Electrical Stimulation of Facial Muscles: User Experience of Two Facial Muscle Stimulation Devices

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M.Sc. thesis
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October 2017

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M.Sc. thesis, 48 pages, 3 index and 13 appendix pages
October 2017

A human face is essential for one's appearance, key senses and vital functions. In addition, facial expressions are an effective way to communicate non-verbally. Unilateral facial paresis disables facial muscles on one side causing several problems for facial functions and non-verbal communication. One way to treat facial paresis is electrical stimulation of facial muscles which is a largely examined method. However, different aspects of user experience of facial stimulation have not been systematically investigated.

This study examined experience of electrical facial stimulation as well as experience of using two commercial stimulation devices. According to several studies, people judge stimuli and organize experiences through three key dimensions: pleasure, arousal and dominance. These dimensions together with acceptance and naturalness were used to evaluate the user experience of electrical stimulation. The user experience of the stimulation devices was evaluated by a modified AttrakDiff model.

The research data was collected by testing two facial stimulation devices with 14 healthy participants. The participants stimulated two facial muscles, *frontalis* (forehead) and *zygomaticus major* (cheek) with both stimulators. The user experience was evaluated by two questionnaires, one focusing on the stimulation as such and one for the devices. The participants were also interviewed shortly before and after testing.

According to the results, both devices' stimulations were accepted quite well. Stimulation of forehead was rated as somewhat more natural than cheek, whereas stimulation of cheek was rated more arousing than forehead with both devices. Neither was stimulation of forehead nor cheek rated more pleasant or dominant. Ten participants out of fourteen preferred the smaller and lighter stimulation device which contains a separate control panel and an electrode.

Keywords and terms: electrical muscle stimulation, facial muscles, stimulation device, user experience.

Acknowledgements

I wish to thank my research supervisors, Dr. Jani Lylykangas and Professor Veikko Surakka, for their useful advises and valuable suggestions during this research work. I would also like to extend my thanks to the University of Tampere for lending the stimulation devices and giving access to the test laboratory. My thanks are also extended to Ville Rantanen from the Department of Science and Engineering at the Tampere University of Technology for measuring the stimuli of the stimulation devices.

My special thanks should be given to the fourteen voluntary participants who tested the facial stimulation devices.

Finally, I wish to thank my husband and sons for their patience and support throughout my study.

Contents

1. Introduction

1.1. Human Face and Electrical Stimulation

A human face is, undoubtedly, an essential part of a human body. If people were asked to list functions of a human face, it would be a long list, and supposedly an easy task to do. Perhaps several respondents would remark that the face is the most important part of one's appearance, and individuals are recognized by their facial features. Eyes, a nose and a mouth are integral parts of the face with crucial senses or vital functions per se: they are needed for eating, drinking, smelling, tasting and seeing. In addition, facial expressions are an effective way to communicate non-verbally with other people. Could you imagine proper interaction without smiling, wrinkling eyebrows, crying, whistling, lifting eyebrows, winking, laughing or looking surprised?

Unilateral facial paresis is a condition, where facial muscles on one side of the face cannot be moved. It causes several problems for facial functions; for example, it is difficult to eat and speak properly when there is no full control over the mouth. In addition, unilateral facial paresis complicates a patient's non-verbal communication, as facial expressions are not symmetric. This may seriously complicate an individual's social life. While some unilateral facial pareses are temporary, other cases turn chronic despite medication and therapy. One way to treat unilateral facial paresis is electrical stimulation of facial muscles. This method has been examined through experiments by numerous researchers [see e.g. Hyvärinen et al., 2008; Ohtake et al., 2006; Teixeira et al., 2012]. In addition to treating facial paresis, electrical stimulation has also been studied for producing dynamic facial renanimation to the paralyzed facial muscles [see e.g. Griffin & Kim, 2011; Yi et al., 2013; Zealear & Dedo, 1977].

However, electrical facial stimulation is not directed exclusively to the patients suffering from facial paresis, but there are several facial stimulation devices, which are freely available for anyone to buy. Some of these devices are designed for beauty treatment, for instance, to prevent wrinkles from forming on the face. Since they are not medical devices, but targeted to public use, no special training for using them is required. Even though it could be assumed that these stimulators are easy and safe to use, the idea of sticking electrodes on the face and conducting current power to the facial muscles may sound a terrifying experience. For this reason, it is very important to produce as pleasant overall user experience as possible. The same applies to the patients suffering from facial palsy who are treated with electrical stimulation.

It is somewhat easy to find scientific articles about the results of electrical facial stimulation experiments – whether stimulation has improved the medical condition or not [see e.g. Hyvärinen et al., 2008; Ohtake et al., 2006; Pereira et al., 2012]. However, user experience of electrical stimulation of facial muscles has not been systematically investigated in the previous stimulation studies. Some researchers, for example Chen et al. [2009] and McDonnall et al. [2009], have paid attention to the physical pain caused by electrical stimulation of facial muscles, but they have not explored other sensations or different aspects of user experience.

1.2. Research Aims

Based on the reflection in the previous section, this thesis focuses particularly on user experience of electrical facial stimulation. The aim of this study is to examine two commercial facial muscle stimulation devices from two perspectives: 1) experience of electrical stimulation as such, and 2) experience of using the stimulators. The latter question includes an overall impression and attitudes towards the stimulators. The precise research question is twofold and defined as follows:

- What kind of experience does electrical stimulation, which moves facial muscles, produce for the users?
- What kind of overall user experience (anticipated, momentary and episodic) do the novel users have of the two facial muscle stimulation devices?

It has been confirmed by several studies that there are three central and pervasive dimensions when humans judge stimuli: pleasure, arousal and dominance [Bradley and Lang 1994; see also Bradley, 1994]. These three dimensions were already referred in the end of 1890s by Wilhelm Wundt. It is also discovered that besides diverse verbal stimuli, objects and events, people evaluate facial expressions and other bodily movements as well as postural positions through these dimensions [Bradley & Lang, 1994]. Based on numerous studies, Bradley and Lang [1994] have concluded that pleasure, arousal and dominance are crucial in organizing both semantic and affective human experience [see also Bradley, 1994]. These three dimensions together with acceptance and naturalness are used to evaluate the user experience of electrical facial stimulation in this study.

Since this research examines only two facial muscle stimulation devices, the results cannot be generalized to all such devices. Even though generalization is not the primary aim of this study, but understanding and explaining the interaction between the user and the stimulation device, the results can suggest ideas and aspects, which can be applied to other cases. Another important goal is to produce information that could be utilized, for instance, to develop facial muscle stimulation devices for medical use – and even

more, to improve the quality of life, as the noble focus has traditionally been on researches in the human-computer interaction field [Lazar et al., 2010].

2. Electrical Stimulation of Facial Muscles

2.1. Precious Human Face

The relevance of the face for human beings cannot be denied. It is an essential and individual part of one's appearance, it contains significant sensors – eyes, a nose and a mouth – and people communicate non-verbally with numerous facial expressions, for example, smiling, frowning and lifting eyebrows. As it was stated already in the 19th century, facial expressions formulate a universal language [Duchenne de Boulogne, 1862]. Altogether, the face can be seen as an important instrument in people's social life. Even newborn babies know that: they tend to turn their faces towards a human face, or to other targets resembling it, such as a doll or a picture of the face [see e.g. Cassia et al., 2004; Farroni et al., 2005; Johnson et al., 1991].

A human face contains numerous muscles: over ten major facial mimetic muscles have been defined. The major mimetic muscles are essential for non-verbal communication, since they produce several facial expressions; for example, they knit the brow, pull the brow in and down, raise different parts of the brow, raise and lower the upper lip, adduct the jaw, raise the chin, contract the lip, pull the lip corner up and back and constrict the eye fissure. [Fridlund & Cacioppo, 1986.] The major muscles of a human face and their location can be seen in Figure 1.

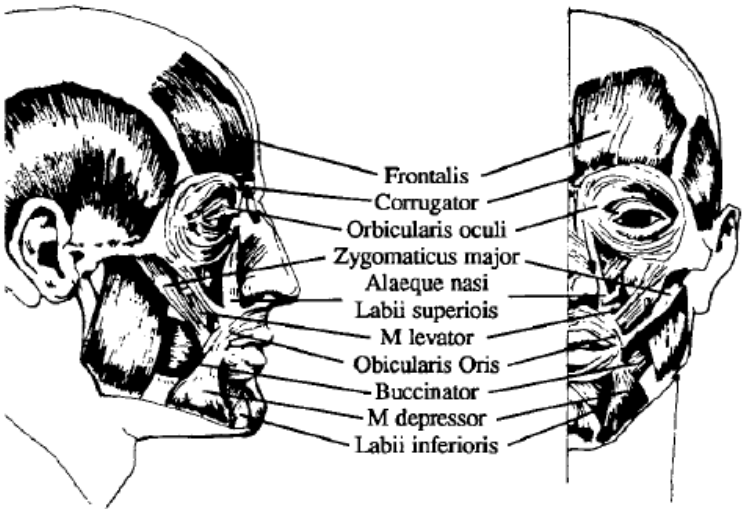

Figure 1. The major muscles of the face [Waters, 1987] (copied by permission of the Association for Computing Machinery).

In this thesis, the electrically stimulated two muscles are *frontalis*, which is located in forehead, and *zygomaticus major*, which can be found in the middle of cheek. *Frontalis*

can be divided into *lateral frontalis* and *medial frontalis*, which are located next to each other; the former is supposed to raise the outer and middle brow, whereas the latter raises the inner brow. [Fridlund & Cacioppo, 1986.] The aim is to stimulate *frontalis* in order to achieve a visible movement in the inner brow. *Zygomaticus major*, instead, is supposed to pull the lip corner up and back [Fridlund & Cacioppo, 1986], which is the aim in the experiment of this study.

Guillaume-Benjamin Duchenne de Boulogne [1862] studied the facial muscles and their functions through electrical stimulation already in the 19th century. Even then it had been discovered that the symptomatic expression of emotions is governed by the facial muscles. To learn the causes affecting the expressions of a human face, the muscle action has to be studied. He used electrical current to stimulate different facial muscles to produce various expressions for his six subjects. Based on the experiments, he divided the facial muscles into four categories due to their capability to produce full expressions: completely expressive, incompletely expressive, expressive in a complementary way, or inexpressive.

Based on the categorization, Duchenne de Boulogne named the facial muscles after their expressive tasks. *Frontalis* belongs to the first category of completely expressive muscle, and Duchenne de Boulogne called it a muscle of attention. The other key muscle in this study, *zygomaticus major*, was considered as an incompletely expressive muscle, and he named it as a muscle of joy. According to Duchenne de Boulogne, *zygomaticus major* expresses only joy to all its degrees, from smile to the raucous laugh. Since it often gives a kindly gaze as well, it could also be called the muscle of kindness. [Duchenne de Boulogne, 1862.]

2.2. Facial Paresis and Electrical Stimulation

Facial paresis is often caused by facial nerve paralysis, which is most frequently idiopathic[1], that is, Bell's palsy. Even though the prognosis for full and spontaneous recovery from Bell's palsy is good, there are numerous patients who suffer from chronic facial paresis and require active treatment [Hyvärinen et al., 2008; see also Alakram & Puckree, 2010; Ohtake et al., 2006; Teixeira et al., 2012]. Even the recovered patients may have persistent residual symptoms [Ohtake et al., 2006; see also Alakram & Puckree, 2010]. In addition, unilateral facial paresis can also be caused by a viral infection which has poorer recovery prognosis than Bell's palsy [Hyvärinen et al., 2008]. Several studies show that there is a need for facial muscle treatment in many cases of facial palsy [see e.g. Hyvärinen et al., 2008; Ohtake et al., 2006; Pereira et al.,

[1] A unilateral facial palsy of unknown etiology [see e.g. Ohtake *et al.*, 2006]

2012; Teixeira et al., 2012]. Since facial functions are extremely important for human beings, unilateral facial paresis may strongly affect an individual's life. Asymmetrical facial expressions and facial weakness may, for instance, interfere with customer service work [see e.g. Ohtake et al., 2006].

Concerning facial reanimation in case of facial paresis, the following goal has always been central: *"to preserve function, produce static symmetry, and achieve dynamic mobility"* [Griffin & Kim, 2012, 365; see also Pereira et al., 2012]. According to Griffin and Kim [2012], there are already methods to protect the eye and avoid oral incompetence, and even techniques to achieve good static symmetry for the face. However, there is still a challenge in achieving reliable, dynamic mobility for the paralyzed side [Griffin & Kim, 2012]. Chronic facial pareses have been treated, for example, by medication, neuromuscular retraining, instructed exercises, thermotherapy, mime therapy and electrical stimulation [Hyvärinen et al., 2008; Pereira et al., 2012]. Surgical rehabilitation has also been used, but it has proven difficult [Griffin & Kim, 2012].

Since this study focuses on exploring user experience of facial electrical stimulation, it is necessary to review experiments on electrical stimulation. As Ohtake et al. [2006] have remarked, stimulating paralyzed facial muscles electrically has been popular with patients suffering from Bell's palsy [see also Alakram & Puckree, 2010]. To examine this topic further, they reviewed three clinical trials. In one experiment, electrical stimulation neither had any appreciable effect on recovery from Bell's palsy, nor caused any harm to the patients. Two other studies indicated positive influence on the facial palsy, but the results were not absolutely confident due to the lack of true control groups. [Ohtake et al., 2006.]

Hyvärinen et al. [2008] examined the effectiveness of electric stimulation through a long-term stimulation (six months) for ten patients who suffered from unilateral facial paresis. The research group obtained very positive results: nine of ten patients reported significantly or slightly better subjective experience of the facial function after the treatment period. Despite numerous positive and promising results, the potency of electric stimulation in unilateral facial paresis is still considered controversial. [Hyvärinen et al., 2008; Pereira et al., 2012; see also Alakram & Puckree, 2010.] According to Teixeira et al. [2012], the evidence is insufficient to conclude whether electrical stimulation actually works, even though it has been shown to limit atrophy of paralyzed muscles, and also to strengthen muscle force and improve recovery after reinnervation [see also Griffin & Kim, 2012]. More research and testing of this treatment method is needed to confirm the conclusions.

