UNIVERSITY OF TWENTE

MASTER THESIS

The fluency effect as the underlying variable for judging beauty and usability

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Abstract

Many studies have found a correlation between beauty and perceived usability. However, the direction of the relation is not yet clear. Hassenzahl and Monk (2010) argued that beauty and perceived usability were not directly related based on their inference perspective. In this study, a different possible explanation is given for this relation, namely processing fluency. In Human Computer Interaction (HCI) research, processing fluency, as used in this study, has not yet been applied to the problem of beauty and perceived usability. The purpose of this thesis was to show that fluency is the underlying, cognitive variable when judging beauty and usability. In HCI research, Likert-scales would have been influenced by fluency. Due to fluency, beauty, and perceived usability of websites would be judged more positive. We were also interested in breaking the fluency effect through a treatment. Due to treatment, the influence of our fluency manipulations would decrease, resulting in less positive judgments. Also, the correlation between beauty and perceived usability would decrease. Our results showed that the fluency manipulations indeed resulted in more positive judgments of beauty and perceived usability. For breaking the fluency effect, results were found for visual complex websites as judgments were less positive when participants received a treatment. This suggests that a practical tool (i.e. treatment) has been developed for future research in beauty and perceived usability. Interestingly, our results also offer a new direction in future research, namely designing for fluency. More possible explanations, implications and future research are provided in the discussion section.

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1. Introduction

For a good user experience (UX), a good understanding of the relationship between perceived beauty and usability is needed. Numerous studies have tried to define this relationship. Some studies concluded that 'what is beautiful is usable', whereas others found that what is usable is beautiful. Despite the different conclusions, it is clear that there is a correlation between these two constructs. Different models are used to explain the correlation between (perceived) beauty and perceived usability or the underlying variable. In 2010, Hassenzahl and Monk used an inference perspective to propose a causal relationship between beauty and perceived usability.

The current study however, proposes a different, possible explanation for the common factor between beauty and perceived usability. Namely, we argue that the common factor of perceived beauty and perceived usability is processing fluency. The fluency effect can explain the high correlation between perceived beauty and perceived usability as well. Although a lot of research has been conducted regarding (perceived) beauty and fluency, (perceived) usability is still an unknown topic in fluency research as far as we know. However, given the strong evidence regarding the relationship of perceived beauty and perceived usability, we assume that they measure the underlying fluency variable. Therefore, a new model is proposed where the influence of fluency on perceived beauty and perceived usability is examined through experimental manipulation. If the model is proven to be true, it would have implications in the current human-computer interaction (HCI) research and UX design/research. If we can prove that high fluency results in more positive judgments of perceived beauty and perceived usability, one can conclude that in order to have a good user experience you should consider designing a product or interface that is fluent.

In the current study, we shall first review different models that tried to explain the correlations between perceived beauty and perceived usability. We will discuss in dept the basic of processing fluency based on the dual processing theory. Then, the effect of fluency and its manipulations will be examined. Taking all of the literature and findings into account, a new model and its associated hypotheses are proposed. Lastly, an attempt to break the fluency effect will be taken with the expectation that the correlation between perceived usability and perceived beauty weakens.

1.1 Beauty and Usability in HCI Research

Before we focus on the relationship of perceived beauty and perceived usability, a good understanding of both terms is needed as literature shows that both have different definitions. In the present study, the focus is not on beauty and usability in general. Beauty and usability will be discussed in the context of HCI research. We will take a look on how perceived beauty and perceived usability is defined. Then, we will discuss the relationship between beauty and usability in different studies.

1.1.1 Definitions of perceived beauty

Lavie and Tractinsky (2004) distinguished between beauty and classic aesthetics, as a factor analysis showed that they loaded negatively together, suggesting that beauty is different from classic aesthetics. Interestingly, classic aesthetics have a high correlation with usability. Hassenzahl and Monk (2010) argued that classic aesthetics could be interpreted as symmetric or clear. They describe beauty as a consequence as it has strong connotations which are evaluative (Hassenzahl & Monk, 2010). Tuch, Presslaber, Stöcklin, Opwis and Bargas-Avila (2012a) argued that aesthetics perception is very complex as it is shaped by objective features of stimuli (e.g. complexity, colour, shape) and perceiver's characteristics (Rolf Reber, Schwarz, & Winkielman, 2004a). Unlike some authors, Tuch et al. (2012a) did not differentiate between the terms of beauty, aesthetics, visual appeal or attractiveness. In this study, we will use the terms aesthetics and beauty interchangeably.

1.1.2 Definition of perceived usability

Usability is defined by the ISO (ISO 9241-11, 1998) as the extent to which a product can be used by specified users to achieve specified goals with efficiency, effectiveness and satisfaction in a specified context of use. Usability can be measured through objective measures (e.g. task completion time) or subjective measures (Likert-scales) (Hornbæk, 2006). Although Hornbæk argued that for a good understanding of usability both measures should be used, most researchers only use the subjectively measures. Hassenzahl and Monk (2010) referred to perceived usability as pragmatic quality, which focuses on quality in use. While interacting with a product, pragmatic quality addresses the 'how' and 'what', it focuses on tasks.

1.1.3 Relationship between perceived beauty and perceived usability

The relationship of beauty and usability has been examined by numerous studies varying on products and approaches. Table 1 illustrates an overview of those studies. Some studies concluded that what is beautiful is usable', suggesting that aesthetics influences usability (Tractinsky, Katz, & Ikar, 2000). Others found the opposite effect wherein perceived usability affected perceived aesthetics (Tuch, Roth, Hornbæk, Opwis, & Bargas-Avila, 2012b). Although the direction of the relation is not clear yet, it appears that there is a direct link between beauty and usability.

Table 1

An overview of studies examining the relation beauty-usability. Source: (Hassenzahl & Monk, 2010b; Tuch et al., 2012b).

Research article	Product (Task)	Correlation (r)
(Tractinsky, 1997)	Lay-outs of ATM	.83 to .92 (Pre-use)
(Chawda, Craft, Cairns, Rüger, & Heesch, 2005)	Search tool (search task)	.76 (Pre-use) .71 (Post-use)
(Kurosu & Kashimura, 1995)	Lay-out of ATM (viewed passively)	.59 (Pre-use)
(Lavie & Tractinsky, 2004)	Online webshop (shopping task)	CA: .68 to .78 (post-use) EA: .40 to .46
(Hassenzahl, 2004) first study)	Skins of MP3 players (passive)	.07 (Pre-use)
(Tractinsky et al., 2000)	Lay-outs of ATM (usage)	.66

However, Hassenzahl (2004) did not find a direct correlation between beauty and perceived usability. In 2010, Hassenzahl and Monk explained the correlation between perceived usability and perceived beauty by using an inference mechanism. They suggest that people use all the information that is currently available and infer the unavailable when they are confronted to judge a product (Hassenzahl & Monk, 2010). Thus, when inexperienced users judge a product, they will use the information that is currently available to infer the information that is unavailable at the time. Their inference model proposes that the starting point of these inference processes is beauty, as its nature is primarily sensory therefore immediate available (Hassenzahl & Monk, 2010).

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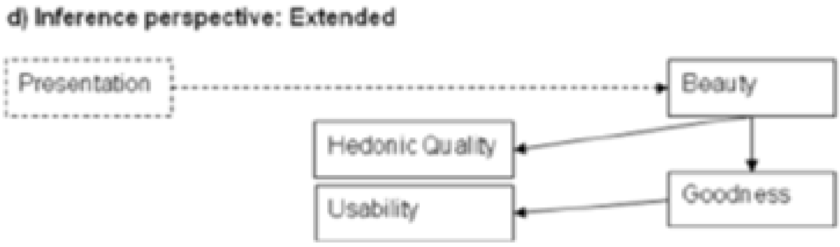

Figure 1. Inference perspective extended by Hassenzahl and Monk (2010).

Regarding the correlation between perceived usability and perceived beauty, Hassenzahl and Monk (2010) propose that there is no direct relation between beauty and perceived usability. Hassenzahl and Monk conducted four different studies. Various different websites (e.g. e-commerce, travel companies, gadget websites) were evaluated by participants on hedonic quality, beauty, goodness and pragmatic quality (usability). They found that the relationship between beauty and usability was fully mediated by goodness. So, goodness is a mediating variable which causes the correlation between perceived beauty and perceived usability. First, we generate a beauty score. We then use this beauty score to infer a ‘general’ score, namely the Goodness variable (Figure 1). As the perceived usability information is unavailable at that time, we infer the usability score from the goodness variable. Hassenzahl and Monk (2010) describe that a “well-proportioned” interface could be immediately easier to see than a structure with good navigational aspects. If no firsthand experience with the navigational structure is available, the perceived usability score is guessed (i.e. inferred) from the goodness variable. In turn, the overall judgment goodness is influenced by perceived beauty which therefore leads to an indirect correlation with perceived usability(Hassenzahl & Monk, 2010). Van Schaik, Hassenzahl and Ling (2012) argued that the inference process was based on rules that connect the unavailable and available information together. In turn, the rules were based on knowledge and lay theories which decide if they are applicable in a specific situation. They argued that these inference rules can be applied deliberately (Kardes, Posavac, & Cronley, 2004; van Schaik, Hassenzahl, & Ling, 2012). However, the application can also be unconscious and automatic.

Analyzing the study of Hassenzahl and Monk, concerns arise regarding their assumptions and limitations. First, the assumption of an inference process suggests that a higher cognition is involved. Assuming that people guess the usability score based on an overall goodness score, one can argue whether people are therefore aware that they did not have all the information available to generate an usability score. When reasoning this, they turn to guessing (i.e. inferring). However, Schmettow and Kuurstra (2013) found that judgments were stable in 17ms which speaks against a higher cognition. In their experiment, 76 company websites were rated on perceived credibility. The websites varied in prototypicality and visual complexity. Participants rated all websites four times as there were four different presentation times (17, 33, 500 and 5000). Even in the 17 ms presentation time, judgments on credibility were stable.

Furthermore, although van Schaik et al. (2012) argued that inference rules are used, they are not specific enough with their reasoning as inference rules could be automatic, but could also be applied deliberately or consciously which again suggests a higher cognition.

Secondly, the study of Hassenzahl and Monk (2010) is correlative. Although the inference model implies a causal relation between beauty and perceived usability, it is based solely on theoretical reasoning. The correlative data used in their study could not test the causality. The assumed direction of perceived beauty effecting perceived usability could even be reversed (Hassenzahl & Monk, 2010b).

Also, Hassenzahl and Monk (2010) did not have beauty as a predictor in their study. There was no experimental manipulation to test the effects of beauty on perceived usability. The criteria's for the websites was face-value and rating scales were used to analyze the correlation between beauty and perceived usability. In contrast with Hassenzahl and Monk (2010), Tuch et al. (2012a) used explicit predictors (presentation time, visual complexity and prototypicality to manipulate the websites in order to understand aesthetic judgments. They conducted two studies. In the first study, 119 company websites varying in visual complexity and prototypicality were presented in one of the three different presentation times (50ms, 500ms and 1000ms). Participants rated the websites on perceived beauty. In the second study, shorter presentation times were used to verify the previous results (17ms, 33 and 50 ms). Both studies confirmed the effect of PT and VC on beauty of websites in all time conditions. In all, Tuch et al. (2012a) argued that due to lack of manipulations in beauty and usability in the study of Hassenzahl and Monk, the relationship between beauty and perceived usability is unclear. Therefore, to examine the relationship between beauty and perceived usability, it is important to test it through experiment manipulations.

Besides the assumptions and limitations, some studies did not find the inference effect of Hassenzahl and Monk (2010). For example, no inference effect was found in the study of Lindgaard, Fernandes, Dudek and Brown (2006). In their study, participants were asked to rate the visual appeal of websites. Participants ranked the websites on a 9-point rating scale with 1 ('very unappealing') to 9 ('very appealing') (Lindgaard et al., 2006). Depending on the condition that participants were assigned to, websites were presented for either 500 ms, 50 ms or limitless. Results showed that visual appeal was influenced by the same design variables in all the different time conditions (50 ms, 500 ms and limitless). This suggests that the inference effect did not occur even when information was not immediately attainable. (Lindgaard et al., 2006).

In the study of Schmettow and Boom (2013), the beauty inference effect did not occur. Schmettow and Boom replicated the study by Tuch et al. (2012a). In their study, 76 websites varying in PT and VC were presented randomly to participants and rated on hedonic quality. Participants rated all websites four times as there were four different presentation times (17 ms, 33ms, 500m and without limit). They found that by varying the presentation times, the judgment of hedonic quality differed from the beauty judgment. It appeared that hedonic quality was guided by prototypicality in the 17ms condition, but not for the beauty judgment (Schmettow & Boom, 2013). According to the inference perspective, there should not be a discrepancy between perceived beauty and hedonic quality in the 17 ms as it is most likely in this presentation time that a beauty inference would occur. The inference perspective would thus expect that the prototypicality effect would also be non-existent in the hedonic quality judgment, in line with the results of the beauty judgment. However, this was not the case.

In both studies, it was more likely that the information was processed in lower stages. They found evidence for the information-processing-stage model of Leder, Belke, Oberst and Augustin (2004). Leder et al. (2004) proposed a theoretical framework regarding aesthetic stimuli and its perception of art. The information-processing stage model regarding aesthetic processing exists of five stages that play a role in our judgment of aesthetics or experience, with the first two stages relevant in the previously described studies (Figure 2). The first stage is perceptual analyses. Here, the stimulus is analyzed perceptually by using features of the stimuli (e.g. visual complexity). This is therefore related to the processing of the stimuli. The second stage is implicit information integration where the characteristics of the stimulus (e.g. previous history or experience of the perceiver: familiarity or prototypicality) shape the process of the perception of aesthetics (Tuch et al., 2012a). Opposing to Hassenzahl and Monk, Leder et al. (2004) showed that information is processed in stages. When not all information can be processed due to lack of time, information is not inferred, information is just processed in lower stages than it would otherwise.

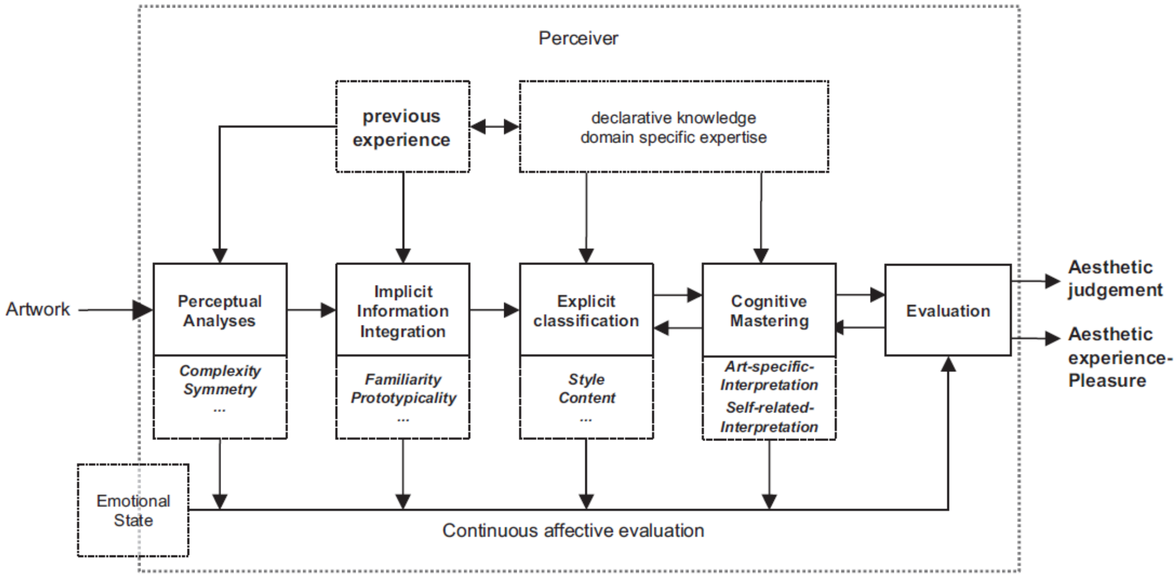

Figure 2. Information-processing stage model by Leder et al.(2004).

In sum, it is clear that different models and theories tried to explain the correlation between beauty and perceived usability. Also, the importance of experiment manipulations is emphasized, in order to understand the relation between beauty and perceived usability.

In this study, we propose a different model to explain the relation between beauty and perceived usability as well, namely processing fluency. Processing fluency has not been considered often in UX or HCI research. In the present study, processing fluency could explain the high correlation between perceived usability and perceived beauty. We reason that we are being unconsciously and automatically influenced by the fluency effect which explains our (positive) judgments towards perceived beauty and perceived usability. Thus, it implies that there is a common factor underlying all UX scales. Before proposing the fluency model in regards with perceived beauty and perceived usability, we will take a look at the basic and effect of processing fluency in human judgment.

1.2 Processing fluency

In order to examine whether fluency is the underlying cognitive process of beauty and perceived usability, a good understanding of processing fluency is needed to fully understand the model and its implications for (future) research.

In this section, processing fluency is explained and based on the dual processing approach of Kahneman (2011), which serves as the theoretical framework of our study. Then, the effect of fluency on judgment in different domains will be explored. We shall discuss how fluency is generated, which finally leads to the proposal of the fluency model regarding beauty and usability judgment.

1.2.1 The dual-processing approach as the theoretical framework of fluency

Kahneman and Frederick (2002) propose the dual processing approach which refers to two agents in the mind, namely System 1 and System 2. Both have their own abilities, functions, constraints and capabilities. The reasoning of System 1 is heuristic, quick, effortless and automatic (Kahneman & Frederick, 2002). System 1 is described as feelings and originating impressions with no effort that are System 2's main sources of deliberate choices and explicit beliefs. System 2 demands concentration, effort and attention. The processes of System 2 are analytical, slow and deliberate (Alter, Oppenheimer, Epley, & Eyre, 2007). It is also conscious, has beliefs and makes choices.

When engaging in effortful mental activities, System 2 allocates our attention for that. In combination with the fact that its operations are effortful, System 2 is reluctant to put more effort in the operation than necessary. Although System 2 believes it has chosen the thoughts and actions, they are often guided by System 1.There are tasks that only System 2 can do because they require attention, effort or self-control instead of the impulse or intuitions of System 1(Kahneman, 2003).

For a better understanding of processing fluency, a closer look at System 1 is needed. Kahneman explains that numerous built-in dials are present in our brain. They are unconsciously, constantly and without effort updating us on important aspects of our environment (Weiss-Lijn, 2012a). These assessments are automatically carried out by System 1 with a function to determine whether extra effort or attention is needed from System 2. One of these built-in dial in our brain is cognitive ease which, in technical terms, is known as processing fluency. Alter and Oppenheimer (2009) define processing fluency as the subjective ease or difficulty of experience in which our brain process information or stimuli. Reber, Schwarz and Winkielman (2004) describe processing fluency as the efficiency and speed of processing a stimulus. Processing fluency itself is not a cognitive process. One must see it as a feeling of ease that is associated with a cognitive process (Oppenheimer, 2008). Processing fluency can range from easy to strain. When a problem exists, System 2 is prompted to solve it. This exertion of effort which is deliberate, induces an experience of strain (e.g. disfluency) (Morewedge & Kahneman, 2010). Otherwise, the information is processed easily and accepted by System 2.

Most of the time, System 1 does a good job in helping us to get things done well and fast and is therefore appropriate to use. When people must judge, System 1 will generate impressions quickly. These impressions are involuntary and automatic (Kahneman, 2003). System 2 then oversees the quality of the suggestions and will endorse, override or correct these most of the time. If System 2 adopts the suggestions made by System 1 without modification, they are then called intuitive judgments (Heukelom, 2012; Kahneman & Frederick, 2002). These intuitive impressions in System 1 are based on heuristics, which people unconsciously use for their decision making, so heuristics are quite useful.

However, heuristics can also lead to systematic errors (Tversky & Kahneman, 1974). System 1 is prone to systematic errors (e.g. bias) in judgment and choice. When System 1 generates a faulty impression (also due to the failing of System 2 to see and correct it), it results in errors of judgment. So, processing fluency is one of the features of associative processes (i.e. memory), that can account for the biases in intuitive judgment as it actually distorts our judgment (Morewedge & Kahneman, 2010)

1.2.2 The fluency effect in judgment

Processing fluency influences our reasoning, judgments and evaluations. Various studies examined what effect fluency has on our judgment. Schwarz et al. (1991) argued that judgment was affected by fluency independently of the cognitive content. They found that when participants experienced an ease of recall, they would rate themselves more assertive. In a later study, Reber, et al. (2004) argued that any variable that would increase the processing fluency would influence judgment. They did an extensive literature review of variables known to influence aesthetic judgment due to changes in fluency. They concluded that aesthetic judgements increased due to the fluency of variables. This uniform effect of fluency was found in all kind of different domains of judgments as described in Table 2. It seems that an increase in fluency will bias our judgments positively.

Table 2

An overview of the fluency effect in different domains of judgment. Source:(Alter & Oppenheimer, 2009).

Source	Domain of judgment	Manipulation of fluency	Basic result
(Bornstein & D'agostino, 1992)	Liking	Ease of retrieval	Stimuli that were easy to retrieve were preferred to stimuli that were difficult to retrieve
(Kelley & Lindsay, 1993)	Confidence	Ease of retrieval	Trivia responses that were easily retrieved from the memory felt more accurate.
(Reber & Schwarz, 1999)	Truth	Visual ease	Statements that were fluent seemed more true than disfluent statements
(Jacoby & Dallas, 1981)	Familiarity	Ease of retrieval	Previously seen rare words were easier to identify
(Whittlesea, 1993)	Familiarity	Semantic priming	Words that were semantically primed felt more familiar than words that were not primed
(Alter & Oppenheimer, 2006)	Valuation / Choice	Linguistic	Financial stock with more easily pronunciation outperform the financial stocks with less easily pronunciation

Ergo, the conclusion can be made that judgments in different domains increased (i.e. more positive) due to the fluency effect. In order to explain this consistent effect on judgment, Reber et al. (2004) proposed the 'hedonic fluency hypothesis' in which they argue that fluency is hedonically marked as a high fluency is experienced positively. They proposed that a function of the processing dynamics of the perceiver is aesthetic pleasure (Reber et al., 2004, p. 377). This proposition assumed four specific beliefs:

1. Fluency of objects differ in which they can be processed;
2. Processing fluency experiences subjectively as positive and is hedonically marked;
3. Aesthetic appreciation judgments are the result of the affective response that is derived by processing fluency; unless the informational value of the experience is called into question by the perceiver;
4. The expectations and attribution of the perceiver moderates the effect of processing fluency.

The fact that processing fluency self is hedonically marked, is interesting. It assumes that the effect of processing fluency is situational, i.e. bound to the stimulus. (Winkielman & Schwarz, 2003).

