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# Evaluating User's Aesthetic Experience During Interaction

Master's Thesis

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This Master's thesis document has been supervised by Mati Mõttus (Tallinn University, Estonia) and David Lamas, PhD (Tallinn University, Estonia).

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## Abstract

The goal of this study is to assess the possible difference in the user's aesthetic experience with four conditions: without interaction, during interaction, and between smartphone and computer devices. Aesthetic appeal influences the user's behaviour towards a website and whether they decide to use it in the future, and recommend it to others.

In the research, literature review was conducted to select the research method suitable for the study and provide an overview of the previous approaches in the field. The adapted version of AttrakDiff and the exploratory aesthetic category scales were chosen for the study to collect data about the user's perceived aesthetic experience. In the study, a quantitative approach was chosen to enable a comparison of the perceived emotions and answer the research questions. This approach was complemented with a qualitative preliminary survey to design the tasks that correspond with the potential user's information-seeking behaviours and needs. Besides quantitative data, also, the supportive data was gathered with a goal to provide a better understanding of the quantitative results. After conducting the experiment, the gathered data were analysed to achieve the goals of the study.

It is expected that the study contributes in finding a deeper understanding about the recently-established aesthetic categories, aim to improve these categories and prove the reliability of the method to evaluate the aesthetics of interaction. Another value is aimed at providing guidelines for improving the attractiveness of a website under study, by getting some insights about the users' aesthetic perception with different devices that can be taken into account for a website's further development.

Keywords: *user experience, aesthetics, aesthetics of interaction, attractiveness, appeal, non-instrumental qualities, hedonics, evaluation*.

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## List of abbreviations

AC: Scales based on aesthetic categories

CUE: Components model of User Experience

EE: participants who indicated Estonian as their preferred language

EN: participants who indicated English as their preferred language

IC: Interaction with Computer

IS: Interaction with Smartphone

NUI: Natural User Interface

UX: User Experience

VC: Video with Computer

VS: Video with Smartphone

# 1 Introduction

Technology has increasingly surrounded people and interactions with different devices are an inseparable part of individual's everyday life. User experience (UX) is present in every field where the users exist and its importance has been emphasized upon, in order to gain deeper knowledge about the perceived experience to design better products and services. Nowadays, people have more choices than ever before to select between the products and services. Choice requires a guiding system - aesthetics - to distinguish between good design choices and the questionable ones (Lenz et al., 2014). Aesthetics helps shape the user's opinion about the products and influence the decision if the user decides to use the product at all, or abandons it after the first contact. A relevant function of aesthetics, as UX quality dimension, is the satisfaction of human requirements, and from the user's viewpoint, aesthetic qualities can make products more readily acceptable and improve their commercial value (Lavie & Tractinsky, 2004).

In a recent HCI research, the aesthetics of interaction has gained interest (Lenz et al., 2014). Quite a long time interactions were limited to pressing buttons, moving dials and sliders, but had a significant broadening of the possibilities that came with smartphones which introduced touch gestures and other technologies introducing free gestures, like Kinect, or conversational gestures like Siri, naming just some of them (Lenz et al., 2014).

Rapid changes of technology have provided a few new ways of interaction and how the users perceive it (Mõttus & Lamas, 2015), which has resulted in ongoing researches to develop a set of suitable models and new scales to measure the aesthetic pleasures in design and explain it. Aesthetic interaction design focuses on aesthetic experiences while interacting with an interactive system, including not only the way it looks but also how it feels (Hashim et al., 2009). The term 'aesthetics of interaction' has been used in relation with enjoyment, beauty, or pleasure in interaction, that is, systems that are "beautiful in use" (Djajadiningrat et al., 2004).

In real HCI situations, like browsing the web, the actual interactions of the users – not the passive viewing – has a major influence in shaping the overall user experience, but when first visiting a website, a set of initial impressions are also formed (Tuch et al., 2012). Users perceive aesthetics differently when they interact with technology, compared to just passively viewing it (Mõttus & Lamas, 2015).

Recently-developed aesthetic category scales are used in this study to evaluate the user's aesthetic perception during a complete interaction on a website, using both smartphone and computer devices. The study also explores whether these categories provide reliable results in the conditions that contain multiple interactions and enable the user to accomplish multiple actions to achieve the goal.

## 1.1 Research problem

Recent UX studies have found that appearance is not the only factor to produce an aesthetic perception. Aesthetic experience is also part of usage process. Visual beauty and beauty of use process are two sides of aesthetics that are difficult to separate, and evaluation tools often do not address one without taking into account the other. Aesthetic evaluation models have mostly used static images to evaluate aesthetics, but users perceive more than just the visual stimuli when they interact with interfaces and products. The aesthetic appeal influences user's behaviour towards the website, and their decision of using it in the future and recommending it to others.

## 1.2 Research goal

The goal of this study is to assess the possible differences in the user's aesthetic experience with four conditions: both without and during interaction, as well as between smartphone and desktop computer devices.

In this study, the evaluation object is the Estonian Official tourist information website, 'Visit Estonia' (https://www.visitestonia.com/en) (Appendix 1, Figure 1). The Visit Estonia website is selected for several reasons. Tourist information website should be attractive and aesthetically appealing to catch the possible visitor's attention for choosing Estonia as a destination country for their visit. Attractiveness and aesthetical appeal are also the focal points of this study. Another important reason for choosing this website is because through the outcome of the thesis, the author can contribute to the improvement of the site's overall attractiveness.

*Hypothesis 1:* There is a significant difference in the perception of aesthetics of interaction between smartphones and computer devices.

*Hypothesis 2:* There is a significant correlation between attractiveness and aesthetic category scales in the conditions that contain multiple interactions and enable the user to accomplish multiple actions in order to achieve the goal.

## 1.3 Research questions

The study aims to find answers to the following research question:

How do different devices influence the user's perceived aesthetic experience during interaction?

## 1.4 Research Methodology

The methodology of this thesis combines a specially designed experiment as the empirical method and literature review as the conceptual method.

To achieve the goal of the thesis, first, a literature review was conducted to select the research method suitable for the study and to provide an overview of the previous approaches in the field. In the study, a quantitative approach was chosen to enable the comparison of perceived emotions and answer the research questions. The experiment involved the user's self-report through questionnaires. Adapted version of AttrakDiff and exploratory aesthetic category scales were chosen to collect data about the user's perceived aesthetic experience. This approach was complemented with a qualitative preliminary survey to design the tasks that corresponded to the potential user's information-seeking behaviours and needs. Besides quantitative data, supportive data were further gathered, with a goal to provide a better understanding of the quantitative results.

After conducting the experiment, the gathered data were analysed to answer the research question and achieve the goal of the study. It is expected to be revealed that different devices influence the user's perceived aesthetic experience during interaction.

# 2 Literature Review

The purpose of this literature review is to provide an overview of the relevant topics and approaches about user experience, aesthetics, and their interdependencies. The main sources of literature were ACM Digital Library, IEEE Computer Society Digital Library, Google Scholar and Mendeley. Among others, search phrases included: user experience, aesthetics, aesthetics of interaction, interaction aesthetics, attractiveness, appeal, non-instrumental qualities and hedonics.

## 2.1 User Experience

Technology surrounds people more than ever, and interactions with different devices and environments are an inseparable part of an individual's everyday life. User experience is present in every field where people exist. Designing for UX can create a competitive advantage, improve chances of user acceptance, and also increase user engagement, so, people prefer certain products or services, and are willing to continue using them.

In the HCI literature the phrase, "user experience" is used in multiple ways. UX is used in the meaning of the design and for the use of user interfaces, as a synonym for interaction, usability, and even user-centred design, but also as a phrase that focuses on the user's non-instrumental needs and experiences in a more complex sense (Bargas-Avila & Hornbæk, 2011). Different research papers discuss UX, but its definitions and characteristics vary broadly (Bargas-Avila & Hornbæk, 2011), and are even contradictory (Battarbee & Koskinen, 2005).

Designing for UX requires a combination of knowledge about design, psychology, business, philosophy, anthropology, cognitive and social sciences, and other disciplines (Forlizzi & Battarbee, 2004) and brings together people from different fields, with their field-specific knowledge and background. The landscape of UX research is fragmented through diverse theoretical models with different directions, such as pragmatism, emotion, affect, experience, value, pleasure, beauty, hedonic quality, etc. (Law et al., 2009).

In 2010, UX was defined as per the ISO 9241-210 standard as "a person's perceptions and responses that result from the use or anticipated use of a product, system or service" (International Organization for Standardization, https://www.iso.org/obp/ui/#iso:std:52075:en). Besides that definition, the author also

brought out some of UX definitions that communicate the focus upon the user's aesthetic experience and interaction:

"All the aspects of how people use an interactive product: the way it feels in their hands, how well they understand how it works, how they feel about it while they're using it, how well it serves their purposes, and how well it fits into the entire context in which they are using it" (Alben, 1996).

"A consequence of a user's internal state (predispositions, expectations, needs, motivation, mood, etc.), the characteristics of the designed system (e.g. complexity, purpose, usability, functionality, etc.) and the context (or the environment) within which the interaction occurs (e.g. organisational/social setting, meaningfulness of the activity, voluntariness of use, etc.)." (Hassenzahl & Tractinsky, 2006).

"The entire set of affects that is elicited by the interaction between a user and a product, including the degree to which all our senses are gratified (aesthetic experience), the meanings we attach to the product (experience of meaning) and the feelings and emotions that are elicited (emotional experience)" (Hekkert, 2006).

"The user experience is the totality of end-users' perceptions as they interact with a product or service. These perceptions include effectiveness (how good is the result?), efficiency (how fast or cheap is it?), emotional satisfaction (how good does it feel?), and the quality of the relationship with the entity that created the product or service (what expectations does it create for subsequent interactions?)." (Kuniavsky, 2010).

Analysing the different definitions of UX shows that it is used as an umbrella phrase, which seeks to cover almost everything that has something to do with user's experience of the product. Early UX research mainly focused on task efficiency and work, and later, labels such as pleasurable products, hedonic quality, or engineering joy were brought in (Bargas-Avila & Hornbæk, 2011). Researchers found that the traditional indicators of UX, like usability, effectiveness, efficiency, and satisfaction are not sufficient enough for capturing it, and hedonic and experiential factors of interacting with technology, such as fun, fulfilment, play, and user engagement should also be considered (Lalmas, O'Brien & Yom-Tov, 2014). Other frequently-mentioned characteristics of UX are attractiveness and aesthetics (Van Schaik & Ling, 2008), self-actualization, focus on positive emotions, and affect that people experience while interacting with products (Bargas-Avila & Hornbæk, 2011). Aesthetics and

appeal are also considered to be hedonic criteria (Diefenbach et al., 2014). Experience consists of multiple aspects that influence how the user perceives the product or service, and if one of those aspects fails, it influences the whole experience. UX research focuses on the dynamics of experience, and on modelling how interactive products, personal characteristics, and context work together in shaping the usage (Bargas-Avila & Hornbæk, 2011). Previously cited definitions hint that experience is personal and different users can perceive the same product differently, depending on their background, previous experiences, personal characteristics, mood, or attention, at the moment of interaction. Löwgren (2008) states that what can be considered aesthetically appropriate depends on what the user expects from the interaction experience is like, that is influenced by the user's initial appraisal of the product, its purpose, and its use potentials – in short, its genre. That means, when the purpose of using the product is connected with finding information, then its pragmatic aspects can be considered more important, and when the purpose of using the product is connected with looking for inspiration, then more hedonic aspects should be considered.

Over time, the UX concept has matured and developed into a holistic approach. Besides the initial UX view, to just remove its usability problems, UX has evolved to focus also on the positive aspects of interaction, in particular, on hedonic, non-instrumental aspects (Bargas-Avila & Hornbæk, 2011). Different aspects of UX are explained by Thüring and Mahlke, who developed the Components model of User Experience (CUE), that specifies the central components of UX and their interrelations (2007). Law et al. (2014) adapted the model and described it as:

> **Instrumental qualities** – the experienced amount of support the system provides and the ease of use. Features, such as the controllability of the system behaviour and, the effectiveness of its functionality, fall into this category;
> **Non-instrumental qualities** – the look and feel of the system and other system qualities that are not instrumental. Features such as visual aesthetics, haptic quality and motivational qualities;
> **Short-term affective response** (cf. experiential qualities) – a user's subjective feeling, motor expression or physiological reaction occurs during or immediately after interacting with a system or a product;
> **Long-term evaluative response** (cf. system appraisal) – long-term effect of interacting with the system on a user's attitude, behaviour and cognition.

This approach has been criticised, because aesthetics have been described as "non-instrumental" component that needs to be embedded into an artefact in addition to instrumental components, but instead, aesthetics should be viewed as a holistic experiential outcome which cannot be separately treated as a particular type of component in addition to others (Lim et al., 2007).

Karapanos (2010) defined a framework of diversity and identified the four sources of diversity in the users' experiences with interactive products:

> **Individual** – the relevance individuals attach to different attributes of an interactive product – some users prefer playful products, while others value simplicity and informativeness;
> **Product** – the type of the product – playfulness might be perceived crucial for the success of a computer game, but is inappropriate for professional software;
> **Situation** – the way individuals use the same product differs across situations and impacts what attributes are attached as important – the same smartphone could be used to play a game or to make an emergency call;
> **Time** – during the time a product is used, the perception of its attributes will change – when people get used to a product, it changes their perception of its usability, and, at the same time, excites them much less than their initial joy. At different phases of use, people attach different weights to different attributes – when the product is novel to them, they may focus on usability, but, after they have used it for some time, other aspects, like novel functionality, become more important (Karapanos, 2010).

The present thesis focuses on the aesthetics of UX, which can be considered as a coherent approach, according to the development of the field. Therefore, the next chapters will provide an overview of aesthetics-related UX evaluation and explore aesthetics in more detail.

### 2.1.1 Evaluation of User Experience

Over the recent years, hedonic qualities of interactive products have received a growing interest in the HCI field (Diefenbach et al., 2014). The most frequent dimensions of UX that are researched in the studies are: flow, aesthetics, emotions, enjoyment and affect (Law et al., 2014; Bargas-Avila & Hornbæk, 2011). Common ways to evaluate UX include using self-report measures, e.g., questionnaires, interviews; or objective measures like psycho-physiological methods, e.g. facial expression analysis, speech analysis; respiratory and

cardiovascular accelerations and decelerations, muscle spasms; and web analytics, e.g., number of site visits, and click depth (Lalmas, O'Brien & Yom-Tov, 2014).

Self-reports can be used to evaluate the quality of UX during or after their interaction. The advantages of such self-report methods are the flexibility of the setting, mode of administration, number of concurrent users reached, but also participant anonymity and scale (Lalmas, O'Brien, & Yom-Tov, 2014). Interviews can be used to provide insights into the experiences of a single user, while questionnaires are more suitable for larger samples, where a large number of responses can support the statistical analysis and permit the evaluation of the questionnaire itself (Fulmer & Frijters, 2009).

Selecting the suitable measure depends on the data collection approach. Qualitative approach enables to get in-depth understanding about user's experiences, but may be challenging to analyse the free response data in a quantified fashion due to individual differences of people. Quantitative approaches rely on using large sample sizes to establish both trends and conclusions and present choices to participants that may be difficult for them to interpret (Lopatovska & Arapakis, 2011), but, on the other hand, enable to compare the perceived emotions. Mixed Methods enable to collect data with both predetermined and emerging methods and analyse both text and statistical data (Creswell, 2003). Evaluating the experience using quantitative approach is useful for experimental analysis, but can miss some of the insights available, therefore combining it with qualitative data provides a richness and details that may be absent from quantitative measures (Swallow et al., 2005).

There are a number of potential measurement approaches and settings, and even UX sub-quality aesthetics is broadly interpreted by the researchers. Moshagen and Thielsch (2010) explain aesthetics as a multidimensional construct, and the exact item wording used in different studies is rarely the same: some researchers have asked the participants to rate attractiveness, beauty, or appeal, or the aesthetic pleasure it provides.

