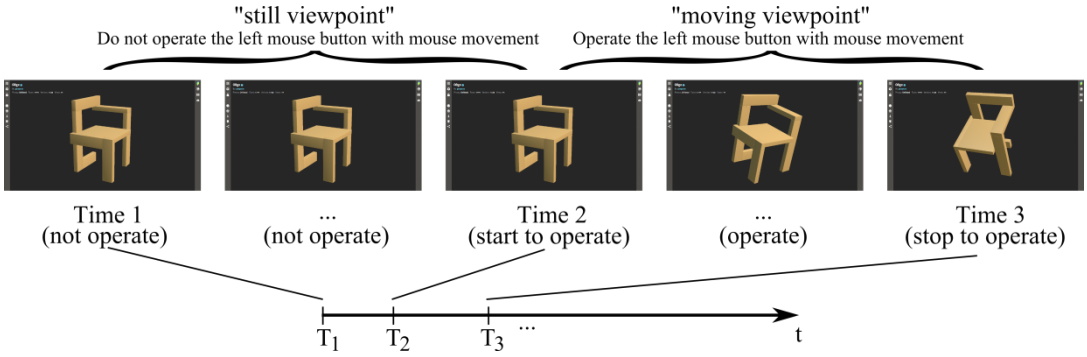

Figure 2. Example of the identification of "still viewpoints" and "moving viewpoints"

3.2. Quantitative parameters of "still viewpoints" and "moving viewpoints"

Here we will identify the parameters that could quantitatively describe the "still viewpoints" and "moving viewpoints" described above.

We tried to keep the number of variables as small as possible. The length, number, and frequency of "still viewpoints" and "moving viewpoints" can create a description of how products are viewed during the generation of impressions. The parameters that quantitatively describe the "still viewpoints" were defined as follows:

- "**Duration of still viewpoints**" was the total amount of time occupied by the "still viewpoints" during the given time period in which the subject was asked to view the model.
- "**Number of still viewpoints**" was the quantity of "still viewpoints" (those longer than one second) observed during the given time period in which the subject was asked to view the model.
- "**Number of still viewpoints longer than two seconds**" was the quantity of "still viewpoints" with a duration of more than two seconds during the given time period.
- "**Average length of still viewpoints**" was the average duration of each "still viewpoint" during the given time period.

The parameters that quantitatively describe the "moving viewpoints" were defined as follows:

- "**Duration of moving viewpoints**" was the total amount of time occupied by "moving viewpoints" during the given time period in which the subject was asked to view the model.
- "**Number of moving viewpoints longer than two seconds**" was the quantity of "moving viewpoints" with a duration of more than two seconds during the given time period.
- "**Average length of moving viewpoints**" was the average duration of each "moving viewpoint" during the given time period.

A number of still viewpoints that were longer than three or four seconds were not considered because only a few of the subjects exhibited still viewpoints or moving viewpoints longer than three or four seconds. The "number of moving viewpoints" was not considered because the process was comprised only of "still viewpoints" and "moving viewpoints," so their numbers were connected. For practical reasons, the operations were considered to start and end with moving viewpoints.

3.3. Verbal features

Verbalization is a common method to investigate users in cases such as Human-Computer Interaction (HCI) (Nielsen et al., 2002) or in interactions with products (Taura & Nagai, 2012). To count the number of words in users' impressions, verbal protocols observed as subjects viewed the models were transcribed. Subjects' speech was analyzed with a morphological parser, and a list of individual words

with parts of speech indicated was generated as the output. The verbal features were counted on the basis of the word and parts of speech lists.
The verbal features—the basic quantitative parameters of the verbal protocols—that were considered were the "**total number of words**" and the number of individual parts of speech ("**number of nouns,**" "**number of verbs,**" "**number of auxiliary verbs,**" "**number of adjectives,**" "**number of adverbs,**" "**number of interjections,**" and "**number of particles**"). The general consideration was that the type of words in the verbalizations could provide insight into user preferences and the generation of ideas. Furthermore, the "**number of repeated words,**" "**number of word repetitions,**" and "**number of unique words**" were considered indicative of the generation of ideas. The general consideration was that the repetition and uniqueness of the words in the verbalizations could provide insight into the generation of original ideas in connection with user preferences.

3.4. User preferences

User preferences were observed with written ratings made on a five-point Semantic Differential (SD) scale (e.g., "dislike-like," "unoriginal-original"). The basic quantitative parameters of "still viewpoints" and "moving viewpoints" were also discussed in the preliminary analysis of the experiment (Georgiev et al., 2014), described in detail below. This paper extends this preliminary analysis and adds an analysis of verbal protocols.