Winkielman et al. (2003) argued that positive valence is associated with high fluency and therefore positive responses are selectively increased. So, one can assume that the affective response is in fact a mediator of the fluency effect on evaluative judgment (Reber et al., 2004). In turn, this affective response can then be linked to the affect heuristic. (Slovic, Finucane, Peters, & MacGregor, 2007)

1.2.3 The affect heuristic as mediator of the fluency effect

The affect heuristic can be seen in the perspective of Kahneman's heuristics of System 1 (Kahneman, 2003). According to Kahneman, heuristics connects a fluency experience to pleasant feelings, resulting in intuitive responses or higher judgments. So, processing fluency is linked to pleasant feelings by heuristics which in turn results in intuitive judgments. An affect heuristic describes how an affective reaction on a target can be used as a heuristic to evaluate or judge (Slovic et al., 2007). So, the fact that a stimuli is easily processed results in a feeling of ease which is an affective impression that is used to evaluate our judgment (Figure 3). Leder et al. (2004) found that aesthetic evaluations are determined by fast, unconscious processes that decide whether a stimulus is seen as more or less pleasant regarding aesthetics. In other words, the heuristic process of System 1 connects the fluency experience to a more pleasant aesthetic evaluation.

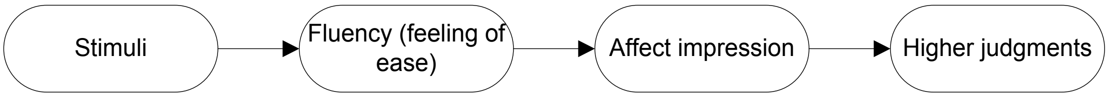

Figure 3. Affect heuristic as a mediator in processing fluency and judgment.

Thus, the fluency effect results in more positive feelings when judging stimuli. Figure 4 shows different feelings of judgments when the stimulus is processed fluently. Ergo, the conclusion can be made that fluency has an uniform positive effect across different domains of judgments (Alter & Oppenheimer, 2009). However, to the best of our knowledge, not a lot of research has been conducted regarding usability judgment and processing fluency. Van Rompay, de Vries and van Venrooij (2010) discussed that the impression of enhanced website usability of a user may be the result of fluent processing. The relationship of beauty and perceived usability however, leads to our proposal of explaining perceived usability and perceived beauty by processing fluency.

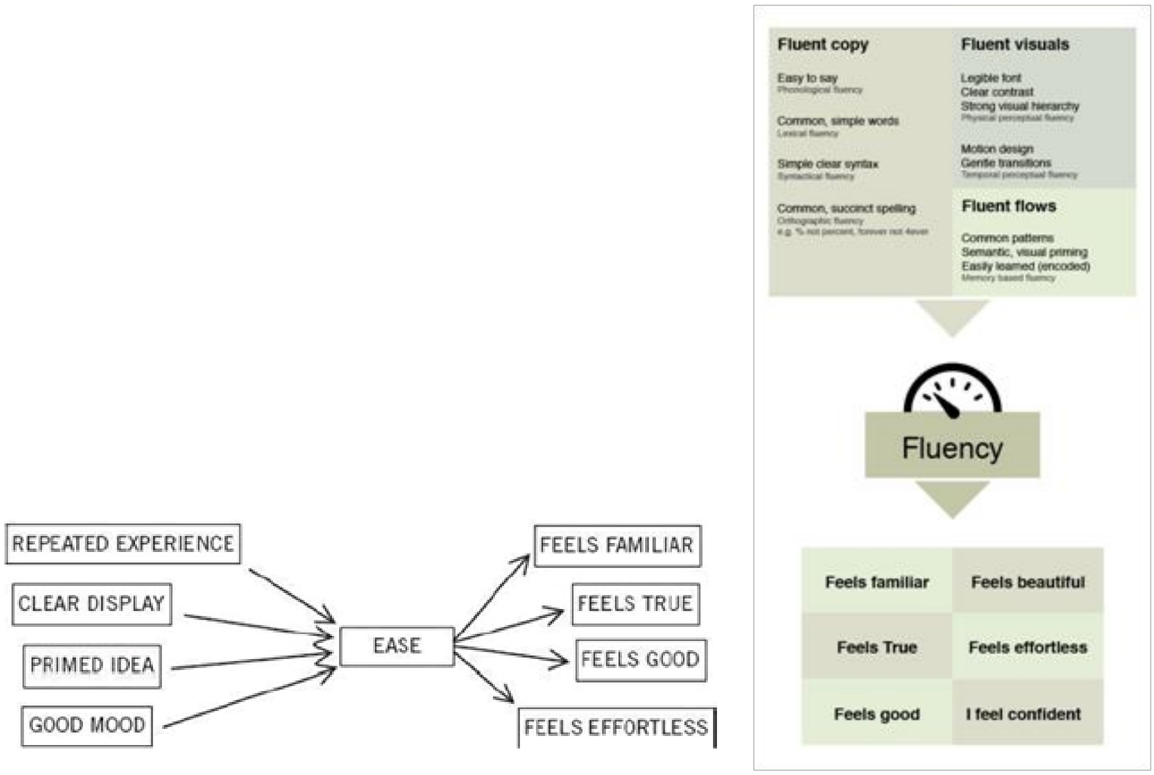

Figure 4. Causes and consequences of Fluency. (Left : Kahneman, 2011, Right: Weiss-Lijn, 2012).

As we have discussed the theoretical framework of fluency and its effect on judgment, we will now focus on how to generate fluency. Illustrated in Figure 4, we see that there are various ways to generate fluency. The different manipulations of fluency will now be discussed.

1.2.4 Manipulations of Fluency

Fluency can be manipulated by different variables, approaches and features of stimuli. Reber et al. (2004) reviewed various empirical literature regarding the variables and procedures that manipulate fluency. Various features of a stimulus manipulate fluency as seen in Table 2. They ensure that the stimulus becomes easier to process, resulting in a high fluency. Tuch et al. (2012a) linked visual complexity and prototypicality to processing fluency. Furthermore, we previously discussed how repeated exposure enhances our attitude. The three manipulations of fluency used in the study will now be discussed: repeated exposure, visual complexity and prototypicality. These three variables have the ability to facilitate and enhance fluent processing of a stimulus (Reber et al., 2004).

1.2.4.1 Repeated exposure

Repeated exposure is a manipulation that increases the fluency of processing a stimulus. The observation that exposure to a mere repeated stimulus enhances the individual's attitude towards the stimuli (which is an affective evaluation), was introduced by Zajonc in 1968 as the mere exposure effect. The mere exposure was seen as a condition where the stimulus was made accessible to a person's perception (Zajonc, 1968). Zajonc's study stimulated debates about the exposure-attitude relationship (i.e. mere exposure) which resulted in interest in the fluency-evaluation link (i.e. exposure-affect relationship (Bornstein & D'agostino, 1992). Bornstein (1989) also showed that repeated exposure to stimuli (e.g. words, pictures, faces) enhanced our positive affect towards them. Prior exposure of the stimulus will thus leads to a more fluent processing as it enhances our subjective feeling of ease (Bornstein & D'agostino, 1992). This exposure effect was also found in sounds and even smells (Lorig, 1999; Peretz, Gaudreau, & Bonnel, 1998). Based on the many empirical literature regarding repeated exposure, it can be assumed that repeated exposure allows us to manipulate fluency as it proved to be an important determinant of processing fluency.

1.2.4.2 Visual Complexity

Tuch et al. (2012a) found that visual complexity (VC) plays a crucial role in aesthetic judgment. In their study, they found that websites with low visual complexity are perceived more beautiful than high visual complex websites. This is understandable as websites with low visual complexity would be easier for our minds to process, thus having a high processing fluency, which results in a more positive judgment. They found that the beauty judgments of websites that were presented for 17 ms presentation were affected by VC.

Thielsch and Hirschfeld (2012) found that low spatial frequencies (websites filtered to a global layout) influence our first impressions regarding perceptions and our judgment of aesthetic appeal. Low spatial frequencies can be considered as low visual complexity. Low spatial frequencies are neurologically processed quickly, thus easy, when presented ultra-rapidly. All in all, one can conclude that when stimuli have low VC, they are processed more fluent as they contain less information to process (Reber et al., 2004) leading to a more positive aesthetic judgment.

1.2.4.3 Prototypicality

With the Internet being a part of our daily lives, users have developed certain expectations how a website should look. It seems that we developed distinct mental models for different website types as people agree mostly what the location should be of a web object (Roth, Schmutz, Pauwels, Bargas-avila, & Opwis, 2010) Also, we tend to have an expectation of how a specific kind of website should look like, for example web shops or newspaper websites.

Prototypicality (PT) can be described as how representative an object look of a class of objects (Leder et al., 2004). It is represented by mental models which are built through experience (Tuch et al., 2012a). This means that the perceiver has a history with the stimulus, which explains our illusions that something feels familiar when it is prototypical. Prior experience with the stimuli can produce a feeling of familiarity (Whittlesea, 1993). A lot of studies found that prototypical stimuli are processed more easily than non-prototypical stimuli, resulting in higher evaluations. Schmettow and Boom (2013) also found that PT resulted in higher judgment of hedonic quality. Also, Schmettow and Kuurstra (2013) found that PT had a positive effect on credibility judgment. As discussed earlier, Tuch et al. (2012a) found that high PT websites were perceived as more beautiful than low PT websites. They also found that the combination of low VC and high PT leads to judgments that are the most positive. Apparently, an interaction is found between VC and PT.

In sum, stimuli that are prototypical are processed easier which results in more positive judgments.

1.2.5 The fluency model

In sum, the dual-processing theory and the fluency effect have been applied in different domains of general decision making. However, they have not yet been applied together to explain the relationship of beauty and (perceived) usability in HCI research.

So, combining these two theories of fluency and their effects and manipulations together, the following fluency model is proposed. Figure 5 presents processing fluency as the common factor of beauty and perceived usability. The presented fluency model is in line with the interactionist view of Reber et al. (2004). This perspective believes that beauty is grounded in the perceiver's experiences of processing that emerge from the interaction of the perceiver's affective and cognitive processes (fluency) and the features of the stimulus (manipulations). Besides beauty, this will also be true for perceived usability.

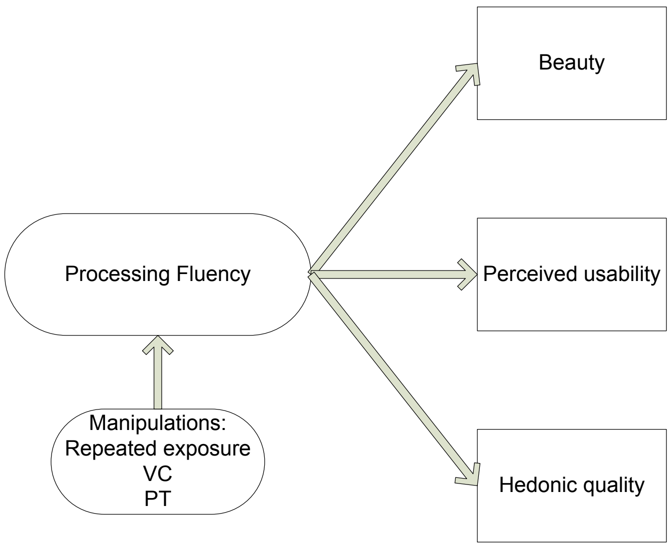

Figure 5. The fluency model.

Figure 5 shows that besides perceived usability and perceived beauty, the construct hedonic quality was added. Numerous studies reported that beauty and hedonic quality are highly related (Cogan, Parker, & Zellner, 2013; Tuch et al., 2012a; van Schaik et al., 2012) . Hassenzahl and Monk found a strong overlap of hedonic quality with beauty (Hassenzahl, 2004). This finding was also apparent in the study by Schwabe and Schmettow (2013). They found that hedonic quality and beauty were indistinguishable, suggesting that they share a common underlying factor. Hedonic quality focuses on aspirations and personal needs, the 'why' of interaction (Hassenzahl & Monk, 2010). It subjectively measures the quality as perceived by the user (e.g. innovative or originality), without a direct connection to the goals that are related to the tasks (Hassenzahl & Monk, 2010). For users, it is important that they perceive the product in the same way as the designers in order for a product to be usable. So, based on these results, hedonic quality was added to the model in order to test it. If processing fluency is true, it will affect all scales.

Furthermore, Figure 5 shows the relevant manipulations of the fluency model for this study. As discussed earlier, repeated exposure, VC and PT will be used to manipulate fluency in order to examine if processing fluency is the underlying variable. As processing fluency influences judgment of perceived beauty positively, the expectation is that high fluency will lead to a more positive judgment of beauty. This study expects that, besides perceived beauty, the judgment of perceived usability and hedonic quality will also be more positive as processing fluency will influence all factors.

Therefore, the research question of this study is: *Is processing fluency the cognitive process of perceived beauty, perceived usability and hedonic quality?*

The hypotheses that will support the research questions are:
H1. High fluency due to repeated exposure will lead to a more positive judgment of perceived beauty, perceived usability and hedonic quality.

H2. High fluency due to low VC will lead to a more positive judgment of perceived beauty, perceived usability and hedonic quality.

H3. High fluency due to high PT will lead to a more positive judgment of perceived beauty perceived usability and hedonic quality.

So, now that the fluency model and its hypotheses are proposed, we want to prove the fluency effect. However, we are also interested in breaking the fluency effect. The following section will discuss how to break the fluency effect.

1.2.6 Breaking the fluency effect

Besides examining the fluency model and its effects on perceived beauty and perceived usability, this study is also interested in how to break these fluency effects. If we assume that the proposed fluency model is true, thus the underlying variable of perceived beauty and perceived usability is fluency, then removing the fluency will result into a weaker relationship between usability and beauty. This will be useful in future HCI research to assess the more ‘true’ opinion and behaviour of users regarding these constructs. Responses on subjective methods used to measure beauty and perceived usability (e.g. Likert-scales) are then less influenced by fluency.

As described earlier, System 1 will propose automatic and involuntary impressions quickly when people have to judge. If System 2 adopts these, they are called intuitive judgments which relates to the fluency effect. In order to break the fluency effect, a shift is needed from System 1 to System 2 when judgments arise. Numerous studies have tried to purposely activate System 2 by manipulating disfluency. As numerous times described in this study, the shift occurs when cognitive strain, or disfluency, is experienced. Alter et al. (2007) manipulated disfluency by changing the questions into a difficult-to-read font (disfluency) or an easy-to-read font (fluency) and by furrowing the brow (disfluency) or puffing their cheeks (fluency). By changing the font of the questions into hard to read or furrowing the brow, the defaults in the judgments were reduced. As System 2 is activated by disfluency during the reasoning process, users attend to use systematic reasoning when they experience disfluency (Alter et al., 2007). They showed that disfluency alarms you, resulting in the activation of analytical reasoning that sometimes correct and assess the output of intuitive reasoning of System 1. Hernandez and Preston (2013) manipulated disfluency and activated System 2 by presenting arguments on issues in a disfluent or fluent format to overcome the confirmation bias. The experience of disfluency prompts the user to use a slower mindset when making judgments, which is in line with System 2. They conclude that the opportunity for better judgment may be offered by disfluency. Furthermore, it should be clear that this can be achieved by manipulating the fluency the other way around as described previously.

Another way to activate System 2 is by manipulating the processes of System 2. By making users aware that they are automatically and unconsciously influenced when judging stimuli, System 2 is activated before judgments arise. As people will engage in analytical thinking and reasoning (i.e. processes of System 2), it disrupts the automatic and unconsciously fluency effect on judgments. Thus, System 2 is activated before judgments start, therefore disrupting the fluency effect. Then, the quality of judgment of ‘true’ perceived beauty and perceived usability will increase as they would not have an underlying common variable, thus they measure the constructs without the influence of fluency.

In the current study, System 2 is activated by instructing the participants. By making the user aware that we judge usability and beauty based on visual properties such as symmetry, VC or PT, we elicit them to think about what truly makes perceived usability and perceived beauty (and thus their responses to it). To engage the participants even more in analytical reasoning, they are asked to make a criteria list regarding their definition of usability and beauty. By giving an instruction and a treatment task, it may reduce their intuitive judgment as they have to put more effort into analytical reasoning associated with System 2. If we assume that the switch from System 1 to System 2 can be active by instructions/treatment and it leads to more 'truly', objective judgments of perceived beauty and perceived usability, then a practical treatment tool is found for future research in HCI. To the best of our knowledge, no research has yet been conducted on examining whether instructions will lead to the activation of System 2, thus proving that it can be manipulated.

Thus, the following hypothesis regarding the breaking effect can be formed:
H4a. The correlation of beauty and perceived usability decreases when receiving the treatment and instruction.

H4b. The influence of VC and PT on beauty and perceived usability decreases when receiving the treatment and instruction. Therefore, the judgment of perceived beauty and perceived usability will be less positive.

Furthermore, we expect that participants in the treatment and control condition will view the stimuli differently. The expectation is that their reaction time will be longer, due to the activation of System 2. As described earlier, Alter et al. (2007) discussed that System 2 demands effort and its processes are slow and analytical. So, in comparison with System 1 (i.e. fluency effect), the reaction time in the treatment condition will be longer which suggests that participants are analytical thinking. Thus, the last hypothesis regarding the breaking fluency effect is:

H5. The reaction time of participants will be longer when receiving the treatment and instructions.

2. Methods

2.1 Participants

Forty-two participants (31 females), consisting of students of the University of Twente and acquaintances of the researcher, took part in the experiment either on voluntarily basis or for completing course requirements. The requirements to participate in the experiment were: a minimum age of 18, sufficiently knowledge of the Dutch language and familiar with websites/the internet. The age ranged between 18 and 57 years with a mean age of 28 years (SD = 10.6). Dutch was the native language of 38 participants and German was the native language of 4 participants. Participants were randomly assigned to a control or treatment condition. Both conditions consisted of 21 participants. The faculty's ethics committee gave approval for the experiment and an informed consent was signed by all participants before participation.

2.2 Design

The experiment had a 2 (VC) x 2 (PT) x 1 (repeated exposure) within-subject research design with the treatment condition as the between-subject. The VC, PT, repeated exposure and treatment condition were the independent variables. The dependent variables were perceived beauty, hedonic quality and perceived usability (pragmatic quality) (Hassenzahl & Monk, 2010; Tuch et al., 2012a).

The experiment consisted of four blocks, each consisting of 48 screenshots (192 stimuli in total). Each screenshot was followed by one question of the three scales (Hedonic, Usability and Beauty). Figure 7 shows the procedure of the stimuli and questions. In order to reduce the workload and to reinforce the treatment condition, two different kinds of breaks were built in. After 24 questions, there was a 30 seconds break which automatically proceeded to the next screenshot when the break was over. Between each block, the participant had a 2 minute break. When the 2 minute break was over, the next block started. In total, there were three 2-minute breaks between the four blocks of the experiment.

The appearance of each scale was balanced out evenly over the fluent and disfluent condition, meaning that each scale appeared 16 times in one block (48 stimuli / 3 scales, 8 times per condition). In order to randomize the order of the screenshots, the scales and its items per screenshot, a specific excel file has been made for each participant. By balancing out and randomizing the scales, six different combinations of scales and items were possible in the blocks (H-U-B, B-U-H, U-H-B, U-B-H, B-H-U, and H-B-U). One of the six combinations was then selected for each participant per screenshot. See Figure 6 for an illustration of the randomization and selection of the stimuli in the experiment. The random selection of items of each scale was not balanced out, resulting in some questions appearing more often than other questions of a scale (See appendix 6.6).

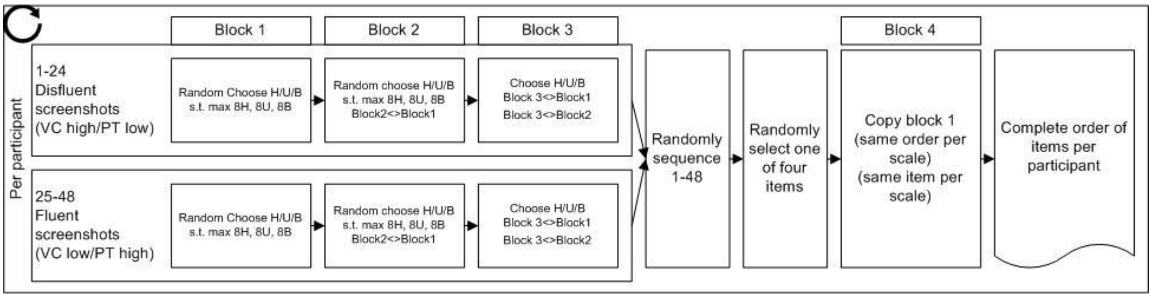

Figure 6. Visualization of the randomization and selection of stimuli.

2.3 Websites rated

In the current study, the websites in the study of Tuch et al. (2012a) were. In the experiment, 48 American companies' websites were selected from the pool used in the study by Tuch et al. (2012b). The websites were chosen from the categories VC low – PT high (20 websites: high fluency) and VC high – PT low (20 websites: low fluency). Furthermore, eight websites were added in order to balance out the three scales more evenly. Analyzing their results, these websites had a VC low-PT high score or VC high-PT low score despite categorized in another group (e.g. VC medium, PT low) (Tuch et al., 2012a). For the practice phase, four new companies' websites were used to avoid priming or repeated exposure in the experiment phase. The companies' websites were selected from Tuch et al. (2012a) study. See appendix 6.8 for an overview of all websites.

2.4 Measures

The items of perceived usability (pragmatic quality) and hedonic quality were taken from the short version of the AttrakDiff 2 questionnaire (Hassenzahl, Burmester, & Koller, 2003). Due to the large number of websites shown, a short version was required. Perceived usability and hedonic quality consisted both of four items. The items were scaled on a 7-point Likert scale, anchored by their opposites. As the experiment was conducted in Dutch, the translated items were used (Klomp, 2011). The perceived beauty was measured by using the single item scale (Hassenzahl & Monk, 2010) and three items based on the classic aesthetics by Lavie and Tractinsky (2004). As the expressive aesthetics showed too much overlap with the hedonic quality scale when translated in Dutch, the classic aesthetics were chosen. The three classic aesthetic items were selected from the study of Tractinsky, Cokhavi, Kirschenbaum and Sharfi (2006), namely: aesthetic design, clean design and pleasant design. These 7-point Likert scales were anchored “Strongly disagree” to “Agree” with the shared question “The website just shown has an ….. design”. The items of the beauty scale were also translated to Dutch. All items of each scale are in appendix 6.5.

2.5 Measurement of the reaction time

In the experiment, there were two types of reaction times. The first reaction time measured how long participants took to answer the questions. When participants pressed the spacebar after viewing the stimulus, the question would appear on the screen (Figure 7). After answering the question and pressing the button, participants moved to the next stimulus. This time of answering the questions is taken as a reaction time. The second reaction time was measured from the moment participants started viewing the stimulus and pressing the spacebar to continue to the question.