Hedonic quality plays a substantial role in forming the user's judgement of appeal, and in the evaluation, it is relevant to find a balance of both hedonic and pragmatic quality aspects, rather than to independently maximise them (Hassenzahl et al., 2000). Hedonic quality of the product is used to refer the extent to which an interactive product is enjoyable or pleasant to use (Hassenzahl, 2001). Pragmatic quality describes the traditional usability aspects, like efficiency, effectiveness, and learnability, while hedonic quality describes quality aspects,

that are not directly related to the tasks the user wants to accomplish, for example, originality and beauty (Schrepp et al., 2006). In order to create a good UX, it is important to understand the relation between aesthetics and usability. (Tuch et al., 2012). Hassenzahl stated and confirmed with his studies that perceived attractiveness results from an averaging process of the perceived pragmatic and hedonic quality (Hassenzahl et al., 2001).

Hassenzahl et al. (2000) used 8 word pairs to describe appeal: unpleasant-pleasant, bad-good, aesthetic-non aesthetic, rejecting-inviting, attractive-unattractive, sympathetic-unsympathetic, discouraging-motivating, desirable-undesirable. In 2003, Hassenzahl et al. continued the work and developed the AttrakDiff questionnaire to study UX. The questionnaire contains 28 measurables, divided into 4 groups. The groups are: pragmatic, hedonic identification, hedonic stimulation and attractiveness qualities. AttrakDiff is the most used questionnaire to study hedonics in UX and besides original AttrakDiff, researchers have frequently used certain adaptations of the questionnaire (Diefenbach et al., 2014).

AttrakDiff was criticized for its higher emphasis on hedonic than on pragmatic qualities, since this was not considered to be appropriate for a comprehensive evaluation of professional software (Diefenbach et al., 2014). In 2008, Laugwitz et al. developed a 26 item User Experience Questionnaire (UEQ) that included the following six factors: Attractiveness (6 items), Perspicuity, Dependability, Efficiency, Novelty, and Stimulation (4 items each).

In 2011, Kujala et al. proposed a method called the ‘‘UX Curve’’ that enabled users and researchers to determine the quality of long-term user experience. UX Curve investigated the attractiveness, ease of use, utility, and the degree of usage (Kujala et al., 2011).

One of the most recent evaluation methods developed was the meCUE questionnaire, based on the CUE (Minge et al., 2017). The questionnaire consists of 4 separately-validated modules, which refer to the instrumental (usefulness, usability) and non-instrumental (visual aesthetics, status, commitment) product perceptions, user emotions, consequences of usage, and an overall judgment of attractiveness (Minge et al., 2017).

Law, Van Schaik and Roto (2014) found that aesthetic appeal is difficult to measure, but attractiveness is perceived as measurable. Aesthetic appeal has been measured by asking how (not) attractive the design was (Blijlevens et al., 2013).

## 2.2 Aesthetics

Aesthetics is the philosophical study of beauty and taste, and is related to the study of sensory values (Interaction Design Foundation https://www.interaction-design.org/). In the field of UX, aesthetics is considered as important, because it creates attractiveness bias and makes the users more tolerant of usability issues (Interaction Design Foundation https://www.interaction-design.org/). Norman has stated that positive affect makes people more tolerant of minor difficulties, and can enhance usability through pleasant, aesthetic designs (2002). The decision whether the user prefers a product to a similar one strongly depends on their aesthetic appeal.

Nowadays, people have more choices than ever before to select between products and services. Choice requires a guiding system - aesthetics - to distinguish something good from questionable design choices (Lenz et al., 2014). Over the years, the relevance of aesthetics have risen and today it has a solid role in UX. Gaver et al. (1999) emphasized that aesthetics is an integral part of functionality, with pleasure as a criterion for design equal to efficiency or usability. After Tractinsky et al. showed a reliable association between the perceived visual aesthetics and subjective evaluations of usability, concluding that beautiful designs are usable (2000), many researches were generated, recognizing that the users' needs go beyond usability and utility, and the shift focuses toward a more general experiential perspective, that includes emotions and visual aesthetics (Moshagen & Thielsch, 2010).

Aesthetics help to shape the user's opinion about the product and influence the decision whether the user decides to use the product at all, or abandons it after first contact. A relevant function of aesthetics, as UX quality dimension, is the satisfaction of human requirements, and from the users' viewpoint, aesthetic quality can make products more readily acceptable and can improve their commercial value (Lavie & Tractinsky, 2004).

Most of the studies of aesthetics focus on visual aesthetics, with reliable results indicating that visual aesthetics affect a variety of constructs, like perceived usability, satisfaction, and pleasure (Moshagen & Thielsch, 2010). Beside the product's visual aesthetics have raised aesthetics of interaction, which has recently gained interest in HCI research (Lenz et al., 2014). Until quite recently, interactions were limited to pressing buttons, moving dials and sliders, but a significant broadening of possibilities came with smartphones, that introduced touch gestures, as well as Microsoft Kinect free gestures, and Apple's Siri conversational

gestures (Lenz et al., 2014). The term aesthetics of interaction has been used in relation with enjoyment, beauty, or pleasure in interaction: systems that are "beautiful in use" (Djajadiningrat et al., 2004). What is beautiful can be considered arguable, as the opinion depends on the user, for example a gesture that is considered beautiful by female participants, can create the opposite feelings for male participants (Wu et al., 2013).

Aesthetic interaction design focuses on aesthetic experiences, while interacting with a system, including not only how it looks but also how it feels (Hashim et al., 2009). Interaction is between the immaterial and the material, providing a form to an immaterial experience in the physical world (Hassenzahl et al., 2015). Mõttus and Lamas have defined interaction aesthetics: "Holistic approach to aesthetic perception considering its' action- and appearance-related components" (2015).

Lin et al. interpreted that designing for the aesthetics of interaction should essentially focus on how pure the feelings or meanings are delivered, especially during the interaction process, and not how powerful the function is, or how easily it can be used (2011). Interaction plays a crucial role in the user's experience, and there is a need for an aesthetics of interaction, an understanding of what constitutes as "good", "pleasurable", "enjoyable", "beautiful" interaction (Hassenzahl et al., 2015).

Interaction aesthetics can be used to evaluate all those internal and external conditions anticipated to support a successful interaction (Xenakis & Arnellos, 2013). Approaches to the aesthetics of interaction are divided into two groups: one group deals with low-level description and specification, i.e., spatio-temporal attributes of interaction sequences (e.g., movement speed, precision, duration), while the other group with high-level experiences, desired emotions and meanings (e.g., thrill, challenge, trust) rather than the interaction itself (Hassenzahl et al., 2015). The problem is that only rarely those two levels are integrated.

Hassenzahl et al. suggest that the overarching principle of an aesthetic interaction is the match between the experience to be created (the Why and What) and the interaction actually suggested through the material to create and mediate this experience (the How) (2015).

### 2.2.1 Evaluation of Aesthetics

Beauty of interaction and potential guiding systems of aesthetics of interaction are just emerging, and it is too early to settle the best approach (Lenz et al., 2014). The importance of

aesthetics is acknowledged in HCI field, and there are ongoing researches to develop suitable models and new scales to measure aesthetic pleasure within design and explain it. There is a lack of consistency of the existing scales, and many scales do not measure aesthetic pleasure in isolation, but instead, include its determinants (e.g., novelty) (Blijlevens et al., 2017). Therefore, besides the researchers using existing scales, new scales are developed to measure aesthetic pleasure.

One of the most recent studies that focuses on identifying different criteria to be used for evaluating aesthetic pleasure is Blijlevens et al.'s (2017) study, that resulted with the scale consisting of 5 items: "beautiful," "attractive," "pleasing to see," "nice to see," and "like to look at".

Previous models of interface aesthetics have been analysed by Mõttus and Lamas (2015). Among the other studies, the author used the existing research as one of the guidance papers to gather deeper knowledge about the topic and provide an overview about its development.

There are different models used to measure aesthetics. Ngo et al. developed a model of 14 aesthetic measures for graphic displays: balance, equilibrium, symmetry, sequence, cohesion, unity, proportion, simplicity, density, regularity, economy, homogeneity, rhythm, order, and complexity (2003). The study suggested that these measures contribute to gaining attention and building confidence in using computer system.

Lavie and Tractinsky developed a measurement instrument of perceived website aesthetics that divides users' perceptions into two main dimensions: ''classical aesthetics'' and ''expressive aesthetics'' (2004). The classical aesthetics emphasize orderly and clear design, while expressive aesthetics represents visual richness and diversity of a website (Lavie & Tractinsky, 2004).

Moshagen and Thielsch developed a measure of perceived visual aesthetics of websites - Visual Aesthetics of Website Inventory (VisAWI) (2010). Simplicity, Diversity, Colours, and Craftsmanship are four interrelated facets in VisAWI that jointly represent the perceived visual aesthetics. The questionnaire is available as a full version with 18 questions, and short version with 4 questions (Moshagen & Thielsch 2013).

Reinecke et al. introduced the means to predict the initial impression of aesthetics based on perceptual models of a website's colourfulness and visual complexity (2013). The outcome of

the research was to develop computational models that measure the perceived visual complexity and colourfulness of website screenshots, and in combination with the demographic variables, explain the ratings of aesthetic appeal (Reinecke et al., 2013). The studies show that visual appearance can be reliably predicted and automated to provide designer feedback, if the design is visually appealing and the elements of visual design that perform poorly (Miniukovich & De Angeli, 2014).

Measuring user's perceived aesthetics needs sophisticated approach. The complexity of interaction makes it difficult to separate the presentation layer from the interaction or behaviour layer (Jiang et al. 2016). Developed models have evaluated aesthetics using static screenshots as visual stimuli, but rapid changes of technology have provided new ways of interaction, and how users perceive the experience (Mõttus & Lamas, 2015). In real HCI situations, like browsing the web, the actual interactions of users – not the passive viewing – has a major influence in shaping the overall UX, but when first visiting a website, initial impressions are also formed (Tuch et al., 2012). Although visual impression strongly influences the user's experience, it is important to go beyond that and evaluate how other sensations, like touch or sound, and maybe even taste and smell, in some cases, influence the experience. Evaluating the visual aesthetics is mostly done by recording self-reported hedonic value, triggered by previously-perceived visual stimulus (Mõttus et al., 2014). As "beauty of use" cannot be pragmatically measured and calculated yet, the methods of evaluating beauty of use can be similar to visual aesthetics evaluation. The scope of this thesis is to explore interactions that are limited to sight and touch. Users perceive the aesthetics differently, when they interact with the technology, compared to just passively viewing it (Mõttus & Lamas, 2015).

Empirical user-studies to evaluate aesthetics can be divided into three categories: snapshot, episode of use and longitudinal use (Mõttus & Lamas, 2015). Snapshot time-frame enables to make conclusions about aesthetics without any interaction involved and it is studied most often (Mõttus & Lamas, 2015). Despite significant influence of first impression on later use, evaluating just aesthetics of appearance is not enough and model of aesthetics needs to consider whole process of interaction (Mõttus & Lamas, 2015). The concern about evaluating interface aesthetics with an episode is that the layout is not kept fixed during interaction, and different users select different routes to complete the task (Mõttus et al., 2014).

Studies of aesthetic evaluation mainly focus on the objects related to traditional computers, like websites or desktop application, but a rising popularity of touch devices and minor number of studies with those devices, suggest additional studies to be conducted (Mõttus & Lamas, 2015). People judge visual complexities and aesthetics of mobile apps in the same way as widescreen: very quickly and reliably (Miniukovich & De Angeli, 2014), therefore, similar approaches to the evaluation method can be used.

### 2.2.2 Attributes of Interaction

In the context of the thesis, an overview about interaction attributes is provided, as they are important elements of interaction aesthetics. As the focus of the thesis is to explore the process of interaction, not just first impression, therefore, the overview is limited to interaction attributes and not all of those that can be associated with aesthetics.

Lim et al. proposed a set of 11 interaction attributes, including connectivity, continuity, directness, movement, orderliness, pace, proximity, resolution, speed, state, and time-depth (2007). In 2009, Lim et al. modified the previous study, and, as a result, proposed 7 interaction attributes with two opposite values: concurrency (concurrent-sequential); continuity (continuous-discrete), expectedness (expected-unexpected), movement range (narrow range-wide range), movement speed (fast-slow), proximity (precise-proximate), response speed (delayed response-prompt response).

In 2011, Lundgren described interaction-related properties, with 30 properties divided into 6 categories: interaction; expression; behaviour; complexity; time and change; and users. Category interaction also had sub-categories: directness, freedom of interaction, interaction flow, input modalities, precision, and tasking (Lundgren, 2011). Those properties consist of two to three values, for example, the subcategory directness has three values: real-world manipulation, direct manipulation, indirect manipulation, but the subcategory freedom of interaction has just two values: forced and free. Also, some of those properties are not comparable to others, for example input device.

Lenz et al. conducted a study to explore the attributes used to describe interaction (2014) and developed an Interaction Vocabulary with a purpose to systematically describe interaction in a modality and technology-free way, and to explain the relations between aesthetic experiences and interaction qualities (2013). Lenz et al.'s interaction vocabulary consisted of 11 dimensions, with opposite values: slow-fast, stepwise-fluent, instant-delayed, uniform-

diverging, constant-inconstant, mediated-direct, spatial separation-spatial proximity, approximate-precise, gentle- powerful, incidental-targeted, apparent-covered (2013).

In a recent study, 23 categories of aesthetics of interaction were established, that described interactions and also influenced the users' aesthetic appraisal (Mõttus et al., 2016). The categories described the interactions on the one hand, and reported the influence of users' aesthetic appraisal on the other (Mõttus et al., 2016). This study focused on the participants' aesthetic perception during interaction for 9 interaction episodes where smartphones and tablets were used. Many of the aesthetic attributes resonated with prior work in the field, but the research also identified 6 new aesthetic attributes: natural realism, congruence, informativeness, smooth texture, dimensionality and closure (Mõttus et al., 2016).

In a referred study, 13 categories were shown to be consistent, 4 could not be assessed for their consistency, and 6 were not consistent. This thesis contributes to seek a deeper understanding of those newly-established attributes of aesthetics of interaction, and through empirical research, provide inputs for future research to evaluate the maturity of the model.

# 3 Study

The research design is an overall strategy of the study to ensure the reliability of the results and effectively address the research questions. It influences the collection of data, its measurement and analyses, therefore, choosing a suitable approach for the study is relevant to achieve the goal of the thesis.

For this study, an experiment is designed where the participants evaluate their perceived aesthetic experience based on a website's visual appearance without interaction, and after actual interactions with the same website. In both cases, evaluation is done by using both smartphone and a computer device. Attractiveness and a scale of recently-established aesthetic categories are used to assess the interaction of a website influenced by a combination of multiple interactions.

In this chapter, the method, selection of stimuli, and participants of this study have been introduced. Also, the experiment and data analysis is described.

## 3.1 Method

This chapter describes what data collection and analyse methods are used in the study. The literature review brought out the possibilities and limitations of potential approaches and enabled the author to choose the suitable one for this study.

Aesthetic experience can be difficult to explain and compare, therefore author assessed that there is a need to use quantitative methods that enable to compare the perceived emotions. Self-report method is used to collect qualitative data, for its flexibility to the setting, mode of administration and for participant anonymity and scale. In addition to that, author also gathers supportive data to get an insight what participants considered important during the session.

The author of the study intends to analyse the collected data calculating averages and correlations. If supportive methods provide useful data, the findings will be highlighted. The author is aware of the statement provided by Alves et al.'s (2014) study that perceptions of user experience evaluation, are not hard facts, and should be interpreted with caution.

To collect comparable data to analyse and achieve the goals of the study, the author chose the following methods.

### 3.1.1 Supportive Data

Background information about the user is collected before the study session. A structured interview is used to collect demographic data, like participants' gender, age, nationality, English proficiency, but also, previous experience with operating systems web browsing with a smartphone and computer, and experience with the website under study.

In the end of the study, the author also conducted a short, semi-structured interview. This interview is used to get an insight of the thoughts that the participants had towards the website and the explanations the participants could not provide when they filled in the questionnaires. This semi-structured interview addressed questions like: what did the participant like or dislike on the webpage and what changes they suggest to make on the website under study.

Additionally, the author observed the participants during the study and made notes of the situations that occurred during, and could have influenced the participants' perceived overall UX.

### 3.1.2 AttrakDiff Questionnaire

Literature review revealed that AttrakDiff or a modified version of it is most frequently-used validated instrument for UX research to study hedonics. AttrakDiff questionnaire enables to collect quantitative data about UX. It could be used to measure the pragmatic, hedonic qualities, and also attractiveness.