4. Study

4.1. Experiment design

We conducted a product impressions experiment of within-subject type, focusing on the differences between products that are more or less preferred by a particular subject. We used 3D models of chairs as products. The choice of chairs was based on the consideration that chairs are common everyday products that have similar spatial configurations and proportions; thus, those aspects will have less influence on the way in which the product is examined.
During the experiment, 3D models of five chairs (Figure 3) were presented in random order to each of the six subjects in the study (all male fourth-year mechanical engineering students). These five models were selected from a larger set of 21 models on the basis of a preliminary questionnaire administered to six other subjects. The preliminary questionnaire contained a simplified rating with three possible answers: "like," "dislike," and "neither." The five models that were chosen represented the most disliked and most liked of the original 21.

Figure 3. 3D models of five chairs used in the experiment
(Note: all models were obtained from blendswap.com and attributed with Creative Commons CC0 Zero attribution license. Model 1 is based on the Eiffel Base Shell Chair by Charles and Ray Eames; Model 2 is based on the Steltman Chair by Gerrit Rietveld; Model 3 is based on the Poäng Chair; and Model 5 is based on the Seashell Adirondack Chair by Thomas Lee. No particular basis could be identified for Model 4. These bases were unknown to the subjects.)

4.2. Setting and procedure

The 3D models were displayed on a computer screen in front of the subjects, who were given a mouse with which to freely move the displayed models. The following procedure was used in the experiment.

I. Training session: (a) Instructions, including examples and training in how to freely verbalize impressions and thoughts about a product; (b) Training in the 3D model viewer

software and examination of an example 3D product model (of a different type than those used in the impressions session) using a computer mouse. (The full-screen browser-based 3D model viewer of www.p3d.in was used.)

II. Viewing and impressions session: Generation of impressions, free verbalizations, and ratings of randomly presented 3D models of five products.

The training session was completed after the subjects were able to freely verbalize and had no difficulty moving and examining the 3D model on the screen. Prior to beginning the viewing and impressions session, we provided the six subjects with the following instructions: "For at least three minutes, please evaluate the product by operating the model. Consider and freely verbalize your impressions and thoughts about the product you evaluate. Please evaluate the product you examine on the following scales." In Session II, the subjects were free to view the products and generate impressions for longer than three minutes. At the end of the task, we obtained written ratings of the examined products on SD scales.

4.3. Data capture and analysis

During the process, data were captured via (a) screen video and general video of the experiment; (b) audio recordings; and (c) written ratings on SD scales.

Using the screen video capture, timings of the "still viewpoints" and "moving viewpoints" were identified, having been manually indicated by video using Idea Transcribe v.2.0 software. The quantitative parameters of the viewpoints and movements were calculated from the timings. The verbal features were counted on the basis of transcribed and analyzed verbal protocols.

5. Results

No correlations between viewpoint dynamics, verbal features, and user preferences were found when the subjects were considered collectively as a sample. We think the reason is that the preferences are individual according to the subject. Therefore, we examined the correlations between viewpoint dynamics, verbal features, and user preferences for the subjects individually. Particularly, we were interested in the differences between liked and disliked chairs of individual subjects.