2.6 Treatment

The treatment consisted of a criteria list given to participants before the experiment started. Participants were asked to make a list of five criteria for beauty and for usability. These ten criteria’s were their definition of beauty and usability. They were not allowed to have the same criteria on their beauty and usability list. Also, an instruction was given to the participants before and during the experiment. The instruction explained to the participants that our judgments of beauty and usability are intuitively and unconsciously influenced by fluency. The participants were asked to think about what makes it beautiful and usable and what usability and beauty truly means to them when answering the questions. During the 20 seconds and two minute breaks, participants were reminded again of their criteria list of usability and beauty and their definition of these two. They were asked to read their answers again and keep them in their mind when answering the questions. See appendix 6.1 and 6.3 for the treatment and instruction.

2.7 Apparatus and materials

The experiment was implemented with the software Opensesame and Excel (Mathôt, Schreij, & Theeuwes, 2012; Microsoft, 2007) The randomization was developed in Excel and a script was written in Opensesame. See appendix 6.2 for the syntax of Excel used in the experiment. The experiment was conducted on a 15.4" laptop with a resolution of 1680 x 1050 pixels and a refresh rate of 60 Hz. The resolution used to run the experiment was 1000 x 800 pixels (Tuch et al., 2012a)

2.8 Procedure

As it is important that the participant do not call the informational value of his or her experience into question for measuring the aesthetic appreciation (Reber et al., 2004; Schwabe & Schmettow, 2013), only the screenshots of the websites were presented. The experiment lasted around 45 minutes.

The participants in the treatment condition had to complete the criteria list task first whereas the control condition had to complete the control task. The experiment started with a welcome and introduction screen, displayed on the computer (see appendix 6.7). Here, the experiment is explained. Both conditions were instructed to view the screenshots shortly and fill in the questions based on their first impressions of the websites. The participants read the instruction at their own pace and started the experiment by clicking on the start button. The participants were then asked to fill in some demographical information (e.g. gender, age). A short practice phase of four stimuli was then presented to make the participant familiar with the experiment. After the practice phase, the treatment group was reminded again to keep their answers on the criteria list task in mind while answering the questions. Then, participants started with the experiment. Pressing the space bar on their own pace, participants moved from a screenshot to a question. No time condition was set. After each screenshot, participants had to fill in one question regarding perceived beauty, hedonic quality or perceived usability. When the question was answered, participants pressed the 'next' button to proceed further (see Figure 7). It was not possible to go back in the experiment. After the fourth block, the ending screen was presented where the participant was thanked for their cooperation. Screenshots of the experiment are shown in appendix 6.7.

Figure 7. Procedure of the experiment.

2.9 Data analysis

All data of the participants were used to analyze. Statistical programs IBM SPSS 21.0 and R were used to analyze the data (R Core Team, 2013; SPSS IBM, NY).

In R, the libraries LME4 (mixed effects models) (Bates, Maehler, Bolker, & Walker, 2014) and MCMCglmm (Markov chain Monte Carlo Generalized Linear Mixed Models) (Hadfield, 2009) were used.

To estimate the relationship between the predictors PT, VC, repeated exposure, and condition, a mixed-effects model was chosen. In comparison with a classic repeated measures ANOVA, the mixed-effects models have several advantages (Gueorguieva & Krystal, 2004). Namely, the GLMM is able to deal with repeated measures and complex clustered design but also have the flexibility of a GLM (Hund, Schmettow, & Noordzij, 2012.). They are more flexible and have greater statistical power. Using asymptotic tests to assess statistical significance in mixed effects models have proven to be problematic and unreliable (Bolker et al., 2009). Therefore, statistical significance was assessed by a Markov Chain Monte Carlo sampling. (Schmettow & Havinga, 2013). Uninformative priors were used (Schmettow &

Havinga, 2013). The Gaussian error term was used for the data model. For testing the hypotheses, we focused on the fixed effects results. The syntax of R can be found in appendix 6.4.

To examine whether the correlation between beauty and perceived usability would decrease after treatment, a bivariate correlation analysis was conducted in SPSS (see appendix 6.9 for the SPSS syntax).

For the reaction time hypothesis, a Generalized Estimating Equations (GEE) analysis was used with the Gaussian distribution. The dependent variable was the reaction time with condition variable as factors. See appendix 6.9 for the SPSS syntax.

3. Results

In total, 8064 responses were measured with 192 responses per participant. For the MCMC glmm analysis, the z-standardized scores of the response, VC and PT were used. The variable VC was transformed into visual simplicity (VS) for easier interpretation (Schmettow & Boom, 2013). The reference group consists of the hedonic quality scale, control condition and block 1. Several models were tested and the less complex model with a lower DIC (27629.75) was chosen. The main effects were VS, PT and blocks whereas the two-way interaction effects were VS*condition, VS*PT and PT*condition. Two three-way interaction effects were introduced in the model. They were VS*condition*scale and PT*condition*scale. The estimated fixed-effects coefficients are shown in Table 1. For treatment contrasts, the reference groups consisted of the control condition, the hedonic quality scale and the first block. The hedonic quality scale was used as the reference group as the study was targeted at the association between beauty and usability.

For the correlation analyses of the rating scales, the data consisted only of block 1 thus resulting in 1008 responses of the 48 screenshots per condition (21 participants per condition).

For the reaction times, the residuals were plotted to check for normality and outliers. Although outliers were observed in the plots, most of them were not removed as the range will be limited when removing them all. Also, it may be relevant for our research as we are interested in the difference in reaction times for both conditions. However, some outliers in the reaction time when answering questions were removed. See R syntax for these outliers (Appendix 6.4). As the data was not normal distributed and was skewed, the reaction times were log-transformed for the GEE analysis to reduce skewness (Appendix 6.9).

Plotting both reactions times against age, it appears that the time spent on viewing the stimuli and answering the questions, increased with age (Figure 8 and 9).

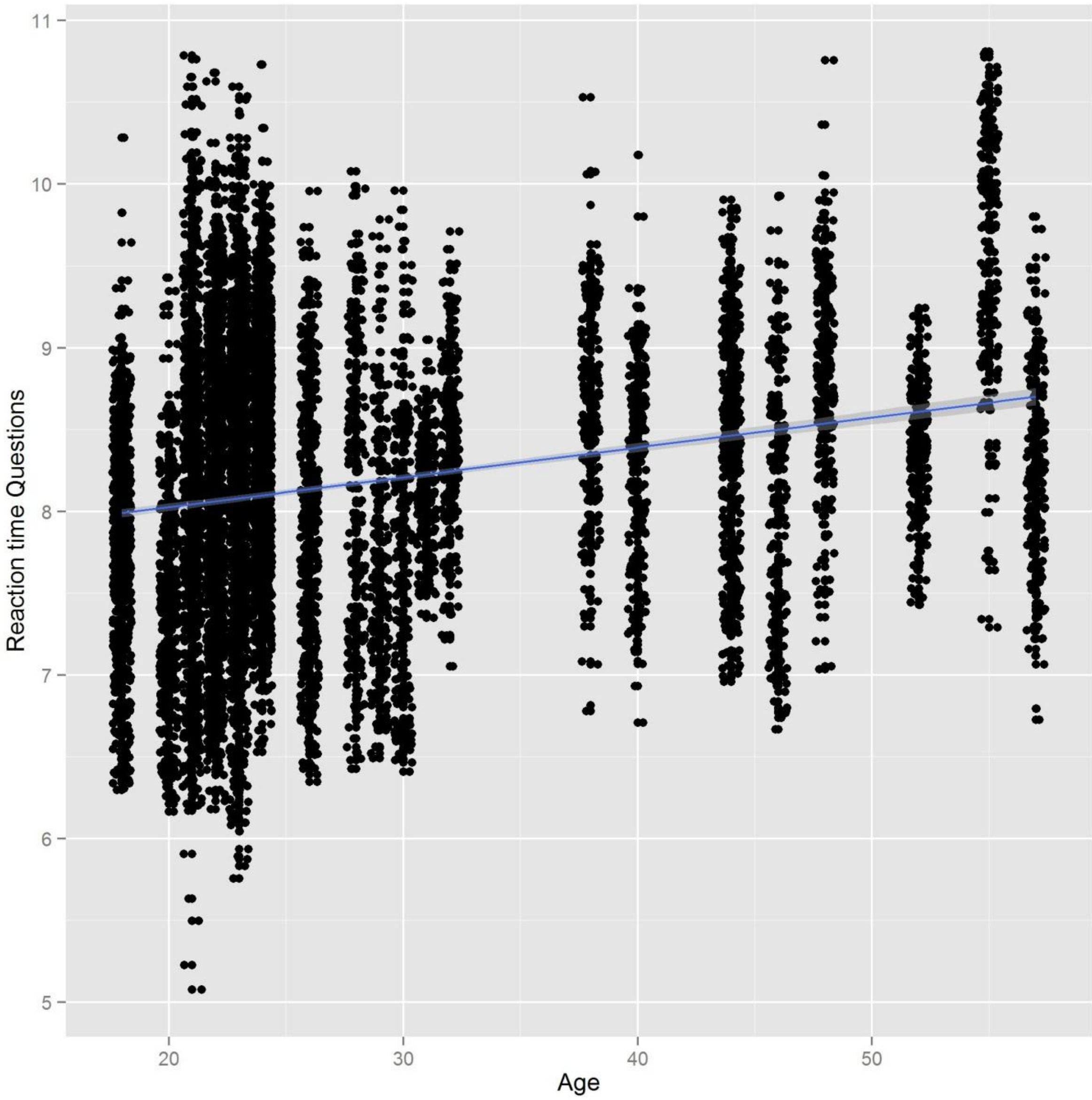

Figure 8. Reaction time of questionnaire against age.

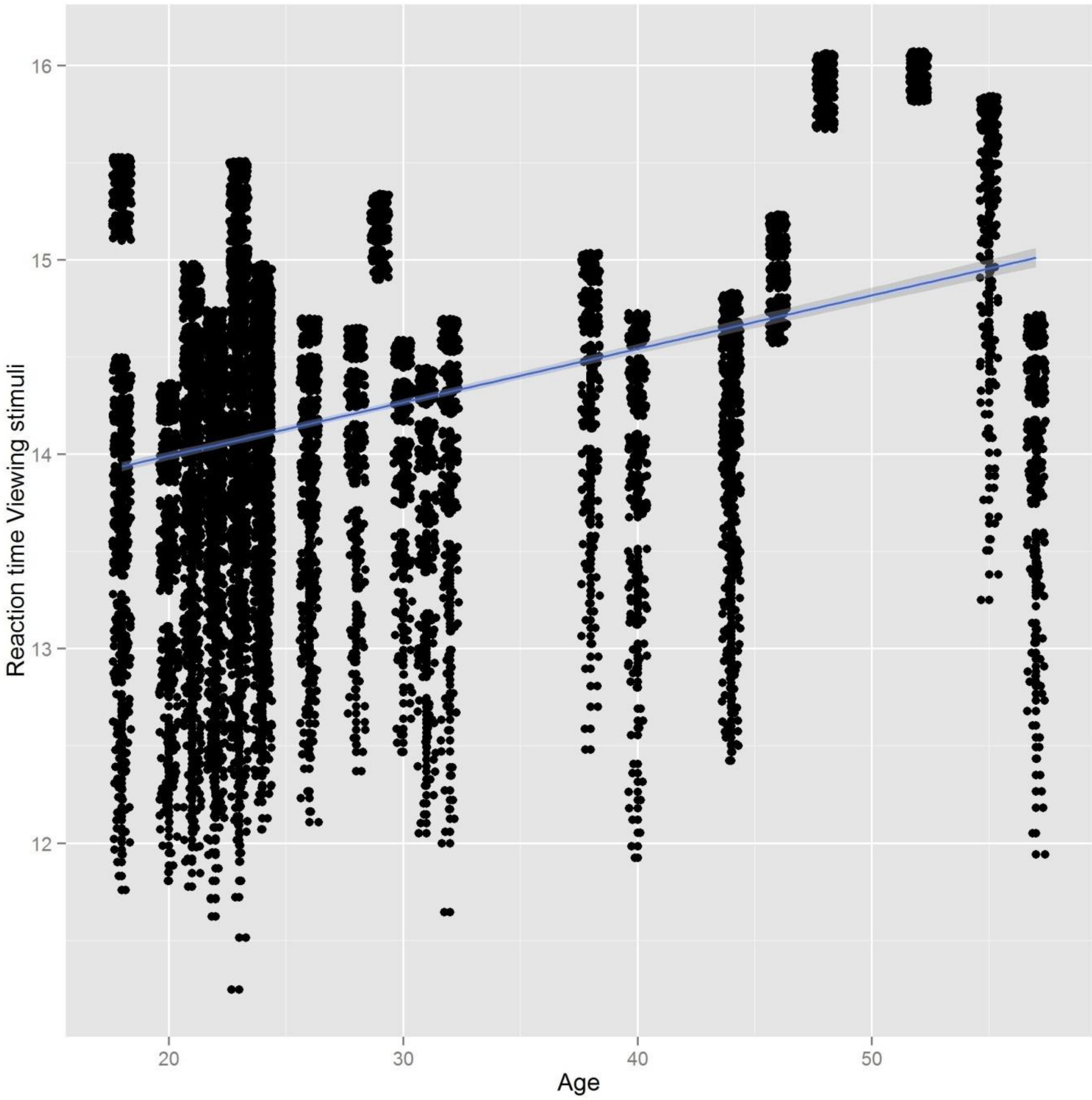

Figure 9. Reaction time of viewing the stimuli against age.

In order to answer the research questions, the estimated fixed-effects coefficients, credible intervals and model effects are provided in Table 3. It shows the main effects, two-way and three-way interaction effects. Furthermore, the regression estimates are shown in Figure 10 for an easier visualization of the coefficients estimates and significance (i.e. overlap zero).

Table 3

Estimated fixed effects coefficients, with alpha error and 95% credible intervals.

Variable	Coef	l-95% CI	u-95% CI	pMCMC
Intercept	2.749	2.313	3.098	.00***
Condition T	-.235	-.465	.048	.078
zVS	.314	.083	.614	.014*
Scale U	.352	.072	.682	.030*
Scale B	.180	-.140	.476	.220
zPT	.646	.427	.953	.001***
Block 2	.089	.001	.167	.038*
Block 3	.082	.005	.168	.050*
Block 4	-.003	-.092	.074	.922
zVS:zPT	.358	.052	.628	.022*
zVS:Cond T	-.217	-.358	-.071	.004**
zVS:Scale U	.130	-.012	.264	.062
zVS:Scale B	.051	-.089	.200	.486
zPT:Cond T	.155	.025	.295	.034*
zPT:Scale U	-.154	-.295	-.012	.030*
zPT:Scale B	.179	.037	.321	.016*
zVS:Cond T:scaleU	.102	-.132	.290	.334
zVS:Cond T:scaleB	.256	.047	.457	.010*
zPT:Cond T:scaleU	-.203	-.384	.019	.058
zPT:Cond T:scaleB	-.247	-.439	-.025	.022*

Note. $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$. T = Treatment, U = perceived usability, B = Beauty. For treatment contrasts, the reference group are Condition=Control, Block=1, Scale=H (hedonic quality).

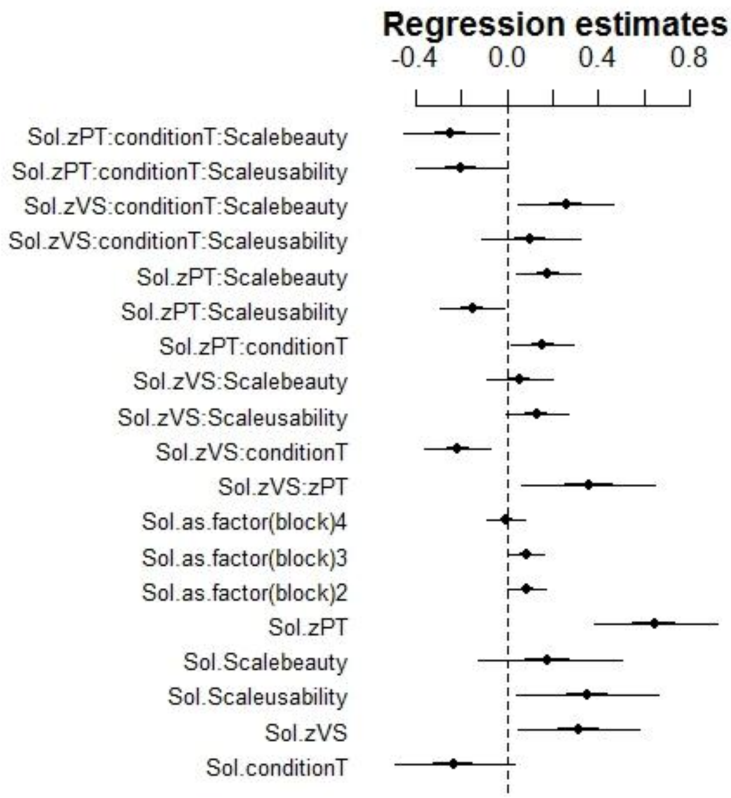

Figure 10. Regression estimates of the model.

3.1 The fluency effect

The research question was whether processing fluency is the underlying variable of perceived beauty, perceived usability and hedonic quality. As we expected that repeated exposure, VC and PT would lead to more positive judgments of these three constructs, they will now be discussed.

3.1.1 Scale

Looking at Table 3, it shows that judgments on the beauty scale and perceived usability scale differed from the hedonic quality scale (=reference group). Responses on the beauty scale were more positive than on the hedonic quality scale (Δresponse =.0180). On the perceived usability scale, judgments were even more positive in comparison with the hedonic quality scale (Δresponse =.0352). Although only perceived usability showed a significant difference in comparison with the hedonic quality scale, responses on both scales were higher than for the hedonic quality scale.

3.1.2 Repeated exposure

Figure 11 displays the plot for repeated exposure. It appears that Block 2 and 3 had higher responses than Block 1 and fourth. It was expected that Block 4 would be in line with Block 2 and 3, therefore it is a surprising result.

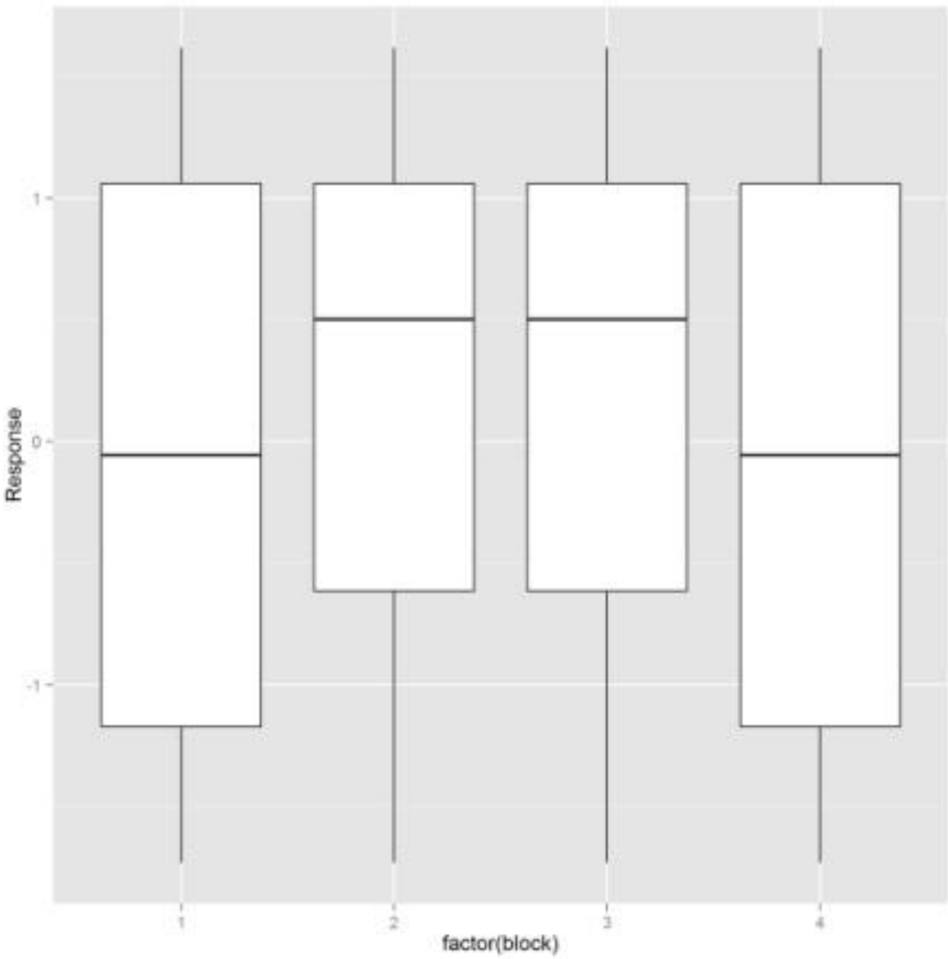

Figure 11. Boxplot of repeated exposure.

Based on Table 3, participants judged the websites more positive when seen a second time when compared to the first time (Δresponse=.089) in Block 2. Block 3 also saw a positive difference with Block 1 (Δresponse=.082). Both Block 2 and Block 3 were found significant. Surprisingly, this effect has not been observed in block 4 when compared to Block 1. In fact, the difference in means between Block 4 and 1 was very small (Δresponse=-.003) and did not reach statistical difference. The difference even suggests a tendency to a slight decrease (less positive) in judgments. This finding was not expected based on the results of Block 2 and 3. It appears that our hypothesis of repeated exposure is thus half-confirmed.

3.1.3 Prototypicality

Based on the research question, the expectation was that a high PT would lead to more positive judgments on websites. Table 1 shows that higher levels of prototypicality in websites are indeed judged more positive on the hedonic quality scale (Δresponse =.646). Prototypicality was found significant ($p<.001$), confirming our hypothesis. Figure 12 illustrates the interaction effect between PT and the scales. The lines of the three scales are not parallel, suggesting an interaction effect as the effect of PT seems to differ across the three scales. It seems that the judgments on the beauty scale increased more when the websites were more prototypical than compared to the hedonism and usability scale. Table 3 shows that the effect of PT was weaker on the perceived usability scale (Δresponse =-.154) in comparison with the means of the hedonic quality scale but nevertheless significant ($p=.034$). Thus, judgments on the usability scale were less positive in comparison with the hedonic scale, but still confirming that higher prototypicality in websites are judged more positive.

Based on Table 3, a difference of the effect of PT was found between hedonic quality and the beauty scale (Δresponse=.179). People judged the more prototypical websites more positive on the beauty scale in comparison with the hedonic quality scale. The interaction effect of PT and the beauty scale reached statistical significance ($p=.016$).