The questionnaire is divided into four groups where each contains 7 measurables. Both pragmatic and hedonic qualities contributed to the judgement about attractiveness, therefore, by evaluating their attractiveness, participants already considered pragmatic and hedonic qualities (Hassenzahl et al., 2003), so, the author of the thesis intended to use just a part of the questionnaire. In the attractiveness group, there were word pairs which were quite easy to understand and evaluate.

In this experiment, the author uses attractiveness group from AttrakDiff questionnaire (Appendix 2, Table 1), because it enables to collect quantitative data about attractiveness and has proven to be a reliable instrument for UX research. Attractiveness group contains the following 7 measurables:

- unpleasant-pleasant

- ugly-attractive
- disagreeable-likeable
- rejecting-inviting
- bad-good
- repelling-appealing
- discouraging-motivating

The data are used to find a correlation with aesthetic categories during the analysis. At first the author of the thesis considered using a complete AttrakDiff questionnaire for the study, but the length of the whole questionnaire, combined with other methods, would be too time-consuming for the participants and the results may get influenced by their exhaustion. The author chose attractiveness group of the questionnaire to find answers to the research question how do different devices influence the user's perceived aesthetic experience during interaction. As aesthetic measures are part of attractiveness, then focusing on attractiveness group is relevant considering the scope of this study.

### 3.1.3. Aesthetic Categories

Aesthetics categories can be used to collect quantitative data about the users' aesthetic perception during interaction. Established aesthetic category scales (AC) contain 23 word pairs. The scale how to use AC has not yet been defined, but as some of the attributes resonate to AttrakDiff, then the author of the thesis uses it similarly, in seven-point scale.

In an experiment, the aesthetic categories are presented to the participant as a questionnaire of 23 word pairs (Appendix 2, Table 2). The word pairs are divided into four groups:

- Affective group contains measurables 1 and 2.
- Semantic group contains measurables 3 to 10.
- Cognitive group contains measurables 11 to 15.
- Perceptual group contain measurables 16 to 23.

Author of the thesis chose this scale because besides computers, the current thesis explores smartphones, and AC enables to study haptic aesthetics of interactive techniques that is used on smartphones. In this study, the challenge is to not focus on the dominating visual appearance, but to explore the aesthetics of interaction.

Although the categories are not yet validated, the author believes that AC can be used not only for evaluating a single interaction at a time, but combination of multiple interactions.

In everyday circumstances, users do not face just one element of the webpage, but many of them, therefore, it is relevant to understand their aesthetic perception during the whole interaction, and not just a part of it. The author of the thesis intends to use the scale to explore the user's aesthetic perception in the conditions that combine multiple interactions. The study can contribute to validating AC, because the results can be used in further studies to measure the inner consistency of those categories.

The author believes that using a scale in the study contributes to finding a deeper understanding about recently-established aesthetic categories, and provides input for future research to evaluate the maturity of a model. The author expects those categories to be useful in developing a set of guidelines to improve the websites' perceived aesthetic appeal across different devices.

## 3.2 Research Design

The research design is described in Figure 2. Based on the literature review research problem, the goals, questions, hypothesis, and an overall methodology are defined. Based on that, the stimuli of this study is selected and a preliminary survey is conducted to define the tasks according to the actual users' feedback. Taking the previous steps as an input, conditions are defined, data are collected and analysed while providing results with some discussions. The results are provided while considering the data from the study and grounding it with literature review. Then, conclusions are made, that provide answers to the research questions, hypothesis, and addresses the research goal and problem.

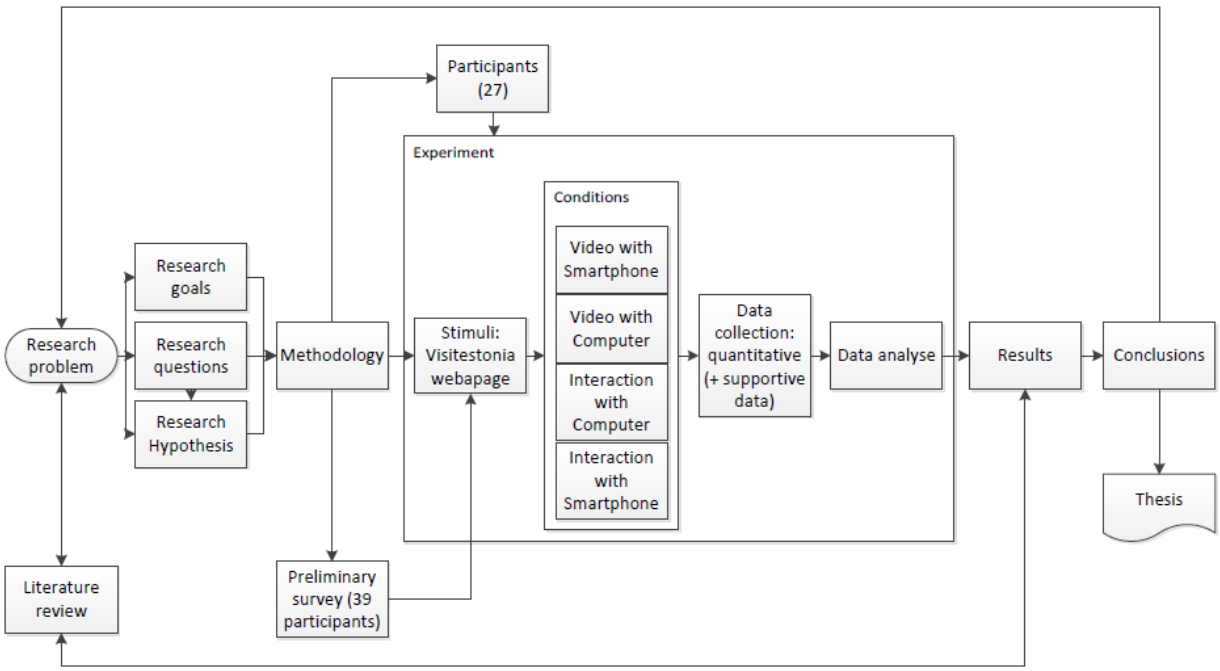


Figure 2. Research design.

## 3.3 Stimuli

It is essential to select the stimuli that contributes to achieving the goals of the experiment. This experiment explores the possible differences in the user's aesthetic experience between smartphone and computer devices of the same website, with the same content and their perception of it, without interaction and during interaction.

### 3.3.1 Selection of evaluation object

In this study, the evaluation object is the Estonian Official tourist information website 'Visit Estonia' (https://www.visitestonia.com/en) (Appendix 1, Figure 1 and 5). This website is selected for several reasons. In order to present Estonia as a desirable country to travel, or the website as a good place to find useful information about what to do in Estonia, the website has to be attractive and aesthetically appealing – those criteria are also the focus of this study. Another important aspect to choose this website is because through the outcome of the thesis, the author can contribute to improving the attractiveness of the website under study with guidelines to the designer. There is also a good deal of public interest towards the website – according to Google Analytics of the website, the number of people who used it in 2016 was more than 5,000,000.

The content of the webpage is the same for each device, but because of screen size the layout is different. Therefore, the presumption is that the participants perceive the webpage to be aesthetically different in computer compared to mobile devices.

### 3.3.2 Selection of Interaction Devices

In the study, a desktop computer and a smartphone were chosen as interaction devices, and all study participants used both devices. The reason behind using desktop and smartphones for the study is because these devices enable to study both – a very wide screen, and, in contrast, a very small screen, and understand the limitations of those devices. Desktop computers are often used for browsing websites and a smartphone can be carried while travelling, which is an important aspect, because tourist information websites should be portable. According to the website's analytics, 61% of the visitors used computer while 39% used mobile device. This study is limited to desktop and smartphone devices, excluding laptops and tablets.

During the study session, every participant used a desktop computer and a smartphone. Participants filled in the questionnaires on the same desktop computer where they conducted the tasks. The desktop computer with a 1920*1080 resolution had Windows operating system and an iPhone 7 and Nexus5 with operation systems IOS or Android were used. The exact smartphone device depended on the user's preference and previous experience. Participants used Chrome browser for interactions, in order to exclude the influence of browser differences. Additionally, the researcher used a laptop for notes.

### 3.3.3 Stimuli Conditions

In the study, four conditions were used to gather data about the participant's aesthetic experience based on their appearance and interaction with computer and smartphone (Table 3).

| **Conditions** | **Computer** | **Smartphone** |
|---|---|---|
| **Video** | Visual experience | Visual experience |
| **Interaction** | Interaction experience | Interaction experience |

Table 3. Stimuli conditions.

Two videos were recorded, one about the website's appearance in smartphone and the other about its appearance in computer. Both were less than 30 seconds in length and showed how

the webpage is used, where the video showed interacting with the main page and menus (Appendix 1, Figure 3 and 6). As the interaction aesthetics is evaluated by using an episode, then the layout changes during interaction, depending on the path that the participant has selected to complete the task. The participants filled in the questionnaires for each condition.

### 3.3.4 Diversity of Stimuli

This experiment explores the user's perceived aesthetics, therefore, it is important to consider the criteria that influence the user's experience and plan how to handle those to achieve goals. The study considers Karapanos' (2010) four sources of diversity in the users' experiences: **Individual** – the participants for this study are selected, based on the participant's selection criteria.

**Product** – the website under study is the same for all the participants, and they use both the computer and smartphone. The input devices are also limited, with mouse for the computer and finger for the smartphone. All participants are presented with the same content, but the layout and how the objects are shown depends whether smartphone or computer is used.

**Time** – all the participants were given the same amount of time. The number of stimuli conditions was limited to four for all the participants to avoid them from getting exhausted of the experiment. The stimuli conditions were video for first impression and interaction for episodes. The first impression of a website is established within a split second with respect to its appeal that later affects the users' opinion (Reinecke et al., 2013). The first aesthetic impression is the most powerful factor, but it would not provide a holistic approach without being followed by interaction (Mõttus & Lamas, 2015). As appearance is an important factor that influences the user and cannot be eliminated, the user's aesthetic experience of the same website is studied both without and during the interaction. User's experience has been studied with websites, both before and after use (Van Schaik & Ling, 2011). At different phases of use, people attached different weights to different attributes, therefore, it was important that the website was similarly unfamiliar to all the participants, and they were not everyday users of the website. The time criteria is added into the participants' selection, so, those who used the website for less than one month ago were not considered suitable for the study. One month is considered because the content of the first page changed quite often. Many websites have similar layout, so participants anyway have some familiarity with the website. Although prolonged use might also provide valuable data, in the case of planning a stay in a foreign country, the actual use of the website might just take place once, and therefore, the current

approach was chosen and the novelty aspect was considered important for this website. **Situation** – situation is the source of diversity that has not been controlled in this experiment. During interaction, it is not controlled how the participants use the website and the paths they choose to achieve the goal of the task. For example, some participants may use menu and some may use search to find what they are looking for, and for that reason, they encounter different elements during the session.

### 3.3.5. Selection of tasks

The website under study is filled with valuable information for the tourist, and it is relevant to set priorities, in order to target the elements that influence the webpage's visitors most. Website's analytics show that besides campaigns that attract people to visit the website, another important category is 'What to See and Do'.

In order to gather feedback about the reasons why people visit or have visited tourist information website, the author conducted a preliminary survey. The author distributed the survey by sharing it with Facebook contacts, and the survey was also shared by some of the contacts. 39 people responded to the survey. From those responses, it was also found that the main motivation to visit tourist information websites was to find different options of what to see and do (56%), find general information (26%), find out about travel deals and transportation (10%) and other reasons (5%).

After looking into the webpage statistics, the results from preliminary study, and considering the importance of a website's aesthetic appeal, the author of the thesis decided to focus on how people use Visit Estonia webpage to find out about what to do and how they perceive the experience. There might be situations where the user already knows what to look for, for example, the name of a restaurant, and also situations where the user just looks for interesting events or things to do, without anything specific in mind.

Another task is connected to the first visual impression of the homepage. Most of the website users land on the main page which can be considered as the main contact point between the user and the web page. It is important to understand how it is perceived, because based on this contact, most users decide if they want to continue to use the website or leave. Therefore, the author chose visual impression of a homepage as another task. Users shape an opinion about the website very quickly when they first see it, therefore it is beneficial to gather feedback about their first impression right after the experience and later gather data about

their experience with actually using the site. The main interactions in computer that user encounters are glide to select, click to navigate, click to select, and scroll. In a smartphone, this translates to: glide to select, tap to navigate, tap to select, tilt, and flick to scroll.

Selected tasks are:
1. Watching a video of how webpage is used.
2. Choosing something interesting to do on a webpage, finding Restaurant NOA (Appendix 1, Figure 4 and 7), and a place where to fill in information to book a table.

On the one hand, those tasks represent the typical interactions that the users have with tourist information websites, and, on the other hand, to accomplish those tasks, it enables the user to encounter most of the available interactions the webpage has.

## 3.4 Participants

Tourist information websites are meant for everyone, so, there are no strict rules for selecting the participants. According to analytics of the website, most of its visitors were female: 65% female and 35% male visitors.

The biggest age group using the website were people from 25-34 (34%) and 35-44 (20%), followed by 45-54 (15%), 18-24 (14%), 55-64 (11%) and 65+ (6%).

The range of the possible users of the websites under study is very large, and there are not many limitations to exclude some of the groups. Considering the size of the population, it is hardly achievable to find fully representative samples in the scope of this study.

A sufficient number of participants is an important aspect of the study to consider the results reliable and to gather comparable data. In this study, the aim is to find at least 16 participants. When the results are statistically reliable, there is no need to invite additional participants.

### 3.4.1 Participant selection criteria

- **Age** – the population of the study is limited to people between ages 18-65.
- **Website browsing experience with computers and smartphones** – participants in the study had to have previous website browsing experience with computers and smartphones.

- **Familiarity with the website** – participant is the study should have never used the website under study, or have used it more than one month ago.
- **Diversity –** Estonians and those to whom Estonian is not the first language should be invited in the study.

## 3.5 Description of the Study

The study is designed as an experimental laboratory study. This experiment explores the possible differences in the user's aesthetic experience between smartphone and computer devices of the same website and with the same content. Participants evaluate their experience with all four stimuli conditions.

### 3.5.1 Setting and Script of Study

In the lab study, the aim is to provide participants similar conditions to participate in the study. All the conducted sessions followed the current setting and script.

- **Invitation to participate**

Study sessions were agreed upon with each participant individually, and sessions were held, one participant at a time. Maximum duration planned for the session was 1 hour, and all took place in a lab environment where the conditions of the study remained the same for all participants.

- **Time**

All the participants equally had the same amount of time for the session. During the experiment, the time was divided into the following:

- 5 minutes to prepare for the experiment: explaining the experiment, signing the consent form, and answering demographic questions.
- 5 minutes to complete one video-related task and answering the questionnaires, in total 10 minutes for both tasks.
- 15 minutes to complete one interaction task and answering the questionnaires, in total 30 minutes for both tasks.
- 10 minutes for a semi-structured interview, summing up and receiving the answers. If the participant had any additional comments or remarks then discussing them.

Planned time for the study was up to one hour. There was also at least an extra 10 minutes between the next session for one participant to leave and the next participant to arrive. It was important to note that all the sessions started on time and participants did not have to wait, because this might have changed their emotional state and increased frustration.

- **Preparations**

Before the participant came for a session, the author had prepared the setting, so that everything was ready for use when the participant arrived.

- **Greeting the participant and introducing the experiment to them**

After the participant had arrived, the author introduced the study. Introduction included explaining that during the study, the participant was asked to assess individual experience at a webpage. In the study there are 4 tasks where the participant is shown 2 videos and is asked to conduct 2 tasks, so for the 2 tasks, a computer is used, and for 2 tasks, a smartphone is used. After each task, a questionnaire is to be filled. All 4 questionnaires have exactly the same questions. In the questionnaire, there are word pairs and the participants should not deeply analyse the meaning of these words, but rather, choose the option that felt right at the moment. Author also told that the study takes up to 60 minutes and the participant do not have to worry about the time and do the tasks at one's own pace. For each task, there is enough time, but when the time limit is exceeded, the participant is asked to move on to the next task. Researcher stays in the room the whole time, but the questions should be asked before or after the study. Although the researcher is in the same room, it is important for the study that all the tasks and questionnaires are solved individually by the participant without additional help.

- **Signing the consent form by the participant**

Participant signs the consent form through two examples. One example of the signed form is given to the participant and the other to the author.