Griffin and Kim [2012] have taken even one step further and discussed electrical pacing of paralyzed facial muscles. Pacing could be enabled by implanting a permanent electrical prosthesis into the paralyzed side of the face. The prosthesis would utilize electromyography (EMG) impulses from the corresponding muscles on the intact side to stimulate the paralyzed muscles. This kind of stimulation has been tested with animals, and the results have been promising. [Griffin & Kim, 2012; see also Yi et al., 2013; Zealear & Dedo, 1977.] For example, Zealear and Dedo [1977] successfully experimented electrical stimulation of axial muscles of dogs. They obtained positive results in restoring natural function of paralyzed muscles, which made the researchers to think of a possibility of implanting a muscle stimulation device for constant stimulation, such as in the case of chronic facial palsy.

When studying and discussing different methods for treating facial palsy, patients' personal experience – either of the treatment itself, or the devices used in the medical attention – is not typically reported. Perhaps patients' experience has not been considered as a key result, or the topic has not been studied at all during the experiments. However, Duchenne de Boulogne [1862] referred in his early studies to the unpleasant sensation or even pain caused by electrical facial stimulation. Therefore, he conducted most of his experiments with a participant whose facial sensibility was lower than normally. There are also newer articles where the researchers have referred to the patients' sensations and individual differences when applying the treatment, but only very briefly [see e.g. Alakram & Puckree, 2010; Chen et al., 2009; McDonnall et al., 2009; Yi et al., 2013]. Both Chen et al. [2009] and McDonnall et al. [2009] tried to produce an artificial blink with a tolerable comfort level. These studies discuss the physical pain, but do not address other aspects of user experience, such as pleasure, naturalness or dominance of the stimulus [see e.g. Bradley & Lang, 1994].

2.3. Electrical Stimulation in Beauty Treatment

Divergent treatment of unilateral facial paresis is not the only target of facial muscle stimulators. There are numerous electrically operated muscle stimulation devices on the market, even designed for treating facial muscles. These devices are available for anyone to buy and try. Since they are not aimed at medical use, but to healthy people, no special licenses or special training before use is required. These commercial devices are mostly targeted at beauty treatment, for example, to prevent wrinkles from forming on the face, to lift cheeks, and to produce a smoother look and a younger appearance. Electrical stimulation devices are used professionally in beauty salons as well.

Even though the commercial muscle stimulators are not designed for medical use, testing their optimal use and threshold values as well as analyzing the user experience

they produce can be useful from the medical perspective. Besides being a central part of the human body, the face is also a very sensitive and personal area. Therefore, proper knowledge of user experience of a device, which is concretely stuck on the face and uses electricity for stimulation, is important. If the user has strong preconceptions, or even fear to use electricity for stimulating the facial muscles, it is possible to ease these constrains with careful design – if the concerns are first recognized and reported. To encourage people to use electrical stimulation devices for medical attention, the user experience should be as pleasant and safe as possible. The two commercial stimulation devices tested in this study are described in detail in Chapter 4.2.

3. User Experience

3.1. Defining User Experience

User experience (UX) is a multidisciplinary term, which is widely used, but often understood in different ways. The term 'user experience' is used to refer to usability, user interface, interaction experience, interaction design, customer experience, web site appeal, emotion, 'wow effect', general experience, or it may be considered as an overall term including all or many of these concepts. Due to several viewpoints, user experience has not one clear definition, which is suitable for every perspective. [Roto et al., 2011.] This can be verified by exploring the web page All About UX[2], which presents over 25 different definitions of user experience, formed by numerous researchers. Here are a few examples of the listed definitions of user experience [All about UX]:

"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]

"UX is a momentary, primarily evaluative feeling (good-bad) while interacting with a product or service." [Hassenzahl]

"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 meanigs we attach to the product (experience of meaning), and the feelings and emotions that are elicited (emotional experience)." [Hekkert]

"An umbrella term used to describe all the factors that contribute to a site user's overall perception of a system. Is it easy to use, attractive and appropriate? Does it meet user needs?" [Public Life]

According to the international standard, *"user experience includes all the users' emotions, beliefs, preferences, perceptions, physical and psychological responses, behaviours and accomplishments that occur before, during and after use"*. In short, user experience covers *"a person's perceptions and responses resulting from the use and/or anticipated use of a product, system or service"*. [ISO 9241-210.] Roto et al. [2011] have also tried to clarify the definition and contents of user experience. According to them, the term 'user experience' can be seen referring to the user's actual encounter

[2] http://www.allaboutux.org/ux-definitions

with a system. This encountering does not continue endlessly, but there is a beginning and an end. User experience covers the whole encountering, and is based on the outcome and memories of the experience. [Roto et al., 2011.]

Since user experience is so widely defined, it has also been criticized for being "vague, elusive and ephemeral". Despite the critique it has been adopted strongly by the human-computer interaction community. User experience is concerned with emotional consequences on the human side, not with the technology. As the term 'user experience' indicates, the evaluated view is the human perspective. [Hassenzahl & Tractinsky, 2006; see also Preece et al., 2002.] Garrett [2003] has presented more practical definition for user experience: it is concerned with *"how the product behaves and is used in the real world"*. Thus, user experience is not about what the product does, but how it works on the outside and how the users are actually interacting with it [Garrett, 2003].

3.1.1. Usability and User Experience

The international standard defines usability along these lines: *"The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use"* [ISO 9241-11]. The three main aspects of usability are the efficiency and effectiveness of the product together with the user's satisfaction. Garrett [2003] has simplified the definition of usability as follows: when thinking about usability the focus is normally on making products easier to use.

According to Nielsen [1993], usability has traditionally been linked with the five following attributes: 1) learnability (easy to learn), 2) efficiency (efficient to use), 3) memorability (easy to remember), 4) errors (a low error rate) and 5) satisfaction (pleasant to use, subjectively satisfied). Of these attributes Nielsen [1993] considers learnability as the most fundamental one, since easy learning is important with new products, and learning to use a product typically brings the very first user experience. The second attribute, efficiency, describes the expert users' level of performance, whereas the third attribute, memorability, is usually studied with casual users. The fourth attribute, errors, can be measured by counting them, while users are performing test tasks. The last usability attribute, subjective satisfaction, refers to the pleasure of the use. Subjective satisfaction may be especially important attribute for products, which are used on leisure time. [Nielsen, 1993.]

Usability is often referred to when discussing user experience. In this study usability and user experience are not seen as synonyms, even though they are strictly connected to each other. Usability can be seen as a part of user experience, since it contributes to the overall user experience [Roto et al., 2011]. If a product has poor usability, user

experience is most probably bad as well. This perspective is supported also by the Department of Pervasive Computing at the Tampere University of Technology, as shown in Figure 2.

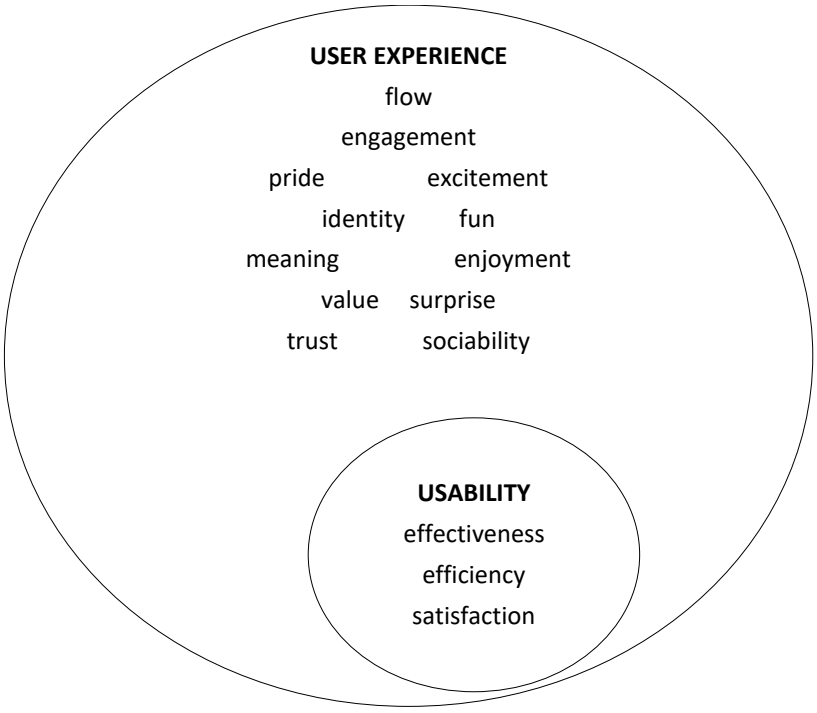

Figure 2. Relations between usability and user experience [Tampere University of Technology].

However, typical ways of measuring usability, such as task completion time or a number of errors, are insufficient for exploring user experience, since they do not include the user's perception [Roto et al., 2011]. In the field of human-computer interaction research, achieving behavioral goals has traditionally been important, which means that completing tasks has been in the focus of studying. This perspective was challenged as of the 1990s by considering non-instrumental factors (e.g. beauty) as a quality aspect of technology. [Hassenzahl & Tractinsky, 2006.] Even in the 1980s there were critical arguments suggesting that besides 'behavioral' usability, the aspects of 'emotional' usability, such as fun, novelty and excitement should be considered as well [Hassenzahl, 2006].

According to Hassenzahl [2001], usability can be seen as use quality, which simply means that a product can be used as it is intended. On top of this, user experience includes also the hedonic quality, which can be defined as a non-task-oriented quality aspect, for instance, innovativeness, fun and beauty. Products and services with good user experience are more than useful – they are also attractive and enjoyable to use.

Emotional side of design can be even more crucial than the practical features in determining whether a product is a success [Norman, 2004]. As Norman [2004] has stated, product usability is surely important, but life would be incomplete without emotions, such as joy, pleasure, anxiety and rage.

To sum up, the user experience perspective requires a more holistic view on the interaction between the user and the product than the usability perspective [see e.g. Hassenzahl, 2006]. This can be verified by Figure 3, which presents the goals of usability and user experience. As Preece et al. [2002] have stated, the usability goals are concerned with the objective usefulness of a product, whereas user experience goals are aiming at the subjective experience of the interaction. However, there is evidence that aesthetically pleasant products are also working better, since their attractiveness produce positive emotions resulting more creative and more tolerable mental processes, which contributes the ease of use [Norman, 2004].

Figure 3. Usability goals and user experience goals (the outer circle) [Preece et al., 2002].

This study focuses on two of the usability attributes: learnability and subjective satisfaction. Since both the tested stimulation devices are targeted to consumers and no

special training or previous experience is required, they should be easy to learn. Subjective satisfaction is measured due to its connection to the hedonic quality of use, which is a key question when studying user experience. Studying of efficiency with expert users, or memorability with casual users are out of the scope of this study. Neither was it relevant to count exact error rate during the test tasks.

3.1.2. Divisions of User Experience

Even though the actual experience of usage can be considered as the core of user experience, it is impossible to reject it solely to the encountering. As stated in ISO 9241-210 [2010], a person's anticipated use of a product, system or service is included in user experience. Before encountering with a system, the user may have expectations and assumptions, which can be seen as the indirect experience. The indirect experience may also expand after the usage, for example, through reflection on previous experiences or other people's opinions. Overall, user experience can be roughly divided into three time spans: 1) anticipated user experience, which refers to the period before the first use, 2) momentary user experience, which refers to the actual encountering with a product or system, and 3) episodic user experience, which refers to the evaluation after the encountering. [Roto et al., 2011.] In this study, all the three time spans of user experience were covered.

User experience can be divided into three parts from another perspective as well. This perspective explores the three factors, or parties, that affect user experience. First, there is the user's internal state, which consists of expectations, needs, mood, attitudes, skills as well as other personal and individual factors. The user's internal state may also change during the three spans of user experience. Second, there is the product (or system) and its characteristics, which affect the user experience – for example, how complex, usable and functional the product is, and what kind of brand image it has. The third factor is the context, in which the product is used; for example, is the usage optional or obligatory, and what kind of social setting there is. [Hassenzahl & Tractinsky, 2006; ISO 9241-210.]

The third way to divide user experience is to study three product dimensions: pragmatic quality, hedonic quality, and attractiveness [AttrakDiff, 2015; see also Hassenzahl et al., 2002 and Hassenzahl, 2006]. Pragmatic quality (PQ) describes the usability of a product; it indicates how successfully the users achieve their goals with the evaluated product. The second dimension, hedonic quality, contains two subcategories: hedonic quality – stimulation (HQ-S) and hedonic quality – identity (HQ-I). HQ-S indicates the extent of the support, which the product can provide to fulfill people's global need to develop and move forward. HQ-I indicates to what degree the product permits the users

to identify with it. Pragmatic and hedonic qualities are independent of each other. The third product dimension, attractiveness (ATT), summarizes a global value of the product based on the subjective quality perceptions. [AttrakDiff, 2015; see also Hassenzahl et al., 2002.] In this study all the three product dimensions were taken into account by the evaluation questionnaire, which was used to evaluate the tested stimulation devices.

3.2. Why Study User Experience

As Garrett [2003] has stated, every product that is used by someone has user experience, which can vary from great to moderately good or even terrible. Nielsen [1993] supports this argument by remarking that any object used by humans is a possible target for usability problems. If user experience has not been studied before a product is launched, the real users will be the test persons in a sense [Nielsen, 1993]. Norman [2002] has even claimed that too many items are designed and constructed without caring how they will be used. There may be only minor things separating a pleasant user experience from a frustrating one, but it is good to bear in mind that the same things apply also to more complex operations, which may affect even human lives, such as aviation safety. [Norman, 2002.]

Nielsen [1993] has presented numerous concrete reasons why usability engineering is worthwhile. Since usability is considered as a central part of user experience, the same arguments are valid for reasoning the studies of user experience. First, it is difficult to understand the users' needs, thoughts and behavior by guessing, let alone to design an optimal product based solely on the best try. Second, designing is easier and the end result will most probably be better, if the designers understand and know the users and their tasks. Studying usability may also reveal users' hidden needs or desires, which even the users themselves do not recognize, but still appreciate. The fourth argument advises the designers to consider their own perspective with wariness. It is tempting to rely only on own intuition in designing, even though the basic users usually differ from the designers – the basic users do not know, for example, the conceptual foundation and the structure of the product as well as the designers. Finally, good usability is often dependent on details, which requires systematic studies to design the details correctly. [Nielsen, 1993.]