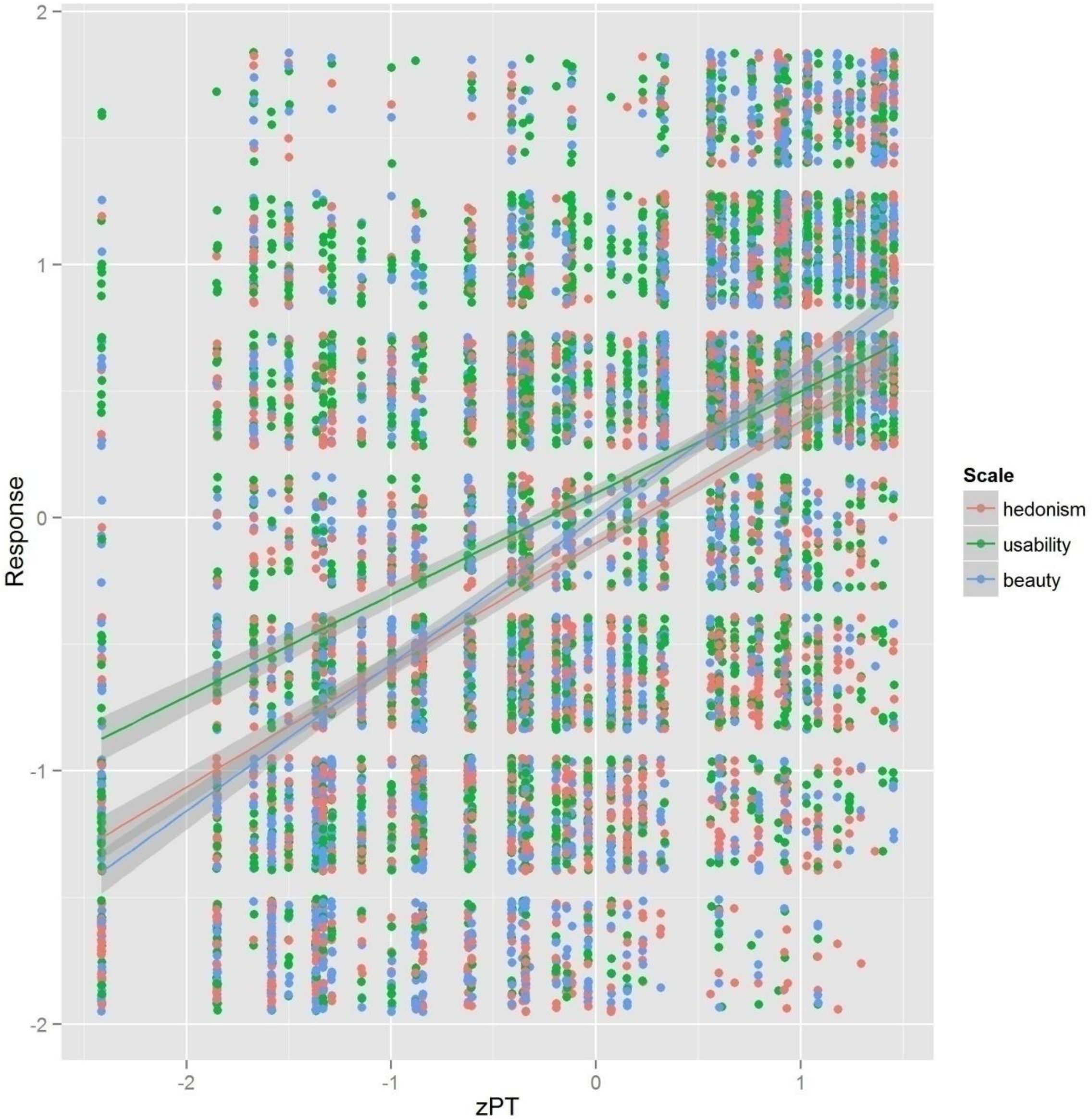

Figure 12. Interaction plot of PT and scale.

3.1.4 Visual Complexity

Based on Table 3, visual simple websites were judged more positive in the control condition, in the first block on the hedonism scale (Δresponse =.314). VS was found significant (p=.014). Figure 13 illustrates the interaction between VS and the scales. The lines of the hedonic quality scale and perceived usability scale are almost parallel, suggesting that there is no interaction effect. Looking at Table 3, no significant interaction effect was found for both perceived beauty and perceived usability, suggesting that the effect of VS is uniform among the three scales. The judgments were more positive of visual simple websites on the perceived usability scale when compared to the hedonic quality scale (Δresponse=.130) although it did not meet statistical significance. The effect of VS on the beauty scale also did not differ much compared to the hedonic quality scale but resulted still in slightly more positive judgments when the websites are visually simple (Δresponse=.051).

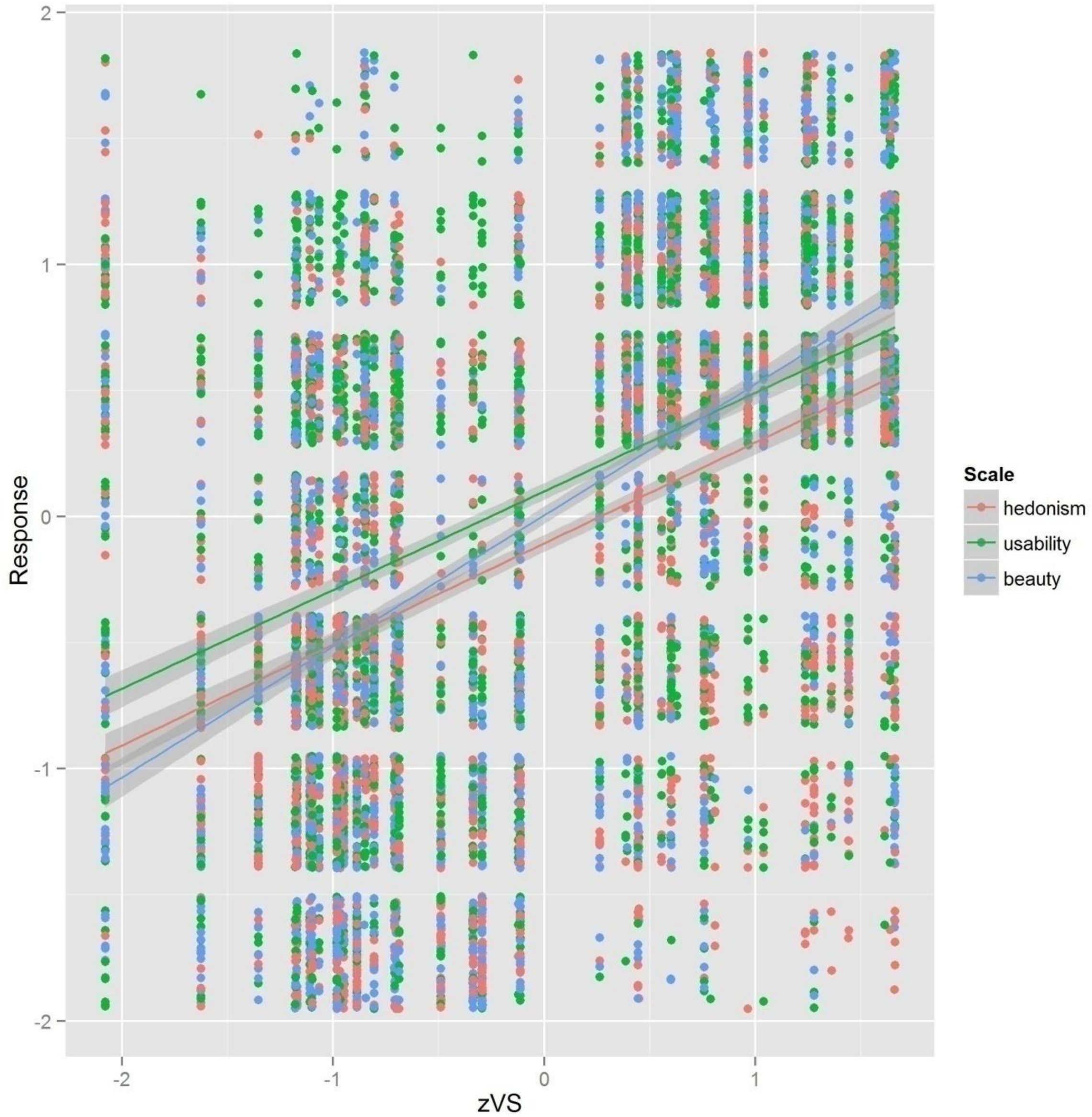

Figure 13. Interaction plot of VS and scale.

3.1.5 Interaction between visual complexity and prototypicality

Table 3 shows that a significant interaction effect was found between VS and PT (Δresponse =.358, p=.022). This means that websites that are visual simple and high in prototypicality results in more positive judgments.

3.2 Breaking the fluency effect

To examine whether the fluency effect was broken by giving the participants a treatment/instruction, the interaction effect of VS*condition and PT*condition were

analyzed. Furthermore, two three-way interaction were introduced in the model, namely VS*condition*scale and PT*condition*scale. Also, we hypothesized that the correlation between beauty and perceived usability would decrease in the treatment condition.
Lastly, we expected that the reaction time in the treatment would be longer than in the control condition due to the activation of System 2.

3.2.1 Treatment condition

In order to answer the hypothesis of breaking fluency, we will take a look at the treatment condition. The expectation is that the effect of fluency is gone in the treatment condition, resulting in less positive judgments on the scales. This would mean that the judgments on the beauty, perceived usability and hedonic quality scales are more “true”.
Based on Table 3, the treatment condition was judged less positive in comparison with the control condition (Δresponse=-.235) although it did not met statistical significance.

3.2.2 Prototypicality and treatment

For easier visualization and interpretation, the interaction effect of PT and condition is plotted in Figure 14. It appears that there is an interaction effect between PT and condition as the lines are not parallel. Based on Figure 14, the effect of PT seem to differ among the control and treatment condition as the control condition shows more positive responses in comparison with the treatment condition when websites are more prototypical.

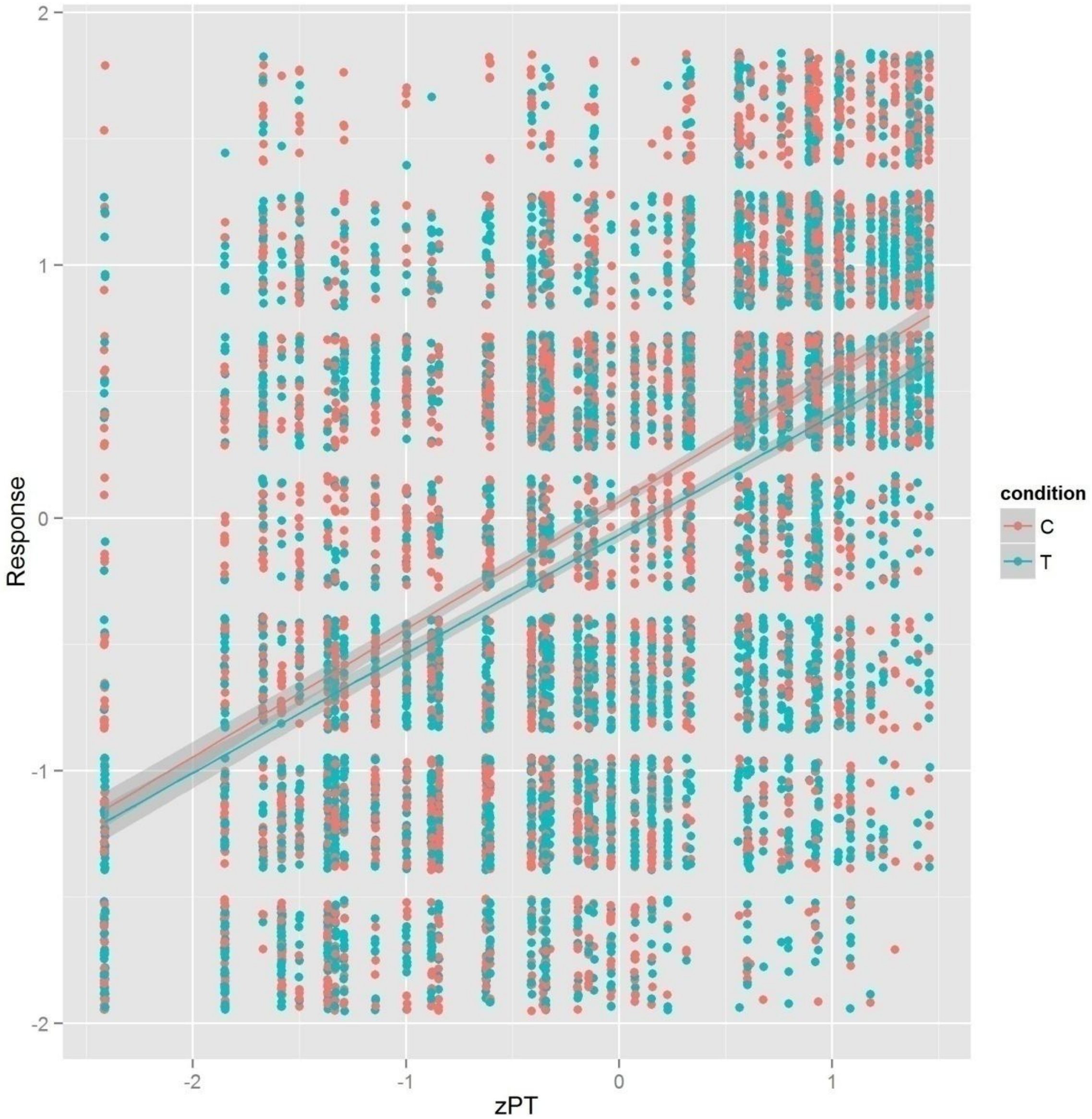

Figure 14. Interaction plot of PT and condition.

Analyzing Table 3, the interaction effect is indeed found which met statistical significance (Δresponse=0.155, p=.034). Thus, the effect of PT differs between the control and treatment condition. However, in contrast with Figure 14, the result suggests that the treatment condition leads to more positive judgments in comparison with the control condition. To see whether the effect of PT and condition differs among the three scales, a 3-way interaction effect is conducted (Figure 15).

Table 3 shows that the interaction effects for the beauty scale were significant, suggesting that the found 2-way interaction is different between beauty and hedonic quality. For the beauty scale, effect of PT and treatment were lower (i.e. less positive) than the 2-way interaction for the hedonic quality scale (Δresponse=-.247). In comparison with the hedonic quality scale, the judgments of PT in the treatment condition were less positive for perceived usability (Δresponse=-.203). For the perceived usability scale, no significant 3-way interaction was found.

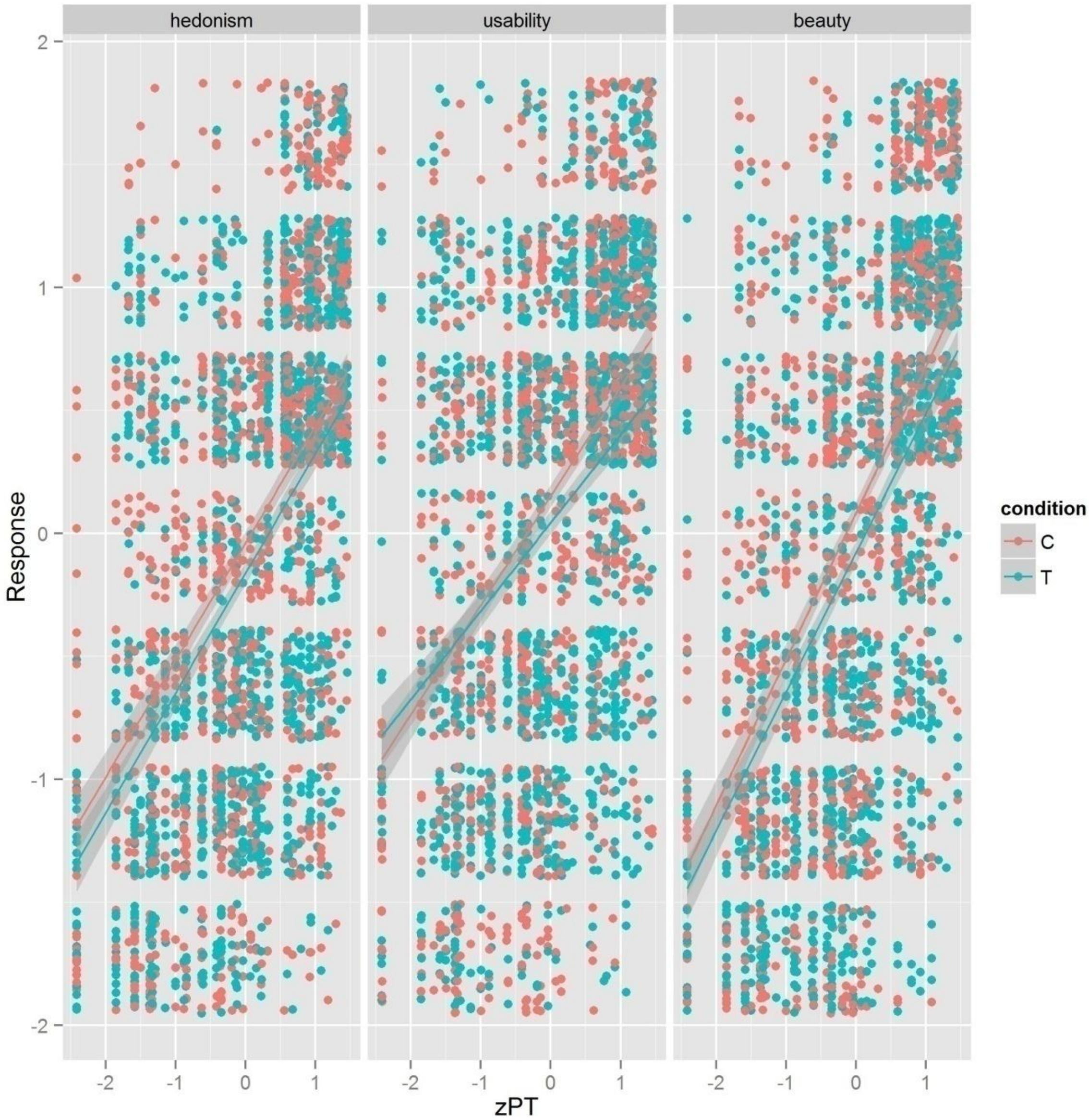

Figure 15. 2-way interaction plot of PT and condition between the three scales.

3.2.3 Visual simplicity and treatment

Figure 16 shows the interaction plot of VS and condition. As the lines of the control and treatment condition are not parallel, it suggests an interaction effect. Based on Figure 16, it appears that judgments are less positive in the treatment condition when websites are more visual simple. Interestingly, it seems that when websites are visual complex, the judgments are almost the same in the treatment and control condition. Visual complex websites are perhaps processed less fluent (more cognitive restrain), thus disfluency can occur which explain the similar results of the treatment and control condition. Looking at Table 3, there is indeed an interaction effect between VS and condition. The judgments are less positive in visual simple websites in the treatment condition, in comparison with the control condition (Δresponse=-.217). The interaction effect between VS and condition reached statistical significance (p=.004). This result supports the breaking fluency hypothesis.

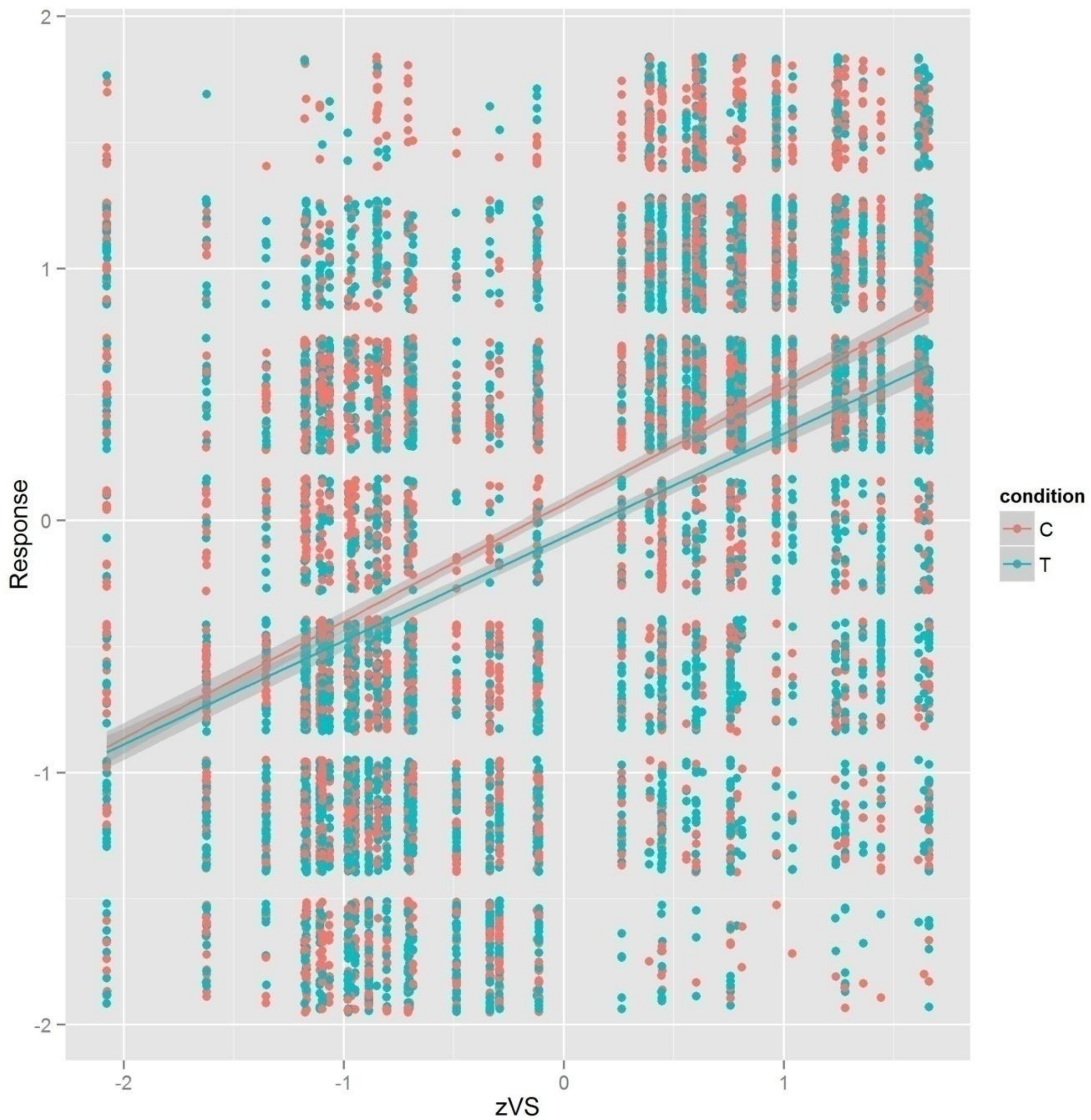

Figure 16. Interaction plot of VS and condition.