- **Asking for background and demographic information about the participant**

When the consent form is signed, the author asks for background and demographic information about the participant and fills in the questionnaire (Appendix 3, Figure 8). The author believes that interviewing the participant with easy questions in the beginning of the study is important to create a rapport through conversation, so that the participant feels more relaxed during the study. The questions are about age, nationality, and also the following:

> English proficiency - your level of understanding of written English. Following options are provided: basic, medium, advanced;

How often do you use computer for web browsing? Following options are provided: every day, every week, every month, fewer than once in a month, never.

How often do you use smartphone for web browsing? Following options are provided: every day, every week, every month, fewer than once in a month, never.

Which operating system do you use on a daily basis? Following options are provided: IOS, Android, Windows.

When was the last time you visited the website visitestonia.ee? Following options are provided: this week, this month, more than a month ago, I have never used it.

- **Introducing the tasks to the participant and opening the file in the desktop computer where the tasks are written**

Every task is written in a different page and the participant is asked not to scroll down to the next page before the task is finished. An instruction for the first task is: "Your task is to watch a 25 second video about how the web page is used. When you are ready, click play button. After watching the video, please fill in the questionnaire. In the questionnaire there are word pairs on a 7 point scale, please choose one option. Your personal opinion is important and there are no "right" or "wrong" answers. The task ends when you have filled in all answers of the questionnaire and submitted the form. After the end of the task, scroll to the next page."

- **Showing a recorded video of the first device and filling the questionnaires**

Participants watch the video about how the VisitEstonia website is used with the first device, randomly selected for that participant. When the first device selected for the user is a smartphone, then the participant will use smartphone for the first and the third task and computer for the second and the fourth task, and the other way around. After watching the video, the participants would fill in questionnaires about the first video.

- **Showing a recorded video of second device and filling the questionnaires**

On the next page, the participant can find the same instruction like the first task, but now, watches the video about how the website is used with the second device and fills in the questionnaires.

- **Participants interact with the first device and fill in the questionnaires**

For the third and fourth tasks, the participant is asked to interact with the webpage. The instruction of the third task is: "A friend proposes to spend a nice day together and visit

different places. He has chosen some places in advance, and asks you to find something what you would like to do and after that book a table for dinner. Please show me on the webpage how you would do this:
1. Choose something interesting to do, and say when you have chosen what you would like to do;
2. Find Restaurant NOA and find a place where to fill in the information to book the table. (It is not necessary to book the table, when you don't really plan to go there).

Start when you are ready. After you are finished with the task, please fill in the questionnaire. The task ends when you have filled in all answers in the questionnaire and submitted the form. After the end of the task, please scroll to the next page." After conducting the task, the participant fills in the questionnaires.

- **Participants interacts with the second device and fills in the questionnaires**

The instruction for the fourth task is almost the same as that for the third task, but without instruction that one can scroll to the next page. After conducting the task, the participant fills in the questionnaires.

- **Measuring time**

While the participant conducts the tasks, the author measures the time that the participants spent on the tasks.

- **Conducting semi-structured interview**

After filling in the last questionnaire, the author conducts a short, semi-structured interview. The semi-structured interview addresses questions like: what did the participant like or dislike on the webpage, and what changes would the participant suggest to make on the website. The interview is a possibility for a participant to share their experience and provide additional information that could not be filled in the questionnaire.

- **Summing up of the received answers**

In the end, the author makes sure that all the answers are received. If the participant has any questions, the author answers them and discusses other circumstances that might come up from the study. After that, the author gives thanks to the participants and orders the study space.

### 3.5.2 Study conditions

Experimental design is used for the study, and to achieve the way environment and research setting can possibly be controlled, the study is designed as a laboratory study. In the

experiment, independent variables are purposely varied (Lawson, 2010). There were four experimental conditions: smartphone, computer, video, and interaction. All the participants conducted the same tasks with all conditions.

The stimuli presented to the participants were previously prepared. 2 videos were presented to the participant, so, after clicking the play button, they started from the beginning. After closing the tab for video in the device, the next webpage was already open from the homepage. Questionnaires were opened and filled in a desktop computer.

The study was held in a lab to provide as similar conditions to the participants as possible. The environment and the settings of the study were the same for every participant, but, it was not achievable, to control the mood of the participant or other factors that might influence them before the study.

The study was conducted in a peaceful environment, with office-like setting. The same devices were used to conduct the study, and for all the sessions, the desktop computer was kept the same, but the smartphone device depended on the participant's preference.

The stimuli was kept the same for every participant. The order of stimuli was important for the study – all participants were first asked to watch the video, and after that, conduct an interaction task. In order to exclude the fact that the order of interaction device would influence the data, 50% of the participants got smartphones and 50% got computers as the first device for the study. A similar setting is used for all the participants, and the time given for each task is also limited and defined.

All the tasks used in the experiments were predefined and available, both in English and Estonian. Participants could choose whether the study was conducted in English or in Estonian, and depending on their choice, all the information, the description of the task, and the webpage were presented to the participant in their preferred language.

Participants conducted the tasks and filled in the questions individually. Questionnaires were filled in immediately after each task, to capture user's subjective feelings, motor expression, or physiological reaction, which occurred during or immediately after interacting with a system (Scherer, 2005). All the comments were discussed after all 4 questionnaires were completed and the experiment was finished.

# 4 Results and Discussion

In this chapter, an analysis of the collected quantitative data is presented with the results and discussion. The author of the thesis complements the quantitative data analyse with supportive data analyse to provide a better understanding of the quantitative results. The study was conducted from 24th of March to 30th of March with 27 participants involved.

## 4.1 Participants

All the participants involved in the study met the participant selection criteria. Data of the 27 participants was collected during the study. 59.26% of the participants were female, and 40.74% male, with average age 33.63 (ranging between 21 to 59). According to the website's statistics, the biggest age group using the website were people in the age from 25-34, which is well represented in this study. 66.67% of the participants had Estonian (EE) as their preferred language for the study and 33.33% of the participants had English (EN) as their preferred language.

All participants had previous website browsing experience with computers and smartphones. 88.89% participants use computer every day and 11.11% use computer every week for web browsing. 77.78% use smartphone every day while 22.22% use smartphone every week for web browsing. Most popular operating system was Windows with 74.07%, followed by IOS at 66.67% and Android at 40.74%. The percent of operating systems participants used daily does not equal to 100% when compounded, because some participants used just one operating system, but many used more than one operating system daily, for example, their computer had Windows, but smartphone had IOS.

51.85% participants used the website more than one month ago, while 48.15% participants were novel users. Without considering the supportive data, all the participants answered 30 x 4 = 120 quantitative questions, and in cumulative, 3240 values were collected from all the participants.

## 4.2 The Results of Website's Perceived Attractiveness

Attractiveness group from AttrakDiff questionnaire was used to measure the perceived attractiveness of the website. Results of the participants' assessment to the website attractiveness are presented in Table 4. The author analysed and presented the average scores

of 27 participants on 7-point scale, with 1 representing the one on the extreme left and negative and 7 to the extreme right and positive option of the word pair. The values presented in the table compare all four stimuli in the study:

| Measurable / Stimuli | Interaction with computer | Interaction with smartphone | Video with computer | Video with smartphone |
|---|---|---|---|---|
| unpleasant-pleasant | 5.63 | 4.74 | 5.44 | 4.78 |
| ugly-attractive | 5.89 | 5.15 | 5.48 | 5.19 |
| disagreeable-likeable | 5.81 | 4.81 | 5.63 | 5.26 |
| rejecting-inviting | 5.15 | 4.85 | 5.89 | 5.00 |
| bad-good | 5.41 | 4.48 | 5.44 | 4.85 |
| repelling-appealing | 5.52 | 4.56 | 5.56 | 5.00 |
| discouraging-motivating | 5.22 | 4.30 | 5.19 | 4.93 |
| **Attractiveness** | **5.52 (+/-0.39)*** | **4.70(+/-0.41)*** | **5.52(+/-0.32)*** | **5.00(+/-0.31)*** |

Table 4. Average results of 4 stimuli's impact to the website's attractiveness by 27 users on a 7-point scale (*Confidence Interval at 95%).

The table shows how the answers were divided in attractiveness group. Attractiveness row is a general value of all the measurables in attractiveness group. Although grouping data loses its precision, it enables to analyse the data and make conclusions and comparisons. The results indicated that perceived attractiveness of the website in a desktop computer was higher than in smartphone, and in desktop computer the perceived attractiveness (5.52) remained the same for interactions and visual stimuli. Results also indicate that interaction with smartphone (4.70) reduced the perceived attractiveness compared to visual stimuli (5.00).

The results showed that participants, who indicated English as their preferred language (EN), gave higher results for website's attractiveness with respect to all stimuli. The total attractiveness average of all the participants was 5.18, compared to 5.62 rated by participants who indicated Estonian as their preferred language (EE).

## 4.3 The Results of Website's Perceived Aesthetics

The average scores of AC are presented in Table 5. The scores shown in the table are average scores of 27 participants on a 7-point scale, with 1 representing the extreme left and 7 to the

extreme option of the word pair in every category. In contrast with the attractiveness questionnaire none of the words in AC endpoints have been considered positive or negative. In different contexts, the values of different endpoints can be desirable. Preferring one polarity to another depends on the context. For example, exciting might be good for a game, but might not be suitable for government service, where the intention is to build security. The values presented in the Table 5 compare all four stimuli in the study:

| Stimuli / Category | Interaction with computer | Interaction with smartphone | Video with computer | Video with smartphone |
|---|---|---|---|---|
| Arousal: exciting vs calm | 3.93 | 3.93 | 3.70 | 4.15 |
| Playfulness: playful vs serious | 3.70 | 3.89 | 3.37 | 3.33 |
| Dynamics: dynamic vs static | 3.19 | 3.56 | 2.74 | 3.30 |
| Fashion: modern vs old fashioned | 3.04 | 3.22 | 2.70 | 2.89 |
| Natural realism: natural vs unnatural | 2.93 | 3.59 | 2.93 | 3.48 |
| Precision: precise vs imprecise | 3.04 | 3.85 | 3.44 | 3.93 |
| Congruence: appropriate vs inappropriate | 2.67 | 3.22 | 2.37 | 3.04 |
| Informativeness: informative vs arbitrary | 2.33 | 3.30 | 2.41 | 2.89 |
| Personal relatedness: fits me vs doesn’t fit me | 2.74 | 3.48 | 2.93 | 3.22 |
| Closure: complete vs incomplete | 3.19 | 4.00 | 3.15 | 4.07 |
| Complexity: complex vs simple | 5.07 | 4.04 | 4.74 | 3.85 |
| Predictability: predictable vs unpredictable | 3.22 | 3.96 | 3.44 | 3.81 |
| Controllability: controlled vs uncontrolled | 3.07 | 3.56 | 3.00 | 3.48 |
| Speed: fast vs slow | 2.48 | 2.96 | 2.56 | 2.37 |
| Delay: immediate vs delayed | 2.59 | 3.00 | 2.81 | 2.96 |
| Synaesthesia: synchronized vs | 3.04 | 3.44 | 3.19 | 3.48 |

| | | | | |
|---|---|---|---|---|
| unsynchronized | | | | |
| Mechanics: continuous vs stepwise | 3.56 | 3.78 | 3.67 | 3.52 |
| Phrasing: flowing vs dripping | 3.00 | 3.56 | 2.85 | 3.00 |
| Force: powerful vs gentle | 4.26 | 4.44 | 4.00 | 4.04 |
| Proximity: close vs distant | 3.04 | 3.59 | 3.48 | 3.56 |
| Texture: smooth vs rough | 2.96 | 3.52 | 2.96 | 2.89 |
| Range: free vs limited | 3.26 | 3.70 | 3.22 | 3.56 |
| Dimensionality: 3-D vs 2-D | 4.96 | 5.19 | 5.30 | 5.63 |

Table 5 Average results of 4 stimuli impact to the website's aesthetics by 27 users on 7-point scale.

In order to provide a comparable overview of the results (Table 5), the author presents them as a graph (Figure 9). Based on the results, some of the categories clearly distinct: in all stimuli, the dimensionality stands out, clearly inclining towards 2-D, and stimuli with computer were perceived as simple and informative. Also, the graph shows that the users experienced the interaction with smartphone most differently from all other stimuli.

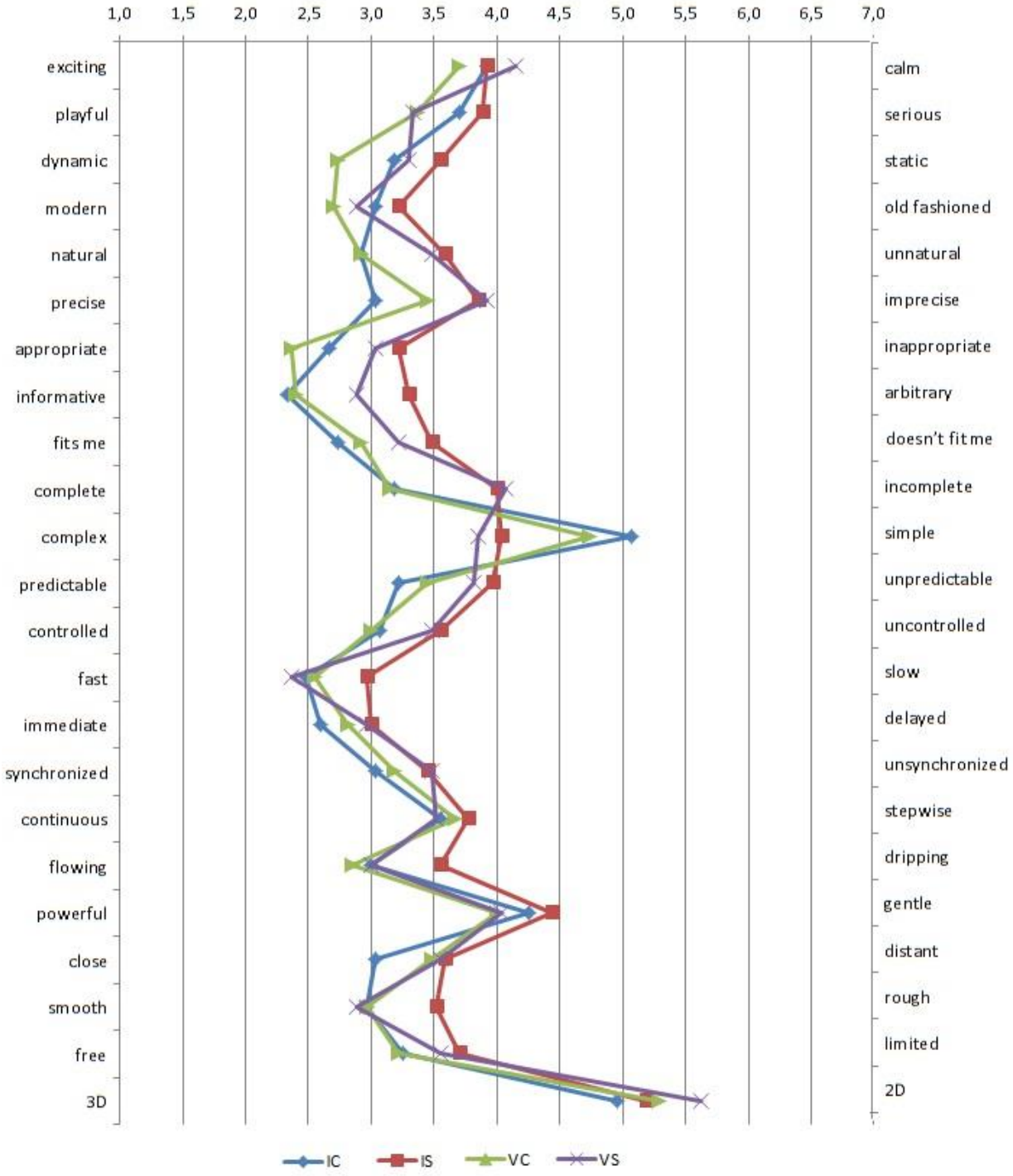


Figure 9. Average results of 4 stimuli's impact to the website's aesthetics by 27 users on 7-point scale. (Following abbreviations are used: IC: Interaction with computer; IS: Interaction with smartphone; VC: Video with computer; VS: Video with smartphone).