According to Hassenzahl et al. [AttrakDiff, 2015], the quality dimensions of user experience, pragmatic quality and hedonic quality, contribute equally to the assessment of attractiveness, which results as the users' emotional and behavioral consequences. For example, if the user finds a product controllable (pragmatic quality) and innovative (hedonic quality), s/he considers the product likeable (attractiveness). A likeable product probably causes joy for the user (emotional consequence) and increases the use

of the product (behavioral consequence). [AttrakDiff, 2015.] The connections between the users' perceived quality, the assessment of attractiveness and its consequences are presented in Table 1.

Designer	**User**				
Intended quality	**Perceived quality**		**Assessment**		**Consequences**
Pragmatic quality, e.g. controllable	Pragmatic quality, e.g. controllable	→	Assessment of attractiveness, e.g. likeable	→	Behavioral, e.g. increased use
Hedonic quality, e.g. innovative	Hedonic quality, e.g. innovative	→		→	Emotional, e.g. joy

Table 1. Connections between perceived quality, assessment and consequences [AttrakDiff, 2015].

To summarize, it can be stated that the users' individual characteristics, varying skills and different attitudes towards technology altogether affect user experience [Nielsen, 1993]. To know the users, it is important to explore their needs, desires and other aspects that affect user experience – and the pragmatic and hedonic quality that they perceive of the product. It is also important to clarify, what kind of user experience a product should have before analyzing the experience, or trying to affect or change it. Norman [2002] has presented design principles[3] that guide to take into account people's psychological restrictions and conceptual models. Knowing these principles should help the designers to pay attention to the user experience of their products.

In addition, it is good to remember that successful user experience is valued also from the economical perspective. User experience may have a remarkable effect on which items consumers choose to try and buy, or how they evaluate whole companies and their images. For example, it is typical that the users blame themselves if they cannot use products properly – even though Norman [2002] urges the users to blame the designers, not themselves. Feeling stupid may discourage the users to try other products of the same company, whereas good user experience encourages coming back again. This way user experience can be seen connected to the customer loyalty. [Garrett, 2003; see also Norman, 2002.]

[3] To learn more about these design principles, see e.g. Norman, Donald. 2002. The design of everyday things. New York: Basic Books.

4. Methods

4.1. Participants

The participants for testing a system or a device should represent the intended users as well as possible. In addition, it is advisable to test systems or devices with novice users. [Nielsen, 1993.] In this study, the tested facial stimulation devices seem to be targeted at middle-aged women, even though they can be used by all healthy adults and one of them even by children under supervision. For this reason, there were no specific requirements for the participants' personal profiles. When the participants were contacted it was confirmed that none of them had used electrical facial muscle stimulators earlier.

The participants were recruited through the researcher's personal contacts. Altogether fourteen volunteer participants, seven females and seven males, completed the actual experiment. All the participants were healthy individuals, that is, no one suffered from facial paresis or other serious medical conditions. The tested devices included a list of warnings and hindrances for usage, which were informed in advance (see the appendix 1, only in Finnish). These preconditions were emphasized also in the consent form, which was signed by the participants before testing (the appendices 2a and 2b). As every participant was a native Finn, all the instructions, forms and questionnaires of this study were presented in Finnish.

The participants' average age was 33, ranging from 23 to 42. To study the relation between the fatty tissue and the detectability and tolerance of the stimulation, the participants were asked to add their height and weight in the background information questionnaire. The participants' BMI[4] was ranging from 20 to 29 (average 23). According to the World Health Organization's definition, a BMI greater than or equal to 25 is overweight, whereas 30 is a threshold value for obesity [World Health Organization, 2015]. None of the participants was obese, while four of fourteen had a BMI between 25 and 29 indicating overweight. Handedness was asked as background information to instruct the participants to use the stimulation devices with the dominant hand. Thirteen participants out of fourteen were right-handed and twelve of them stimulated the right side of the face. Two participants stimulated the left side of the face – one because of using his dominant left hand and the other one due to eczema on the right side of his face.

[4] Body Mass Index (BMI) is an index of weight-for-height. It is calculated by dividing a person's weight in kilograms by the square of his/her height in meters (kg/m²). [World Health Organization, 2015.]

4.2. Apparatus

Both the tested stimulation devices had been purchased from online stores. They have a proper CE marking, which means *"the manufacturer's declaration that the product is in conformity with the EU requirements that apply to it"*. However, the CE marking does not comprehensively guarantee the safety for users, since it covers only certain features of products, for example, durability or flammability. [CE marking.] The stimulation devices are described in more detail in the following sections.

4.2.1. Ageless Wonder™

Ageless Wonder™ (hereinafter referred to as AW) is a portable electrical muscle stimulation (EMS) device for beauty treatment. It consists of a control panel, a headset, an application wand, an application wand with a connecting wire, an application wand handle and conductive replacement sponges (see Figure 4). It is a battery-powered, and it uses specially designed bipolar low voltage micro-current impulses for stimulation. The device generates small electrical pulses, which are to activate the users' motor nerves resulting in muscle contractions. According to the User's Guide, the impulses should mimic the natural nerve signal in order to produce efficient, pleasant and continuous contractions. The device is claimed to have been clinically tested to prove its effectiveness. [AW User's Guide.]

Figure 4. Ageless Wonder™: a control panel and a wand with two electrodes (blue sponges) connected with a wire.

According to the measurements conducted by the Department of Automation Science and Engineering at the Tampere University of Technology, AW produces sine curved

carrier waves, sine pulses. The carrier wave is 6.667 kHz. Sine pulses start smoothly, which is more pleasant for the user, since the tension of the muscles does not happen suddenly. Therefore, the user can sense the stimulation before the muscle tenses up. The voltage peak values vary from 40 to 225.

AW promises the user to *"improve facial tone, rejuvenate the skin, reduce puffiness, even out skin tone, and improve facial circulation"*. When the device exercises facial muscles, they become firmer, and the face will have a more lifted appearance. The device has six pre-programmed modes which are designed for five different facial areas: cheeks (lift, firm and tone), a lower cheek, a forehead, a chin (jaw line) and under the eye area. The device has power with thirty intensity levels. Level one is the first intensity that can be felt. The User's Guide advises to try different intensity levels, and discover the best level based on personal experience. It is recommended to set the intensity at a low level; the right level is said to be 1-3 levels less than the maximum tolerable level. The device should be used for 15 minutes a day for four weeks to get results. [AW User's Guide.]

4.2.2. Lift Plus™

The second stimulation device was Lift Plus 60 Second Face Lift™ (hereinafter referred to as LP). Similar to the first device, LP is also made for beauty treatment and its name indicates the main purpose: to tone, lift and rejuvenate the face.

LP includes a battery-powered, portable device with two ball electrodes (positive and negative) and an LCD display (see Figure 5). The display shows which program is being used and it illustrates the intensity level. The intensity of the treatment can be increased or decreased with two separate buttons. A third button is for programs and switching the device on or off. The device is turned automatically off if no button is pressed in 30 minutes. The device has also a 60 second timer, which makes the device beep every 60 seconds indicating a complete treatment cycle. [LP User Guide.] Based on the measurements by the Department of Automation Science and Engineering at the Tampere University of Technology, LP uses asymmetric square waves for producing electrical impulses. The voltage peak values vary from 10 to 90.

Figure 5. Lift Plus™: a stimulation device with two ball electrodes.

LP refers to science when explaining the functionality of the device. It uses two kinds of technology: faradic facial toning uses electrical muscle stimulation (EMS) technology, whereas galvanic infusion (i.e. iontophoresis) uses micro current technology. EMS pulses tone and tighten sagging facial features by contracting and relaxing facial muscles. This stimulation also increases local circulation, which brings more oxygen to the cells and accelerates the removal of toxins. To obtain best results, it is recommended to use the device daily for the first few weeks, and afterwards as required to maintain the results. Micro current technology, instead, infuses the active ingredients from the collagen and retinol patches into the skin. This way it helps to reduce the appearance of fine lines and wrinkles and increases skin elasticity. These collagen and retinol patches are recommended to use only once in 24 hours. [LP User Guide.]

LP offers four programs with various treatments. Three of these programs are based on faradic treatment with intensity levels from 1 to 20: firming, extended firming and tap toning. Faradic toning can be used for forehead and brow, under eye, cheeks, naso labial, lower and upper lip, chin, neck and behind the ear. During the treatment, the pulses give a mild tingling sensation. If the intensity is increased, muscle contractions can be noticed. Diverse areas of the face require different intensity levels; for example, the forehead requires higher levels. The fourth program uses galvanic infusion with intensity level from 1 to 10. The treatment zones for the galvanic infusion are forehead, crow's feet, under eye, naso labial, a chin and an upper lip. Since the galvanic infusion gives a continuous high frequency sensation, it is recommended beginning on a low intensity level on each treatment zone, and to build up until a steady tingling sensation is felt. [LP User Guide.]

4.3. Stimuli

Before the actual experiment, three initial tests were conducted to select reasonable intensity levels for the experiments, to ensure appropriateness of the stimulation test programs, and to ensure smoothness of the whole experimental setting. As the pre-tests indicated that there were clear subjective differences between the detectable, pleasant and tolerated intensity levels, the initial experimental setting was revised: the tested intensity levels were not selected in advance, but each participant stimulated his/her facial muscles until visible movement for the muscle was produced. In addition, the muscle under eye (*orbicularis oculi*) was excluded from the actual stimulation test program based on the pre-tests as none of the stimulation programs could stimulate the eyelid properly.

AW contained six and LP four different stimulation programs which were pre-tested to select the most suitable ones for the experiment. Based on the measurements by the Department of Automation Science and Engineering at the Tampere University of Technology, the stimulation devices had diverse waves for the electrical impulse (sine wave or asymmetric square wave). Frequency of the impulse and duration of the stimuli and pauses between impulses also varied from program to another (Table 2). As the stimulators were compared to each other, it was important to select programs, which produce as similar stimulus as possible. Another criterion was naturalness of the stimulation, because it was one of the evaluated features. Shorter impulses were mainly discovered more natural than the longer ones. Based on the pilot studies and the technical details, the program number two (AW) and number one (LP) were selected for the experiments.

Device	**Waveform**	**Program**	**Frequency (Hz)**	**Duration of stimulus / pause (sec)**
AW	Sine wave	1	20	5 / 1
		2	**70**	**3 / 1**
		3	50	5 / 1
		4	70	3 / 1
		5	48	3 / 1
		6	20	3 / 1
LP	Asymm. square wave	**1**	**40**	**2 / 3**
		2	80	long impulse (> 5 sec)
		3	40	5 / 3
		4	200	constant

Table 2. Main characteristics of the stimulations. The bolded programs number two (AW) and number one (LP) were selected to use in the experiments.

According to the AW User's Guide, the program number two *"will act to give your face a firmer and more toned appearance and also gives your skin a tighter and smoother look and feel".* Besides different programs, there were thirty different intensity levels to choose for the stimulation. AW could also be used in two ways: with a headset or by using a handheld wand. As LP had to be used by holding the device in hand, AW was used with a handheld wand to ensure a proper comparison between the devices. Regarding LP, the program P1 (firming) with faradic technology was selected for testing. According to the LP's User Guide, firming produces *"rhythmic two second muscle contractions to condition muscles with a short three second interval between each pulse"*. LP offered 20 different intensity levels for the stimulation.

After the final experimental setting was defined, the whole testing session (the interviews, stimulations and evaluations) was run through with two female participants. The results of these two pilot studies were not included in the analysis.

4.4. Questionnaires

4.4.1. Stimulus Evaluation Questionnaire

The stimulus evaluation questionnaire (hereinafter referred to as 'the evaluation questionnaire') was used to evaluate the subjective experience of the electrical stimulation of facial muscles. The questionnaire is mainly based on the dimensional theory of evaluating stimuli. In short, the participants were asked to evaluate each stimulus through five dimensions, which are *acceptance, naturalness, pleasure, arousal* and *dominance*.

To evaluate acceptance, a participant had to choose whether the stimulus was acceptable or not based on the following question: could you stimulate your face at the intensity level, which you recently tested? Naturalness was approached by studying whether it is possible to produce an artificial electrical stimulus, which moves a facial muscle and feels natural. The participants were instructed to rate naturalness high, if the stimulation felt as if the muscle had moved naturally. The third dimension, pleasure, was evaluated by simply stating how pleasant the stimulus was. To evaluate the arousal, the participants were asked to rate how calm or aroused they felt during the stimulation. Finally, dominance was evaluated by the concept of control through the following question: did the participant feel that the stimulus had control over him/her or vice versa?

All the dimensions except acceptance were measured on a scale from -4 to +4. The bipolar adjectives or descriptions represented the extremes of the scale. A center segment of the scale, zero, could also be chosen. Naturalness was measured on a scale unnatural (-4) – natural (+4), pleasure on a scale unpleasant (-4) – pleasant (+4), and arousal on a scale calm (-4) – arousing (+4). The last evaluated dimension, dominance, was measured with the scale options "I felt that I was dominant" (-4) versus "I felt that the stimulation was dominant" (+4). The nine-point scale is based on the Semantic Differential Scale, which has been widely used to evaluate pleasure, arousal and dominance [Bradley & Lang, 1994]. The evaluation questionnaire can be viewed in the appendices 6a and 6b.

4.4.2. User Experience Questionnaire (AttrakDiff)

The second questionnaire (hereinafter referred to as 'the UX questionnaire') was aimed at evaluating the whole user experience of the experiment including both the stimuli and the stimulation devices. The UX questionnaire was founded on the AttrakDiff

instrument, which is based on a semantic differential technique [AttrakDiff, 2015; Hassenzahl et al., 2001]. The original evaluation questionnaire consists of 28 items, whose poles are opposite adjectives, such as human – technical, pleasant – unpleasant, and simple – complicated. Each pair of adjectives represents furthest contrasts, and every item is evaluated by a seven-step scale. This scale enables the respondents to describe the intensity of the quality. The respondents are asked to select the values, which they consider as the most appropriate descriptions for the evaluated product. [AttrakDiff, 2015.]

In this study, the UX questionnaire included 24 pairs of opposing features through which a participant was asked to rate the user experience on a scale 1-7. Four pairs of features[5] were excluded from the original AttrakDiff questionnaire, as they were not considered usable for this study. The UX questionnaire was especially aimed at measuring the participant's subjective satisfaction, ease of use and attractiveness of the devices. The UX questionnaire can be viewed in the appendices 7a and 7b.