Figure 17 illustrates the three-way interaction effect of VS, condition and scales. It seems that the three-way interaction effect differs at the different scales. Table 3 shows if the interaction effect of VS and condition indeed differs between scales. For the perceived beauty scale, the interaction effect of VS and condition was found significant (p=.010). In comparison with the hedonic quality scale interaction effect, the judgments on the beauty scale were more positive on visual simple websites in the treatment condition (Δresponse=.256) However, this effect is almost cancelled out when compared to the interaction effect VS and condition on the hedonic quality scale. The interaction effect did not reach statistical significance on the perceived usability scale and the judgments were a bit more positive in comparison with the hedonic quality scale (Δresponse=.102).

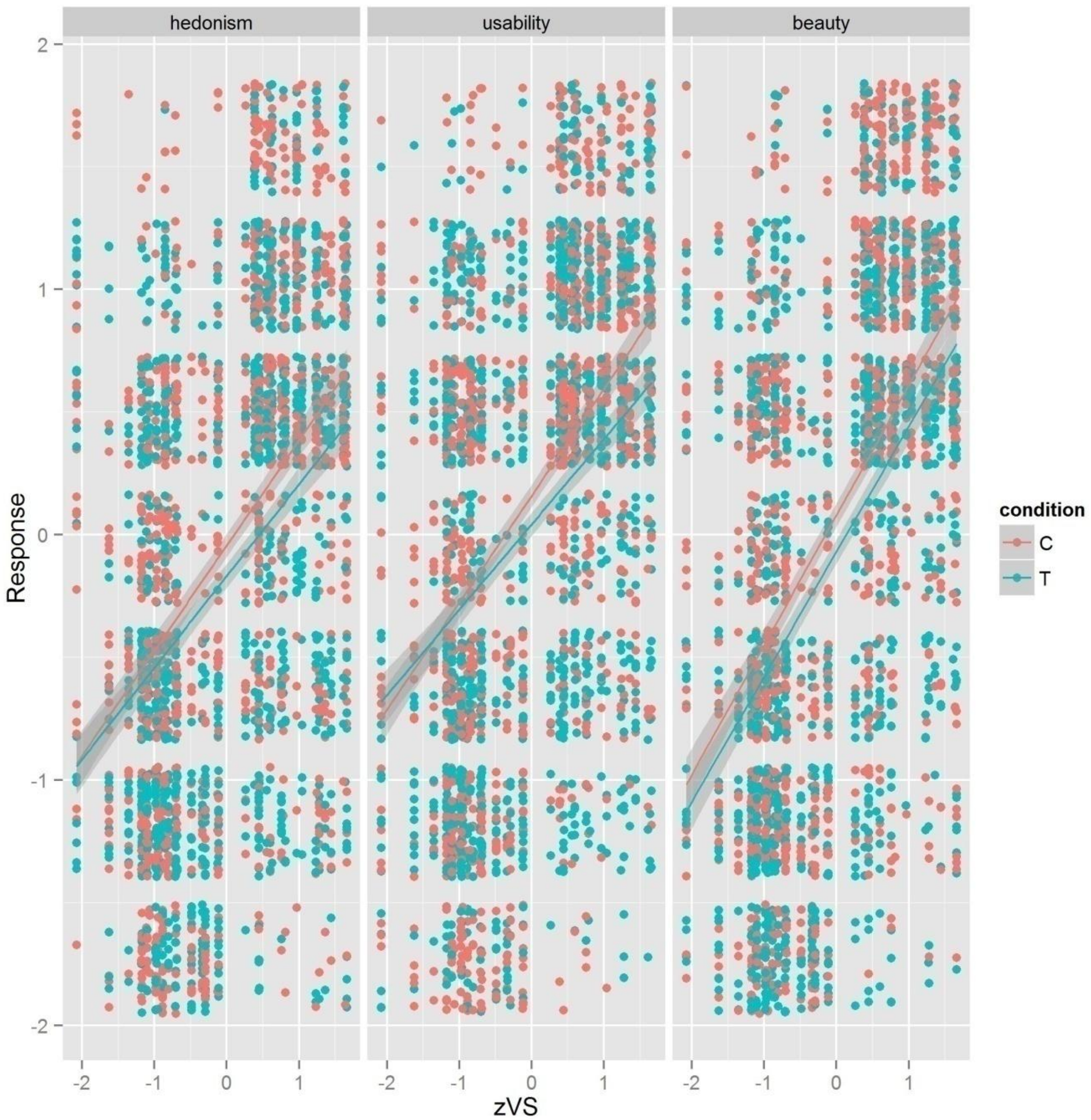

Figure 17. 2-way interaction plot of VC and condition for the three scales.

3.2.4 Correlation between beauty and perceived usability

The bivariate correlations between beauty, perceived usability and hedonic quality for the two conditions are shown in Table 4. Regarding beauty and perceived usability, it appears that the correlation between them is lower in the treatment condition (r= .468) than in the control condition (r= .576). This would suggest that the treatment results in a decrease in correlation between beauty and perceived usability due to the distortion of the fluency effect. This effect was also found for the correlation between hedonic quality and perceived usability. In the treatment condition, the correlation between them was lower (r= .433) than in the control condition (r= .505). Interestingly, the correlations between beauty and hedonic quality were strong in both conditions.

Table 4

Pearson correlation between scales in the conditions

	Hedonic	Usability
Control		
Hedonic		
Usability	,505**	
Beauty	,636**	,576**
Treatment		
Hedonic		
Usability	,433**	
Beauty	,658**	,468**

Note. **p < 0.01.

3.2.5 Reaction time

Regarding the reaction time, we expected that the treatment condition would have longer reaction times than the control condition due to the activation of System 2. The reaction times were measured for answering the questions and viewing the stimuli.

Reaction time for answering the questions

Figure 18 shows the reaction times when answering the questions for the two conditions. Based on the plot, it seems that the reaction times are almost the same in both conditions.

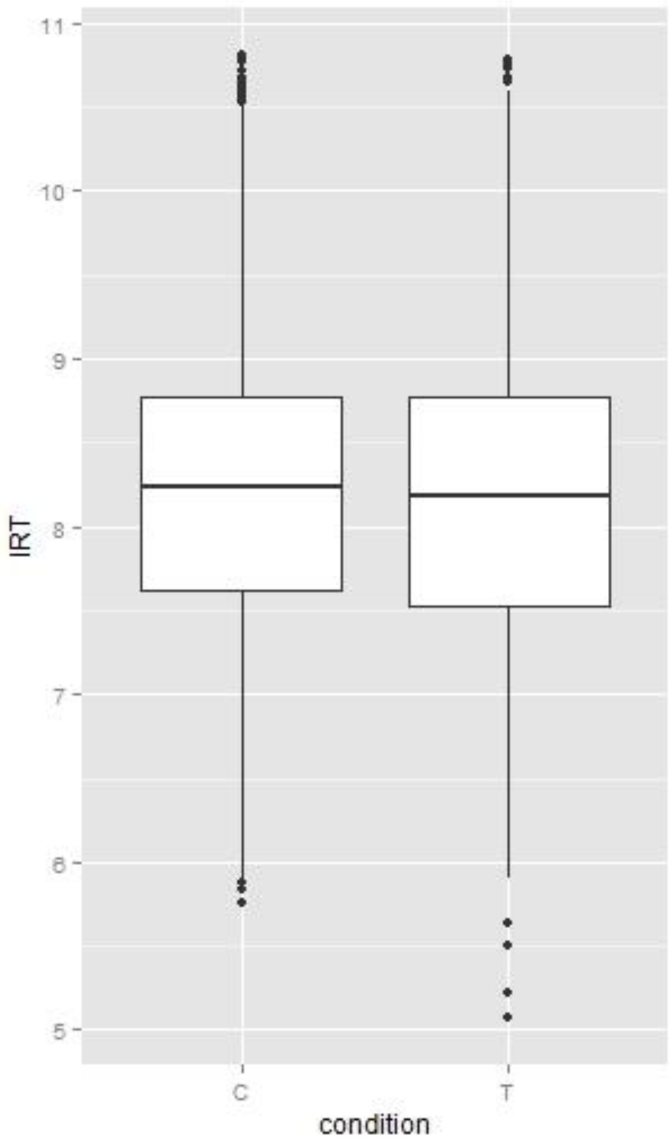

Figure 18. Boxplot of the reaction time of answering the questions and condition.

Table 5

Parameter estimates and estimated marginal means of reaction time when answering the questions

Parameter	B	SEβ	Wald's χ^2	*df*	*p*
Intercept	8.159	.0820	9893.61 1	1	.000
Control	.040	.1271	.098	1	.754
Treatment	0				
Scale	0.676				

Estimated marginal means

Moderated	*M*	*SE*
Control	8.199	.097
Treatment	8.159	.082

Looking at Table 5, the reaction time in the control condition is slightly higher. This means that participants in the control condition took longer to answer the questions in comparison with the treatment condition (β= .040). It did not meet statistical significance. However, the difference is minimal as we can see in the estimated marginal means for the control condition (M=8.199) and treatment condition (M=8.159).

Reaction time for viewing the stimuli

However, a different result is found for the reaction time when viewing the stimulus. Looking at Figure 19, it appears that there is a difference in the reaction time in the two conditions when viewing the stimuli. Table 6 shows that the reaction time in the control condition was lower than in the treatment condition (β= -.215). Although it did not meet statistical significance, participants viewed the screenshots longer in the treatment condition than in the control condition. The treatment condition (M=14.334) was slightly higher in reaction time than the control condition (M=14.119).

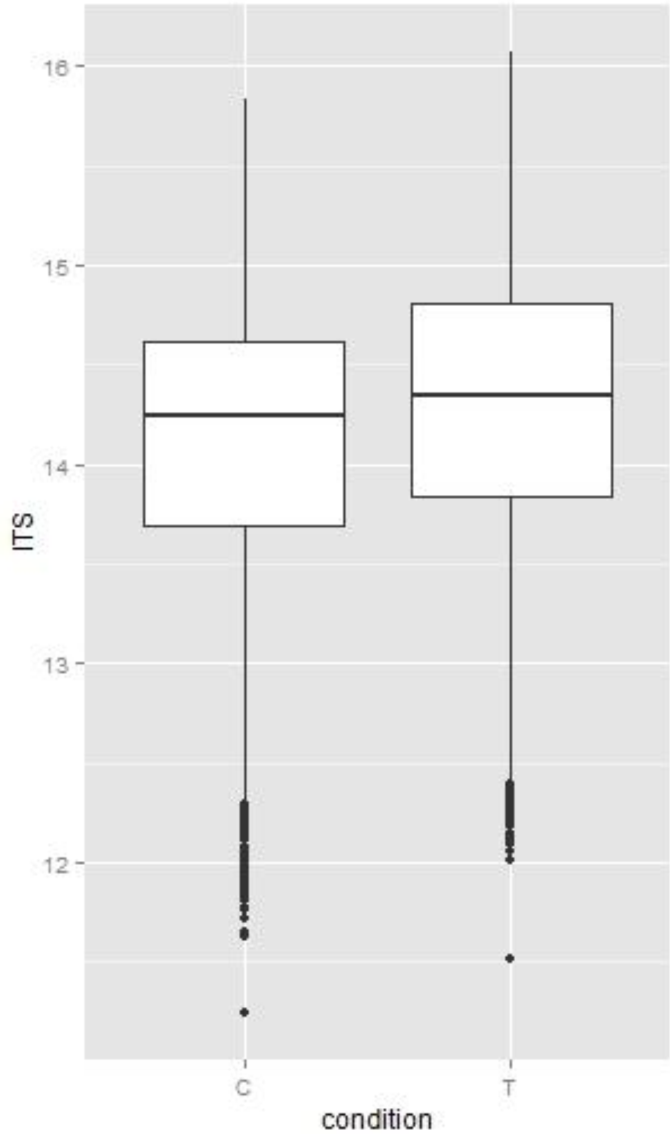

Figure 19. Boxplot of the reaction time when viewing the stimuli and condition.

Table 6

Parameter estimates and estimated marginal means of reaction time when viewing the stimuli.

Parameter	β	SEβ	Wald's χ^2	df	*p*
Intercept	14.334	.1465	9577.157	1	.000
Control	-.215	.180	.137	1	.232
Treatment	0				
Scale	0.676				

Estimated marginal means

Moderated	M	SE
Control	14.119	.104
Treatment	14.334	.146

3.3 Conclusion

3.3.1 The fluency effect

In conclusion, most of the hypotheses regarding the fluency model are confirmed. The fluency model is supported by our results, which leads to the conclusion that processing fluency influences our judgments positively. Websites with higher levels of prototypicality and visual simplicity (i.e. lower levels of visual complexity) results in more positive judgments of the websites. Significant interaction effects were found for prototypicality and scale, meaning that the effect of prototypicality differs, depending on the level of the scale. Thus, judgments of prototypical websites significantly differs on the perceived beauty and hedonic quality scale, whereas the judgments on the perceived usability scale are less positive but nevertheless significant. Visual complexity was also found significant, meaning that judgments on the hedonic quality scale are more positive on visual simple websites. Although the perceived usability and perceived beauty scale were not significantly different from the hedonic quality (i.e. effect of VS did not differed depending on the scale variable), judgments are still more positive on visual simple websites.

Interestingly, repeated exposure is only half-confirmed as the fourth block was almost identical in the level of judgments to the first block.

As we have confirmed the fluency effect, we shall now analyze whether the fluency effect can be broken.

3.3.2 Breaking the fluency effect

Besides proving the fluency model to be true, this study also focused on how to break the fluency effect. The research question was whether the fluency effect could be broken by giving participants an instruction and treatment. This would result in less positive judgments of beauty and perceived usability. The expectation was that judgments would be less positive in the treatment condition as the fluency effect would disappear due to the activation of System 2 by instructing and treating the participants, which caused awareness and analytical thinking when they judged the stimuli.

Although the fluency-reducing effect of prototypicality was not found, results for visual complexity were found. A strong significant effect was found for the treatment group on the hedonic scale, meaning that judgments are less positive in comparison with the control condition. This suggests that System 2 is activated, thus people engage in deeper thinking or more analytical reasoning (i.e. System 2), which influence their judgments. Interestingly, only the perceived beauty scale was found significant with a slight higher effect in comparison with the hedonic scale. Although the fluency-reducing effect of prototypicality could not be disrupted in the treatment condition, the three-way interaction effect of the beauty scale showed that it significantly, negatively differed from the hedonic scale. Interestingly, it appears that in the treatment condition, only the perceived beauty and hedonic quality sale were found significant whereas perceived usability did not reach statistical significance in both three-way interactions. Also, the fact that the fluency effect was broken on the hedonic quality scale despite the fact that the interaction and criteria list did not include nor discuss hedonic quality, is an unexpected finding.

Regarding the correlation between beauty and perceived usability, we expected that it would decrease when the fluency effect was broken. Comparing the correlation between beauty and perceived usability in both conditions, it appears that the correlation indeed decreased due to receiving of the treatment and instruction.

Regarding the reaction time, we expected that the reaction in the treatment condition would be longer than in the control condition due to the activation of System 2 and its processes. Results showed that participants viewed the stimuli longer in the treatment condition than in the control condition as we hypothesized. This finding suggests that System 2 is indeed activated. Due to the treatment and instructions, participants could view the screenshots in a different way, i.e. more analytical and aware of their criteria for judgment. However, when answering the questions, the reaction time was almost similar for the control and treatment condition. So, the activation of System 2 is most visible when viewing the stimuli rather than answering the questions.

4. Discussion

The goal of this study was to examine the fluency effect as the underlying variable for judging beauty and usability. To see whether processing fluency is the cognitive process of perceived beauty, perceived usability and hedonic quality. Repeated exposure, VS and PT were used as manipulations of fluency. Furthermore, the current study was also focused on breaking the fluency effect by using a practical tool in the form of instruction and treatment. The found results and conclusions will now be discussed and the research question will be answered.

4.1 The fluency effect: critical reflection of the scales

As previously concluded, there is strong evidence for the fluency effect in the study, thus supporting the fluency model. Both hypotheses were confirmed regarding VS and PT: Judgments of perceived beauty, hedonic quality and perceived usability were more positive if the stimulus was processed more fluently. Furthermore, prototypicality and visual complexity in websites can both be used for studying the fluency effect.

As illustrated earlier, Figure 5 shows the fluency implications and features of the stimuli. Now, perceived usability can be added as an implication of fluency, meaning that it leads to the perception that it “feels usable”, explaining the correlation between perceived beauty and perceived usability. Also, these results support the hedonic fluency hypothesis as proposed by Reber et al. (2004). In addition to their stand on beauty judgments, the hedonic fluency hypothesis is also true for hedonic quality and perceived usability judgments.

Looking at the results, a difference in significant interaction effects were found between scales and VS and PT. As the effect of PT differed among the scales whereas VS did not, it suggests that prototypicality and visual simplicity behave differently, or perhaps are processed differently. A possibility is that the prototypicality effect is stronger than the visual complexity effect. This possibility would be in line with Schmettow and Kuurstra (2013), who found that prototypicality had a larger positive effect than visual simplicity. As the experiment was conducted without a time limit, participants could complete the experiment on their own pace. Tuch et al. (2012a) found that in short presentation times, visual complexity was stable after 17 ms. However, the effect of prototypicality increased with longer presentation times. Schmettow and Boom (2013) found that the effect of VC diminished when presentation time was longer. Regarding processing fluency, it could be that due to our limitless time condition, the effect of prototypicality was stronger than visual complexity. So, websites that were familiar mattered more for participants than websites that were visual complex. Although both were processed fluently (as the judgments of both were more positive), it could be that participants associated their mental models of websites stronger with the stimuli when they viewed it on their own pace. Perhaps visual complexity would have had a stronger effect when the presentation time of the screenshots was short, as the processing of the visual simple websites is easier when time is short. Even though both conditions were instructed to fill in the questions based on their first impressions, we did not control for presentation time.

Furthermore, the results supported the study of Tuch et al. (2012a) regarding the interaction effect of visual complexity and prototypicality. Websites that were low in visual complexity and high in prototypicality were judged more positively.

Regarding repeated exposure, only our half of our hypothesis was confirmed. Block 2 and 3 showed a significant increase in our judgments, thus suggesting the fluency effect. However, Block 4 did not differ much in comparison with our judgments in Block 1. As Block 4 was the identical copy of Block 1, it was therefore unexpected that the judgments were almost the same (i.e. no difference between Block 1 and Block 4). An explanation could be that participants were tired, annoyed or lost their interest during the experiment. Although breaks were built in to reduce the tiredness, it appears that it did not work. During the debriefing, some participants expressed they were actually annoyed with the breaks as they wanted to continue and complete the experiment. Also, as the experiment was conducted remotely, there is a chance that participants were more distracted. Another explanation could be that people were aware that Block 4 and Block 1 were identical and thus answered the same way. However, the chances are very low as they had to exactly know which question belonged to which screenshot in the same order as in Block 1. Participants expressed that they had the feeling that something was repeating (besides the screenshots) but could not exactly point out what. Therefore, it is unlikely that the fluency effect of repeated exposure in Block 4 did not occur due to awareness of exact repetition.

Regarding the relationship between beauty and usability, an interesting observation was made during the completion of the criteria task in the treatment condition. The criteria list specifically instructed that it was not allowed to have the same criteria’s for beauty and usability in order to discriminate between these two constructs. Participants expressed their difficulty in separating the criteria for beauty and usability, suggesting that beauty and usability are indeed related to each other as participants had a hard time differentiating them.

So, as the fluency model is supported by the found evidence in this study, it will have implications for the HCI research. We can come to the conclusion that the subjective response on user experience Likert-scales, used to measure beauty and usability, are influenced by fluency. Thus, the responses do not reflect a user's 'true' opinion or behavior regarding perceived beauty or perceived usability, due to the fact that users are influenced how fluently a website is designed. There is a high possibility that the response is the automatic, unconsciously response of processing fluency. Furthermore, it can be argued that the fluency effect is the third variable, thus underlying the UX rating scales. Therefore, it emphasizes the importance of objective measures as the subjective methods do not measure what one thinks it measures.

4.2 Breaking the fluency effect

This study tried to break the fluency effect by instructing (instruction and criteria task) the participants in order to activate System 2 and thus engage in deeper reasoning and more analytical thinking. Although evidence to break the fluency effect by disfluency was found in previous studies by providing the stimuli in degrading font or furrowing the brows during the experiment (Alter et al., 2007), these kind of treatments are only useful to demonstrate (i.e. prove) how to activate System 2 in users. With the results found in this study, an important step has been taken in breaking the fluency by using a practical, feasible treatment.

After receiving the treatment and instruction, participants judged the visual simple websites less positive in the treatment group than the control group. When participants had to reason what beauty and usability meant for them, and what their criteria's were, analytical thinking was activated. As they were told that they were unconsciously influenced by features of the stimuli, it made them aware of their judgment. So, this would suggest that a switch has indeed been made in users from System 1 to System 2 after receiving the treatment and instruction. System 2 was thus activated as the fluency effect was less strong in the treatment condition for visual simple websites. Further support for the activation of System 2 was found in the reaction times. Even though both conditions were instructed to answer the questions based on their first impression, the treatment condition viewed the screenshots longer. This could support our argument that participants are viewing the stimuli differently because of their awareness and analytical thinking why they thought the website was beautiful or usable. By constantly reminding the participants of their definition and criteria's during the breaks, even more awareness was created in the participants.

As the processes of System 2 are slow, conscious and demands effort, it resulted in longer viewing of the stimuli. Therefore, it shows the switch from System 1 to System 2 which was activated by the instruction and treatment.

Interestingly, the breaking fluency effect was not found for prototypicality. A possible explanation for why this effect was not found in prototypical websites, is perhaps the fact that visual complexity is a natural assessment (Tversky & Kahneman, 1983). Visual complexity is automatically registered by the perceptual system without effort (Heukelom, 2012; Kahneman, 2003). Thus, one can assume that visual complexity comes first in mind when seeing the stimuli, activating analytical reasoning for this variable.

Another explanation is that the fluency effect on visual complex websites was weaker than on websites that were more prototypical. One can argue that when the fluency effect is small for the visual complex websites, it is easier to break it instead of the strong fluency effect found in prototypical websites. As prototypicality is based on mental models of previous knowledge, the information on these websites could be easier to process resulting in a more robust processing fluency. Perhaps that the stronger the fluency effect, the harder to break it. A third explanation is that PT was on the participants' criteria list as it is based on previous knowledge of the participant regarding websites. This means that PT is easier accessible for participants and could result in mere exposure of PT, therefore explaining why the fluency effect could not be broken.