Author presents the average results, divided in two groups: computer and smartphone devices (Figure 10). The results indicate that computer and smartphone stimuli were perceived quite differently from each other, and computer stimuli were evaluated to be more near to the endpoints of each category.

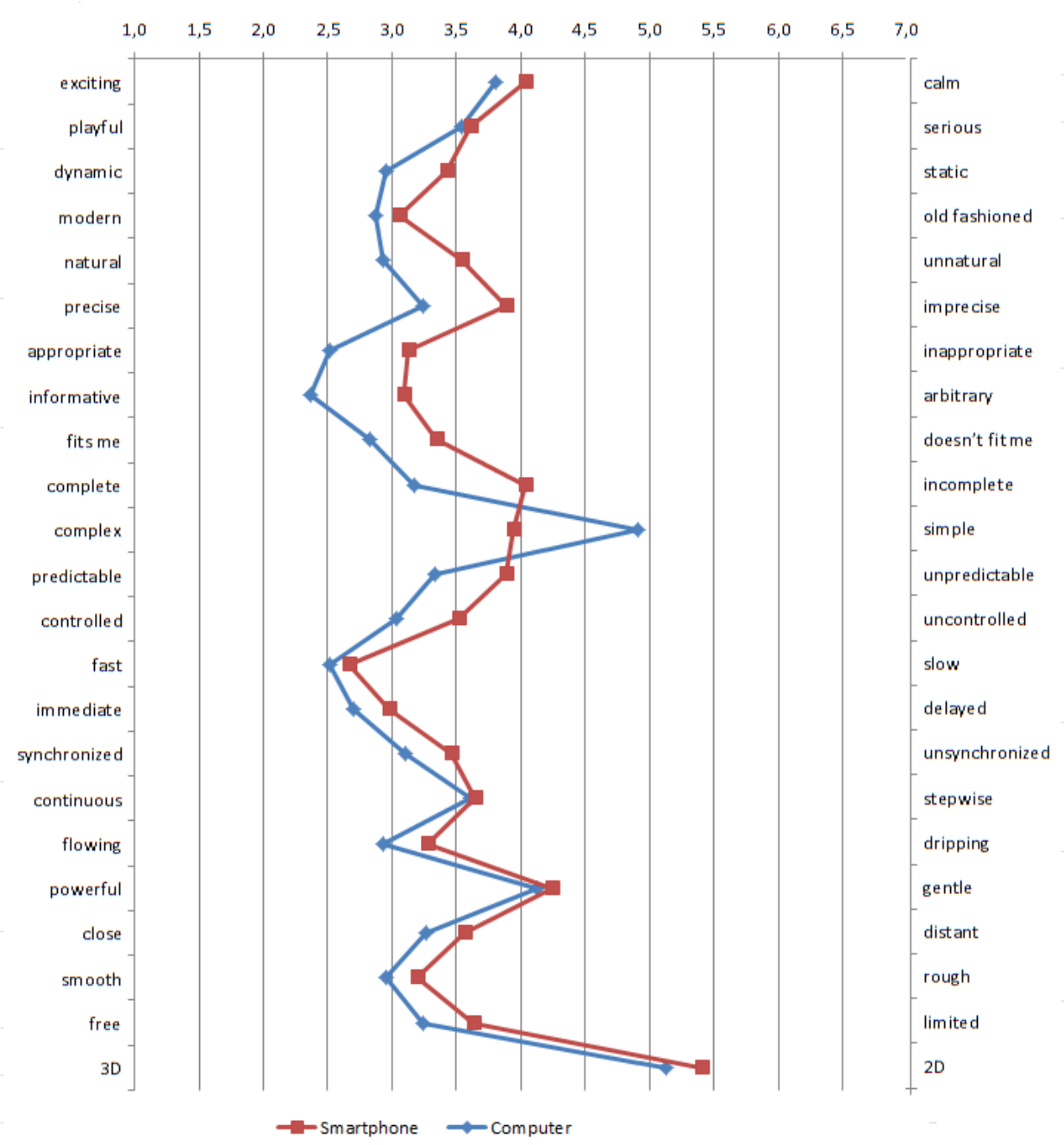


Figure 10. Average results of videos and interactions grouped by devices, evaluated by 27 users on 7-point scale.

The average of all results divided into 4 groups: visual stimuli, interaction stimuli, computer and smartphone stimuli are shown in Appendix 4, Table 6 This table provides an overview of all stimuli types grouped.

## 4.4 Correlation Analysis of the Results

The correlation between general value of attractiveness group (Table 4) and AC divided by stimuli is shown in Table 7. In the table with pink background, one can see the categories that correlate insignificantly at a level less than 95%, with yellow background correlate significantly at level 95%, and with green background, it correlates significantly at level 99%*. As for the evaluation of aesthetics, the opinions of the participants depend much more on the participants' personal preference than pragmatics, then correlation 0.50 can be considered quite strong.

| Stimuli / Category | IC (unattractive vs attractive) | IS (unattractive vs attractive) | VC (unattractive vs attractive) | VS (unattractive vs attractive) |
|---|---|---|---|---|
| Arousal: exciting vs calm | -0.04 | -0.20 | -0.13 | 0.30 |
| Playfulness: playful vs serious | -0.23 | -0.08 | -0.12 | -0.16 |
| Dynamics: dynamic vs static | -0.49 | -0.16 | -0.35 | -0.12 |
| Fashion: modern vs old fashioned | -0.64 | -0.53 | -0.39 | -0.58 |
| Natural realism: natural vs unnatural | **-0.85** | **-0.79** | -0.66 | -0.51 |
| Precision: precise vs imprecise | -0.41 | -0.53 | -0.63 | -0.46 |
| Congruence: appropriate vs inappropriate | **-0.70** | -0.56 | -0.64 | -0.46 |
| Informativeness: informative vs arbitrary | **-0.75** | -0.68 | **-0.78** | -0.69 |
| Personal relatedness: fits me vs doesn't fit me | **-0.80** | -0.65 | **-0.72** | -0.64 |
| Closure: complete vs incomplete | -0.57 | -0.61 | -0.65 | -0.52 |
| Complexity: complex vs simple | 0.55 | 0.64 | 0.38 | 0.32 |
| Predictability: predictable vs unpredictable | -0.51 | -0.57 | -0.18 | -0.21 |
| Controllability: controlled vs uncontrolled | -0.62 | **-0.78** | -0.43 | -0.52 |
| Speed: fast vs slow | -0.65 | -0.59 | -0.16 | -0.34 |

| | | | | |
|---|---|---|---|---|
| Delay: immediate vs delayed | -0.34 | -0.66 | -0.58 | -0.51 |
| Synaesthesia: synchronized vs unsynchronized | -0.47 | -0.40 | -0.30 | -0.41 |
| Mechanics: continuous vs stepwise | -0.43 | -0.51 | -0.22 | -0.25 |
| Phrasing: flowing vs dripping | -0.51 | -0.50 | -0.52 | -0.36 |
| Force: powerful vs gentle | 0.26 | -0.20 | -0.10 | 0.17 |
| Proximity: close vs distant | -0.53 | **-0.71** | -0.42 | -0.48 |
| Texture: smooth vs rough | -0.46 | -0.58 | -0.19 | -0.02 |
| Range: free vs limited | -0.59 | **-0.71** | -0.42 | -0.24 |
| Dimensionality: 3-D vs 2-D | -0.23 | -0.14 | -0.22 | -0.30 |

Table 7. The correlation between attractiveness and aesthetic measures of stimulis. (*Pink p>0.05, yellow 0.05>p>0.01, green p<=0.01).

The results show that in majority, there is a negative correlation between attractiveness and AC, but there were also some exceptions. In the category ‘complexity’ there was positive correlation in all stimuli, but this was expected as the participants tended to perceive simplicity to be more attractive, when they are novel to the website. Another category that also showed 50% of the stimuli’s positive correlation was force, and arousal had 25% of the stimuli.

It can be seen that the correlation between attractiveness and aesthetic categories is quite high (Table 7), and there is considerable correlation (78%) in the categories when the stimuli is interaction**.** When the stimuli was Interaction with computer, then, in 56% categories, there was a strong correlation, and 22% for both moderate and very weak correlation. When the stimuli was Interaction with smartphone, then in 74% of the categories, there was a strong correlation, 4% of categories had moderate correlation, and 22% had very weak correlation. Based on the results, the highest correlation was found in interaction stimuli. Four categories: arousal, playfulness, force and dimensionality showed insignificant correlation for all stimulis.

The correlation between attractiveness and aesthetic categories is much lower, especially when the stimuli is video – considerable correlation existed in 57%-61% of the categories depending on the device. When the stimuli is Video with computer, then in 35% of

categories, there was a strong correlation, 22% categories had moderate correlation and 43% had very weak correlation. When the stimuli was Video with smartphone, then in 35% categories there was a strong correlation, 26% categories had moderate correlation, and 39% had very weak correlation. Based on the results, the highest correlation was found in interaction stimuli. Those results indicate towards the scale's suitability to evaluate interactions.

## 4.5 Observation of Results

The author collected data from observation and took notes, based on the discussions in the end of the session, as many participants gave further comments about their experience. Author used the collected supportive data to conduct content analyse.

The time spent on websites to conduct all the tasks varied from 4-34 minutes, and the average time spent on the websites was 9 minutes.

**Information seeking behaviour:** Based on information-seeking behaviour, the participants can be divided into 2 groups: those who click the first interesting event on the page, and those who explore and calculate between different events and possibilities.

Those participants who didn't have a certain event in mind quickly found something interesting that they would like to do, but the participants who were looking for a certain event on the page spent much more time finding it. There were two cases where the participants even said they did not find what they actually looked for. 67% of the participants used search at least once during the session, and also, most participants emphasized on the importance of finding information quickly.

**Search:** Only 14% of the users did not look for search, 67% used search, and 19% could not find it. In desktop, the search field is in the top right corner and when scrolling down the page, it is not visible any more. In the smartphone design, the search field is behind *Hamburger* menu, so the user has to know where to search for search. This is a critical element in both device's design and not finding the search field was the most annoying thing participants verbalized during the session. In both cases, search should be made easily accessible in the page.

**Menus:** Similar to search, scrolling down on the page hides the main menus, which was confusing for the participants.

**Text vs pictures:** Here, the participants were divided into two groups. In case of desktop computer, the first group liked the visual design and use of pictures. The other group found that there were too many pictures on the website and preferred to see fewer, because the amount of pictures felt exhausting to them. More than two users from this group commented that they would remove Instagram from the webpage, as its presence did not make sense.

In case of smartphones, the majority of participants reported that they would like to reduce the amount of pictures and replace it with text. Also, on some pictures, the text was slightly mixed with the background picture, and the overall preference was to have text on a single-colour background.

**Personal preferences:** Typically participants had clear preference of device, and said that they preferred to browse websites on desktop computer compared to smartphones.

**Content:** Although the content is the same for desktop and smartphone in the website under study, some participants perceived that smartphones had much less content and their choices were limited. This might be due to the screen size of the device, as in the desktop computer, most part of the menu is already seen at first glance, but on smartphone, the menus are behind clicks.

**Labels:** Some labels on the webpage were confusing for the participants. Participants had the task to find a certain restaurant, and instead of “Book the table”, the button is named “Request information” in English, and “Order” in Estonian website. “Request information” was associated with asking additional questions, and “Order” was associated with ordering food for delivery.

## 4.6 Discussion

The experiment conducted within the study can be considered as successful. The result show considerable correlation between the categories and attractiveness in 78% cases when the stimuli is interaction. This indicates that AC might be a useful tool to evaluate aesthetics of interaction and provides ground for future research.

### 4.6.1. Aesthetic Categories

In this study AC was used both in Estonian and English. In both cases, some of the categories' word pairs caused confusion. The categories that most often needed an explanation were: texture, synaesthesia and proximity. In Estonian category precision also needed explanation. Therefore, future research might be considered relevant to collect data to evaluate semantic preciseness of words used in the word pairs, and also consider better equivalents in translating them into other languages when similar discoveries occur.

Some of the participants later explained that they had never considered those words in connection with any website, and therefore, it seemed strange. So, a certain set of categories might need consideration in the context of evaluation of objects. For example in the case of free gestures like Kinect, some of the categories can be found beneficial, that are at the same time not suitable for conversational gestures like Siri's an vice versa.

Some participants pointed out that categories like arousal, precision, closure were difficult to evaluate without interaction, but they did not have the difficulty after interaction. Some were confused with the AC and were expecting that one of the words in the word pair would have a negative meaning. 7 measurables from AttrakDiff questionnaire, where the extreme left word can be considered negative and extreme right word positive, were presented at first to the participants and after that AC. Therefore, it might have seemed like a pattern that suddenly did not make any sense. In the future, when similar studies are conducted, it should be considered to use recognisable layouts for different questionnaires and scales.

Few users also had questions whether they should evaluate the whole interaction process which they had in a device, or if they should first evaluate their experience with exploratory task and then later, a certain task or both tasks together. One of the arguments while developing the approach of the study was that if in everyday situations, people conduct complex tasks and have different interactions mixed. Therefore in this study all the participants filled in the questionnaire about their entire interaction experience. Depending on the goal of the study, there might be a need to separate similar tasks in future studies.

### 4.6.2. Recommendations for the Website

In this chapter, a set of recommendations have been provided, that can be used as guidelines by the designer to improve the attractiveness of the website under study. The correlation

between aesthetic categories and attractiveness showed which categories participants consider more important in the context of current webpage's attractiveness. Based on the results, categories with strong correlation over 0.70 are selected, and should be highly considered. The author does the recommendations based on literature, quantitative data, content analysis based on observations, and discussions with the participants and supports it with some examples developed by the author in the context of the current webpage. The examples are developed while considering the holistic user experience. The recommendations are done considering the interactions when the input device is a mouse or fingers and are developed for both computer and smartphone. The recommendations are done using the approach Mõttus et al. (2016) have developed, describing the categories to influence the design.

**Category highly relevant for both devices**

**Natural realism**: natural vs unnatural – natural interactions are perceived as similar to real life interactions.

The results indicate that natural interactions are perceived more attractively (correlation -0.85 for computer and -0.79 for smartphone).

Based on Hinman's (2012) principles of natural user interfaces (NUI), the author has provided some examples that can be considered for this website:

• Scaffolding: NUI should be intuitive and easy to use. It should behave in the manner users expect it to behave (Hinman, 2012).

*Example for smartphone:* It can be advised to enable to close the main menu by horizontal swipe. At the moment, users can close the main menu by clicking the X button in the bottom of the page. Closing the menu was, in some cases, difficult for the participants, as they did not notice the small X button on the page, and intuitively tried to close the menu with a swipe.

• Contextual Environments: NUI is dynamic and can locate itself in time and space. It is responsive to the environment and suggests the next interaction with the user (Hinman, 2012).

*Example:* It can be recommended to use small animations to help the webpage become more alive and help the user to navigate the page, like if the user has not chosen anything on a webpage for a certain time, then the most popular events or search is slightly highlighted.

Social Interaction: NUI should be simple to use, highly visual, and require little cognitive focus to use. It should enable the users to interact with one another instead of only interacting with the system (Hinman, 2012).

*Example:* In order to reduce the cognitive focus needed from a user, different objects and events on the webpage should have different pictures. At the moment, events and their content is imported from external systems, but, if the users see the same pictures for different events, they would assume that it is the same event (Figure 11).