4.5. Interviews

To enrich the experimental findings and understand better the overall user experience, two personal interviews were conducted as a part of each testing session. The main purpose of the pre-interviews was to explore the participants' anticipated user experience, that is, thoughts before the use of the stimulation devices. The participants were asked to describe their spontaneous thoughts about the facial electrical stimulation and their attitudes towards the stimulation in beauty treatment and for medical purposes. One topic was electrical stimulation of the participants' own facial muscles – expectations and potential prejudices against it. The participants were also asked to comment on the devices based on the first impression.

After the experiment, the participants were interviewed again. The purpose of the post-interview was to deepen and widen the results obtained by the UX questionnaire – to understand better the episodic user experience, which refers to the evaluation after the use of the product. First, the participants could tell about their feelings straight after the testing. In addition, the participants were asked to describe the stimulation experience in more detail: did anything surprising happen during the experiment, and could they think of using electrical stimulation for beauty or medical treatment themselves. The third topic was to evaluate verbally the tested stimulators (e.g. buttons, display, sensation) and to select, which of the two stimulators they preferred.

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[5] The excluded pairs of features are: isolating – connective, alienating – integrating, brings me closer to people – separates me from people, motivating – discouraging [AttrakDiff, 2015]. The Finnish translation of the final pairs of features was available in Väätäjä, Koponen and Roto, 2009 [Väätäjä et al., 2009].

As Eskola and Suoranta [1999] have stated, interviews can be divided into different categories. One way of categorizing interviews is based on the structural flexibility. In *a fully structured interview* all the questions and the questioning order are the same for everyone and the response options are given. *A semi-structured interview* is similar to the structured one, except for the interviewees can reply in own words and the interviewer may ask additional questions if necessary. *A theme interview* is even more freely structured; the themes to be discussed are set in advance, but the actual questions vary between interviews. *An open interview* is the most flexible interviewing method and close to a normal discussion, since the counterparts are discussing a certain topic, but all the themes are not necessarily the same from one interview to another. [Eskola & Suoranta, 1999; see also Lazar et al., 2010.]

A semi-structured interview method was selected for this study, since it gave a possibility to extend and deepen the topics easily by both the counterparts [see Lazar et al., 2010]. The questions were set in advance and mainly asked in the same order, but the respondents could reply in own words. The pre-interview consisted of seven and the post-interview of eight questions. The interview questions can be viewed in appendices 4a, 4b, 5a and 5b. Regarding the number of interviewees, qualitative analysis does not require mechanically a certain number of participants due to generalizability. One key rule is to continue gathering the data, until it reaches saturation: the interviews stop producing new information for the research question. [Eskola & Suoranta, 1999.] In this study, the number of interviewees was given since the number of participants was decided as per the experiments.

4.6. Procedure

The experimental sessions were held in the usability laboratory of the University of Tampere in January and February 2015. When a participant arrived at the laboratory, the whole experimental setting was described according to a certain script. Volunteer participation was emphasized, and the participant was asked to read and sign the consent form (appendices 2a and 2b), as well as to fill in the background questionnaire (appendices 3a and 3b). The two stimulated areas of the face were presented to the participant through the Figure 6.

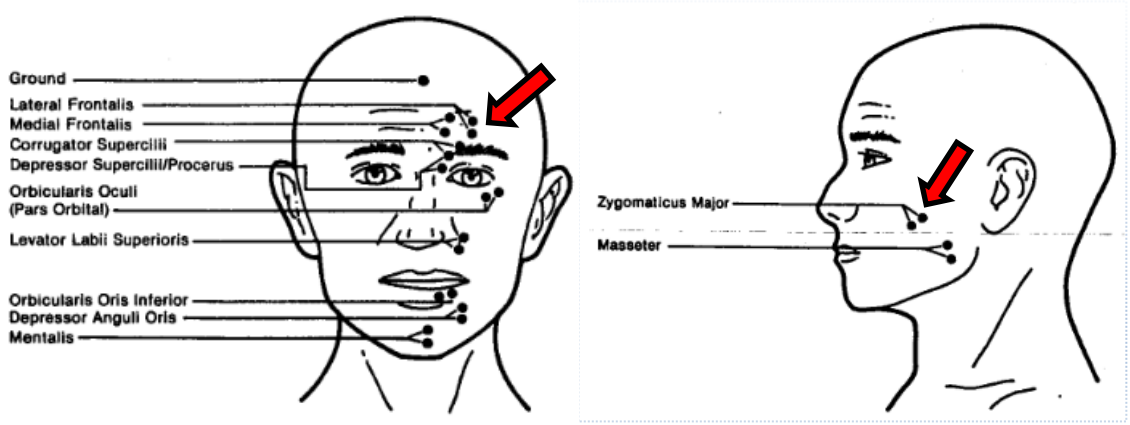

Figure 6. Stimulated facial muscles pointed by the arrows: *frontalis* and *zygomaticus major* [Fridlund and Cacioppo, 1986].

The session was started with a pre-interview followed by the presentation of the two questionnaires. The functionality of the stimulation devices was also shown by the moderator, and the participant could first practice the stimulation on the skin of his/her hand. The participant's facial skin was cleansed by freshen-up towels before the actual experiment. Half of the participants started with AW and continued with LP whereas the other half used the devices in a reversed order. Both the muscles were stimulated by both the devices on one side of the participant's face. The four cases of the test arrangement can be described as follows:

Case	Device	Area in the face (muscle)
1	AW	forehead (*frontalis*)
2	AW	cheek (*zygomaticus major*)
3	LP	forehead (*frontalis*)
4	LP	cheek (*zygomaticus major*)

Table 3. The four cases of the test arrangement

As one aim of this study was to explore the user experience of the stimulators, the participant used the devices by him-/herself. To guarantee high quality results, the moderator helped the participant to locate the right places on the face. The participant was also advised to think aloud when using the devices, and fill in the evaluation questionnaire every time after stimulating one muscle. When the stimulation was finished, the participant evaluated both the stimulators' user experience through the UX questionnaire, each device separately. In the end, the participant was interviewed shortly for the second time.

Before starting the stimulation with AW, each sponge in the electrode was moistened with tap water. The participant started with the lowest intensity level (1), and added more intensity as long as it required obtaining visible movement to the stimulated muscle. There was a mirror available for the participant and the moderator confirmed the movement. The participant was also asked to tell when s/he first started sensing the stimulation (the detectable threshold). When adequate intensity level was reached, the participant held the device on the muscle during five pulses to obtain sufficient sensation for the evaluation (the muscle movement threshold). With LP the procedure was the same but before starting the stimulation, conductive gel was applied to each of the ball electrodes of the device. If the participant experienced any discomfort during the stimulation, s/he could add more water on the conductive sponges or conductive gel on the ball contacts, depending on the device. The last option was to remove the device from the treated area.

One session lasted approximately 60 minutes, and it was recorded with permission from the beginning of the pre-interview until the end of the post-interview. The researcher interviewed all the participants, and acted as a moderator during the experiment. In the end of the session the participants were debriefed, including information of the researcher's contact details in case of questions, comments or adverse events after the experiment. One experimental session can be described as follows:

Phase	Content		Time
1.	Introduction		
2.	Signing the consent form		10 min
3.	Filling the background questionnaire		
4.	A pre-interview	Rec	5 min
5.	Explaining the evaluation questionnaire	Rec	5 min
6.	Instructions for the first device	Rec	
7.	Practicing with the first device (on the hand)	Rec	15-20 min
8.	Stimulating facial muscles with the first device + evaluation questionnaire	Rec	
9.	Evaluation of user experience + UX questionnaire	Rec	
10.	Instructions for the second device	Rec	
11.	Practicing with the second device (on the hand)	Rec	15-20 min
12.	Stimulating facial muscles with the second device + evaluation questionnaire	Rec	
13.	Evaluation of user experience + UX questionnaire	Rec	
14.	A post-interview	Rec	5 min
Total			≈ 55-65 min

Table 4. Structure and content of the experimental session

4.7. Data Analysis

The subjective ratings of the detectable and muscle movement thresholds were first studied by calculating means and standard deviations. In addition, causality between gender and BMI and required intensities were analyzed with Pearson's correlation. As the test group could be divided by two different variables, a device and a location on the face, the subjective ratings of the five evaluated dimensions were analyzed with two-way 2 x 2 (device x stimulus location) repeated measures analyses of variance (ANOVAs). Pairwise Bonferroni-corrected t-tests were used for post-hoc tests. The participants' AttrakDiff model ratings were analyzed by calculating means and standard errors of the means. To illustrate the results better all the negative features of the opposite adjective pairs were afterwards coded with the lowest value (1). All the statistical analyses were run by the SPSS program.

Regarding the qualitative data, no precise qualitative analysis frame was followed in analyzing the data. There were no strict pre-defined hypotheses to test either, as the purpose of the interviews was to enrich the statistical analysis as well as to understand better the user experience of electrical facial stimulation in the experiments – both the experience as such, and the reasons behind it. Eskola and Suoranta [1999] have divided qualitative analysis methods into six categories: quantitative techniques, thematic analysis, typification, content analysis, discourse analysis and conversation analysis. In this study, the method can be described as a 'loose content analysis' in which the interview themes and questions were guiding the analysis. In addition, the findings were quantified to describe how strong and unanimous the subjective experiences were.

5. Results

5.1. Stimulus evaluations

During the experiment, the participant reported both the detectable and muscle moving stimulation levels. Table 5 shows the mean values, standard deviations as well as the minimum and maximum values of the detection and muscle movement thresholds in each case type. The table shows also how big proportion of the muscle movement thresholds were considered acceptable compared to the total cases:

Device (intensity levels)	Location	Stimulus intensity								Acceptance rate / total (N)
		Detection threshold				Muscle movement threshold				
		Mean	SD	Min	Max	Mean	SD	Min	Max	
AW (1-30)	forehead	2.6	1.8	1	6	7.4	3.5	2	13	11/14
	cheek	4.1	2.6	1	9	9.0	5.2	3	15 (*20)	13/14
LP (1-20)	forehead	4.0	1.2	2	6	7.3	1.9	5	12	11/14
	cheek	4.1	1.1	3	6	6.4	1.4	4	9	13/14

*a clear movement was not reported but the participant did not want to increase the intensity level

Table 5. Stimulus intensity thresholds of stimulus detection and muscle movement, and acceptance rate of the stimulus intensity causing muscle movement.

On average cheek required higher intensity levels than forehead to make the stimulus detectable and a muscle to move except for one case: moving forehead by LP required a higher mean threshold than cheek. The AW values' standard deviations were considerably higher than LP's. When comparing genders there was no significant difference for a required intensity: $-0.5 > r < 0.5$ and $p > .05$ (95% confidence interval) in each case. However, there seemed to be causality between participants' BMI and a required intensity but not consistently. This causality could be seen in the case type one (forehead stimulated by AW) where $p < .05$ regarding the movement threshold. Further, in the case type four (cheek stimulated by LP) both the detected and the movement thresholds resulted two-sided Pearson $p < .05$

It seems that both the devices' muscle movement thresholds were quite well accepted: 11-13 participants out of 14 considered the stimulation acceptable, especially when stimulating cheek (the acceptance rate 13/14). However, one male participant considered all the stimuli unacceptable. Besides him two other male participants felt stimulating forehead unacceptable, one of them only with AW. One female participant reported an unacceptable sensation when stimulating forehead with LP. The unacceptable experiences were described unpleasant, and even light pain or headache

was mentioned. Regarding BMI there was no indication of causality against acceptance. An interesting point was that in those eight cases, where the muscle movement threshold was rated unacceptable, only once (when stimulation forehead with AW) it was the highest evaluated intensity level per location. In other words, other participants tolerated most often higher intensity levels than the ones that were rated unacceptable.

The first evaluated dimension was naturalness of the stimulus. A two-way 2 x 2 (device x stimulus location) ANOVA showed that the main effect of device was non-significant $F(1, 13) = .143$, $p = .711$, whereas the main effect of stimulus location approached significance $F(1, 13) = 4.369$, $p = .057$. The interaction of the main effects was non-significant $F(1, 13) = .959$, $p = .345$. Post hoc pairwise comparisons showed that stimulation of forehead was rated as somewhat more natural than cheek with both devices $MD = .643$, $p = .057$.

Pleasantness of the stimulus was the second evaluated dimension. According to two-way 2 x 2 (device x stimulus location) ANOVA, the main effect of device was non-significant $F(1, 13) = .085$, $p = .775$, as well as the main effect of stimulus location $F(1, 13) = .410$, $p = .533$. The interaction of the main effects was also non-significant $F(1, 13) = .356$, $p = .561$.

The third evaluated dimension was arousal. A two-way 2 x 2 (device x stimulus location) ANOVA showed that the main effect of device was non-significant $F(1, 13) = .209$, $p = .655$, whereas the main effect of stimulus location indicated weak significance $F(1, 13) = 3.521$, $p = .083$. The interaction of the main effects was non-significant $F(1, 13) = .610$, $p = .449$. Post hoc pairwise comparisons indicated that stimulation of cheek was rated as somewhat more arousing than forehead with both devices $MD = .679$, $p = .083$.

The last evaluated dimension was dominance. Similar to pleasantness, a two-way 2 x 2 (device x stimulus location) ANOVA showed that the main effect of device was non-significant $F(1, 13) = .436$, $p = .520$, as well as the main effect of stimulus location $F(1, 13) = .959$, $p = .345$. The interaction of the main effects was also non-significant $F(1, 13) = 1.319$, $p = .271$. The subjective mean ratings of the four dimensions and standard error of the means (SEMs) are presented below in Figure 7 by the device and stimulus location.