Regarding the scales, the effect of VS and PT appeared to differ in the treatment condition. The effect of VS for the beauty and perceived usability scale on judgments differs in comparison with the hedonic quality scale as they were a bit more positive, although the effect in the beauty scale was almost cancelled out. As the effect of breaking fluency was found on the hedonic quality scale, the instruction and treatment on visual simple websites were not that effective for the perceived usability scale and beauty scale when compared to the hedonic quality scale. This is unexpected as the treatment and instruction defined beauty and perceived usability. However, as we discussed earlier, the items of the beauty scale resembled perhaps less the definition and criteria's of the participants.

PT shows that beauty and perceived usability judgments are more negative in comparison with the hedonic quality scale. Although this would mean that instruction and treatment influenced the perceived beauty and perceived usability judgments, it was not enough to achieve less positive judgments. We expected that prototypicality and visual complexity would achieve similar results in the treatment condition, but they behaved differently as the results differed.

However, it is fascinating that the disrupted fluency effect was found on the hedonic quality scale as no instruction nor treatment was defined for this variable. This would suggest that by merely giving instructions and treatment, it will be enough to alter user's reasoning and influence their judgment irrespective of the content of the instruction and treatment. This of course is exciting, as it shows the power of instruction as a simple tool to use in breaking the fluency effect and activate System 2. Another possible explanation could be that hedonic quality and beauty are indistinguishable. Schmettow and Schwabe (2013) found that hedonic quality and beauty were indistinguishable and should be used as one factor instead of separate constructs. Looking at Appendix 6.5, the items of the perceived beauty scale and hedonic quality scale are shown. As previously described, the perceived beauty scale was measured with the single item scale and classic aesthetics (Hassenzahl & Monk, 2010; Tractinsky et al., 2006). As mentioned before, classic aesthetics were chosen as the translated items of expressive aesthetics showed too much overlap with the hedonic quality scale. However, one can argue whether the items of classic aesthetics (i.e. clean, pleasant and aesthetic design) reflected perceived beauty as defined by the participants (Appendix 6.5). It could be that the items of the hedonic quality scale reflected the definition of beauty for some participants, explaining why hedonic quality was also influenced by the instruction and treatment.

Another interesting result found in the treatment condition, is that the perceived beauty scale was significant for both VS and PT in comparison with the hedonic quality. However, perceived usability did not reach statistical significance. This could be explained by the fact that participants viewed the stimuli passively. For measuring the usability of a website, participants often have to complete tasks or use the website (Hornbæk, 2006). When one want to prove processing fluency, these measures would not be possible as the informational value is called in. However, this could explain the results in the treatment condition regarding usability. When people defined their criteria of usability (i.e. what makes a website usable?), they reasoned their criteria's based on usability in general. A few examples of the criteria usability were: fast loading of the website, no pop-ups, tab pages, clear sub titles, drop down menu and no too much clicking through the website. These examples show that participants were not thinking in terms of perceived usability but rather of usability in use. The definition of usability could then be more practical (goal-oriented) with the focus on using the website. This means that by passive viewing of a screenshot, the idea of applying their definition and criteria of usability on to the website will not come to full effect as it is impossible. Thus, passive viewing of the stimuli makes it difficult for the participants to associate their criteria's for (perceived) usability with the screenshots.

4.3 Design in Fluency

The results found in the present study have interesting implications for UX designers. Namely, one can argue that in order to achieve a good UX, websites could focus on designing for fluency. As the current study found that visual simplicity and prototypicality increases the fluency experience of websites, it would be interesting for UX designer to consider other aspects of websites when designing for fluency. UX designers can for example consider transitions as a factor to manipulate fluency (Weis-Lijn, 2012a). A fluent transition between web pages would improve the UX of the website as it allows users to track the changes between web pages (Robertson, Card, & Mackinlay, 1993). Users have difficulty to process sudden changes as they cannot track it. Zellweger and Bouvin (2001) argued that changes between web pages are easier perceived by users when the transition is animated. Transitions without animated require cognitive effort as users have to reconcile the start and end states and can be disruptive (Zellweger, Chang, & Mackinlay, 1998). Klein & Bederson (2005) suggested that transition by animated scrolling would reduce the cognitive load of users. In sum, animated transitions appear to increase fluency and reduce cognitive workload. Therefore, UX designers can consider this design factor in order to design for fluency.

Another example, are advertisement banners on websites and how they influence fluency. Numerous studies in HCI research showed that users ignore advertisement banners consciously or unconsciously, which is also known as banner blindness (Benway & Lane, 1998). However, even though users ignore the banners, Burke, Hornof, Nilsen and Gorman (2005) showed that flashing text banners increased an user's perceived workload. Workload is the opposite of experiencing fluency and system 1 as it is an effortful process.

So, in order to achieve a good UX, designer could focus on reducing banners to increase the fluency experience or designing the banners more fluently.

Besides designing for fluency, it would be interesting to consider that one can also design for disfluency. This sparks the question why designers would make their designs disfluent (i.e. cognitive strain) as it results in users evaluating their designs less positive. Most of the time, designers want to maximize the processing fluency (and thus beauty and usability) of products or interfaces as low fluency could result into dissatisfaction or unpleasant experiences as it creates cognitive strain. However, breaking the fluency effect may be useful for designers in UX. It could be that designers sometimes want users to critically inspect facts or overcome first impressions or pre-conceptions (Weiss-Lijn, 2012b). It is sometimes important to break the fluency as it will reduce your (incorrect) intuitive answers or errors and increase the quality of judgments and other significant decisions (Weiss-Lijn, 2012b). It takes effort to overcome these first impressions or critically inspect the facts as users have to engage in analytical reasoning, emphasizing the need of a switch from system 1 to system 2. In other words, designers sometimes strive for disfluent designs, in order to overcome impressions or critically inspect facts on a website.

There are examples where it is important to break the fluency for designers is when users want to critically inspect security indicators of web browsers. Darwish and Bataineh (2012) examined the interaction of users with security indicators in websites in a controlled security risk. The security risk used in their study was phishing, which illegally collects information of the user. They found that simplicity in web design does not help the online security, instead it creates more damage. Due to the visual simple design of the websites, users focused on the logon area and overlooked the security indicators. Not focusing on the security indicators, users were vulnerable for phishing attacks as they could be tricked in phishing websites that appears to be legitimate. So, the factor of simplicity as a design factor poses dangerous risks in the user's security. Thus, one can conclude that fluency can sometimes be harmful in designs, therefore emphasizing the importance of designing for disfluency in situations when we have to critically inspect the facts.

4.4 Limitations

Although the present study found evidence for the fluency model and breaking the fluency effect, it is important to discuss the limitations and assumptions of this study.

The first assumption was that the requirements of the experiment were met, namely that participants were sufficient in English and familiar with websites in general. Although these requirements were shown to the students of the University of Twente before they signed up, we assumed that the other participants also met these requirements. In order to create a more diverse population (i.e. not focusing on students alone), participants consisted of different backgrounds (i.e. education) and age. As background was not included in the descriptive questions, it is difficult to prove that these requirements were indeed met. Even though participants can be familiar with websites in general, it does not necessarily mean that they are familiar with international company websites in English which is a specific kind of website (Tuch et al., 2012a). Although the assumption is that regarding VC and PT of a website is universal (i.e. no difference between Dutch websites and English websites regarding VC and PT), there is a possibility of influence on our participants and data.

Secondly, it was assumed that the practice phase would not influence the participants. Although the stimuli presented in the practice phase were 'new', they were derived from Tuch et al. (2012a), meaning that their VC and PT also differed. Also, the four questions were items of the used scales in the experiment. The fact that no data was measured for the practice phase based on the above assumption, it is not possible to exclude a learning effect. Although repeated exposure is not possible as the websites were different, there is a possibility that participants were perhaps primed for company websites in general.

Based on the debriefing, it turned out that a lot of participants in the treatment condition found it difficult to fill in the criteria list of beauty and especially usability as discussed earlier in this chapter. Several participants asked whether the criteria's were regarding beauty and usability in general or specific for websites only. It not only implies that the criteria task was not defined and explained specific enough, it also suggests that beauty and usability are perceived differently for websites in general. Furthermore, there is a chance that some participants thought that the criteria and definition of beauty and usability was meant in general, therefore resulting in a criteria list which could be hard to apply to the websites. It makes it harder to associate their definition to the stimuli.

Another interesting matter what came to light during the debriefing was that participants were sometimes surprised at the question as they did not know what kind of question they could expect after viewing the website. Several participants said that the moment when the question was presented, they forgot how the website looked like or even which website it was, even though they had enough time to view it. Regarding the treatment condition, it could be that they had then difficulty focusing on their definition of perceived beauty and the perceived usability (perhaps both) in detail for the website and relating them to the question when they forgot how the website looked like. Although we do not know in which condition the participants were that claimed this, it could influence the response. As the questions were presented after viewing the website and there was no option in going back to the website when proceeding further in the experiment, it could be that presenting the question together with the screenshot is a better alternative for the treatment condition. In the control condition, the question could raise awareness and analytical reasoning when the question is seen with the screenshot as there is a chance the participant's view of the website is based on the question, therefore reducing and perhaps breaking the fluency effect.

In this study, the experiment was conducted in the lab and remotely as described earlier. We assumed that it would not influence the data as participants were most likely more comfortable in their own environment. However, there is of course a chance that it perhaps influenced our data as participants in their own environment could be distracted whereas the possibility of distraction is lower when testing in the lab.

Another limitation of the study is the fact that only company websites were used. Roth et al. (2010) defined several categories of websites for studying mental models. They showed that a consistent mental model was present in users regarding company websites. Besides company pages, there were also online newspapers, social networking sites, search engines and online shops. It would be interesting to extend the fluency effect on these kinds of websites, thus to find similar results in online web shops. Furthermore, the websites were derived from the study of Tuch et al. (2012a) who selected the websites based on their visual complexity and prototypicality. The selection was based on the answers of participants in an online survey regarding the question whether they found the websites visual complex and if it looked like a typical website of a company (i.e. prototypical company website). Tuch et al. (2012a) admit that a limitation of the websites is that the underlying factors of prototypicality and complexity are not understood, analyzed nor controlled for. Therefore, we cannot conclude which factors lead to high or low levels of visual complexity and prototypicality in websites which in turn maximize the effect of processing fluency even more.

Furthermore, this study did not take different cultures into account. The population in our data consisted mostly of participants with the native language Dutch which we assume to be Dutch. It could be that perceived beauty, hedonic quality or perceived usability differ among cultures regarding the website design. This implies that the effect of prototypicality and visual complexity could vary. Furthermore, even though our population was quite diverse, our sample was rather small for both conditions. In order to provide more evidence for the fluency model, a larger sample could be tested.

Besides taking different cultures into account, this study did not focus on gender. Tuch, Bargas-Avila and Opwis (2010) found a gender effect in analyzing symmetry in design of aesthetic websites. They found that symmetrical designed websites were perceived as more beautiful than asymmetrical websites. Interestingly, this effect was only found among the male participants as they reacted unfavorably to asymmetrical websites. On the contrary, no effect of symmetry was found among women's judgments of websites (Tuch et al., 2010). As the gender effect was not included in our study, we cannot conclude whether the effect of fluency on beauty and perceived usability judgments is different for male and female.

Lastly, this study focused only on the constructs hedonic quality, perceived beauty and perceived usability. As the fluency effect was found in these three variables, it would be interesting to extend the fluency models by including other constructs, for example goodness or true. Also, processing fluency was only manipulated by visual complexity and prototypicality. It is important to test other features that manipulate fluency, for example familiar treatment or priming in order to support the fluency model and explain the relationship between beauty and usability.

4.5 Future research

For future research, it would be interesting to expand the fluency model on other constructs and manipulations of fluency in order to see whether similar results will be found. As previously discussed, the UX design factor transitions can be considered as a manipulation of fluency.

A possible future research can be to analyze whether beauty, usability and goodness judgment of websites would become more positive when participants are made familiar with them by giving a familiarity treatment and select (high-low) prototypical websites. It can then be expected that the fluency effect will be strong for the explicit interaction effect between familiarity treatment and prototypical websites. However, it can be expected that the familiarity treatment will also be more effective on websites that are less prototypical.

Another possible model to explain the relationship between beauty and perceived usability is the attribute substitution model (Kahneman, & Frederick, 2001). Kahneman and Frederick describe attribute substitution as another feature of the associative memory which can result in biases of intuitive judgments. Attribute substitution is when a heuristic attribute, which is another property of an object, serves as substitution for a specific target attribute of that same object. The heuristic attribute comes to our mind more readily and easily whereas the target attribute is less accessible and does not come to our mind immediately (Kahneman & Frederick, 2001) With this perspective, the role of perceived usability and beauty can be explained. We assume that perceived usability is more complex and less accessible when evaluating the screenshots. This assumption is partly based on the observation of participants during the criteria list task. Various participants expressed their difficulty in filling in the criteria's for usability whereas the criteria's of beauty were filled in more easily. This is of course not measured thus cannot serve as strong evidence, but it seems that usability did not came to mind easily. On the contrary, beauty comes to our mind more easily as it is a more natural process of perception. Looking at the process of information judgments by Briggs, Burford, Angeli and Lynch (2008), the feel and look are judged in the first process. In the first process, visual appeal of websites thus plays an important role (Briggs, Burford, Angeli, & Lynch, 2008). Furthermore, Lindgaard et al. (2006) found that users determined rapidly the visual appeal of websites. We can assume that visual appeal, beauty and aesthetics are indistinguishable; therefore leading to the assumption that beauty comes faster to mind than perceived usability. Therefore, beauty serves as the heuristic attribute. According to Kahneman & Frederick (2001), attribution substitution takes place, only when three conditions are met:

1. The target attribute of the judged object is not accessible;
2. The candidate attribute is associatively related and highly accessible;
3. System 2 does not reject the substitution of the heuristic attribute.

Based on the assumptions above, we can argue that condition 1 and 2 are met. Regarding condition 3, System 2 does not reject the substitution which results in a bias of intuitive judgment. This could explain the notion ‘what is beautiful is usable’, found by Tractinksy et al. (2000), concluding that aesthetics influences usability. Schenkman and Jönsson (2000) found effects of visual appeal on perceived usability. Assuming that beauty substitutes perceived usability based on the previously named studies, we assume that condition 3 is met. This leads us to a new model which is illustrated in Figure 20.

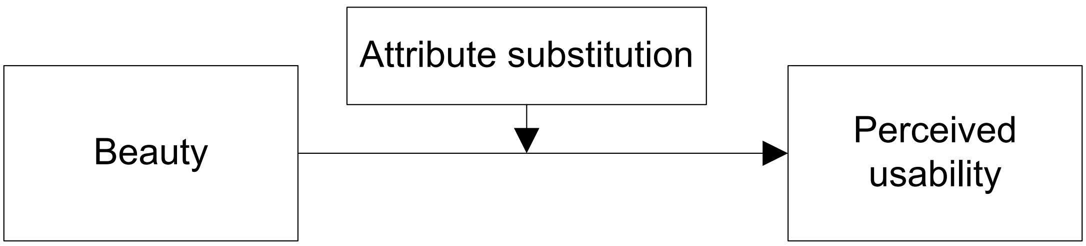

Figure 20. Attribute substitution model of beauty and perceived usability.

We argue that perceived usability is substituted by beauty when a user has to judge an object. Meaning, the answer to an easy, beauty-related question is used to answer the more complex perceived usability question. Answering a target question is more difficult than answering a heuristic question when asked. Although it tries to explain the relationship between beauty and perceived usability from a different perspective, it does not mean that the fluency model and attribute substitution model exclude each other. In fact, we can even argue that processing fluency could serve as the basis for attribute substitution. Song and Schwarz (2008) found that difference in fonts of recipes, resulted in people concluding that the recipe had a longer preparation time when the recipe had a fancier font which made it harder to read. The fancier font was thus processed more strained, resulting in the substitution of the target question “How long the dish takes to prepare” by the heuristic question “Is it hard to read the recipe?” (Song & Schwarz, 2008). Regarding the attribute substitution of beauty and perceived usability, this would translate in the fluency of the features that influences beauty (e.g. symmetry, color) mediates the substitution. Another possibility of the two models working together is that the fluency model would address to different errors in judgments in System 1, whereas attribution substitution could account for errors in judgments when System 1 and System 2 are joint. These are of course assumptions as no evidence is found as of today. Therefore, it would be good and interesting to test the model. This would not only lead to a better and possible different understanding of beauty and perceived usability, but it would also analyze how the fluency model interacts (i.e. fits) with the attribution substitution assuming of course that they do not exclude each other.

Lastly, future research should focus more on how to break the fluency effect by activating system 2 by using treatments than can also be applied in the real world. Although disfluency also breaks the fluency effect, furrowing our brows is not an useful treatment for designers. Therefore, different treatments should be explored and tested in order to make subjective measures (i.e. Likert-scales) more ‘true’ while designers would have a practical, effective and valuable tool.

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6. Appendix

6.1 Treatment criteria list

CRITERIA LIJST **SCHOONHEID**

Maak een lijst van 5 woorden die voor u een criteria zijn voor **Schoonheid** (Beauty). Dit zijn woorden waarmee u Schoonheid definieert. Deze woorden mogen niet hetzelfde zijn als de woorden in de Gebruiksvriendelijkheid (usability) lijst hieronder.

1. ………………………………………..……………………………………
2. ………………………………………..……………………………………
3. ………………………………………..……………………………………
4. ………………………………………..……………………………………
5. ………………………………………..……………………………………

CRITERIA LIJST **GEBRUIKSVRIENDELIJKHEID**

Maak een lijst van 5 woorden die voor u een criteria zijn voor **Gebruiksvriendelijkheid** (Usability) . Dit zijn woorden waarmee u gebruiksvriendelijkheid definieert. Deze woorden mogen niet hetzelfde zijn als de woorden in de Schoonheid lijst hierboven.

1. ………………………………………..……………………………………
2. ………………………………………..……………………………………
3. ………………………………………..……………………………………
4. ………………………………………..……………………………………
5. ………………………………………..……………………………………

6.2 Example participant specific input for randomization of the stimuli, scales and items: excel.

30	fantasy_junction	2	1	5
2	airgas	2	1	5
47	behr	1	3	3
21	powermadd	2	4	8
3	american_express	3	3	11
48	exchange_consultancy_group	1	2	2
14	izmocars	2	3	7
45	ansa	1	1	1
10	freedom	3	4	12
8	ebizautos	3	1	9
5	bureau_van_dijk	3	3	11
16	military	1	2	2
17	sensient	2	1	5
19	snowcare_for_troops	2	3	7
12	Honeywell	3	1	9
40	pioneer	3	4	12
46	harley_davidson	1	2	2
9	first_european	2	2	6
13	horschel	3	3	11
4	bank_of_america	2	3	7
27	ameresco	1	4	4
20	Taxproblem	1	2	2
7	chase	3	2	10
11	geico	3	1	9
39	pg&e	3	3	11
37	northeast_system	3	2	10
1	abraxas	1	1	1
26	allete	1	2	2
28	chevrolet	3	1	9
38	novasyn_organics	3	2	10
44	tesla	1	3	3
31	gem	2	4	8
15	Lloyd	1	3	3
34	jvc	3	2	10
18	snl_financial	2	2	6
25	aiam	2	3	7
41	quintiles	3	2	10
22	plows_unlimited	1	3	3
24	synchem	1	4	4
32	hebei_yanuo	2	4	8
23	bajaj	1	1	1
36	national_heat	2	4	8
42	sabic	3	3	11
35	mafs	2	2	6
29	engro_corp	2	3	7
43	sherwin_williams	1	1	1
33	honda	2	4	8
6	chain	1	3	3

6.3 Opensesame Instructions for both conditions

6.3.1 Control condition

Welkom bij dit onderzoek over de factoren Schoonheid (beauty) en Gebruiksvriendelijkheid (usability) van websites.

Voordat u begint aan het onderzoek, zullen er een paar algemene vragen worden gesteld. Daarna zal het onderzoek worden uitgelegd. Het experiment duurt ongeveer 45 minuten. De data van het onderzoek zal anoniem worden verwerkt.

Voordat het onderzoek begint, volgt er nu eerst een korte oefening zodat u weet hoe het onderzoek zal gaan. Deze oefenfase bestaat uit 4 screenshots met ieder een vraag.

Als u klaar bent met het bekijken van de screenshot, druk dan op de <u>spatiebalk</u> om door te gaan naar de vraag.

Denk erom dat het gaat om uw 1e impressie van de screenshot als u de vraag invult.

Het onderzoek zal nu beginnen.

6.3.2 Treatment instruction for breaking the fluency effect

##Instruction breaking fluency effect

Als we antwoord moeten geven of iets (bv. een website) mooi of gebruiksvriendelijk is, denken we niet goed na over wat schoonheid (beauty) en gebruiksvriendelijkheid (usability) voor ons betekenen. We staan niet echt stil bij wat het mooi of gebruiksvriendelijk maakt.

In plaats daarvan worden wij onbewust en intuïtief beïnvloed.

We beoordelen onbewust schoonheid en gebruiksvriendelijkheid. Namelijk op basis van visuele kenmerken zoals symmetrie, bekendheid of complexiteit etc. Als u zometeen de vragen in het onderzoek beantwoordt, denk dan eerst goed na over wat het mooi of gebruiksvriendelijk maakt.

Wat betekenen <i>schoonheid en gebruiksvriendelijkheid</i> werkelijk voor u? U heeft net een lijst gemaakt met criteria voor schoonheid en gebruiksvriendelijkheid. Deze woorden definiëren dus schoonheid en gebruiksvriendelijkheid voor u.
Houdt deze alstublieft goed in gedachten als u de vragen invult

---

U krijgt nu het eerste screenshot van een website te zien.

Bekijk hem kort en druk vervolgens op <u>spatiebalk</u> als u klaar bent om naar de vraag te gaan. Beantwoord de vraag op basis van uw eerste impressie.

Denk goed na over wat de website mooi of gebruiksvriendelijk maakt. Herinner uw critera lijst over <i>gebruiksvriendelijkheid</i> en <i>schoonheid</i>. Deze woorden omschrijven wat u mooi of gebruiksvriendelijk vindt. Houdt dit goed in gedachten als u de vragen invult. Dus:
Wat betekenen <i>schoonheid en gebruiksvriendelijkheid</i> werkelijk voor u?

Druk op de button om te starten met het onderzoek.