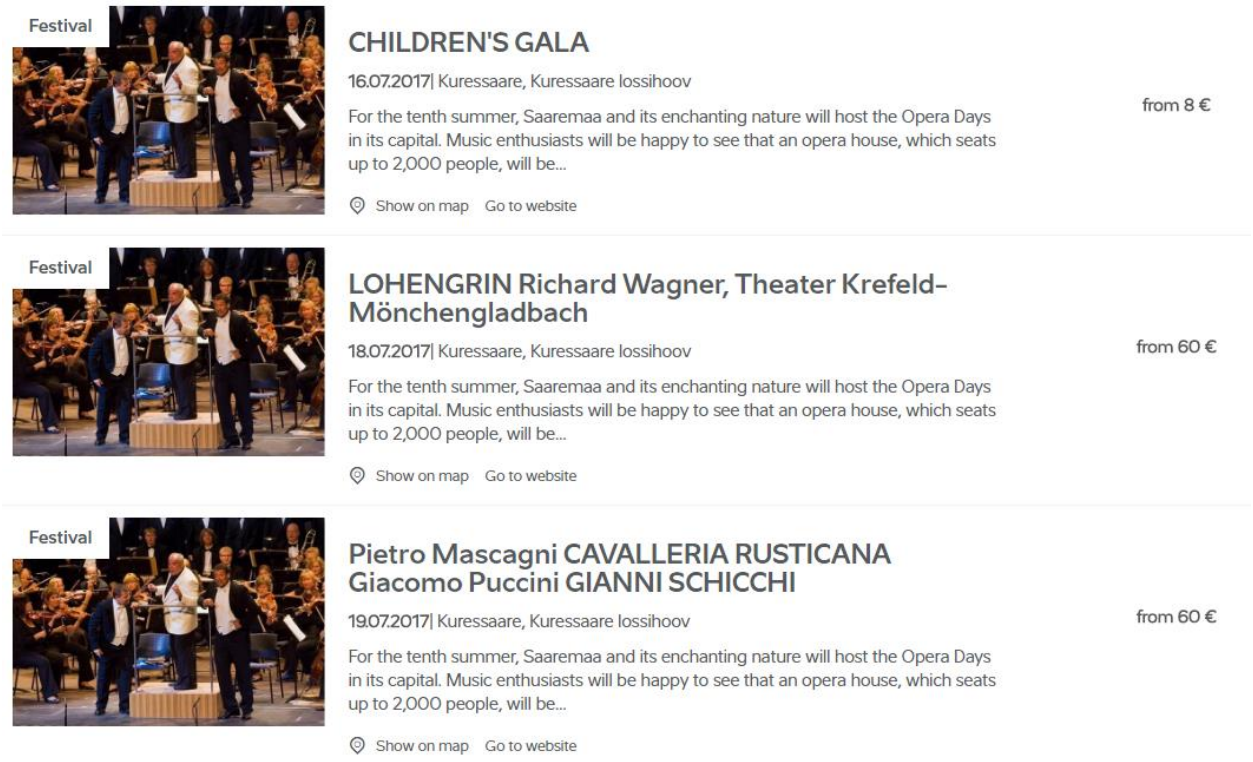

Figure 11. Layout of events

*Example:* It can be advised to make search and main menus accessible in the page even when user scrolls down, otherwise user easily forgets that those possibilities existed on the top of the page.

**Category highly relevant for desktop solution**

**Congruence:** appropriate vs inappropriate - appropriate interactions use self-evident ways about how things are done in certain situations.

The results indicate that appropriate interactions are perceived more attractively (correlation -0.70).

*Example:* A possibility to search for objects should be also near other filters. At the moment, search is only on the top right corner of the page, and is not visible for the user while they are on filtering section (Figure 12). Participants in the study explained that the first place to look for search is near the filters.

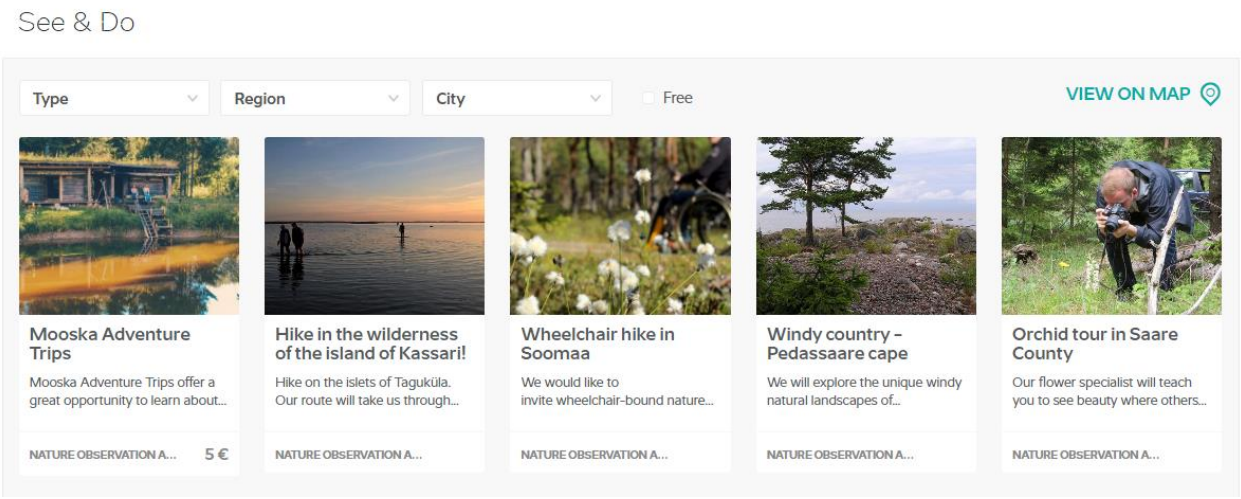


Figure 12. Filters and Search

*Example:* Users should be provided with more options on category sub-pages. For example, when the user is on Category subpage Restaurants then on the page's filtering area, he/she should be provided with more options to navigate between categories, or have the possibility to select a category. The filter should be removed when there is just one option available (Figure 13). The described situation was confusing for several participants.

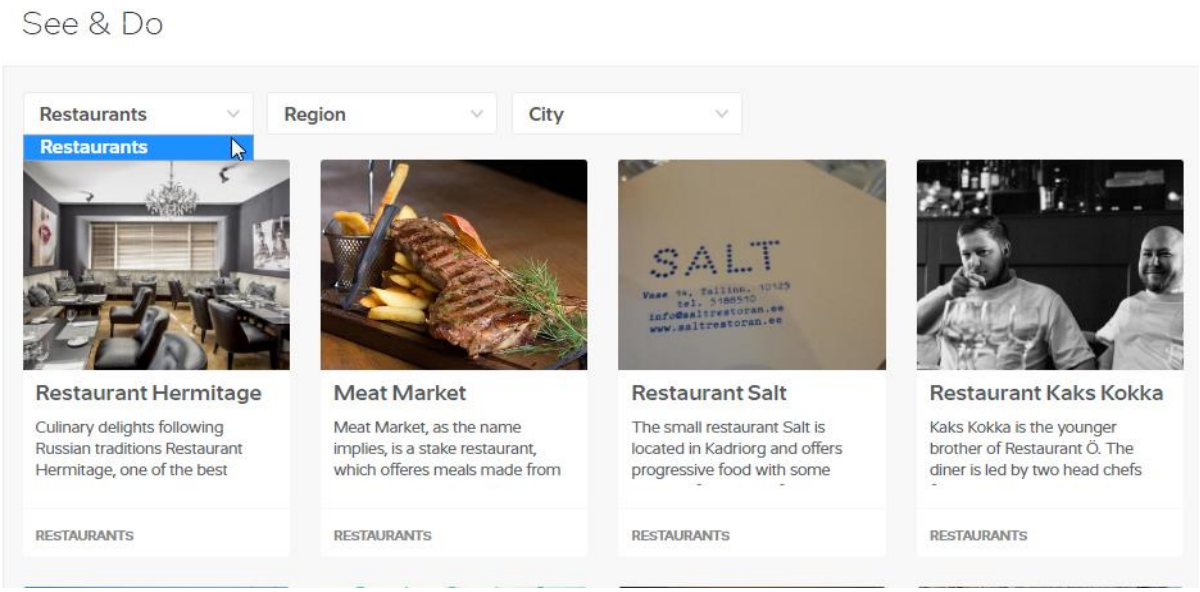


Figure 13. Filters

**Informativeness:** informative vs arbitrary- informative means that relevant, meaningful information is provided, opposite to seemingly arbitrary output.

The results indicated that informativeness is perceived more attractively (correlation -0.75).

*Example:* It can be advised to remove Instagram from the webpage and just leave the icon. Several participants commented that it is confusing to see Instagram on the webpage (Figure 14).

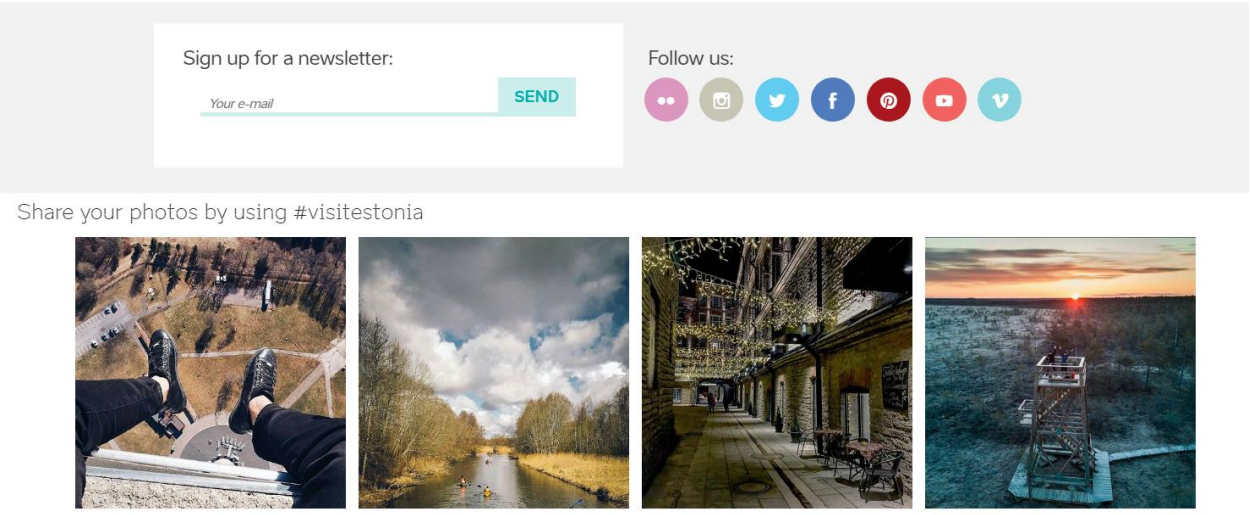


Figure 14 Instagram

Additionally, in this category, there is one example for mobiles as well, because more than 50% of the participants indicated that they preferred textual information to pictures, and as the screen is quite small, it was hard to get a good overview of the possibilities. Also at least 5 participants mentioned that it was difficult to read the text on the picture

*Example:* In smartphones the text on a single colour background should be preferred in design.

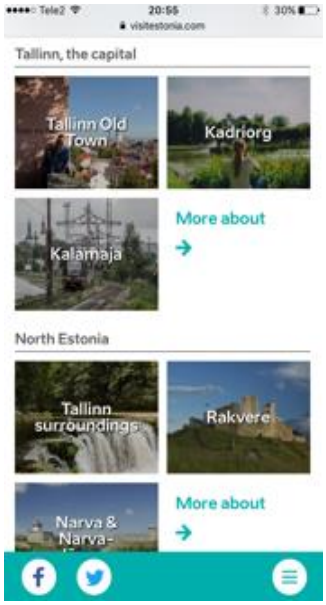


Figure 15. Text on a picture.

**Personal relatedness:** fits me vs doesn't fit me- this category shows if the user feels attached to a webpage while interacting.

The results indicated that interactions that fit with the user are perceived more attractively (correlation -0.80).

Interactive elements used on the webpage are commonly used for most of the similar webpages, so there was no confusion with that. What might influence this category is the choice of device, as several participants commented that their daily preference was to use desktop for browsing, and so, it might influence their opinion.

**Category highly relevant for smartphone solution**

**Controllability:** controlled vs uncontrolled. Controlled interactions mean that things happen as expected. For example, tapping the same X button every time closes the tab. In contrast, when throwing a dice, the results are not controlled.

The results indicated that controlled interactions are perceived to be more attractive (correlation -0.78).

*Example:* It can be advised to enable to close the main menu with a swipe. Closing the menu was, in some cases, difficult for the participants, and they verbalized that they could not do anything with the menu, before they noticed X button on the page.

**Proximity:** close vs distant. Close indicates if the user feels physical closeness with the system and can touch it.

The results indicated that close interactions are perceived more attractively (correlation -0.71). Designing while keeping the needs of smartphone users in mind, might be an opportunity to take advantage of this category.

*Example:* It can be advised to design some additional options available for smartphones that differ from desktop, like physically shaking the device to clear the filters.

**Range:** free vs limited. Range is related to the active area of the interface and the number of ways for reaching the goal - the scope of possible user actions. Range can be extended by using sensory multimodality, the number of input options, and the duration of interactions.

The results indicated that free interactions are perceived more attractively (correlation -0.71).

*Example:* It can be advised to add the possibilities to reach the same goal, for example, when the user has clicked on an object, like a certain restaurant for a detailed view, then the user can navigate to the next restaurant in the same category with a horizontal swipe, so that one does not have to go back to the previous menu.

The study results confirm Löwgren's (2008) statement about the importance of genre. As the interaction task in the study was to find information, therefore, the results indicated that more pragmatic categories, like informativeness, controllability etc., were considered to be attractive by the participants on this webpage.

### 4.6.3. General Factors about the Study

AC was seen to be a useful tool to contribute in the field, and should definitely be tested in future aesthetic interaction studies. Except minor problems with semantic confusions with

respect to some of the words in the categories, the participants did not have difficulties in filling in the scale after interaction.

Observing and taking notes during the sessions also showed some usability concerns on the sight, and gave inputs about what to improve on the website. Conducting the study was a very valuable experience for the author, because while exploring correlations between attractiveness and aesthetic categories, in the conditions that contain multiple interactions with smartphone and computer devices, the study also gave very good insights about the user's experience on the webpage. It also added knowledge about the participant's behaviours, information-seeking patterns, and also ideas about what the participants expected to see on similar webpages.

In conclusion, the study was successful and completed all the steps, provided answers to the research question and added confirmation to the hypothesis. The study provided some answers to the research question about how different devices influence user's perceived aesthetic experience during interaction (Figure 9 and 10). It can be concluded that the device influences user's aesthetic experience more than interaction, and there is a considerable difference between smartphones and computers.

Hypothesis 1 has been proved positive, as there is a significant difference in the perception of aesthetics in the interaction between smartphone and computer devices.

Hypothesis 2 has partly been proven positive (Table 7), as for 78% of the categories, there is a significant correlation between attractiveness and aesthetic categories in the conditions that contain multiple interactions and enable the user to accomplish multiple actions, in order to achieve the goal. Future studies are suggested to explore 22% of those categories that did not show such significant correlation.

## 4.7 Limitations

The study was designed so that participants filled in a questionnaire about the whole interaction experience with the device. It is not known how much the results differ, if the interaction tasks – to find something interesting to do and find a certain restaurant – were evaluated separately.

Users had interactive tasks in the study, and the path they chose to achieve their goal influenced what pages they visited and what elements were used. It is not known how it influenced the results.

Due to the experimental lab setting, all studies were conducted in as much of a similar setting as possible. One of the devices used in the study was smartphone, and as laboratory is an isolated environment, it does not depict the user's usual experience to be able to provide more fragmental attention to the device. Therefore, it is not known how much the results differ, especially if the study was conducted as a field study in case of smartphones.

During the study, selection of devices was limited to desktop computers and smartphones. Laptops, tablets, and other devices were not included in the study. Also, selecting certain devices might have made an impact on those results, for example, based on the webpage under the study, making selections is different with Android compared to IOS. It is not known whether this influences the results.

Only the main input devices were considered in the study. As an input mouse was used for the computer, and fingers were used for smartphone to conduct the tasks and navigate the pages. When a different input, like voice for example is selected, the results might be different.

Although the participants of this study frequently use smartphones and computers for web browsing, they have certain preferences about their browsing device. It is not known how it influences the results.

## 4.8 Further Studies

This study explored whether the AC can be used in conditions that contain multiple interactions and enable the user to accomplish multiple actions to achieve their goal. Future studies are suggested to continue exploring a minority of those categories with very weak or weak correlation, and gather evidence if the tool can be considered as valid.

Also, future studies might address the categories that were confusing to the participants, in order to improve them semantically. Another direction is to use a study with smaller tasks, to evaluate separately the interaction of exploratory and certain tasks of this study, but also, to evaluate specific interactions, not multiple of them in the same time.

Future research should consider evaluating the aesthetics of interaction by using different inputs and gestures, besides the main inputs like mouse and finger. As the field is rapidly-developing, while evaluating the aesthetics of interaction, one should consider those developments.