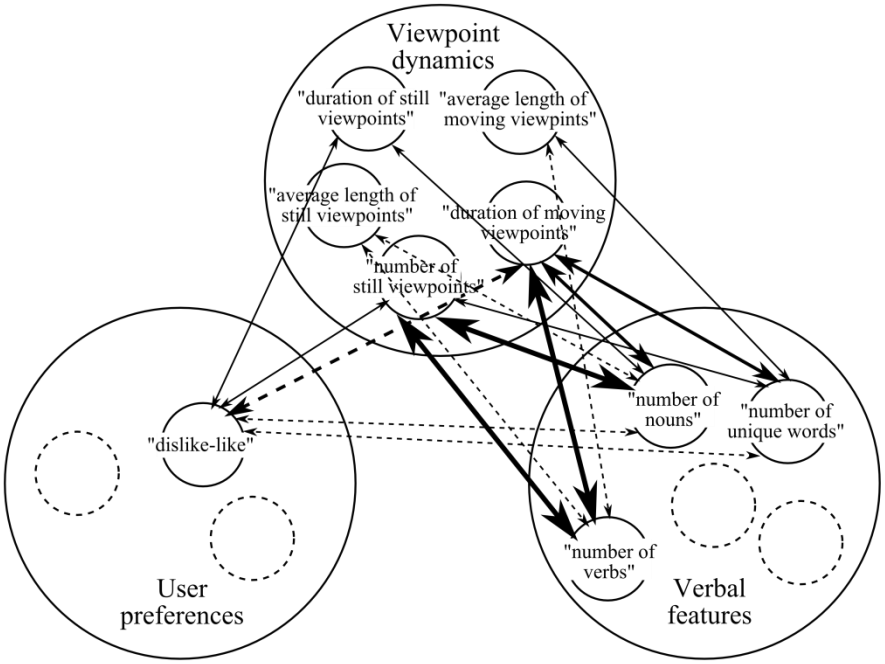

Figure 4. Connections between viewpoint dynamics, verbal features, and user preferences (Note: only the most important connections are shown to avoid further complexity. Thicker lines indicate that connections are observed in more cases, while continuous lines indicate positive correlations and dotted lines negative correlations.)

Spearman rank correlations were performed on the analysed data. Figure 4 illustrates the most important connections between viewpoint dynamics, verbal features, and user preferences. The correlations between viewpoint dynamics and user preferences were discussed in a previous short paper (Georgiev et al., 2014). Table 1 shows all of the observed cases of significant correlations between viewpoint dynamics and verbal features. Subjects are considered independently. For two-tail Spearman rank correlations the values in Table 1 do not exceed the critical values.
It should be noted that the relationship of the general parameters of "duration of still viewpoints" and "duration of moving viewpoints" with verbal features is based on the fact that a longer time period will result in more viewpoints and more verbalizations; yet, this does not provide insights and thus will not be further discussed here. However, the parameters of "duration of still viewpoints" and "duration of moving viewpoints" do provide insights in terms of user preferences.

Table 1. Spearman rank correlations between viewpoint dynamics and verbal features

	"number of still viewpoints"	"duration of still viewpoints"	"number of still viewpoints longer than two seconds"	"average length of still viewpoints"	"duration of moving viewpoints"	"number of moving viewpoints longer than two seconds"	"average length of moving viewpoints"
"total number of words"	S2:.900* S4:1.000** S5:.900*	S4:.900*	-	S2:-.900*	S2:1.000** S5:1.000**	S2:1.000** S5:.975**	-
"number of nouns"	S2:1.000** S4:1.000** S5:.900*	S4:.900*	-	S2:-1.000**	S2:.900* S5:1.000**	S2:.900* S5:.975**	-
"number of verbs"	S2:.975** S4:.900* S5:.900*	-	-	S2:-.975**	S2:.975** S4:.900* S5:1.000**	S2:.975** S4:.900* S5:.975**	S1:-.900*
"number of auxiliary verbs"	S2:1.000** S4:1.000**	S3:.900* S4:.900*	S3:1.000**	S2:-1.000**	S2:.900* S5:.900*	S2:.900*	-
"number of adjectives"	S5:.900*	-	-	-	S2:.900* S3:.949*	S2:.900*	S2:.900*
"number of adverbs"	-	-	-	-	S2:.900* S4:.975**	S2:.900* S5:.921*	S2:.900*
"number of interjections"	S2:.900*	-	-	S2:-.900*	S2:1.000**	S2:1.000**	-
"number of particles"	S2:.900* S4:.900*	-	-	S2:-.900*	S2:1.000** S5:.900*	S2:1.000**	S4:-.900*
"number of repeated words"	S2:.975** S4:1.000**	S4:.900*	-	S2:-.975**	S5:.900*	-	-
"number of word repetitions"	S2:.900* S4:1.000**	S4:.900*	-	S2:-.900*	S2:1.000** S5:.900*	S2:1.000**	-
"number of unique words"	S5:.900*	-	-	-	S2:.900* S5:1.000**	S2:.900* S4:1.000** S5:.975**	S2:.900*

(Note: Subjects are indicated with the letter S and a number, e.g., S1. Only significant correlations are shown. Negative correlations are underlined for easy identification. *p<0.05; **p<0.01)

6. Discussions

6.1. Viewpoint dynamics, verbal features and user preferences

The analysis of the viewpoint dynamics and user preferences in this experiment (for the preliminary analysis, see Georgiev et al., 2014) showed that for Subject 1, the "duration of still viewpoints" and

"number of still viewpoints" were connected with higher ratings on the scale of "dislike-like." In contrast, the "duration of moving viewpoints" for Subjects 4 and 6 was connected with lower ratings. These correlations may point to two complementary aspects of the same process—more and longer "still viewpoints" relate to higher user preference, while longer "moving viewpoints" relate to lower user preference.
Few significant correlations between user preferences and verbal features were observed for Subject 1. "Number of nouns" and "number of unique words" were found to be negatively related to "dislike-like." However, it is not possible to make definitive conclusions due to their basis on a single subject.