6.4 R syntax

```
library(ggplot2)

library(lme4)

library(MCMCglmm)

library(foreign)

library(effects)


citaload(file = "C:/Users/Gebruiker/Documents/School/Master/Masterthese/Data R/DN.Rda")

#load(file = "DN.Rda")

load(file = "C:/Users/Gebruiker/Documents/School/Master/Masterthese/Data R/MCMC regression.Rda")

#load(file = "MCMC regression.Rda")


##load spss file with scale 1H 2U 3B

dataSPSS2<-read.spss("C:/Users/Gebruiker/Desktop/Data/DataLongHUB.sav",
to.data.frame=TRUE)


## Judgments ####

qplot(DN$questions)


##transform VC to VS

DN$zVS <- -DN$zVC

zVS <- DN$zVS
```

```
dev.off()

## Response Time ####
qplot(DN$response_time_Screenshot)
qplot(DN$response_time_Screenshot[DN$response_time_Screenshot<50000])

##Outliers reaction time
plot.BoxRT <- qplot(condition, DN$response_time_Screenshot, data = DN, geom="boxplot")
print(plot.BoxRT)

DN$RT <- DN$response_time_Screenshot
DN$RT[DN$RT > 50000] <- NA
DN$lRT <- log(DN$RT)
summary(DN)

qplot(DN$lRT)

summary(lm(lRT ~ Leeftijd + condition, DN[!is.na(DN$RT),]))
qplot(DN$Leeftijd, DN$RT) + geom_jitter() + geom_smooth(method="lm")
plot.RTAge <- qplot(DN$Leeftijd, DN$lRT, xlab="Age", ylab="Reaction time Questions") +
geom_jitter() + geom_smooth(method="lm")
```

```
ggsave(filename="Reaction time questions Age.jpg", plot.RTAge, width=100, height=100, units="mm", scale=2)


plot.TSAge <- qplot(DN$Leeftijd, DN$lTS, xlab="Age", ylab="Reaction time Viewing stimuli") + geom_jitter() + geom_smooth(method="lm")

ggsave(filename="Reaction time viewing.jpg", plot.TSAge, width=100, height=100, units="mm", scale=2)


##Testing the time of the screenshots (viewing time) on the VC against conditions

qplot(DN$time_Screenshot)

qplot(DN$time_Screenshot[DN$time_Screenshot<10000000])

DN$TS <- DN$time_Screenshot

DN$TS[DN$TS > 100000] <- NA

DN$lTS <- log(DN$TS)

summary(DN)

qplot(DN$zVC, DN$TS, color=DN$condition, xlab="zVC", ylab="Viewing time Screenshot") + geom_jitter() + geom_smooth(method="lm")

qplot(DN$zPT, DN$TS, color=DN$condition, xlab="zPT", ylab="Viewing time Screenshot") + geom_jitter() + geom_smooth(method="lm")

qplot(DN$zPT, DN$lTS, color=DN$condition, xlab="zPT", ylab="Viewing time Screenshot") + geom_jitter() + geom_smooth(method="lm")

qplot(DN$zVC, DN$lTS, color=DN$condition, xlab="zVC", ylab="Viewing time Screenshot") + geom_jitter() + geom_smooth(method="lm")
```

```
plot.TSCond <- ggplot(DN, aes(x=zPT, y=DN$TS, color=condition)) + geom_jitter() + geom_smooth(method="lm")

print(plot.TSCond)


##Testing the time of the screenshots (viewing time) on the PT against conditions

qplot(DN$time_Screenshot)

DN$TS <- DN$time_Screenshot

qplot(DN$zPT, DN$lTS, color=DN$condition, xlab="zPT", ylab="Viewing time Screenshot") + geom_jitter() + geom_smooth(method="lm")


####QUESTIONS

##Plot interaction zVC and condition on questions

plot.vcpt <- ggplot(DN, aes(x=zVC, y=zPT, color=condition)) + geom_jitter() + geom_smooth(method="lm")

print(plot.vcpt)

ggsave(filename="ZVC and condition questions.jpg", plot.vcQ, width=100, height=100, units="mm", scale=2)

##Plot interaction zVC and condition on questions

plot.vcQ <- ggplot(DN, aes(x=zVC, y=questions, color=condition)) + geom_jitter() + geom_smooth(method="lm")

print(plot.vcQ)

ggsave(filename="ZVC and condition questions.jpg", plot.vcQ, width=100, height=100, units="mm", scale=2)
```

##Plot interaction zPT and condition on questions

plot.ptQ <- ggplot(DN, aes(x=zPT, y=questions, color=condition)) + geom_jitter() + geom_smooth(method="lm")

print(plot.ptQ)

ggsave(filename="ZPT and condition questions 1.jpg", plot.ptQ, width=100, height=100, units="mm", scale=2)

####RESPONSE

##Plot interaction zVC and condition on response(z-standardized)

plot.vcR <- ggplot(DN, aes(x=zVC, y=Response, color=condition)) + geom_jitter() + geom_smooth(method="lm")

print(plot.vcR)

ggsave(filename="ZVC and condition 1.jpg", plot.vcR, width=100, height=100, units="mm", scale=2)

##Plot interaction zVS and condition on response(z-standardized)

plot.vsR <- ggplot(DN, aes(x=zVS, y=Response, color=condition)) + geom_jitter() + geom_smooth(method="lm")

print(plot.vsR)

ggsave(filename="ZVS and condition 1.pdf", plot.vsR, width=100, height=100, units="mm", scale=2)

ggsave(filename="ZVS and condition 1.jpg", plot.vsR, width=100, height=100, units="mm", scale=2)

##Plot interaction zPT and condition on response(z-standardized)

plot.ptR <- ggplot(DN, aes(x=zPT, y=Response, color=condition)) + geom_jitter() + geom_smooth(method="lm")

print(plot.ptR)

```
ggsave(filename="ZPT and condition 1.jpg", plot.ptR, width=100, height=100, units="mm", scale=2)

##Plot interaction zPT and scale on response(z-standardized)

plot.ptS <- ggplot(DN, aes(x=zPT, y=Response, color=Scale)) + geom_jitter() + geom_smooth(method="lm")

print(plot.ptS)

ggsave(filename="ZPT and condition 1.jpg", plot.ptS, width=100, height=100, units="mm", scale=2)

##Plot interaction zVC and scale on response(z-standardized)

plot.vcS <- ggplot(DN, aes(x=zPT, y=Response, color=Scale)) + geom_jitter() + geom_smooth(method="lm")

print(plot.vcS)

ggsave(filename="ZPT and condition 1.jpgf", plot.vcS, width=100, height=100, units="mm", scale=2)

##Plot block regression line scatterdot

plot.block <- ggplot(dataSPSS2, aes(x=block, y=Response)) + geom_jitter() + geom_smooth(method="lm")

print(plot.block)

ggsave(filename="block.pdf", plot.scale1, width=100, height=100, units="mm", scale=2)

##Plot interaction zVC and scales on response does not make sense: regression line over the scales?

plot.block <- ggplot(dataSPSS2, aes(x=block, y=Response)) + geom_jitter() + geom_smooth(method="lm")

print(plot.block)
```

```
#Reaction time on VC on Scale

plot.RT <- ggplot(DN, aes(x=zVC, y=DN$RT, color=Scale)) + geom_jitter() + geom_smooth(method="lm")

print(plot.RT)

ggsave(filename="RT VC Scale.jpg", plot.RT, width=100, height=100, units="mm", scale=2)

#Reaction time on PT on Scale

plot.RTPT <- ggplot(DN, aes(x=zPT, y=DN$RT, color=Scale)) + geom_jitter() + geom_smooth(method="lm")

print(plot.RTPT)

ggsave(filename="RT PT Scale.jpg", plot.RTPT, width=100, height=100, units="mm", scale=2)

#Reaction time on PT on Condition

plot.RTPTCond <- ggplot(DN, aes(x=zPT, y=DN$lRT, color=condition)) + geom_jitter() + geom_smooth(method="lm")

print(plot.RTPTCond)

ggsave(filename="RT PT Condition.jpg", plot.RTPTCond, width=100, height=100, units="mm", scale=2)

#Reaction time on VC on Condition

plot.RTVCCond <- ggplot(DN, aes(x=zVC, y=DN$lRT, color=condition)) + geom_jitter() + geom_smooth(method="lm")

print(plot.RTVCCond)

ggsave(filename="RT VC Condition.jpg", plot.RTVCCond, width=100, height=100, units="mm", scale=2)
```

```
#Boxplot response time questions of PT on Condition

plot.RTCondBox <- qplot(condition, lRT, data = DN, geom="boxplot")

print(plot.RTCondBox)

#Boxplot response time questions of VS on Condition

plot.TSCondBox <- qplot(condition, lTS, data = DN, geom="boxplot")

print(plot.TSCondBox)

##Boxplot for block and response

d <- ggplot(dataSPSS2, aes(factor(block), Response))

k <- d + geom_boxplot()

ggsave(filename="block boxplot.pdf", k, width=100, height=100, units="mm", scale=2)

#Plot zVC and zPT on Scale for H2 and H3

#VC and scale

plot.Scale <- ggplot(DN, aes(x=zVC, y=Response, color=Scale)) + geom_jitter() + geom_smooth(method="lm")

plot.Scale

ggsave(filename="VC and Scale1.jpg", plot.Scale, width=100, height=100, units="mm", scale=2)

#VS and scale

plot.Scale2 <- ggplot(DN, aes(x=zVS, y=Response, color=Scale)) + geom_jitter() + geom_smooth(method="lm")

plot.Scale2

ggsave(filename="VS and Scale2.jpg", plot.Scale2, width=100, height=100, units="mm", scale=2)
```

```
#PT and scale

plot.Scale1 <- ggplot(DN, aes(x=zPT, y=Response, color=Scale)) + geom_jitter() + geom_smooth(method="lm")

plot.Scale1

ggsave(filename="PT and Scale1.jpg", plot.Scale1, width=100, height=100, units="mm", scale=2)

## Influence of aesthetics ####

plot.vc <- ggplot(DN, aes(x=zVC, y=Response, color=condition)) + geom_jitter() + geom_smooth(method="lm") + facet_grid(.~Scale)

print(plot.vc)

ggsave(filename="VC Condition Scale.jpg", plot.vc, width=100, height=100, units="mm", scale=2)

plot.vs <- ggplot(DN, aes(x=zVS, y=Response, color=condition)) + geom_jitter() + geom_smooth(method="lm") + facet_grid(.~Scale)

print(plot.vs)

ggsave(filename="VS Condition Scale.jpg", plot.vs, width=100, height=100, units="mm", scale=2)

plot.pt <- ggplot(DN, aes(x=zPT, y=Response, color=condition)) + geom_jitter() + geom_smooth(method="lm") + facet_grid(.~Scale)

print(plot.pt)

ggsave(filename="PT Condition Scale.jpg", plot.pt, width=100, height=100, units="mm", scale=2)

#setwd(wualadir)

ggsave(filename="VC and condition.pdf", plot.vc, width=100, height=100, units="mm", scale=2)
```

```
ggsave(filename="PT and condition.pdf", plot.pt, width=100, height=100, units="mm", scale=2)

#m1 <- MCMCglmm(Resp_usability ~ Resp_hedonism * condition, random =~ subject_nr, data = DN.wide)

summary(m1) # Usability and hedonism**

#m2 <- MCMCglmm(Resp_usability ~ Resp_beauty * condition, random =~ subject_nr, data = DN.wide)

summary(m2) # Usability and beauty **

#m3 <- MCMCglmm(Resp_usability ~ (Resp_hedonism * condition) + (Resp_beauty * condition), random =~ subject_nr, data = DN.wide)

summary(m3) # Usability and hedonism

#m4 <- MCMCglmm(Response ~ condition + as.factor(block), random =~ subject_nr + SSName + ItemNum, data = DN)

summary(m4)

## **** ##

#m5 <- MCMCglmm(questions ~ condition * zVS * Scale + condition * zPT * Scale + as.factor(block), random =~ subject_nr + SSName + ItemNum, data = DN)

round(summary(m5)$solutions,2)

summary(m5)

## **** ##

#m6 <- MCMCglmm(questions ~ zVS:zPT +condition * zVS * Scale + condition * zPT * Scale + as.factor(block), random =~ subject_nr + SSName + ItemNum, data = DN)

summary(m6)
```

```
#m7 <- MCMCglmm(questions ~ zVC:zPT +condition * zVC * Scale + condition * zPT * Scale + as.factor(block) - Scale:condition, random =~ subject_nr + SSName + ItemNum, data = DN)

summary(m7)

#trace and density plot

plot(m7)

#Coefficient regression estimates plot

source("http://www.math.mcmaster.ca/~bolker/classes/s756/labs/coefplot_new.R")

coefplot(m7)

plotInteraction(DN,'ZVC','condition','questions')

plotResiduals(m7)

save(m1,m2,m3,m4,m5,m6,m7, file="MCMC regression.Rda")
```

6.5 Items

Hedonic Quality (HQ)

Original (in German) (Hassenzahl et al., 2003)	Translated in English (Hassenzahl & Monk, 2010b)	Translated in Dutch (Klomp, 2011)
Phantasielos-Kreativ	Unimaginative-Creative	Fantasieloos-Creatief
Stillos-Stilvoll	Tacky-Stylish	Stijlloos-Stijlvol
Lahm-Fesselnd	Dull-Captivating	Saai-Fascinerend
Minderwertig-Wertvoll	Cheap-Premium	Minderwaardig-Waardevol

Perceived usability (Pragmatic quality)

Original (in German) (Hassenzahl et al., 2003)	Translated in English (Hassenzahl & Monk, 2010b)	Translated in Dutch (Klomp, 2011)
Unpraktisch-Praktisch	Impractical-Practical	Onpraktisch-Praktisch
Verwirrend-Uebersichtlich	Confusing-Clearly structured	Verwarrend-Overzichtelijk
Unberechenbar-Voraussagbar	Unpredictable-Predictable	Onvoorspelbaar-Voorspelbaar
Kompliziert-Einfach	Complicated-Simple	Ingewikkeld-Eenvoudig

Beauty and classic aesthetics (N Tractinsky, Cokhavi, Kirschenbaum, & Sharfi, 2006)

Original (in German) (Hassenzahl et al., 2003)	Translated in English	Translated in Dutch
Schoen - Haesslich	Attractive-Ugly (Hassenzahl & Monk, 2010b)	Mooi – Lelijk (Klomp, 2011)
	Clean design	De net getoonde website heeft een nette design: Mee oneens - Mee eens
	Pleasant design	De net getoonde website heeft een aangenaam design: Mee oneens - Mee eens
	Aesthetic design	De net getoonde website heeft een esthetisch design: Mee oneens - Mee eens

6.6 Randomization scales, screenshots and items: Excel.

To Block not admissible combinations, an error is built in. New sequences can then be easily generated, thus admissible combinations can be found.

Screenshot	Block 1	Block 2	Block 3	random block 1	random block 2	random block 3
1	1	2	3	0,013629791	0,538682125	0,167889707
2	3	2	1	0,557735658	0,161929873	0,381532271
3	3	1	2	0,251270572	0,981461388	0,162974431
4	2	1	3	0,099795873	0,124377917	0,839931822
5	3	2	1	0,622830526	0,24949182	0,795687012
6	3	1	2	0,439871514	0,082851285	2,04809E-05
7	3	2	1	0,335337409	0,940865336	0,364464559
8	2	3	1	0,626235993	0,939192711	0,799019308
9	1	3	2	0,341857745	0,458825213	0,712178767
10	1	2	3	0,245153988	0,487598116	0,339880751
11	1	3	2	0,355913199	0,227843233	0,306399092
12	3	2	1	0,789741377	0,321821449	0,994529492
13	3	2	1	0,960228052	0,26868158	0,910899985
14	2	3	1	0,621916202	0,061887112	0,309301922
15	1	3	2	0,030890474	0,973276488	0,639221644
16	3	1	2	0,02989353	0,67049144	0,58931287
17	1	3	2	0,298513318	0,562123203	0,725027471
18	1	2	3	0,976482501	0,996583566	0,826699294
19	1	3	2	0,693853224	0,558853877	0,395849109
20	2	3	1	0,313350424	0,880141228	0,13386776
21	2	1	3	0,589146352	0,597119136	0,608740283
22	2	1	3	0,623876748	0,101629577	0,039458327
23	2	1	3	0,469775216	0,347730065	0,211516037
24	2	1	3	0,23314149	0,560091551	0,065835632
25	3	1	2	0,946129785	0,165697178	0,073071321
26	3	1	2	0,359211312	0,461780988	0,316637172
27	2	1	3	0,717061132	0,691905774	0,112710846
28	1	2	3	0,696840052	0,332874264	0,418427687
29	3	2	1	0,189728738	0,497312155	0,785398977
30	3	2	1	0,806883049	0,801071625	0,287849932
31	3	2	1	0,687876313	0,993739405	0,293302382
32	1	3	2	0,385222177	0,844130863	0,168646562
33	2	3	1	0,080505467	0,848448309	0,195094591
34	2	3	1	0,972177363	0,542854792	0,980979238
35	3	2	1	0,442236068	0,127294184	0,54551424
36	3	2	1	0,868874452	0,182143638	0,115536967
37	2	3	1	0,341927525	0,597513235	0,661066493
38	2	1	3	0,861090948	0,907259345	0,725762341
39	3	1	2	0,554623092	0,838130838	0,009930789
40	1	2	3	0,854997512	0,385426118	0,254600804
41	2	1	3	0,419306913	0,682813983	0,662913555
42	1	2	3	0,319485362	0,442402491	0,559015666
43	2	1	3	0,662165768	0,674158164	0,784635246
44	2	1	3	0,40328864	0,694381463	0,884646355
45	1	3	2	0,625230565	0,14536364	0,978036402
46	1	3	2	0,182451445	0,478174608	0,313662176
47	1	3	2	0,38669752	0,292891801	0,113661862
48	1	3	2	0,941710501	0,577769834	0,653501487

	Block 1					Block 2			
Order	Screenshot	Scale	Item	ItemNum	Order	Screenshot	Scale	Item	ItemNum
1	abraxas	1	3	3	24	synchem	1	2	2
27	ameresco	2	3	7	7	chase	2	2	6
10	freedom	1	4	4	46	harley_davidson	3	4	12
5	bureau_van_dijk	3	4	12	4	bank_of_america	1	2	2
30	fantasy_junction	3	4	12	11	geico	3	3	11
23	bajaj	2	3	7	2	airgas	2	4	8
14	izmocars	2	1	5	44	tesla	1	3	3
33	honda	2	4	8	43	sherwin_williams	1	2	2
15	Lloyd	1	3	3	19	snowcare_for_troops	3	2	10
9	first_european	1	3	3	22	plows_unlimited	1	3	3
17	sensient	1	1	1	10	freedom	2	1	5
39	pg&e	3	4	12	14	izmocars	3	4	12
46	harley_davidson	1	4	4	12	Honeywell	2	2	6
29	engro_corp	3	1	9	1	abraxas	2	3	7
3	american_express	3	4	12	45	ansa	3	1	9
2	airgas	3	3	11	32	hebei_yanuo	3	2	10
11	geico	1	4	4	28	chevrolet	2	1	5
48	exchange_consultancy_group	1	1	1	48	exchange_consultancy_group	3	1	9
36	national_heat	3	2	10	26	allete	1	4	4
12	Honeywell	3	4	12	41	quintiles	1	4	4
28	chevrolet	1	3	3	30	fantasy_junction	2	3	7
31	gem	3	4	12	3	american_express	1	2	2
25	aiam	3	4	12	16	military	1	2	2
8	ebizautos	2	1	5	27	ameresco	1	1	1
45	ansa	1	2	2	8	ebizautos	3	4	12
18	snl_financial	1	2	2	20	Taxproblem	3	4	12
38	novasyn_organics	2	4	8	35	mafs	2	1	5
37	northeast_system	2	2	6	15	Lloyd	3	1	9
7	chase	3	4	12	23	bajaj	1	3	3
40	pioneer	1	2	2	37	northeast_system	3	4	12
35	mafs	3	4	12	47	behr	3	3	11
19	snowcare_for_troops	1	1	1	39	pg&e	1	4	4
4	bank_of_america	2	2	6	40	pioneer	2	1	5
47	behr	1	2	2	25	aiam	1	3	3
24	synchem	2	3	7	5	bureau_van_dijk	2	3	7
43	sherwin_williams	2	4	8	9	first_european	3	1	9
16	military	3	4	12	31	gem	2	2	6
42	sabic	1	3	3	42	sabic	2	3	7
26	allete	3	4	12	38	novasyn_organics	1	4	4
41	quintiles	2	4	8	17	sensient	3	2	10
22	plows_unlimited	2	4	8	34	jvc	3	1	9
13	horschel	3	2	10	18	snl_financial	2	1	5
34	jvc	2	1	5	33	honda	3	3	11
21	powermadd	2	4	8	36	national_heat	2	2	6
32	hebei_yanuo	1	2	2	6	chain	1	2	2
6	chain	3	3	11	21	powermadd	1	3	3
20	Taxproblem	2	2	6	13	horschel	2	1	5
44	tesla	2	2	6	29	engro_corp	2	4	8

1 ; 24

VCH PTL

	Block 3					Block 4 Repeat			
Order	Screenshot	Scale	Item	emNu	Order	Screenshot	Scale	Item	ItemNum
11	geico	2	1	5	1	abraxas	1	3	3
24	synchem	3	1	9	27	ameresco	2	3	7
10	freedom	3	4	12	10	freedom	1	4	4
43	sherwin_williams	3	3	11	5	bureau_van_dijk	3	4	12
40	pioneer	3	3	11	30	fantasy_junction	3	4	12
1	abraxas	3	2	10	23	bajaj	2	3	7
23	bajaj	3	2	10	14	izmocars	2	1	5
41	quintiles	3	1	9	33	honda	2	4	8
35	mafs	1	3	3	15	Lloyd	1	3	3
22	plows_unlimited	3	3	11	9	first_european	1	3	3
18	snl_financial	3	1	9	17	sensient	1	1	1
48	exchange_consultancy_group	2	3	7	39	pg&e	3	4	12
45	ansa	2	4	8	46	harley_davidson	1	4	4
19	snowcare_for_troops	2	4	8	29	engro_corp	3	1	9
31	gem	1	1	1	3	american_express	3	4	12
29	engro_corp	1	3	3	2	airgas	3	3	11
36	national_heat	1	3	3	11	geico	1	4	4
42	sabic	3	3	11	48	exchange_consultancy_group	1	1	1
25	aiam	2	2	6	36	national_heat	3	2	10
9	first_european	2	1	5	12	Honeywell	3	4	12
30	fantasy_junction	1	2	2	28	chevrolet	1	3	3
3	american_express	2	1	5	31	gem	3	4	12
14	izmocars	1	1	1	25	aiam	3	4	12
4	bank_of_america	3	3	11	8	ebizautos	2	1	5
5	bureau_van_dijk	1	4	4	45	ansa	1	2	2
21	powermadd	3	1	9	18	snl_financial	1	2	2
6	chain	2	4	8	38	novasyn_organics	2	4	8
26	allete	2	3	7	37	northeast_system	2	2	6
39	pg&e	2	4	8	7	chase	3	4	12
16	military	2	1	5	40	pioneer	1	2	2
17	sensient	2	4	8	35	mafs	3	4	12
12	Honeywell	1	1	1	19	snowcare_for_troops	1	1	1
13	horschel	1	4	4	4	bank_of_america	2	2	6
47	behr	2	2	6	47	behr	1	2	2
27	ameresco	3	1	9	24	synchem	2	3	7
8	ebizautos	1	1	1	43	sherwin_williams	2	4	8
33	honda	1	2	2	16	military	3	4	12
37	northeast_system	1	1	1	42	sabic	1	3	3
2	airgas	1	3	3	26	allete	3	4	12
15	Lloyd	2	3	7	41	quintiles	2	4	8
34	jvc	1	3	3	22	plows_unlimited	2	4	8
28	chevrolet	3	4	12	13	horschel	3	2	10
38	novasyn_organics	3	2	10	34	jvc	2	1	5
44	tesla	3	1	9	21	powermadd	2	4	8
46	harley_davidson	2	4	8	32	hebei_yanuo	1	2	2
20	Taxproblem	1	2	2	6	chain	3	3	11
7	chase	1	4	4	20	Taxproblem	2	2	6