Future research should also consider evaluating the aesthetics of interaction as a field study, in order to gather the results of users' experience in everyday environment. This might provide valuable feedback, especially for designing solutions for smartphones. Also, longitudinal studies should be considered, which enable an evaluation of the aesthetics of interaction over longer periods of time and provide insights about the experience when the participant is not influenced by a given task and its pragmatic nature to achieve the goal.

# 5 Conclusion

The goal of this study is to assess the possible difference in the user's aesthetic experience with four conditions: without interaction, during interaction, and between smartphone and computer devices.

The emergence of new technologies and interactions has raised the importance of the aesthetics of interaction in HCI. It is at its early development phase, and there is not yet an universal approach or tool for evaluating it. Therefore, the research problem of the thesis addresses the user's aesthetic experience during interaction, comparing the impact of these devices and finding the possible methods for its evaluation.

Based on the literature review, the approach of the study was selected. Conducted literature review showed that there is not yet a reliable tool to evaluate the aesthetics of interactions, and moreover, in the conditions that contain multiple interactions and enable the user to accomplish multiple actions for achieving a goal. The thesis explores whether the categories in the recently developed aesthetic category scales provide reliable results in certain conditions that contain multiple interactions.

The study provides several interesting answers to the research question and adds a confirmation to the hypothesis. It answers how smartphones and computers influence the user's perceived aesthetic experience during interaction. It can be concluded that devices influence the user's aesthetic experience more than interaction, and there is considerable difference between smartphones and computers.

Hypothesis 1 has been proved positive, as there is a significant difference in the perception of aesthetics of interaction between smartphone and computer devices.

Hypothesis 2 has partly been proven positive, as for 78% of the categories, there has been significant correlation between attractiveness and aesthetic category scales in the conditions that contain multiple interactions and enable the user to accomplish multiple actions in order to achieve their goal.

The thesis contributes to validating aesthetic category scales, because the results of the study can be used to measure the inner consistency of those categories. Validating those categories could contribute in the field of HCI to improve user experience through aesthetically

designed solutions. Based on the results, the thesis also provides several guidelines to improve the attractiveness of the website under study, both for mobile and computer.

The whole process of writing the thesis has broadened the author's understanding and perception about not only the aesthetics of interaction, but especially UX field in general.

## Summary in Estonian: Kasutaja esteetilise kogemuse hindamine interaktsiooni käigus

Käesoleva teadustöö eesmärgiks on välja selgitada, kuidas erineb kasutajate esteetiline kogemus kasutades veebilehte mobiili ja nutitelefoniga ning lihtsalt hinnates sama veebilehte visuaalselt mõlemas seadmes. Esteetika on oluline kasutajakogemuse komponent, mis mõjutab kasutaja otsust ühte lahendust teisele eelistama, kui lahenduste pragmaatilised omadused on samaväärsed.

Esimene osa tööst annab ülevaate eelnevatest uuringutest kasutajakogemuse ja esteetika valdkonnas. Seejärel kirjeldatakse uuringu läbiviimist ja tulemusi. Käesolev töö toob lisateadmist hiljuti välja töötatud interaktsiooniesteetika kategooriate kasutamise võimaluste osas. Samuti valmis töö tulemusel ülevaade, kuidas suurendada uuritud veebilehe atraktiivsust nii mobiilis, kui arvutis koos konkreetsete soovitustega disainerile, arvestades nende olulisust ja mõju.

Koos tehnoloogia kiire arenguga, mis on kaasa toonud uusi interaktsioone, on esile kerkinud interaktsiooniesteetika olulisus. Interaktsiooniesteetika valdkond on hetkel kiirelt arenev ning ei ole veel üheselt kokku lepitud lähenemist ega vahendeid selle mõõtmiseks. Antud uuringus kasutatakse interaktsiooniesteetika kategooriaid tingimustes, mis on lähedased inimeste igapäevasele infootsingule turismiinfo veebilehel, kus kasutaja puutub kokku nii veebilehe visuaalse disaini, kasutusprotsessi, kui erinevate interaktsioonielementidega.

Töö tulemuseks on põhjalik 27 kasutajaga läbi viidud kvantitatiivne uuring, millest selgub, et kasutajad tajuvad veebilehe kasutamist mobiilis esteetiliselt erinevalt arvutis kasutamisest. Samuti leiab tõendust, et interaktsiooniesteetika kategooriate ja atraktiivsuse vahel on märkimisväärne seos ja kategooriaid saab kasutada ka tervikliku esteetilise kasutajakogemuse hindamiseks.

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## Appendix 1: Screenshots of the webpage

The following figures present the layout of a webpage. (Figure 1, Figure 3, Figure 4) present the design of the webpage on desktop and (Figure 5- Figure 7) present the design of the webpage on smartphone.

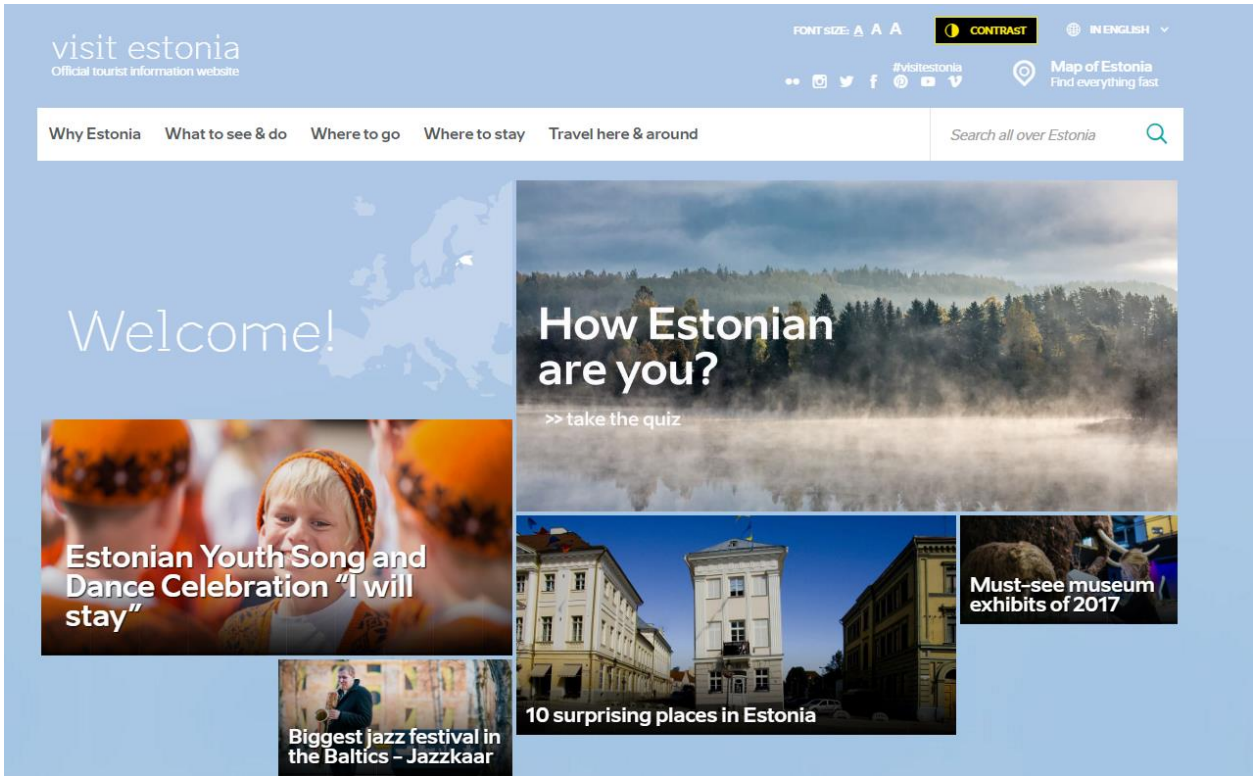



Figure 1. Homepage layout (desktop)

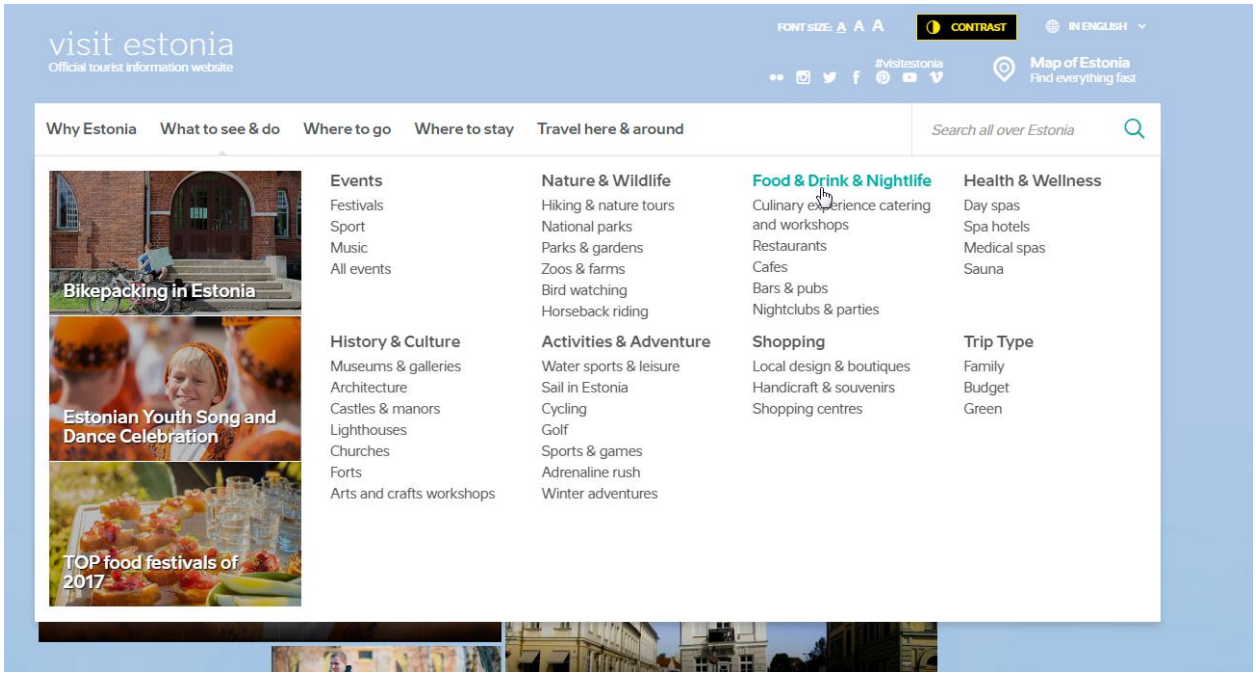



Figure 3. Menu layout (desktop)

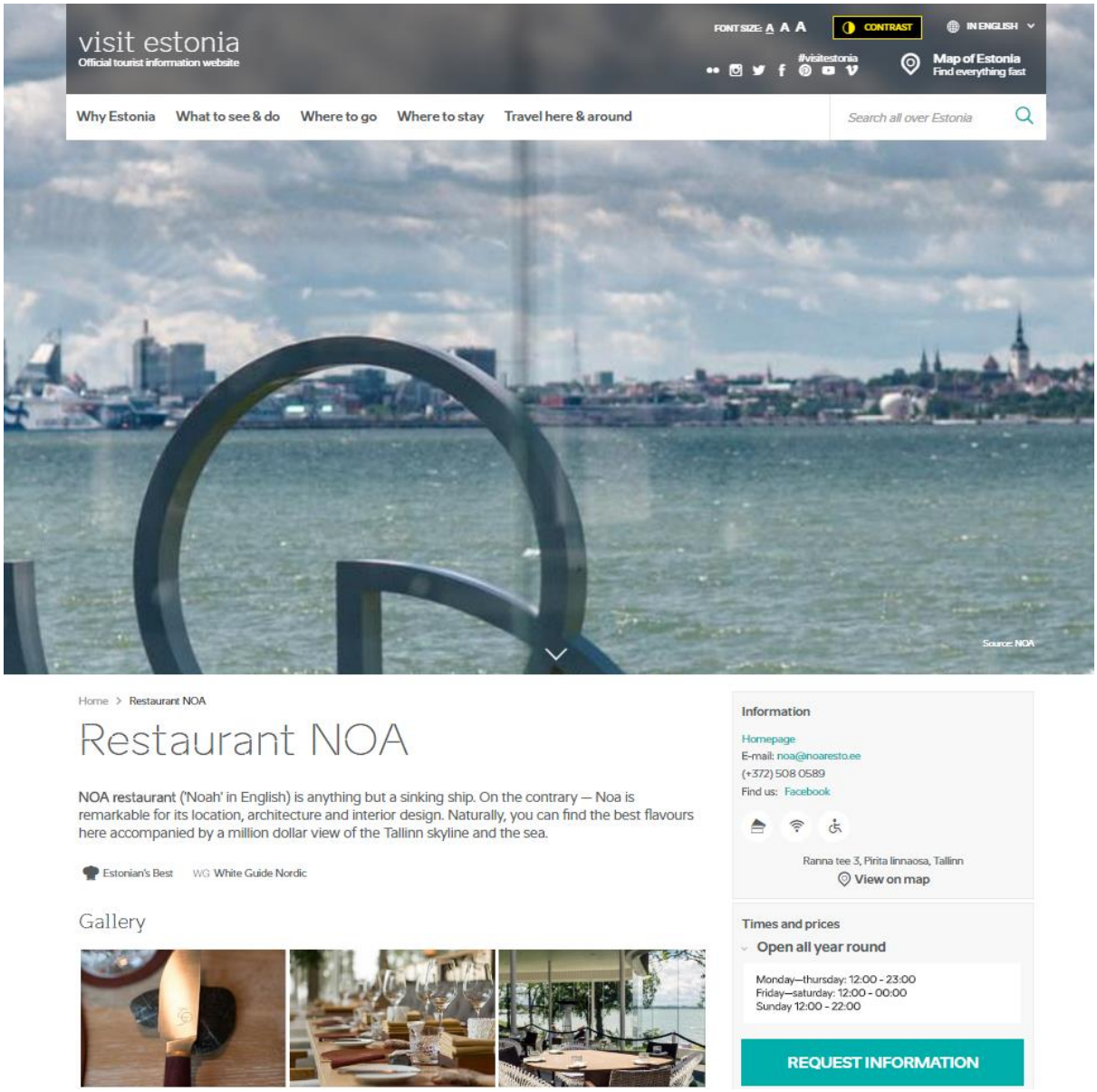


Figure 4.Object layout (desktop)

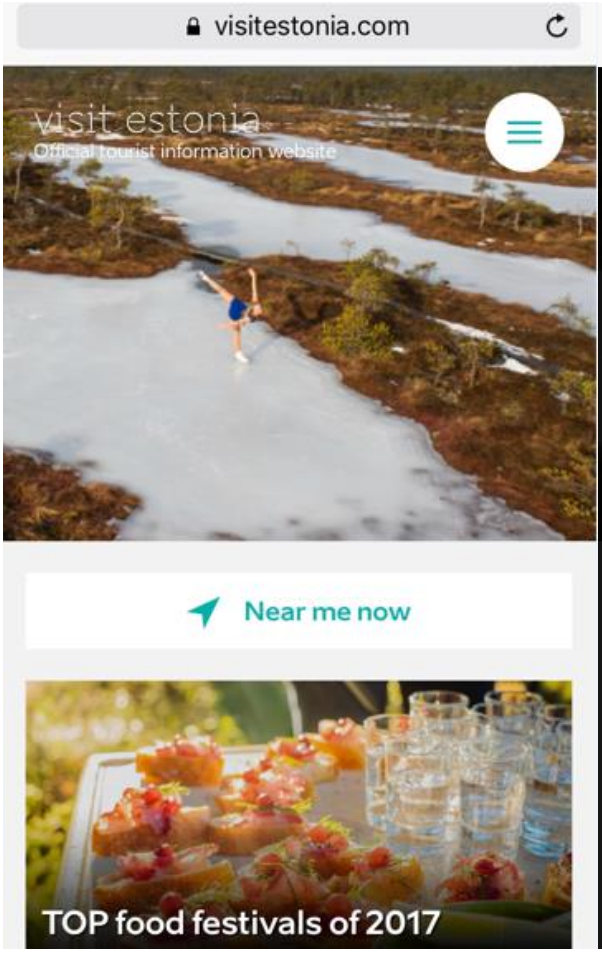



Figure 5.Homepage layout (smartphone)