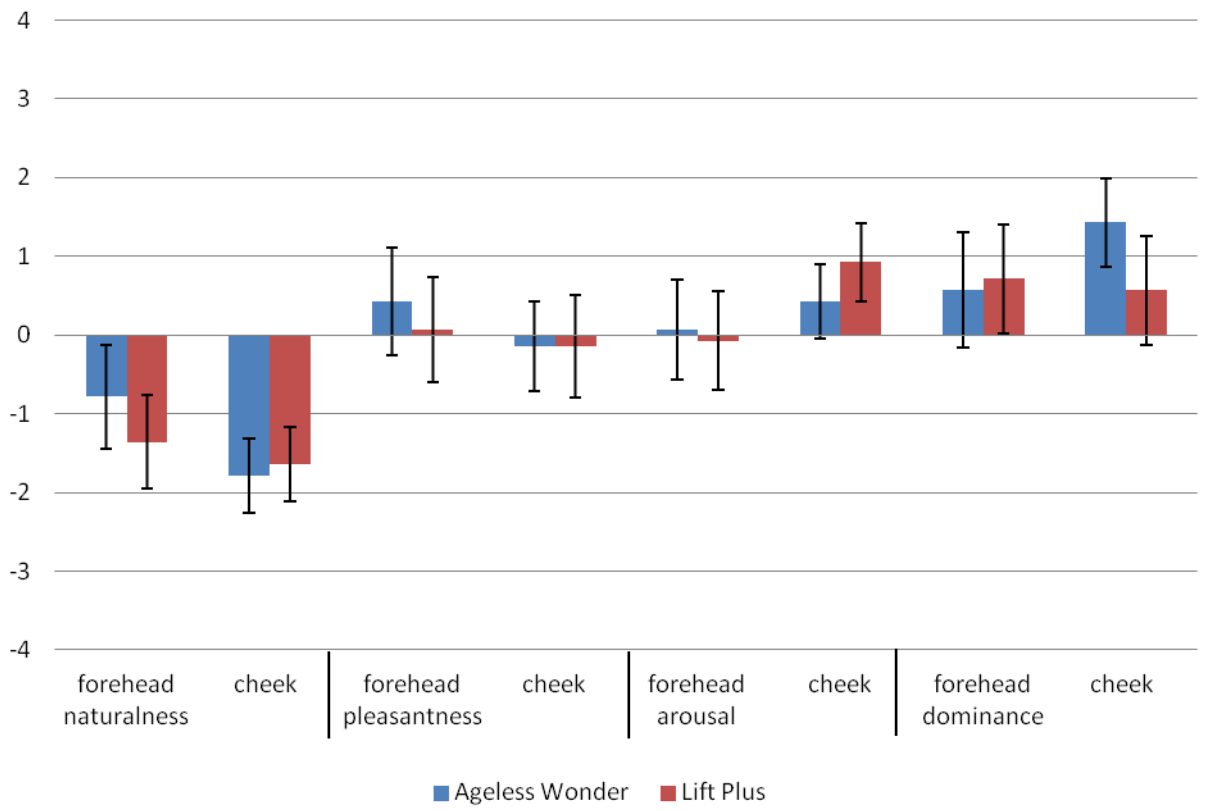

Figure 7. The subjective mean ratings of four dimensions (scale: -4 – 4). Error bars represent SEMs.

5.2. User Experience

The mean ratings and standard error of the means (SEMs) are presented below in Figure 8 by the device. The rating scale of 1-7 was transformed to (-3) – (+3) to illustrate the negative-positive dimensions of the bi-polar scales.

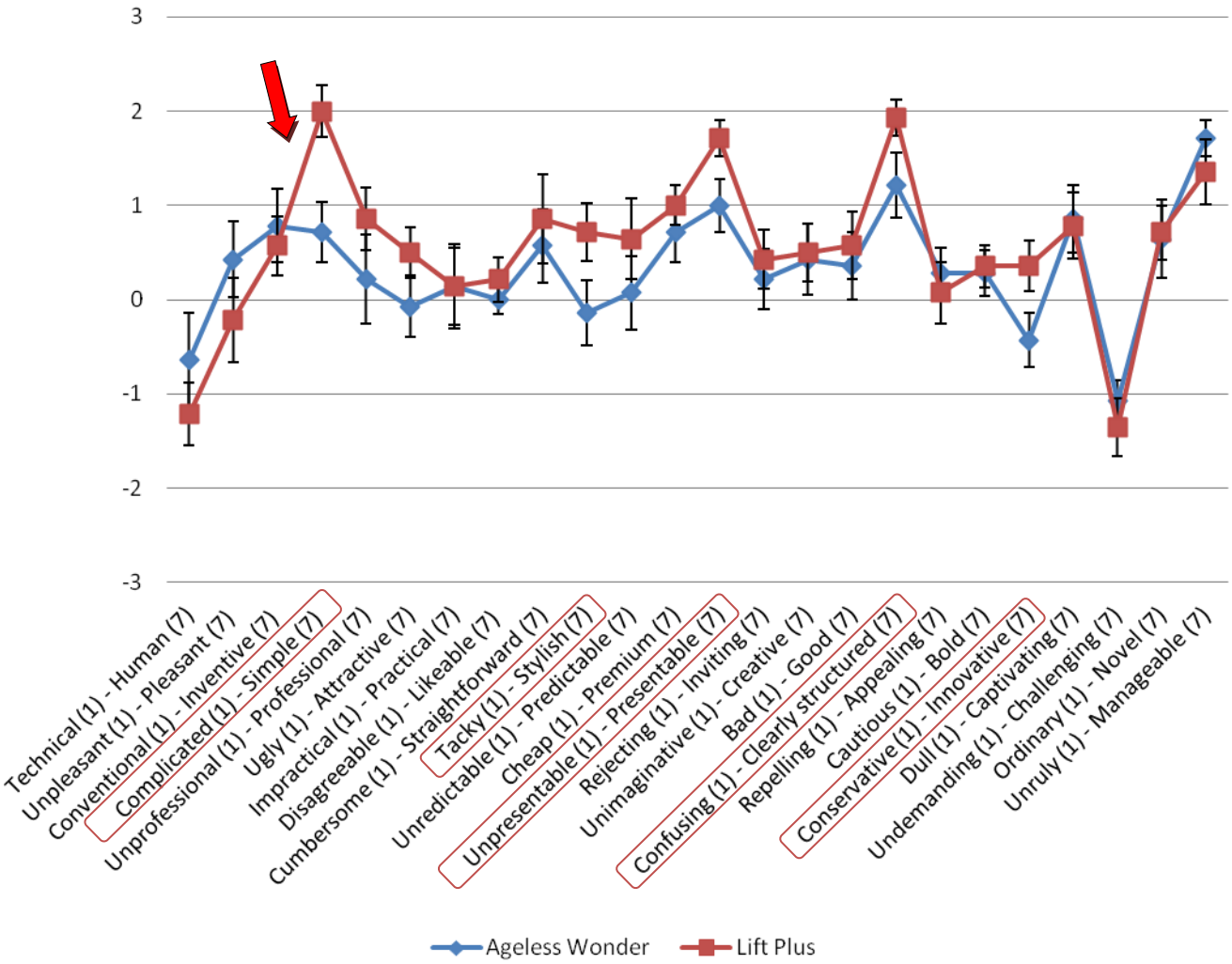

Figure 8. Mean user experience ratings. Error bars represent SEMs. The features indicating significant difference are framed and the biggest difference between the devices is pointed by an arrow.

Based on the SEM results, there are five features that were indicating potentially significant difference between the two devices. These features are *simplicity* (complicated – simple), *stylishness* (tacky – stylish), *presence* (unpresentable – presentable), *clarity* (confusing – clearly structured) and *innovativeness* (conservative – innovative). The biggest difference between the ratings is in simplicity: even though both devices are considered simple, LP is seen even simpler than AW. According to the participants' evaluations, LP is also more stylish, more presentable, more clearly structured and more innovative than AW. The rest of the differences between the studied features do not refer to statistically significant difference, but they indicate that AW is more human and pleasant but less attractive than LP. LP, instead, seems to have a more professional appearance than AW.

5.3. Interviews

5.3.1. Expectations and attitudes towards electrical facial stimulation

None of the participants had earlier tried electrical facial stimulation, and most of them heard about it first time in pursuance of the current experiment. At the beginning of the pre-interview, the participants were asked to describe their overall thoughts about the electrical stimulation of facial muscles. Three participants found the method overall interesting, one considered it exciting and one thought it is weird. Nobody thought it would be dangerous to use electricity for stimulating facial muscles. However, several participants expressed spontaneously being skeptical about the impact of the stimulation for healthy persons because of no scientific evidence. One male participant called electrical muscles stimulation even a nonsense referring to muscle treating devices that can be bought, for example, from TV Shop.

On the other hand, electrical facial stimulation was seen as a reasonable method because muscles can be stimulated electrically in other body parts as well. About half of the participants started immediately thinking about the sensation of the stimulation. Two male participants had slightly negative prejudices towards the use of electricity and they expected the stimulation being unpleasant. One female participant was excited about the stimulation but was hoping that the stimulus is not very strong. Another female participant had just received beauty treatment for her face by a cosmetologist and was wondering if the electrical stimulation feels the same.

The second topic of the interview was the participants' attitudes towards electrical stimulation in beauty and medical treatment. All the participants looked kindly on stimulation for beauty treatment if somebody wants to use it, even though many regarded it with suspicion. None of the participants knew anyone who had been using this kind of beauty treatment with proper results. A few participants compared it to other beauty care actions like botox injections or operations and considered electrical stimulation as a better option because it is easier to use and control. Electrical stimulation was also seen quite natural way to do beauty care since it could be seen as a facial massage. Regarding electrical stimulation in medical treatment the participants were very unanimous and positive: if stimulation was effective and could help somebody in case of facial paralysis, it should definitely be used. At least it would be worth trying among other treatment.

As the third topic, the participants were asked about the electrical stimulation of their own facial muscles – what kind of expectations and preconceptions they had. Most participants had no prejudices since they had no previous experience. A few participants referred to electric shocks but none of them thought that stimulation would feel as strongly or even the same.

> *"No ei mitään käsitystä. […] Ei itse asiassa oikeestaan oo… sähköiskuja oon joskus saanut mutta tuskin se nyt ihan sitä luokkaa on… vähän pienempiä ja isompia sähköiskuja."* (male, number 1)

A few participants expected the stimulation feeling like a tic in a muscle. One participant wondered if the stimulation feels warm whereas a few thought it could feel itchy. A couple of participants were expecting neutral experience whereas one participant was not sure whether the stimulation feels pleasant or unpleasant. Two participants were expecting negative experience; one of them thought the stimulation could feel unpleasant at least in the beginning. The other one did not refer to actual pain but to an unpleasant feeling:

> *"…niin taikka ei se välttämättä oo kipeetä, en mä usko että noi aiheuttaa siis todennäköisesti kipua, mutta se on epämiellyttävää että, joku ulkopuolinen taho niinkun saa sun lihaksen jännittymään, joka… ja varsinkin sitten jos itse sattuu vielä niinkun tavallaan jännittään vastaan."* (male, number 9)

On the actual stimulation of their own facial muscles, most participants were either interested, curious, excited or they considered it fun to test how the facial stimulation feels. One participant was wondering whether it is difficult to get the muscles move. One participant was slightly worried about the safety of using electricity for the stimulation – could it be dangerous, and actually lead to a facial paralysis? The final conclusion was, however, that the stimulation devices should be safe since they are accepted to be sold within the European Union. Two other participants were also slightly worried about the sensation and the impact of the stimulation because they had very sensitive and dry facial skin.

As the face is a sensitive area, one participant suggested that the facial stimulation would cause sensations for the whole body like a facial massage. One participant was expecting that the whole face will move but at the same time she stated that probably the stimulation feels less than she thinks:

> *"…tärryyttää naamaa…en mä tiiä, voi olla että se tuntuu vähemmän ko mitä mä ehkä aattelen tällä hetkellä…[miltä ajattelet että se tuntuu? –TA] no että tuntuu että koko naama heiluu, hyllyy meneen."* (female, number 11)

Even though most participants were suspicious towards the actual impact of commercial stimulation devices, majority could think of using electrical facial stimulation at home for beauty treatment if there turned out to be solid proof of its impact – either scientific evidence or recommendation by a trustworthy person. Five male participants did not see any reason to use stimulation for their own face only for beauty treatment purposes. For medical reasons, all the participants could think of using electrical stimulation if they were suffering from facial paralysis. However, one participant would like to hear a doctor's recommendation prior to usage, and another one could use electrical stimulation if it did not hurt or feel very unpleasant.

To get the first impression out of the tested devices, the participants were asked to tell their spontaneous thoughts about the stimulators before usage. Several participants described Lift Plus™ as big, metal and heavy, and therefore more robust, reliable, convincing, professional, durable and expensive than Ageless Wonder™. For a few participants LP's metal electrodes looked cold and they were wondering whether the electrodes warm up during the stimulation. For one participant LP was less appealing due to the big electrodes; some participants considered them even frightening as they indicated big shocks. On the other hand, metal electrodes were also considered hygienic because they should be easy to keep clean. At this point two participants would have chosen LP because it contained no disposable parts contrary to AW.

Compared to LP, AW looked to many participants more delicate, smaller, friendlier and overall more appealing because of a softer and more neutral appearance. On the other hand, a small and plastic device with a long wire gave an impression of a cheap device with poor quality. One female participant compared the devices with children's toys: the more plastic and lighter they are, the easier and quicker they get broken. Due to AW's more complicated appearance one participant thought it might be more difficult to use than LP. Several participants were worried how hygienic AW's electrodes are in use. AW's disposable electrode pillows were not seen as a good feature either.

5.3.2. Feelings and thoughts after the stimulation

After the experiment, the participants were interviewed again. First, the participants were asked to describe their feelings of the experiment in general, and how did it feel to stimulate own facial muscles. Second, the participants were asked to tell about the stimulation experience in more detail: did they experience anything surprising during the stimulation, could they think of using electrical facial stimulation later at any purposes, and could they recommend facial stimulation to relatives or friends.

Most participants described it ‘interesting’ to stimulate their facial muscles. For most participants, it was slightly unnatural that an external stimulus moved own facial muscles, but still not uncomfortable though not relaxing or appealing as such. The experience was neutral or positive in most cases, even though two male participants described it uncomfortable and one of them referred even to torturing. For him the sensation of muscle movement was similar to pinching. On the contrary, one male participant described the experience very comfortable and even funny. For one female participant, the sensation was more delicate than she had expected in advance:

> *”…varmaan se ylipäätään se tunne mimmonen siitä [stimuloinnista – TA] tuli, just se… en ollu odottanu… et se on aika hienovaranen mut samalla tosi niinku selkee.”* (female, number 12)

In addition, she had expected stronger haptic or auditory feedback. For her it was more comfortable to stimulate forehead, as stimulating cheek felt like a tic all over the cheek and even around the eye. For another participant stimulating cheek was more unpredictable, since the muscle began to move suddenly when the stimulus affected the right muscle. That caused an uncontrolled feeling which the participant described almost frightening. On the contrary, one participant considered it more difficult to stimulate forehead because of the more difficult hand position.