6.2. Viewpoint dynamics and verbal features

Number of still viewpoints is connected to numbers of verbal features possibly because the subjects had more time to express themselves verbally when the model was still. However, an interesting observation is that the longer moving viewpoints and shorter still viewpoints both attracted a greater number of verbal features. Further, Table 1 shows that the "number of still viewpoints" correlates positively with most of the verbal features in the cases of Subjects 2, 4, and 5. Additionally, there are similar positive correlations regarding "still viewpoints" of longer than two seconds in the cases of Subjects 1 and 3. Notably, the "number of moving viewpoints longer than two seconds" has many positive correlations with verbal features in the cases of Subjects 2, 4, and 5 (with one exception).
The correlations discussed above outline a picture of the **viewpoints dynamics** related to more intensive verbalizations (**verbal features**), including more *unique* ones. Thus, it can be speculated that such a way of examining products may be related to more intensive idea generation and more unique ideas, and thus relevant to cognition in creative design and design creativity.
Furthermore, the observation can be made that the "average length of still viewpoints" is negatively correlated with verbal features in the case of Subject 2. Moreover, correlations for the "average length of moving viewpoints" are inconsistent (both positive and negative). The cases of verbs, auxiliary verbs, nouns, particles, and many/unique words were most often correlated with the parameters of "still viewpoints" and "moving viewpoints." It should be noted is that the data for Subject 6 did not exhibit any correlations, positive or negative, between the parameters included in Table 1.

6.3. Summary of discussion and implications

In summary, more and longer "still viewpoints" relate to higher user preference which is according to our hypothesis, however, longer "moving viewpoints" relate to lower user preference. It is possible to assert that numerous short "still viewpoints" are complemented by "moving viewpoints" in time—in other words, viewpoint dynamics are related to quantitatively more verbalizations (verbal features), including unique verbalizations. Thus, **user preference** may reflect on **viewpoint dynamics**, which on its own is closely related to **verbal features**. However, user preference and verbal features are not strongly connected. Furthermore, viewpoint dynamics may be related to the generation of user impressions, as well as to design idea generation and design creativity. The overall goal of this research was to understand the mechanism of users' preferences for and impressions of products and how they are related, in order to inform the design of preferred products. The results provide relevant insights about this mechanism. The *implications* relate to the generation of ideas in general and original ideas in particular. The implication is the potential of use of products presented in a particular way as inspirations or stimuli for idea generation. The use of "multiplicity" (the polysemy of viewpoints) and viewpoint dynamics as tools may therefore positively influence creativity in design.
However, the *experiment* in this study can be regarded as *exploratory*; it demonstrated the connections between verbal features, viewpoint dynamics and preferences during product impression generation. This is *not a strong validation* and more extensive experiments must be conducted in order to gain insights into the mechanism of users' preferences and the generation of product impressions.

6.4. Establishing future hypotheses

The logical step after the above discussion is to establish future hypotheses in order to further investigate viewpoint dynamics. These hypotheses may aim at the investigation of "multiplicity" (polysemy) and viewpoint dynamics upon interaction with and generation of user impressions of

products, or the different stages of ideation about and design processes of products. One such hypothesis might be the following: Viewpoint dynamics in the early stages of design relate to the originality and creativity of the generated design ideas. We believe that the polysemy of user impressions can be expressed in relation to the viewpoint dynamics that appear during the generation of user impressions of (and interactions with) a given product.

6.5. Limitations and future work

This study has several limitations. First, the method is focused on collecting high-level data, and the impressions generated from the use of 3D product models may differ from those generated by interaction with real products. However, the method allows for the free generation of impressions in accordance with the subjects' feelings. Second, our experiment was limited in terms of the number and type of products and subjects. The limited number of subjects is a considerable limitation of this exploratory study, and it must be addressed in future. Future work should aim at delving deeper into the issue of viewpoint dynamics in relation to verbalizations, thus focusing on the qualitative aspect of such verbalizations. The aforementioned research findings provide a basis for the further investigation of the generation of ideas and the multiplicity of viewpoints and verbalizations—the polysemy of meanings.

7. Conclusion

In order to explore the mechanism of user preferences for and impressions of products, in this study we hypothesized that user preferences and impressions are connected with the way in which a product is observed. We considered that user preferences are affected by the viewpoint dynamics and verbal features that arise during the generation of product impressions. The findings from an experiment that used 3D product models, show that, for most of the subjects, viewpoint dynamics are related to quantitative increases in subjects' verbalizations, as well as other verbal features, including unique verbalizations. Thus, viewpoint dynamics and verbal features may reflect user preferences and the generation of user impressions.

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