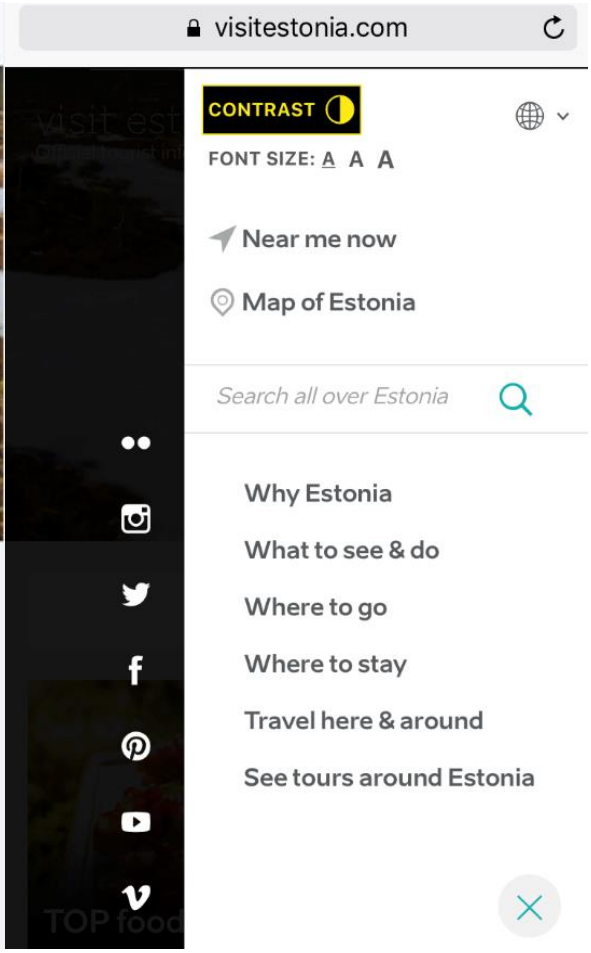



Figure 6. Menu layout (smartphone)

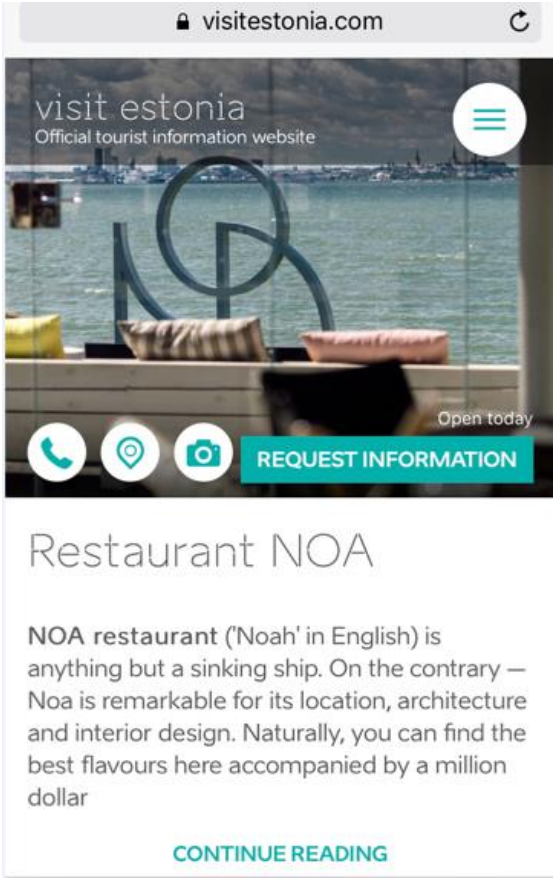



Figure 7. Object layout (smartphone)

## Appendix 2: Attractiveness questionnaire and aesthetic category scales: Categories and Wordpairs

The following table presents the categories and measurable items used in the study, in both Estonian and English:

| Right word (Estonian) | Left word (English) | Right word (English) | Right word (Estonian) |
|---|---|---|---|
| ebameeldiv | meeldiv | unpleasant | pleasant |
| inetu | atraktiivne | ugly | attractive |
| vastuvõetamatu | vastuvõetav | disagreeable | likeable |
| hülgav | kutsuv | rejecting | inviting |
| halb | hea | bad | good |
| tõrjuv | veetlev | repelling | appealing |
| heidutav | motiveeriv | discouraging | motivating |

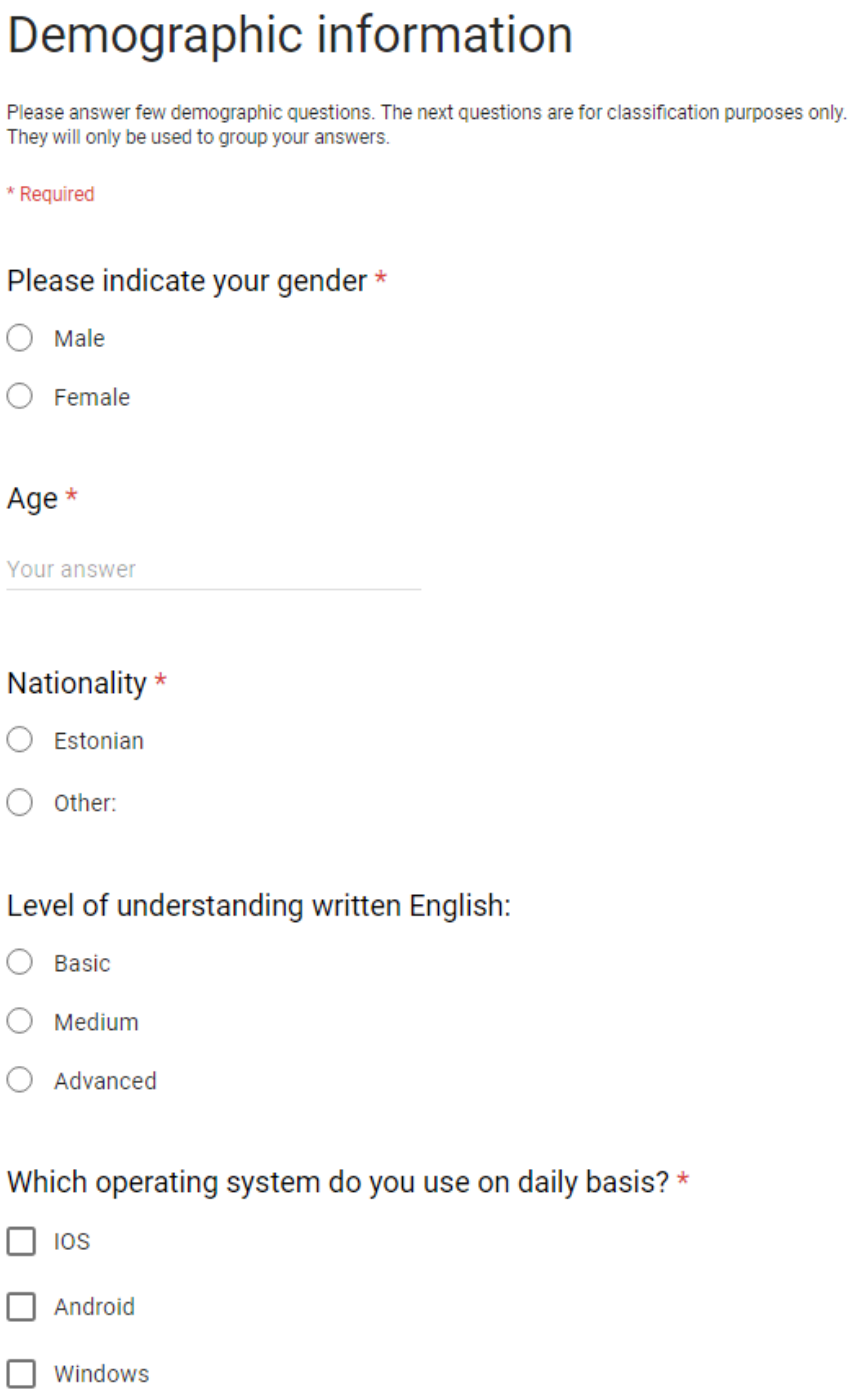
Table 1. Attractiveness questionnaire from AttrakDiff

| Category (Estonian) | Left word (Estonian) | Right word (Estonian) | Left word (English) | Right word (English) | Category (English) |
|---|---|---|---|---|---|
| Virgumine | põnev | rahulik | exciting | calm | Arousal |
| Mängulisus | mänguline | tõsine | playful | serious | Playfulness |
| Dünaamika | dünaamiline | staatiline | dynamic | static | Dynamics |
| Laad | uudne | vanamoeline | modern | old fashioned | Fashion |
| Elutruudus | loomulik | ebaloomulik | natural | unnatural | Natural realism |
| Täpsus | täpne | ebatäpne | precise | imprecise | Precision |
| Sobivus | kohane | kohatu | appropriate | inappropriate | Congruence |
| Informatiivsus | informatiivne | mitteinformatiivne | informative | arbitrary | Informativeness |
| Isiklik eelistus | mulle sobilik | mulle mittesobilik | fits me | doesn’t fit me | Personal relatedness |
| Lõpetatus | täielik | mittetäielik | complete | incomplete | Closure |
| Keerukus | keeruline | lihtne | complex | simple | Complexity |
| Etteaimatavus | etteaimtav | etteaimamatu | predictable | unpredictable | Predictability |
| Kontrollitavus | kontrollitav | kontrollimatu | controlled | uncontrolled | Controllability |
| Kiirus | kiire | aeglane | fast | slow | Speed |
| Viivitus | kohene | hilinev | immediate | delayed | Delay |
| Sünkroonsus | sünkroonne | ebasünkroonnne | synchronized | unsynchronized | Synaesthesia |
| Mehaanika | pidev | etapiviisiline | continuous | stepwise | Mechanics |

| | | | | | |
|---|---|---|---|---|---|
| Väljendus | voolav | katkendlik | flowing | dripping | Phrasing |
| Jõud | jõuline | õrn | powerful | gentle | Force |
| Kaugus | lähedane | kauge | close | distant | Proximity |
| Tekstuur | sile | karm | smooth | rough | Texture |
| Ulatus | vaba | piiratud | free | limited | Range |
| Dimensionaalsus | 3-D | 2-D | 3-D | 2-D | Dimensionality |

Table 2. Aesthetic category scales-categories

## Appendix 3: Screenshots of Demographic Information Questionnaire



Demographic information

Please answer few demographic questions. The next questions are for classification purposes only.
They will only be used to group your answers.

* Required

Please indicate your gender *

- ○ Male
- ○ Female

Age *

Your answer

Nationality *

- ○ Estonian
- ○ Other:

Level of understanding written English:

- ○ Basic
- ○ Medium
- ○ Advanced

Which operating system do you use on daily basis? *

- ☐ IOS
- ☐ Android
- ☐ Windows

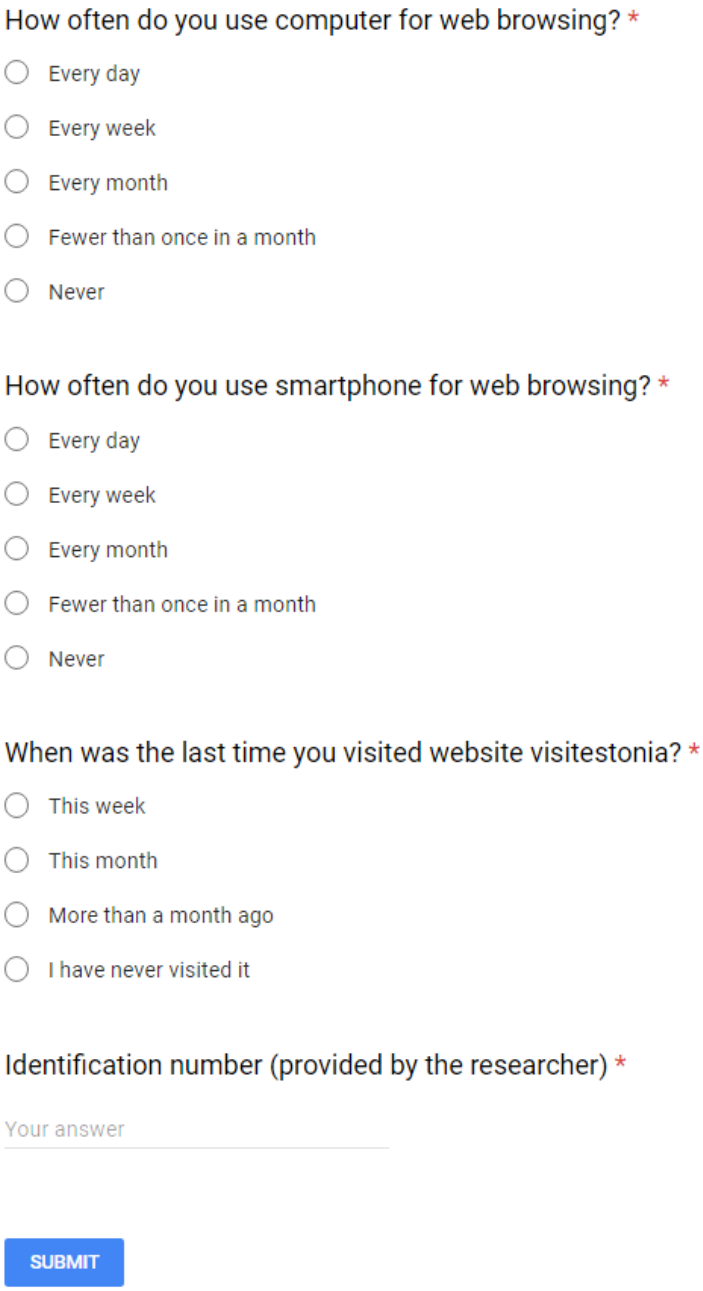



Figure 8. Demographic Information Questionnaire

## Appendix 4: The average results of stimuli grouped

| Stimuli / Category | Average of visual stimuli | Average of Interaction stimuli | Average of CP stimuli | Average of SP stimuli |
|---|---|---|---|---|
| Arousal: exciting vs calm | 3.93 | 3.93 | 3.81 | 4.04 |
| Playfulness: playful vs serious | 3.80 | 3.35 | 3.54 | 3.61 |
| Dynamics: dynamic vs static | 3.37 | 3.02 | 2.96 | 3.43 |
| Fashion: modern vs old fashioned | 3.13 | 2.80 | 2.87 | 3.06 |
| Natural realism: natural vs unnatural | 3.26 | 3.20 | 2.93 | 3.54 |
| Precision: precise vs imprecise | 3.44 | 3.69 | 3.24 | 3.89 |
| Congruence: appropriate vs inappropriate | 2.94 | 2.70 | 2.52 | 3.13 |
| Informativeness: informative vs arbitrary | 2.81 | 2.65 | 2.37 | 3.09 |
| Personal relatedness: fits me vs doesn't fit me | 3.11 | 3.07 | 2.83 | 3.35 |
| Closure: complete vs incomplete | 3.59 | 3.61 | 3.17 | 4.04 |
| Complexity: complex vs simple | 4.56 | 4.30 | 4.91 | 3.94 |
| Predictability: predictable vs unpredictable | 3.59 | 3.63 | 3.33 | 3.89 |
| Controllability: controlled vs uncontrolled | 3.31 | 3.24 | 3.04 | 3.52 |
| Speed: fast vs slow | 2.72 | 2.46 | 2.52 | 2.67 |
| Delay: immediate vs delayed | 2.80 | 2.89 | 2.70 | 2.98 |
| Synaesthesia: synchronized vs unsynchronized | 3.24 | 3.33 | 3.11 | 3.46 |
| Mechanics: continuous vs stepwise | 3.67 | 3.59 | 3.61 | 3.65 |
| Phrasing: flowing vs dripping | 3.28 | 2.93 | 2.93 | 3.28 |
| Force: powerful vs gentle | 4.35 | 4.02 | 4.13 | 4.24 |

| | | | | |
|---|---|---|---|---|
| Proximity: close vs distant | 3.31 | 3.52 | 3.26 | 3.57 |
| Texture: smooth vs rough | 3.24 | 2.93 | 2.96 | 3.20 |
| Range: free vs limited | 3.48 | 3.39 | 3.24 | 3.63 |
| Dimensionality: 3D vs 2D | 5.07 | 5.46 | 5.13 | 5.41 |

Table 6. The average results of videos and interactions grouped by devices and average results of computers and smartphones grouped by videos and interactions, evaluated by 27 users on a 7-point scale.