Several participants mentioned unexpected sensations that the stimulus caused. One male participant had expected a tic or numb feeling under the electrode but instead the stimulus could be felt on a broader area. In addition, he could feel the muscle subtractions. Two other male participants shared the same sensation around the face. For one of them the stimulus felt like a mild electric shock as expected. For one male participant, the stimulation felt like a tic as he had expected, but cold shivers on top of head had been surprising and uncomfortable. One female participant had expected a gentler sensation but during the test she could even feel electricity coming to her face. For one male participant feeling pain during the stimulation was surprising – he described the sensation as “almost like a headache”.

One female participant compared the external power moving muscles to a sensation of a normal reflex. One female participant pointed out that the external stimulus was not uncomfortable because she could control the sensations all the time by moving the device or changing the intensity level. Another female participant mentioned that a weird feeling stopped when the right place for moving the target muscle was found. A couple of other participants referred to the same finding – the same power level could be felt mildly or strongly depending on the stimulated area. In addition, they found it interesting to see how the sensation changed and which muscles reacted when the electrode was moved on the face.

Several participants were surprised how powerful the tested devices actually were. The stimulus could be felt clearly and muscles were really moving even with low power levels. A few participants were even concerned of the effect which the strongest power levels could cause.

> *"…yllätti mun mielestä se, varsinki se, kyl se must yllätti et miten niinko oikeesti ensinnäki tää peukkuki jo et miten se oikeesti saa niinku täältä liikkumaan näitä… yllätti, joo, ihan ehdottomasti --- [liikekö siinä oli yllättävää? –TA] siis se, että oikeesti et sä tiettyyn kohtaan annat sitä signaalii ja sit se liikuttaakin jossain muualla."* (female, number 13)

The experiment did not change any participants' readiness to use electrical facial stimulation in case of personal facial paralysis, but they would like to see clear evidence that it really helps. When it comes to beauty treatment, the participants were still skeptical whether electrical stimulation could really affect healthy muscles and make the face to stay in better shape – even though the devices worked better than they had expected. However, almost half of them could recommend the stimulation devices to relatives or friends but just for interest, not because they were convinced of the effect. Two male participants would recommend neither of the tested devices because the sensation was uncomfortable. Overall, from their perspective the idea of using electricity to treat facial muscles was not appealing at all.

Four out of those five male participants, who did not see any reason to use stimulation for beauty treatment before the experiment, even strengthened their opinion because the stimulation experience was more or less uncomfortable. In addition, one female participant who was hesitating before the experiment would not use electrical stimulation for treating her healthy face based on this experience. However, one male participant had a very positive experience which made him to think of using facial stimulation devices at home and recommending them warmly to others as well. The rest of the participants had the same attitude towards electrical stimulation for personal beauty treatment than before: one of them still could not think of using it whereas the others were slightly more positive.

The third discussion topic was the look and feel of the tested stimulation devices. On top of that the participants were asked to select which one of the two stimulators they preferred. Most participants considered AW as a better device because it was smaller and lighter than LP. Light electrodes were seen easier to hold, especially, if the user stimulates the face for a long time. Many participants were also pleased with AW's separate control panel and the electrodes: the user could see and adjust the power level easily while holding the electrodes on one hand and stimulating the muscles on the

other hand. Overall, AW's screen was considered better by several participants because it was more informative. One participant pointed out that the device was even portable. However, AW's appearance was still polarizing the opinions.

LP was criticized for several reasons. First, two participants considered its electrodes hard and cold providing uncomfortable feeling on the skin. In addition, several participants disliked using gel on the electrodes because it was cold and messy, required extra effort and it needs to be bought separately. On the other hand, the metal electrodes pleased many participants because they would be easier to keep clean than the sponges in the AW's electrode and there were no disposable parts. Several participants thought that LP may be even too big and heavy device for holding a long time. In addition, the steps between the power intensity levels were considered higher in LP compared to AW which was seen as a negative feature:

> *"…tossa [Lift Plus™] oli vähän sillain että aluks se ei tuntunu ollenkaan ja sit se tota, ja sitte niinkö jossakin vaiheessa alko tuntuun, tavallaan, et siinä niinkun, tota niinku ei ilmeisesti pysty tai ainakaan mulla se ei tuntunu tai niinku kovin pienellä teholla vaikuttanu mitään [että tuli yllättäen ja nopeasti tuntemus, sellaistako tarkoitat? –TA]… joo, joo, sit se alko tosiaan selvästi tuntuun [että tuntemuksessa tuli selvä hyppäys jossakin kohdin? –TA] joo, joo --- niin, ei se, ainakin tässä tota, niin ei se tuntunut kovin miellyttävältä."* (male, number 4)

Regarding usability, many participants found it difficult to use LP because the user had to hold the device, find the right place for the stimulation and press the buttons in one hand simultaneously. All participants agreed that not seeing the screen when stimulating the face was LP's clear weakness. It was also considered weird that the user had to push a button twice before the intensity level changed – if the button was pushed only once nothing happened.

> *"…että se [Lift Plus™] ei ollu niinku yhtään niinku… musta se ei ollut kätevä vaan yksinkertasesti että… se on, se, se oli hölmö, hölmö niinku käytännön kannalta… plus sitten mä en nää niitä että jos mä nostan poweria tai muuta niin mä en nää niitä leveleitä, eli mä saan peilin edessä niin sillain jotenkin niin, se on vähän hakevaa… enkä mä sillain niinkö sormella edes tunne kumpi tässä nyt on se plussa tai miinus --- sitä on hankalaa niinkö kattoa että miten se meni nyt oikein ja muuta että musta toi on niinku käytettävyyden kannalta oikein niinku, musta vähän järjetön."*(male, number 8)

> *"…mä koin tässä kömpelöksi sen että mä en nää edes että mikä voimakkuus siellä on päällä --- ja sit se oli kans tosi huono että se, niinku piti painaa aina kaks kertaa että se muuttu, mistä mä tiedän että onks se kerinny se näyttö sammua, että pitääks mun painaa kerran vai kahdesti, tosi nolo käytettävyysmoka, että ihmettelen kyllä että tommonen on tossa laitteessa."* (female, number 5)

However, a few participants thought that LP was easier to hold and move on the face because the whole device was used on one hand. Two male participants highlighted that LP looks nicer because it is in one piece and does not include any wires. Most participants agreed that LP was a simpler device because it contained only a few clear buttons. However, everyone considered both the devices easy to use since there were not too many buttons and options available to select.

Approximately half of the participants did not see difference between the stimuli of the devices. For the rest, the sensations were polarized: for one participant, the AW's stimulus was more uncomfortable and even painful whereas another participant felt LP's stimulus uncomfortable even on teeth. One participant considered LP's metal electrodes more comfortable than the sponges in the AW's electrode. Three participants considered AW's stimulus more comfortable and softer. A few participants could feel the AW's stimulus sooner.

When the participants were asked to name the preferred device, ten participants out of fourteen chose AW. For eight participants, the choice was easy whereas two of them did not prefer AW as strongly. AW was considered better than LP because it was smaller and easier to handle, no messy gel was needed, the screen could be seen while using the device, it provided softer sensation and it could be used even on lower levels. In addition, LP's appearance with big metal electrodes was less appealing to most of the participants who preferred AW. One participant would choose AW but with LP's electrodes or even electrodes that could be attached to the face. Four men and six women preferred AW.

However, four participants would choose LP – three men and one woman. Two male participants preferred LP without no doubts; for them LP was more comfortable to use than AW even though the intensity level could not be seen while using the device. They appreciated a simple device in one piece. Both participants disliked the AW's long wire and as a whole, LP looked more robust, reliable and appealing. Two other participants were not as sure of their choice but they preferred LP's stimulus over AW's. Additionally, two participants liked to use the gel on LP's electrodes for moving the device over the face.

6. Discussion

In this study, facial muscle stimulation was examined from two perspectives: experience of electrical stimulation as such, and experience of using two commercial stimulation devices. The research data was collected by electrical facial stimulation experiments with 14 healthy participants and measuring their subjective ratings of the stimuli and the devices with questionnaires. The experiments were supported with personal semi-structured interviews which studied the participants' expectations and attitudes towards electrical facial stimulation as well as their user experience of the stimulation and stimulators.

The experimental setting can be considered reliable, as the laboratory context was similar to each participant. All the participants were instructed according to the pre-written script and manuals, the moderator was the same and the experiments were performed according to the same stimulation plan. The forms and questionnaires were unchanged throughout the tests. However, it is good to remember that the results obtained in a laboratory might vary from the results in everyday life. As Abraham et al. [2013] have remarked, the signals that are considered as "too strong" in the laboratory tests might be regarded as "appropriate" in day-to-day situations. In addition, participants may act differently in a laboratory compared to their typical behavior[6], since being observed typically improves the users' performance [Lazar et al., 2010].

Since one aim of this study was to explore the overall user experience of the stimulators, the participants used the stimulation devices themselves during the experiment. Even though the moderator helped the participants to locate the right places on their faces, it was occasionally hard to find the right place for the stimulation, especially when stimulating cheek. This problem was already recognized by Duchenne de Bologne in his facial stimulation experiments at the end of 19th century: de Bologne reported of difficulties in finding the exact localization of the stimulus on the face. Consequently, the stimulus was easily addressed to neighboring muscle fascicles [Duchenne de Bologne, 1862].

The explored usability attributes in this study were learnability and subjective satisfaction. Because of the simple and repetitive nature of the test tasks, learnability was only discussed with the participants after using the stimulation devices. However, it should be kept in mind that contrary to the laboratory experiments, users do not usually study new products and their features carefully before usage [Nielsen, 1993]. The other

[6] The phenomenon is called the "Hawthorne effect" [see e.g. Lazar et al. 2010].

usability attribute, subjective satisfaction, was measured by asking the users' ratings of the stimulation and the devices. Even though single users' opinions are subjective, the average of several opinions results a usable measure. When several products are tested at the same time, as in this study, it is possible to measure subjective satisfaction also by asking preference of the products. [Nielsen, 1993] The rated dimensions of the stimulation were acceptance, naturalness, pleasure, arousal and dominance.

The importance of the human face and its functions was confirmed in this study. All the fourteen participants would be willing to try electrical stimulation as treatment in case of facial paralysis even though the experiment was unpleasant for some participants. As several studies have stated [see e.g. Ohtake et al., 2006], asymmetrical facial expressions and facial weakness may strongly affect an individual's life which encourages patients to try all potential treatment. On the other hand, using electrical stimulation personally for beauty treatment polarized the participants' opinions: most of them could think of trying it, whereas a few participants would not need it in any case, and three participants would refuse due to unpleasant sensations. However, the participants' general attitude towards beauty treatment was not systematically studied in advance which may have affected the opinions. In addition, the participants were also relatively young (13/14 under 40 years old) so they were not worried about wrinkles on their facial skin at this point.

Regarding the anticipated user experience, the participants were mostly excited, interested or curious of trying the electrical facial stimulation personally. Most participants had no prejudices against the stimulation, whereas a few of them were slightly worried if the stimulus could cause pain or feel unpleasant. A couple of participants disliked the idea of using electricity for activating their facial muscles. However, all the participants knew that the devices had been tested in advance, and they seemed to trust the test procedure because it was done under control and for scientific purposes. Additionally, volunteer participants may be more curious to try new devices than common people – they may even have more positive attitude towards new technology than others. To analyze the anticipated user experience deeper, the preconceptions and attitudes towards electrical facial stimulation should be studied more systematically in advance.

Overall, the stimulation of both devices was well accepted, especially when stimulating cheek. However, the results indicated that the acceptance varies remarkably between individuals and stimulus locations. Some participants could feel the stimuli almost from the beginning whereas others had to use clearly higher intensity levels to detect the stimuli and make their muscles move. Before the experiments it was suggested that due

to a thicker skin the male participants' face require higher intensity levels to produce muscle movement and they should also tolerate higher intensity levels than females. Based on the test results, this assumption was incorrect. One male participant considered all the stimuli unacceptable, and besides him two male participants felt stimulating forehead unacceptable, one only with AW. Only one female felt stimulating forehead by LP unacceptable. To study further potential causality between genders and the detected and tolerated thresholds, a larger group of participants should be involved in the experiments. In addition, thickness of the participants' skin should be measured which was not done in these tests.

The second assumption suggested that the higher BMI a person has, the higher intensity level is tolerated and also required to produce muscle movement due to a thicker fatty tissue. The results supported this assumption partially and indicated causality between participants' BMI and a muscle movement threshold, but not consistently. This causality could be seen when stimulating forehead with AW and when stimulating cheek with LP but not in the other cases. To accept or reject this assumption more tests should be conducted with participants who have more varying BMIs. Within the group of fourteen participants in this study the deviation among the BMIs was moderate. Regarding the four other rated dimensions, stimulation of forehead was considered as more natural than cheek, whereas stimulation of cheek was rated more arousing than forehead. Pleasure and dominance of the stimulation did not differ significantly by the location or the device.

Based on the post-interviews, the experienced stimulation sensations followed a normal distribution: two participants out of fourteen described the sensation comfortable and positive, whereas two participants described it really uncomfortable. The rest of the participants shared neutral experiences which could be described neither comfortable nor uncomfortable. When studying the ratings of the stimulation experience by gender, men's sensations varied more than women's: two male participants disliked the stimulation, one male liked it and the rest of the men fell in the middle group. Most women – six out of seven – could be located in the middle group and only one female participant described the sensation comfortable. None of women clearly disliked the stimulation, even though one female participant would not use electrical stimulation for beauty treatment based on this experiment.

Regarding the stimulation devices, ten participants out of fourteen would have selected Ageless Wonder™. It was considered better than Lift Plus™ because it was smaller and lighter and therefore easier to hold even for a long time. The other critical point was AW's screen which could be seen all the time while using the device. In addition, no messy gel was needed for using AW although it was criticized for its non-hygienic and

disposable sponges in the electrode. A light and plastic appearance gave also a cheap impression of the device. LP with metal electrodes was seen as a more professional, convincing and hygienic device than AW, even though a few participants considered the big electrodes too big and frightening. However, LP's main weakness was its poor usability: it was difficult to see and adjust the intensity levels while using the device and it was heavy to hold on one hand, especially when stimulating forehead. Overall, both devices were easy to learn to use due to few buttons and options to choose.