1 abraxas
2 airgas
3 american_express
4 bank_of_america
5 bureau_van_dijk
6 chain
7 chase
8 ebizautos
9 first_european
10 freedom
11 geico
12 Honeywell
13 horschel
14 izmocars
15 Lloyd
16 military
17 sensient
18 snl_financial
19 snowcare_for_troops
20 Taxproblem
21 powermadd
22 plows_unlimited
23 bajaj
24 synchem
25 aiam
26 allete
27 ameresco
28 chevrolet
29 engro_corp
30 fantasy_junction
31 gem
32 hebei_yanuo
33 honda
34 jvc
35 mafs
36 national_heat
37 northeast_system
38 novasyn_organics
39 pg&e
40 pioneer
41 quintiles
42 sabic
43 sherwin_williams
44 tesla
45 ansa
46 harley_davidson
47 behr
48 exchange_consultancy_group

Number	Randvalue	Screenshot name		Count for block 1			Count for block 2			Screenshot	Block 1	Block 2	Block 3	random	if 2> 8
1	0,286269	6	Disfluent	0	0	1	0	1	0	6	3	2	1	0,089231	1
2	0,99436	24		0	1	1	0	1	1	24	2	3	1	0,762908	3
3	0,248611	5		0	2	1	0	1	2	5	2	3	1	0,91962	3
4	0,895867	22		0	3	1	0	1	3	22	2	3	1	0,452765	1
5	0,794309	20		0	4	1	1	1	3	20	2	1	3	0,937614	3
6	0,690394	16		0	4	2	2	1	3	16	3	1	2	0,511839	3
7	0,783151	18		0	5	2	2	1	4	18	2	3	1	0,040629	1
8	0,637682	12		1	5	2	2	1	5	12	1	3	2	0,031879	1
9	0,972189	23		2	5	2	2	1	6	23	1	3	2	0,789514	3
10	0,313691	8		2	6	2	2	1	7	8	2	3	1	0,306209	1
11	0,647798	14		2	7	2	3	1	7	14	2	1	3	0,015695	1
12	0,421752	9		2	8	2	4	1	7	9	2	1	3	0,888824	3
13	0,445292	10		3	8	2	4	1	8	10	1	3	2	0,871627	1
14	0,548537	11		4	8	2	4	2	8	11	1	2	3	0,1867	1
15	0,687667	15		5	8	2	4	3	8	15	1	2	3	0,52107	1
16	0,79349	19		6	8	2	4	4	8	19	1	2	3	0,003786	1
17	0,291078	7		7	8	2	4	5	8	7	1	2	3	0,019582	1
18	0,026208	1		8	8	2	4	6	8	1	1	2	3	0,491492	1
19	0,759296	17		8	8	3	4	7	8	17	3	2	1	0,613681	1
20	0,892738	21		8	8	4	5	7	8	21	3	1	2	0,16743	1
21	0,647455	13		8	8	5	6	7	8	13	3	1	2	0,757066	1
22	0,130957	4		8	8	6	6	8	8	4	3	2	1	0,001517	1
23	0,100066	3		8	8	7	7	8	8	3	3	1	2	0,006993	1
24	0,061729	2		8	8	8	8	8	8	2	3	1	2	0,203249	1
25	0,24555	32	Fluent	1	0	0	0	0	1	32	1	3	2	0,71687	3
26	0,365571	36		1	1	0	0	0	2	36	2	3	1	0,247218	1
27	0,231849	31		1	1	1	1	0	2	31	3	1	2	0,53498	3
28	0,340202	34		2	1	1	1	1	2	34	1	2	3	0,206716	1
29	0,100338	28		2	2	1	2	1	2	28	2	1	3	0,550847	3
30	0,859546	48		2	3	1	2	1	3	48	2	3	1	0,085115	1
31	0,357715	35		3	3	1	2	1	4	35	1	3	2	0,804799	3
32	0,458736	40		3	4	1	2	1	5	40	2	3	1	0,517843	3
33	0,022356	26		4	4	1	2	1	6	26	1	3	2	0,561274	3
34	0,125682	29		5	4	1	2	1	7	29	1	3	2	0,472676	1
35	0,575366	44		6	4	1	2	2	7	44	1	2	3	0,171869	1
36	0,058108	27		6	4	2	3	2	7	27	3	1	2	0,479841	1
37	0,476401	41		6	4	3	3	3	7	41	3	2	1	0,386928	1
38	0,499706	42		6	5	3	4	3	7	42	2	1	3	0,890882	3
39	0,615288	45		6	6	3	4	3	8	45	2	3	1	0,112925	1
40	0,505752	43		6	6	4	4	4	8	43	3	2	1	0,697433	1
41	0,372342	37		6	7	4	5	4	8	37	2	1	3	0,993441	1
42	0,190463	30		6	7	5	5	5	8	30	3	2	1	0,24663	1
43	0,331679	33		7	7	5	5	6	8	33	1	2	3	0,306018	1
44	0,021217	25		8	7	5	5	7	8	25	1	2	3	0,423257	1
45	0,841279	46		8	7	6	6	7	8	46	3	1	2	0,191161	1
46	0,845788	47		8	7	7	6	8	8	47	3	2	1	0,117243	1
47	0,442298	39		8	7	8	7	8	8	39	3	1	2	0,641637	1
48	0,44004	38		8	8	8	8	8	8	38	2	1	3	0,443131	1

6.7 Screenshots of the experiment

Introduction screen in both conditions

Welkom

Welkom bij dit onderzoek over de factoren Schoonheid (beauty) en Gebruiksvriendelijkheid (usability) van websites.

Voordat u begint aan het onderzoek, zullen er een paar algemene vragen worden gesteld. Daarna zal het onderzoek worden uitgelegd. Het experiment duurt ongeveer 45 minuten. De data van het onderzoek zal anoniem worden verwerkt.

Alvast bedankt voor uw deelname!

Ga verder

Descriptive information

Algemene informatie

1. Wat is uw geslacht? Man Vrouw

*(In het veld mogen alleen **getallen** worden ingevoerd. Druk op **Enter** na het invullen)*

2. Wat is uw leeftijd? Klik hier..

3. Is Nederlands uw moedertaal? Ja Nee

Ga verder

Instruction and explanation in the treatment condition

Fluency

Als we antwoord moeten geven of iets (bv. een website) mooi of gebruiksvriendelijk is, denken we niet goed na over wat schoonheid (beauty) en gebruiksvriendelijkheid (usability) voor ons betekenen. We staan niet echt stil bij wat het mooi of gebruiksvriendelijk maakt.

In plaats daarvan worden wij **onbewust en intuïtief** beïnvloed.

We beoordelen onbewust schoonheid en gebruiksvriendelijkheid. Namelijk op basis van visuele kenmerken zoals symmetrie, bekendheid of complexiteit etc. Als u zometeen de vragen in het onderzoek beantwoordt, denk dan eerst goed na over wat het mooi of gebruiksvriendelijk maakt.

Wat betekenen *schoonheid en gebruiksvriendelijkheid* **werkelijk** voor u? U heeft net een lijst gemaakt met criteria voor schoonheid en gebruiksvriendelijkheid. Deze woorden definiëren dus schoonheid en gebruiksvriendelijkheid voor u.
Houdt deze alstublieft **goed** in gedachten als u de vragen invult.

Ga verder

Instructie

In het onderzoek krijgt u zometeen een screenshot van een website te zien. Het is de bedoeling dat u deze **kort** bekijkt en dan aan de hand van uw **eerste indruk**, de vraag invult.
Er zal dus gedurende het experiment steeds 1 screenshot worden getoond, waarna u 1 vraag moet invullen.

Denk goed na over wat de website mooi of usable maakt. Herinner uw lijst over *gebruiksvriendelijkheid* en *schoonheid*. Houdt dit **goed in gedachten** als u de vragen invult. Dus:

Wat betekenen *schoonheid en gebruiksvriendelijkheid* **werkelijk** voor u?

Druk op de button om verder te gaan naar de oefening.

Ga verder

Practice phase in both conditions

Oefening

Voordat het onderzoek begint, volgt er nu eerst een korte oefening zodat u weet hoe het onderzoek zal gaan. Deze oefenfase bestaat uit 4 screenshots met ieder een vraag.

Als u klaar bent met het bekijken van de screenshot, druk dan op de **spatiebalk** om door te gaan naar de vraag.
Denk erom dat het gaat om uw 1e impressie van de screenshot als u de vraag invult.

Druk op de button om te starten met de oefening.

Start Onderzoek

Start of the experiment, reinforcing the instruction in the treatment group

Onderzoek

Het onderzoek zal nu beginnen.

U krijgt nu het eerste screenshot van een website te zien.

Bekijk hem **kort** en druk vervolgens op **spatiebalk** als u klaar bent om naar de vraag te gaan.
Beantwoord de vraag op basis van uw eerste impressie.

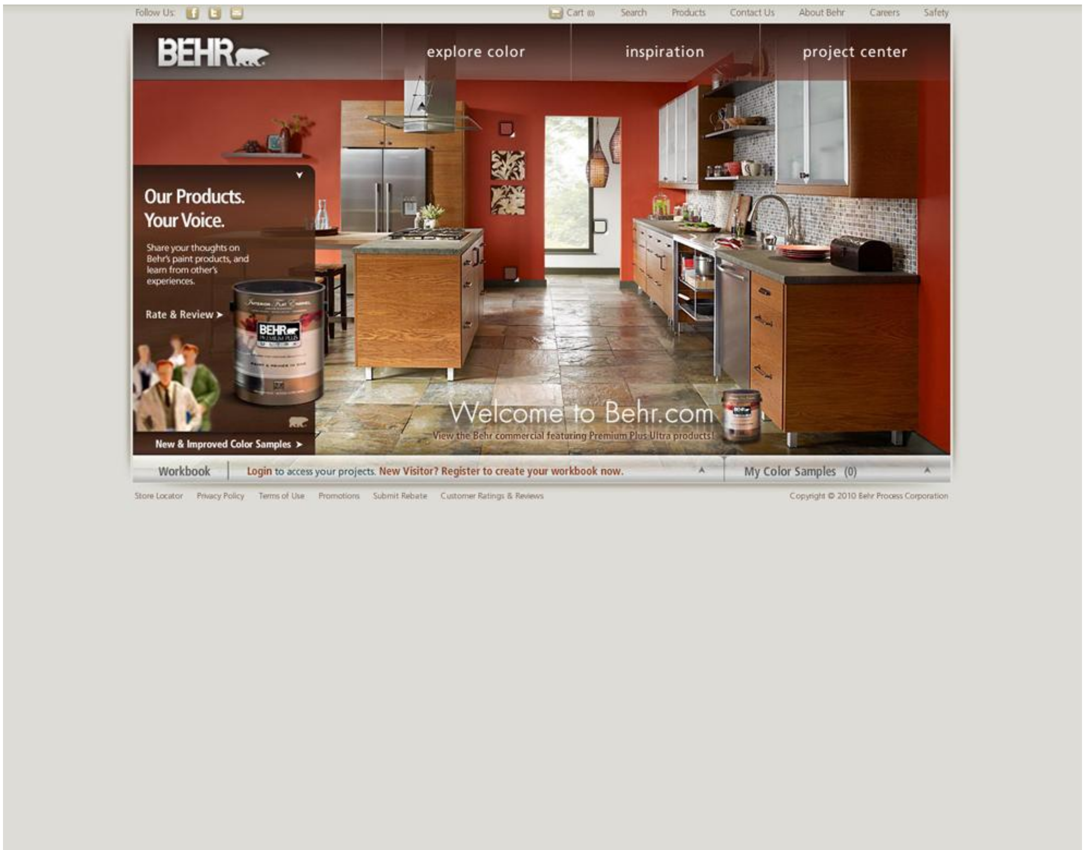
Denk goed na over wat de website mooi of gebruiksvriendelijk maakt. Herinner uw critera lijst over *gebruiksvriendelijkheid* en *schoonheid*. Deze woorden omschrijven wat u mooi of gebruiksvriendelijk vindt. Houdt dit **goed in gedachten** als u de vragen invult. Dus:

Wat betekenen *schoonheid en gebruiksvriendelijkheid* **werkelijk** voor u?

Druk op de button om te starten met het onderzoek.

Start Onderzoek

Stimuli screenshot websites



Question relating to the screenshot previously viewed

De net getoonde website is:

Fantasieloos ☐ ☐ ☐ ☐ ☐ ☐ ☐ Creatief

Volgende

Break between the four blocks. In the treatment condition, the instruction is again reinforced.

U heeft nu een pauze van 2 minuten

Bekijk uw ***criteria lijst*** over gebruiksvriendelijkheid en schoonheid nog een keer. Deze woorden definiëren dus schoonheid en gebruiksvriendelijkheid voor u. Denk goed na over wat schoonheid en gebruiksvriendelijkheid werkelijk voor u betekenen. Houd dit alstublieft **goed in gedachten** als u de vragen invult.

Nog 2 min.

6.8 Websites used

6.8.1 Fluent websites (low VC – high PT)

Stimuli Name	VC_mean	VC_sd	PT_mean	PT_sd	Website url
honda	2,708333	2,053188	4,833333	1,761093	http://powersports.honda.com
allete	3,208333	1,718927	4,875	1,701981	http://www.allete.com
pg&e	3,428571	1,68533	5	1,608799	http://www.pge.com
behr	3,777778	2,025479	5,111111	1,502135	http://www.behr.com/Behr/home
harley_davidson	3,772727	1,925563	5,590909	1,469016	http://www.harley-davidson.com
chevrolet	3,590909	1,816829	5,227273	1,631004	http://www.chevrolet.com/#cruze
hebei_yanuo	3	1,752549	5,275862	1,250616	http://www.yanuo.com
sabic	3,454545	1,818615	4,863636	1,753784	http://www.sabic.com/corporate/en
quintiles	3,62963	1,690429	5,407407	1,474378	http://www.quintiles.com
ameresco	3,272727	1,804276	5,454545	1,438494	http://www.ameresco.com
pioneer	3,727273	1,723281	4,636364	1,890967	http://www.pioneerelectronics.com
aiam	2,857143	1,292412	4,928571	1,59153	http://www.globalautomakers.org
northeast_system	3,590909	2,130484	5,136364	1,859223	http://www.nu.com
novasyn_organics	2,928571	1,439246	5,357143	1,499084	http://www.novasynorganics.com
fantasy_junction	2,685714	1,811263	4,828571	1,67131	http://www.fantasyjunction.com
ansa	3,885714	1,761874	5,028571	1,524037	http://ansaautomotive.com
mafs	3,037037	1,580688	5,148148	1,406132	http://www.usemafs.com
engro_corp	3,566667	1,735697	5,233333	1,356551	http://engro.com
national_heat	3,727273	1,723281	4,545455	1,738288	http://www.nationalheatexchange.com
sherwin_williams	3,409091	1,918806	5,136364	1,726418	http://www.sherwin-williams.com
exchange_consulta	2,666667	1,464557	4,25	1,799758	http://www.exchangeconsulting.com
tesla	3,028571	1,932473	5,514286	1,268891	http://www.teslamotors.com
jvc	3,272727	2,229282	5,545455	1,534594	http://www.jvc.com
gem	3,724138	1,509412	4,62069	1,473911	http://www.polarisindustries.com

6.8.2 Disfluent websites (high VC – low PT)

Stimuli name	VC_mean	VC_sd	PT_mean	PT_sd	Website url
powermadd	4,214286	1,847184	3,214286	1,368805	http://www.powermadd.com
chase	4,942857	1,679336	3,628571	1,516298	http://www.chase.com
plows_unlimited	4,409091	1,816829	2,772727	1,47783	http://www.plowsunlimited.com/archive
Lloyd	5,142857	1,09945	3,5	1,286019	http://www.lloydsstsb-offshore.com
Taxproblem	4,971429	1,790263	4,057143	1,589355	http://www.taxproblem.org
airgas	4,727273	1,351606	4,318182	1,358794	http://www.airgas.com
chain	4,888889	2,100061	3,185185	1,35978	http://www.chain-auto-tools.com
snl_financial	5,074074	1,356634	4,185185	1,468569	http://www.snl.com
american_express	5,137931	1,186957	4,413793	1,63701	http://www.americanexpress.com
synchem	4,371429	1,800093	3	1,57181	http://www.synchem.com
abraxas	4,541667	2,08471	2,291667	1,517411	http://www.abraxasenergy.com
bank_of_america	5,136364	1,320009	3,818182	1,562549	http://www.bankofamerica.com
geico	5,533333	1,547709	3,6	1,940494	http://www.geico.com
izmocars	4,714286	1,724758	4,228571	1,646488	http://www.izmocars.com
freedom	5,083333	1,529895	3,25	1,823756	http://www.freedomoffroad.com.au
ebizautos	4,851852	1,292097	4,074074	1,858989	http://www.ebizautos.com
horschel	4,733333	1,595972	3,833333	1,821014	http://www.hbpllc.com
first_european	4,818182	1,468279	4	1,573592	http://www.first-european.co.uk
sensient	4,958333	1,680558	3,375	1,68916	http://www.sensient-tech.com
Honeywell	5,296296	1,234592	4,481481	1,451004	http://honeywell.com/Pages/Home.aspx
snowcare_for_troops	4,857143	1,561909	4	1,88108	http://projectevergreen.com/scft
bajaj	4,222222	1,281025	2,925926	1,591466	http://www.bajajauto.com
bureau_van_dijk	5,045455	1,174218	4,045455	1,214095	http://www.bvdinfo.com
military	5,928571	0,916875	3,071429	1,59153	http://www.armedforces-int.com

6.9 SPSS Syntax

Check for skewness: Histogram of residuals of reaction time 'answering questions'

```
* Chart Builder.
GGRAPH
  /GRAPHDATASET NAME="graphdataset" VARIABLES=ResidualRT MISSING=LISTWISE
REPORTMISSING=NO
  /GRAPHSPEC SOURCE=INLINE.
BEGIN GPL
  SOURCE: s=userSource(id("graphdataset"))
  DATA: ResidualRT=col(source(s), name("ResidualRT"))
  GUIDE: axis(dim(1), label("Raw Residual"))
  GUIDE: axis(dim(2), label("Frequency"))
  ELEMENT:          interval(position(summary.count(bin.rect(ResidualRT))),
shape.interior(shape.square))
END GPL.
```

Check for skewness: Histogram of residuals of reaction time 'viewing stimuli'

```
* Chart Builder.
GGRAPH
  /GRAPHDATASET         NAME="graphdataset"         VARIABLES=ResidualRTScr
MISSING=LISTWISE REPORTMISSING=NO
  /GRAPHSPEC SOURCE=INLINE.
BEGIN GPL
  SOURCE: s=userSource(id("graphdataset"))
  DATA: ResidualRTScr=col(source(s), name("ResidualRTScr"))
  GUIDE: axis(dim(1), label("Raw Residual"))
  GUIDE: axis(dim(2), label("Frequency"))
  ELEMENT:       interval(position(summary.count(bin.rect(ResidualRTScr))),
shape.interior(shape.square))
END GPL.
```

GEE analysis of the log transformed data of reaction time 'asnwering the questions'

```
* Generalized Estimating Equations.
GENLIN lRT BY condition (ORDER=ASCENDING)
  /MODEL condition INTERCEPT=YES
 DISTRIBUTION=NORMAL LINK=IDENTITY
  /CRITERIA     SCALE=MLE     PCONVERGE=1E-006(ABSOLUTE)     SINGULAR=1E-012
ANALYSISTYPE=3(WALD) CILEVEL=95 LIKELIHOOD=FULL
  /EMMEANS TABLES=condition SCALE=ORIGINAL
  /REPEATED SUBJECT=subject_nr SORT=YES CORRTYPE=INDEPENDENT ADJUSTCORR=YES
COVB=ROBUST
  /MISSING CLASSMISSING=EXCLUDE
  /PRINT CPS DESCRIPTIVES MODELINFO FIT SUMMARY SOLUTION
  /SAVE RESID.
```

GEE analysis of the log transformed data of reaction time 'viewing stimuli'

```
* Generalized Estimating Equations.
GENLIN lRTScr BY condition (ORDER=ASCENDING)
  /MODEL condition INTERCEPT=YES
 DISTRIBUTION=NORMAL LINK=IDENTITY
  /CRITERIA     SCALE=MLE     PCONVERGE=1E-006(ABSOLUTE)     SINGULAR=1E-012
ANALYSISTYPE=3(WALD) CILEVEL=95 LIKELIHOOD=FULL
```

```
  /EMMEANS TABLES=condition SCALE=ORIGINAL
  /REPEATED SUBJECT=subject_nr SORT=YES CORRTYPE=INDEPENDENT ADJUSTCORR=YES
COVB=ROBUST
  /MISSING CLASSMISSING=EXCLUDE
  /PRINT CPS DESCRIPTIVES MODELINFO FIT SUMMARY SOLUTION
  /SAVE RESID.
```

Correlation analysis of Control condition

```
USE ALL.
COMPUTE filter_$=(condition = 1).
VARIABLE LABELS filter_$ 'condition = 1 (FILTER)'.
VALUE LABELS filter_$ 0 'Not Selected' 1 'Selected'.
FORMATS filter_$ (f1.0).
FILTER BY filter_$.
EXECUTE.
CORRELATIONS
  /VARIABLES=Resp_hedonism Resp_usability Resp_beauty
  /PRINT=TWOTAIL NOSIG
  /STATISTICS DESCRIPTIVES
  /MISSING=PAIRWISE.
```

Correlation analysis of Treatment condition

```
USE ALL.
COMPUTE filter_$=(condition = 2).
VARIABLE LABELS filter_$ 'condition = 2 (FILTER)'.
VALUE LABELS filter_$ 0 'Not Selected' 1 'Selected'.
FORMATS filter_$ (f1.0).
FILTER BY filter_$.
EXECUTE.
CORRELATIONS
  /VARIABLES=Resp_hedonism Resp_usability Resp_beauty
  /PRINT=TWOTAIL NOSIG
  /STATISTICS DESCRIPTIVES
  /MISSING=PAIRWISE.
```