The results of the AttrakDiff evaluation were mostly in accordance with the interviews. There were five features that were indicating significant difference between the two stimulation devices: simplicity, stylishness, presence, clarity and innovativeness. LP was seen as a simpler, more stylish, more presentable, more clearly structured device and more innovative than AW. The rest of the discovered differences indicate that AW was considered as a more human and pleasant device but less attractive than LP. When it comes to the subjective ratings of the stimuli, AW's averages' standard deviations were considerably higher than LP's which is probably due to a different type of wave, frequency and duration of the impulse. An interesting point is that based on the AttrakDiff evaluations LP was seen as a better device in most features but still most participants would have chosen AW based on the experiment. This finding suggests that the UX questionnaire should be revised for future studies.

7. Conclusions

A human face is an important and sensitive part of a human body, and facial expressions are used to communicate non-verbally with other people. If a person is suffering from unilateral facial paresis, s/he cannot move the muscles on one side of the face. Due to this condition, facial expressions are not symmetric which may seriously complicate an individual's social life. Unilateral facial paresis may be temporary or turn chronic in spite of medication and therapy. One method to treat unilateral facial paresis is electrical facial stimulation which has been examined by several researchers. Electrical facial stimulation has also been studied for producing dynamic facial functions to the paralyzed facial muscles. However, the patients' personal experience of the electrical stimulation itself or the stimulation devices is not typically reported.

The focus of this study was on the experience of electrical stimulation as such, and experience of using two commercial stimulation devices. Based on the results, it seems that humans' readiness for treating facial muscles with electrical stimulation in case of facial palsy is very high. However, all the participants were more or less suspicious of the method's impact on facial muscles, and some participants were even worried of using electricity for their face. In addition, unpleasant feelings or even pain during the stimulation were reported. A great variation between persons regarding the sensitiveness for the stimuli was also seen: some participants could feel the stimuli on the lower intensity levels than others, and the thresholds for moving the muscles varied clearly as well. In addition, the right location for stimulation was easier to find when stimulating *frontalis* than *zygomaticus major*. When stimulating cheek the stimulus activated more often other muscles than the targeted one, for example, *orbicularis oculi* around the eye or *orbicularis oris* around the mouth.

All these findings suggest that the users' feelings and sensations should be taken into account when evaluating the success of treatment of facial palsy with electrical stimulation. It is also recommended to involve several patients in planning and designing stimulation devices as one kind of stimulus will most probably not suit to everyone. The more user experience is studied, the better it is to reduce unpleasant sensations and to relieve negative preconceptions. To avoid stimulating wrong muscles, the stimuli should be able to address to a precise area. It would be even better if the device could guide the user to find the desired muscles. Based on this study, small steps between the intensity levels are also appreciated in order to avoid sudden and surprising sensations, which may weaken the user's feeling of control. It might also be worth offering a few options of different kind of stimuli to the patients.

When it comes to the device itself, weight is a critical feature to take into account, especially if the device is designed to be used on one hand. In addition, this study suggests that the device should be simple enough to use to guarantee good learnability. The device should also be hygienic, long-lasting and it should show clearly which set up or program is being used. Disposable parts and too plastic appearance are not appreciated and long wires may also cause trouble. To design a functional and appealing device, which can be adjusted to different kind of patients, proper user testing with a large group of people of different age, gender, BMI and skin is needed. Good user experience encourages potential users to try a new device and continue its usage.

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APPENDIX 1: Information letter to the participants (only in Finnish)

Hei!

Olet alustavasti ilmoittanut olevasi vapaaehtoinen osallistumaan yliopisto-opintojeni lopputyöhön liittyvään tutkimukseen. Tutkimuksen käytännön osio toteutetaan yksilötesteinä Tampereen yliopiston laboratoriossa. Testeissä arvioidaan sähköisten kasvolihasstimulaattorien optimaalista käyttöä ja käyttökokemusta. Tutkimuksessa käytetään tiedonkeruumenetelminä kasvolihasten stimulointia kahdella erilaisella stimulaattorilla, arviointia kyselylomakkeilla ja yksilöhaastattelua.

Koko testaustilanne kestää arviolta noin 60 minuuttia sisältäen haastattelut ja arvioinnit. Testaustilanne tallennetaan videolle. Kerättyä dataa käytetään ainoastaan lopputyöhöni ja siihen liittyvien tieteellisten julkaisujen laatimiseen.

Koska testissä käytetään sähköstimulointia, on varmistettava, ettei sinulla ole mitään sairautta tai muuta lääketieteellistä estettä testattavien laitteiden käyttämiseksi kasvojen alueella. Seuraavat sairaudet tai lääketieteelliset tilat voivat estää laitteiden käytön:

raskaus; turvonnut tai tulehtunut iho; ihovauriot tai avohaavat; ihottuma; ruusufinnit tai märkäiset finnit; herkistynyt iho; tuore arpikudos; ihoalueet, joilla tuntoaisti ei toimi normaalisti; pistoshoidot tai kirurgiset implantit kasvoissa; akuutti trauma tai äskettäinen leikkaus; sairauden, vamman tai leikkauksen aiheuttama kudostulehdus; taipumus verenvuotoon; lääkitys alhaiseen verenpaineeseen; sydänsairaus tai sydämen vajaatoiminta; sydämentahdistin tai muu implantoitu laite; muut ongelmat sydämen toiminnassa; epilepsia; multippeli skleroosi; laskimotulehdus aktiivisessa vaiheessa; suonikohjut myöhäisvaiheessa

Mikäli et voi tämän tiedon perusteella osallistua tutkimukseen, voit perua osallistumisesi ilman tarkempaa syyn yksilöintiä. Vaikka kaikki edellä mainitut sairaudet tai lääketieteelliset tilat eivät välttämättä estä laitteiden käyttöä, vetäytyminen tutkimuksesta on aiheellista terveysriskien minimoimiseksi.

Lopputyöni ohjaajia ovat tohtoriopiskelija Jani Lylykangas ja professori Veikko Surakka Tampereen yliopiston informaatiotieteiden yksiköstä. Jos sinulla herää kysymyksiä aiheeseen liittyen, voit ottaa yhteyttä suoraan minuun.

Pyydän sinua ystävällisesti vastaamaan tähän viestiin, voitko osallistua tutkimukseen vai ei. Osallistujien kanssa sovitaan testausajankohdat myöhemmin. Testit toteutetaan tammi-helmikuussa.

Parhain terveisin
Taru Annala

puh. 040 5272252
annala.taru.m@student.uta.fi

APPENDIX 2a: Consent form

A STUDY ON "USER EXPERIENCE OF ELECTRICAL STIMULATION OF FACIAL MUSCLES" FOR A GRADUATION THESIS

GENERAL: You are invited to participate in the experiment, in which user experience of electrical stimulation of facial muscles is studied. In this experiment, your face is stimulated by two stimulation devices, Ageless Wonder™ and Lift Plus™. Subjective evaluations as well as personal interviews are used as data gathering methods.

DESCRIPTION: The testing session begins with a short interview. After that, you are instructed to use the first stimulation device. During the experiment, your task is to stimulate certain muscles in your face, and evaluate your experience through questionnaires.

Next, you are instructed to use the second stimulation device. Again, your task is to stimulate certain facial muscles, and evaluate your experience through questionnaires. Finally, you are interviewed shortly for the second time.

The whole session is recorded on video. The gathered data is handled confidently according to the law, and will be used only for pro gradu and other scientific publications.

DURATION: Conducting the experiment with all the evaluations and interviews will take approximately 60 minutes.

RISKS: Since electrical stimulation is used during the experiment, you should be sure that you do not have any of the following medical conditions that could cause physical harm to you when stimulating the facial muscles. These conditions are:

pregnancy; swollen, infected or inflated facial skin; facial skin lesions or open wounds; facial skin eruption; rosacea, pustular acne or abraded skin; recent scar tissue; facial skin areas that lack normal sensation; injections or surgical implants in your face; acute trauma or recent surgery; tendency to hemorrhage; receive treatment for low blood pressure; heart disease or cardiac infirmities; pacemaker or other implanted device; other heart problems; epilepsy; Multiple Sclerosis; phlebitis in its active phase (inflammation of a vein); varicose veins in later stages.

BENEFITS: Although there is no monetary compensation for participating in the experiment, your participation will provide useful and important data.

PARTICIPANT RIGHTS: All the data collected during this experiment will be handled anonymously, and cannot be combined with a person. The participation is voluntary, and you can cancel your approval to participate, or stop the test at your own will at any time without specifying the reason or any consequences.

By signing this consent form I agree to participate in the experiment, which is recorded, and I understand there is no monetary compensation for the participation. I have fully understood that participation is voluntary, and I am entitled to refuse to participate, or stop the test at any time without consequences.

DATE AND PLACE: _____

SIGNATURE: _____

CONTACT INFORMATION: If you have any questions, concerns or complaints about this experiment, please contact Taru Annala (tel. 040 527 2252, email: annala.taru.m@student.uta.fi)

APPENDIX 2b: Suostumuslomake

PRO GRADU -TUTKIMUS: SÄHKÖISTEN STIMULAATTORIEN KÄYTTÖKOKEMUS KASVOLIHASTEN STIMULOINNISSA

YLEISTÄ: Sinut on kutsuttu kokeeseen, jossa arvioidaan sähköisten stimulaattorien käyttökokemusta kasvolihasten stimuloinnissa. Tutkimuksessa kasvojasi stimuloidaan kahdella kasvostimulaattorilla (Ageless Wonder™ ja Lift Plus™). Tiedonkeruumenetelminä käytetään arviointia kyselylomakkeilla sekä yksilöhaastattelua.

KUVAUS: Testaustilanne alkaa lyhyellä haastattelulla, jonka jälkeen sinulle annetaan ohjeet ensimmäisen kasvostimulaattorin käyttöön. Kokeen aikana sinun tehtäväsi on stimuloida tiettyjä kasvolihaksiasi, ja arvioida tätä kokemusta kyselylomakkeiden avulla.

Tämän jälkeen sinulle annetaan ohjeet toisen kasvostimulaattorin käyttöön. Myös tällä laitteella sinun tulee stimuloida tiettyjä kasvolihaksiasi, ja arvioida tätä kokemusta kyselylomakkeilla. Lopuksi sinua vielä haastatellaan lyhyesti toisen kerran.

Koko testaustilanne tallennetaan videolle. Videomateriaalia käsitellään luottamuksellisesti henkilötietolain edellyttämällä tavalla. Kerättyä dataa käytetään ainoastaan pro gradun ja siihen liittyvien tieteellisten julkaisujen laatimiseen.

KESTO: Koko testaustilanne kestää arviolta noin 60 minuuttia sisältäen haastattelut ja arvioinnit.

RISKIT: Koska testissä käytetään sähköstimulointia, on varmistettava, ettei sinulla ole mitään sairautta tai muuta lääketieteellistä estettä testattavien laitteiden käyttämiseksi kasvojen alueella. Seuraavat sairaudet tai lääketieteelliset tilat voivat estää laitteiden käytön:

raskaus; turvonnut tai tulehtunut iho; ihovauriot tai avohaavat; ihottuma; ruusufinnit tai märkäiset finnit; herkistynyt iho; tuore arpikudos; ihoalueet, joilla tuntoaisti ei toimi normaalisti; pistoshoidot tai kirurgiset implantit kasvoissa; akuutti trauma tai äskettäinen leikkaus; sairauden, vamman tai leikkauksen aiheuttama kudostulehdus; taipumus verenvuotoon; lääkitys alhaiseen verenpaineeseen; sydänsairaus tai sydämen vajaatoiminta; sydämentahdistin tai muu implantoitu laite; muut ongelmat sydämen toiminnassa; epilepsia; multippeli skleroosi; laskimotulehdus aktiivisessa vaiheessa; suonikohjut myöhäisvaiheessa

HYÖDYT: Vaikka testiin osallistumisesta ei tarjota rahallista korvausta, sinun osallistumisesi tutkimukseen on hyvin tärkeää ja antaa arvokasta tietoa.

OSALLISTUJAN OIKEUDET: Kaikkea kerättyä tietoa käsitellään nimettömästi, eikä tuloksia voi liittää yksittäisiin osallistujiin. Testiin osallistuminen on vapaaehtoista, ja voit keskeyttää testaustilanteen missä vaiheessa tahansa ilman seurauksia. Sinun ei myöskään tarvitse kertoa syytä keskeyttämiselle.

Allekirjoittamalla tämän lomakkeen hyväksyn testaustilanteen tallentamisen. Ymmärrän, että kokeeseen osallistumisesta ei tarjota rahallista korvausta. Ymmärrän, että kokeeseen osallistuminen on vapaaehtoista ja voin kieltäytyä osallistumasta tai keskeyttää testaustilanteen milloin tahansa ilman seurauksia.

PAIKKA JA AIKA: _____

ALLEKIRJOITUS: _____

YHTEYSTIEDOT: Mikäli sinulla on kysyttävää tai muuta palautetta tästä tutkimuksesta, ota yhteyttä Taru Annalaan (puh. 040 527 2252, sähköposti: annala.taru.m@student.uta.fi).

APPENDIX 3a

BACKGROUND INFORMATION

Date: _____

Number of the participant: _____

Please mark the suitable alternatives or fill in the blank fields when necessary.

1. Age: _____ years

2. Gender: [ ] Female [ ] Male

3. Height: _____ cm

4. Weight: _____ kg

5. Are you right-handed or left-handed?

[ ] Right-handed
[ ] Left-handed

6. Have you used any kind of electrical stimulation devices for facial muscles before?

[ ] No
[ ] Yes, please specify: _____
[ ] Cannot say

THANK YOU!

APPENDIX 3b

TAUSTATIEDOT

Päivämäärä: _____

Osallistuja nro: _____

Ole hyvä ja vastaa alla oleviin kysymyksiin valitsemalla sopiva vaihtoehto tai kirjoittamalla vastauksesi siihen tarkoitettuun tilaan.

1. Ikä: _____ vuotta

2. Sukupuoli: [ ] Nainen [ ] Mies

3. Pituus: _____ cm

4. Paino: _____ kg

5. Oletko oikea- vai vasenkätinen?

[ ] Oikeakätinen
[ ] Vasenkätinen

6. Oletko aikaisemmin käyttänyt minkäänlaista sähköistä stimulaattoria kasvolihasten aktivoimiseksi?

[ ] En
[ ] Kyllä, minkälaista laitetta ja missä? _____
[ ] En osaa sanoa

KIITOS!

APPENDIX 4a

Pre-interview (before the stimulation)

1. How do you feel of the idea of electrical stimulation of facial muscles? Why?

2. Stimulation devices for facial muscles are used both for beauty treatment and for medical use. What do you think of stimulating facial muscles

a) For beauty treatment, e.g., to prevent wrinkles and lift cheeks to look younger?

INFORMATION ON UNILATERAL FACIAL PARESIS: Unilateral facial paresis means that some or all of the muscles on one side of the face cannot be moved. A person suffering from facial paresis cannot, for example, blink one of his/her eyes properly or smile symmetrically.

b) For medical use, e.g., to treat facial paresis?

3. How do you feel of stimulating your own facial muscles? Why?

a) Do you have any fears or preconceptions for using electrical stimulation for your own face? Why?

4. How do you expect the electrical stimulation feels?

5. Could you think of using commercial electrical stimulation devices for your own facial muscles? Why? Why not?

a) For beauty treatment?
b) For medical treatment, e.g. in case of facial paresis?

6. How do you feel of these devices, which we are going to use today? Why?

7. Do you have any other thoughts or comments before starting the stimulation?

APPENDIX 4b

Alkuhaastattelu (ennen stimulointia)

1. Miltä sinusta tuntuu ajatus kasvolihasten sähköisestä stimuloinnista? Miksi?

2. Kasvolihasstimulaattoreita käytetään sekä lääketieteellisiin että kauneudenhoidollisiin tarkoituksiin. Mitä mieltä olet kasvolihasten stimuloinnista

a) Kauneudenhoidollisiin tarkoituksiin, esim. estämään ryppyjä ja kohottamaan kasvoja, jotta näyttäisi nuoremmalta?

TIETOISKU TOISPUOLEISESTA KASVOHALVAUKSESTA: Toispuoleinen kasvohalvaus tarkoittaa, että kasvojen toisen puolen lihaksia (tai osaa niistä) ei voi liikuttaa eikä hallita. Kasvohalvauksesta kärsivä henkilö ei voi esimerkiksi räpyttää toista silmäänsä tai hymyillä symmetrisesti, koska toinen suupieli ei liiku.

b) Lääketieteellisiin tarkoituksiin, esim. hoitamaan kasvohalvausta?

3. Miltä sinusta tuntuu ajatus omien kasvolihastesi stimuloinnista? Miksi?

a) Onko sinulla pelkoja tai ennakkoluuloja sähköisen stimuloinnin käytöstä omien kasvojesi alueella? Miksi?

4. Miltä arvelet sähköisen kasvolihasstimuloinnin tuntuvan?

5. Voisitko ajatella käyttäväsi kaupallisia sähköisiä kasvostimulaattoreita omien kasvolihastesi aktivoimiseen? Miksi? Miksi et?

a) Kauneudenhoitoon?
b) Lääketieteelliseen hoitoon, esim. jos sinulle tulisi kasvohalvaus?

6. Miltä nämä tässä testissä käytettävät laitteet vaikuttavat? Mitä ajatuksia ne herättävät? Miksi?

7. Onko sinulla vielä muita ajatuksia tai kommentteja, ennen kuin aloitamme stimuloinnin?

APPENDIX 5a

Post-interview (after the stimulation)

1. Spontaneous comments on your experience of the stimulation?

2. How did you feel of stimulating your own facial muscles? Why?

    a) How did you feel the movement of your facial muscle produced by a detached device?

3. How would you describe your experience of the two tested devices? Good and bad sides?

    a) Buttons? Display? Feedback? Sensation? Else?
    b) How easy or difficult it was to learn to know how to use the devices?

4. If you compare the two tested stimulation devices, which device would you prefer? Why?

5. Now when you have tested the two commercial electrical stimulation devices for facial muscles, could you think of using this kind of devices for your own face? Why? Why not?

    a) For beauty treatment?
    b) For medical treatment, e.g. in case of facial paresis?

6. Could you recommend electrical stimulation of facial muscles to your friends and relatives? Why? Why not?

7. Did the stimulation surprise you? Did you feel surprised at any point?

8. Do you have any other thoughts or comments to share?

APPENDIX 5b

Loppuhaastattelu (stimuloinnin jälkeen)

1. Miten kommentoisit stimulointikokemusta yleisesti?

2. Miltä sinusta tuntui stimuloida omia kasvolihaksiasi? Miksi?

   a) Miltä ulkopuolisen laitteen tuottama liike kasvolihakseen tuntui?

3. Miten kuvailisit kokemuksiasi kahden testaamasi stimulaattorin käytöstä? Laitteiden hyvät ja huonot puolet?

   a) Nappulat? Näyttö? Laitteen antama palaute? Tuntemus? Muuta?
   b) Kuinka helppoa tai vaikeaa oli oppia käyttämään näitä laitteita?

4. Jos vertaat kahta testaamaasi stimulaattoria, kumpaa laitetta pidät parempana? Miksi?

5. Nyt kun olet testannut kahta kaupallista sähköistä kasvostimulaattoria, voisitko ajatella käyttäväsi tällaisia laitteita omien kasvolihastesi aktivoimiseen? Miksi? Miksi et?

   a) Kauneudenhoitoon?
   b) Lääketieteelliseen hoitoon, esim. jos sinulle tulisi kasvohalvaus?

6. Voisitko suositella kasvolihasten sähköistä stimulointia ystävillesi ja sukulaisillesi? Miksi? Miksi et?

7. Yllättikö stimulointi sinua mitenkään? Tunsitko itsesi missään vaiheessa yllättyneeksi?

8. Onko sinulla vielä muita ajatuksia tai kommentteja aiheeseen liittyen?

APPENDIX 6a

Electrical Stimulation of Facial Muscles: Evaluation

Date: _____

Number of participant: _____

Device: ❒ Ageless Wonder™ ❒ Lift Plus™

Stimulated area: ❒ Forehead ❒ Cheek

Detectable intensity level: _____

Evaluated intensity level: _____

Please evaluate the stimulation by the following questions.
Select the suitable option for each question by marking it.

1. Was the final stimulation intensity at acceptable level?

❒ Yes
❒ No, why not?

_____

2. How natural did you feel the stimulation, which moved your facial muscle?

	-4	-3	-2	-1	0	+1	+2	+3	+4	
Unnatural	❒	❒	❒	❒	❒	❒	❒	❒	❒	Natural

3. How pleasant did you feel the stimulation, which moved your facial muscle?

	-4	-3	-2	-1	0	+1	+2	+3	+4	
Unpleasant	❒	❒	❒	❒	❒	❒	❒	❒	❒	Pleasant

4. How arousing did you feel the stimulation, which moved your facial muscle?

	-4	-3	-2	-1	0	+1	+2	+3	+4	
Calm	❒	❒	❒	❒	❒	❒	❒	❒	❒	Arousing

5. During the stimulation, which moved your facial muscle, did you feel that you were dominant or the stimulation was dominant?

	-4	-3	-2	-1	0	+1	+2	+3	+4	
I felt that I was dominant	❒	❒	❒	❒	❒	❒	❒	❒	❒	I felt that the stimulation was dominant

APPENDIX 6b

Kasvolihasten sähköinen stimulointi: Arviointi

Päivämäärä: _____

Osallistuja nro: _____

Laite: ❒ Ageless Wonder™ ❒ Lift Plus™

Stimuloitu alue: ❒ Otsa ❒ Poski

Havaittu teho: _____

Arvioitu teho: _____

Ole hyvä ja arvioi stimulointia (ärsykettä) vastaamalla seuraaviin kysymyksiin.
Valitse sopivat vastaukset rastittamalla ne annetuista vaihtoehdoista.

1. Oliko korkein käyttämäsi stimulointiteho mielestäsi hyväksyttävällä tasolla?

❒ Kyllä
❒ Ei, miksi ei?

_____

2. Kasvolihasta liikuttava stimulointi tuntui…

	-4	-3	-2	-1	0	+1	+2	+3	+4	
Epäluonnolliselta	❒	❒	❒	❒	❒	❒	❒	❒	❒	Luonnolliselta

3. Kasvolihasta liikuttava stimulointi tuntui…

	-4	-3	-2	-1	0	+1	+2	+3	+4	
Epämiellyttävältä	❒	❒	❒	❒	❒	❒	❒	❒	❒	Miellyttävältä

4. Kasvolihasta liikuttavan stimuloinnin aikana tunsin oloni…

	-4	-3	-2	-1	0	+1	+2	+3	+4	
Rauhalliseksi	❒	❒	❒	❒	❒	❒	❒	❒	❒	Virittyneeksi

5. Koitko kasvolihasta liikuttavan stimuloinnin aikana, että sinä olit hallitseva vai että stimulointi (ärsyke) oli hallitseva?

	-4	-3	-2	-1	0	+1	+2	+3	+4	
Koin, että minä olin hallitseva	❒	❒	❒	❒	❒	❒	❒	❒	❒	Koin, että stimulointi (ärsyke) oli hallitseva

APPENDIX 7a

Electrical Stimulation of Facial Muscles: User Experience

Date: _____

Device: ❒ Ageless Wonder™ ❒ Lift Plus™

Number of the participant: _____

Please evaluate your overall experience of the stimulation device through the following features. Select the suitable number, which describes the device best, on a scale 1-7 for each pair of features.

	1	2	3	4	5	6	7	
Human	❒	❒	❒	❒	❒	❒	❒	Technical
Pleasant	❒	❒	❒	❒	❒	❒	❒	Unpleasant
Inventive	❒	❒	❒	❒	❒	❒	❒	Conventional
Simple	❒	❒	❒	❒	❒	❒	❒	Complicated
Professional	❒	❒	❒	❒	❒	❒	❒	Unprofessional
Ugly	❒	❒	❒	❒	❒	❒	❒	Attractive
Practical	❒	❒	❒	❒	❒	❒	❒	Impractical
Likeable	❒	❒	❒	❒	❒	❒	❒	Disagreeable
Cumbersome	❒	❒	❒	❒	❒	❒	❒	Straightforward
Stylish	❒	❒	❒	❒	❒	❒	❒	Tacky
Predictable	❒	❒	❒	❒	❒	❒	❒	Unpredictable
Cheap	❒	❒	❒	❒	❒	❒	❒	Premium
Unpresentable	❒	❒	❒	❒	❒	❒	❒	Presentable
Rejecting	❒	❒	❒	❒	❒	❒	❒	Inviting
Unimaginative	❒	❒	❒	❒	❒	❒	❒	Creative
Good	❒	❒	❒	❒	❒	❒	❒	Bad
Confusing	❒	❒	❒	❒	❒	❒	❒	Clearly structured
Repelling	❒	❒	❒	❒	❒	❒	❒	Appealing
Bold	❒	❒	❒	❒	❒	❒	❒	Cautious
Innovative	❒	❒	❒	❒	❒	❒	❒	Conservative
Dull	❒	❒	❒	❒	❒	❒	❒	Captivating
Undemanding	❒	❒	❒	❒	❒	❒	❒	Challenging
Novel	❒	❒	❒	❒	❒	❒	❒	Ordinary
Unruly	❒	❒	❒	❒	❒	❒	❒	Manageable

APPENDIX 7b

Kasvolihasten sähköinen stimulointi: Käyttökokemus

Päivämäärä: _____

Laite: ❒ Ageless Wonder™ ❒ Lift Plus™

Osallistuja nro: _____

Ole hyvä ja arvioi kasvostimulaattorin käyttöä kokonaisuudessaan seuraavien ominaisuuksien avulla. <u>Merkitse kunkin ominaisuusparin kohdalle testaamaasi stimulaattoria parhaiten asteikolla kuvaava kohta.</u>

	1	2	3	4	5	6	7	
Inhimillinen	❒	❒	❒	❒	❒	❒	❒	Tekninen
Miellyttävä	❒	❒	❒	❒	❒	❒	❒	Epämiellyttävä
Kekseliäs	❒	❒	❒	❒	❒	❒	❒	Tavanomainen
Yksinkertainen	❒	❒	❒	❒	❒	❒	❒	Monimutkainen
Ammattimainen	❒	❒	❒	❒	❒	❒	❒	Harrastelijamainen
Ruma	❒	❒	❒	❒	❒	❒	❒	Kaunis
Käytännöllinen	❒	❒	❒	❒	❒	❒	❒	Epäkäytännöllinen
Viehättävä	❒	❒	❒	❒	❒	❒	❒	Vastenmielinen
Hankala	❒	❒	❒	❒	❒	❒	❒	Vaivaton
Tyylikäs	❒	❒	❒	❒	❒	❒	❒	Tyylitön
Ennustettava	❒	❒	❒	❒	❒	❒	❒	Ennalta arvaamaton
Huonolaatuinen	❒	❒	❒	❒	❒	❒	❒	Korkealaatuinen
Esittelykelvoton	❒	❒	❒	❒	❒	❒	❒	Esittelykelpoinen
Luotaantyöntävä	❒	❒	❒	❒	❒	❒	❒	Kutsuva
Mielikuvitukseton	❒	❒	❒	❒	❒	❒	❒	Luova
Hyvä	❒	❒	❒	❒	❒	❒	❒	Huono
Sekava	❒	❒	❒	❒	❒	❒	❒	Selkeä
Inhottava	❒	❒	❒	❒	❒	❒	❒	Vetoava
Uskalias	❒	❒	❒	❒	❒	❒	❒	Varovainen
Omaperäinen	❒	❒	❒	❒	❒	❒	❒	Sovinnainen
Pitkästyttävä	❒	❒	❒	❒	❒	❒	❒	Mukaansatempaava
Helppo	❒	❒	❒	❒	❒	❒	❒	Haastava
Uudenlainen	❒	❒	❒	❒	❒	❒	❒	Perinteinen
Vaikeasti hallittava	❒	❒	❒	❒	❒	❒	❒	Helposti hallittava