THE EFFECT OF EMOTIONAL FACIAL EXPRESSIONS OF A VIRTUAL CHARACTER ON PEOPLE'S PERFORMANCE FOR INTERACTIVE DIGITAL TASKS

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ALPER KARADOĞANER

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submitted by **ALPER KARADOĞANER** in partial fulfillment of the requirements for the degree of **Master of Science in Design Research for Interaction, Department of Industrial Design, Middle East Technical University** and **Faculty of Industrial Design Engineering, Delft University of Technology** by,

Prof. Dr. Canan Özgen _____
Dean, Graduate School of **Natural and Applied Sciences, METU**

Prof. Dr. Cees de Bont _____
Dean, **Faculty of Industrial Design Engineering, TUDelft**

Assoc. Prof. Dr Gülay Hasdoğan _____
Head of Department, **Department of Industrial Design, METU**

Inst. Refik Toksöz _____
Supervisor, **Department of Industrial Design, METU**

Assist. Prof. Dr. Valentijn Visch _____
Supervisor, **Faculty of Industrial Design Engineering, TUDelft**

Examining Committee Members:

Assist. Prof. Dr. Fatma Korkut _____
Department of Industrial Design, METU

Inst. Refik Toksöz _____
Department of Industrial Design, METU

Assist. Prof. Dr. Valentijn Visch _____
Industrial Design Engineering, TUDelft

Prof. Dr. Paul Hekkert _____
Industrial Design Engineering, TUDelft

Assist. Prof. Dr. Owain Pedgley _____
Department of Industrial Design, METU

Date: 15 September 2010

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Last Name: Alper Karadoğaner

Signature :

ABSTRACT

THE EFFECT OF EMOTIONAL FACIAL EXPRESSIONS OF A VIRTUAL CHARACTER ON PEOPLE'S PERFORMANCE FOR INTERACTIVE DIGITAL TASKS

Karadoğaner, Alper
M.S., Department of Industrial Design, METU
M.Sc., Faculty of Industrial Design Engineering, TUDelft
Supervisor (METU) : Inst. Refik Toksöz
Supervisor (TUDelft) : Assist. Prof. Dr. Valentijn Visch

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This thesis investigates the effect of emotional facial expressions of a virtual character on people's performance for interactive digital tasks. The basic and universal emotions are used in the study. Facial expressions of these emotions are created according to the Facial Action Coding System (FACS), which is a system that describes facial movements in the face. The patterns of cooccurences of Action Units (descriptions of facial movements defined in FACS) for basic emotions are also implemented into emotional facial expressions with regard to findings of the studies in the literature. A study was conducted to validate the recognition of emotion specific facial expressions that are built by Poser software. To investigate the effect of emotional facial expressions on people's performance for digital interactive tasks in a virtual environment, a digital interactive application created by Unity software was used in the final study of the thesis.

Keywords: facial expression, emotional expression, virtual character, interactive digital task

ÖZ

ETKİLEŞİMLİ DİJİTAL GÖREVLERDE KULLANILAN SANAL KARAKTERİN DUYGUSAL YÜZ İFADELERİNİN İNSANLARIN PERFORMANSI ÜZERİNDEKİ ETKİSİ

Karadoğaner, Alper
Yüksek Lisans, Endüstri Ürünleri Tasarımı Bölümü, ODTÜ
Yüksek Lisans, Endüstri Ürünleri Tasarımı Mühendisliği Fakültesi, TUDelft
Tez Yöneticisi (ODTÜ) : Öğr. Gör. Refik Toksöz
Tez Yöneticisi (TUDelft) : Y.Doç. Dr. Valentijn Visch

Eylül 2010, 174 sayfa

Bu çalışma, etkileşimli dijital ortamlarda kullanılan sanal karakterlerin duygusal yüz ifadelerinin insanların performansı üzerindeki etkisini araştırmaktadır. Bu çalışmada temel ve evrensel duygular kullanılmıştır. Duygusal yüz ifadeleri, yüzdeki hareketleri tanımlayan yüz hareket kodlama sistemi kullanılarak yaratılmıştır. Literatürdeki çalışmaların sonuçlarından yola çıkarak, temel duygular için hareket birimlerinin (yüz hareket kodlama sisteminde tanımlanan yüz hareketlerinin tanımları) birlikte gerçekleşmesi sonucu oluşan paternler duygusal yüz ifadelerine uygulanmıştır. Poser programı kullanılarak oluşturulan duygusal yüz ifadelerinin tanınmasını doğrulamak için bir çalışma gerçekleştirilmiştir. Sanal karakterlerin duygusal yüz ifadelerinin etkileşimli dijital görevlerde insanların performansı üzerindeki etkisini araştırmak için de Unity programı kullanılarak oluşturulan dijital etkileşimli uygulama çalışması gerçekleştirilmiştir.

Anahtar Kelimeler: yüz ifadesi, duygusal ifade, sanal karakter, etkileşimli dijital görev

To my parents

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CHAPTER 1

INTRODUCTION

1.1 Problem Definition

In the 50's, simple video games have been emerged by adapting systems used in missile defense systems in the late 40's. With the development of the computers in the late 50's and in the 60's, more computer games were developed and computer games have been increasingly developed in terms of sophistication and complexity. As a result of these developments, the first commercial video game called Computer Space was announced in 1971. A new entertainment industry emerged in the late 70s in the USA, Europe and Japan.

The golden age of video games appeared in the 80s and this age brought genre defining games in this decade, including; adventure games, fighting games, maze games, platform games, platform adventure games, racing games, role playing games, stealth games, survival horror, vehicle simulation games and so on (History of video, n.d.). For instance, 'Street Fighter' was firstly released in 1987 by Japanese developer, Capcom, which introduced the special moves of the fighters in the game that could be discovered with the experiment of the game controls (History of video, n.d.). Until today, newer versions of 'Street Fighter' has been developed and released (History of video, n.d.). As a popular maze game, 'Pac-Man' was the first video game to be known universally popular. 'Pac-Man' is a maze game released in 1980 and developed by Namco, Japanese game developer. 'Pac-Man' is thought to be the one of the classics of the video games and an icon of 1980s (Pac-Man, n.d). To give a more recent example, 'Medal of Honor' is a first person shooter game for Nintendo Wii and PlayStation Portable, announced in 2007. 'Medal of Honor' can also be noted for 3D video game.

With the development in the technology and the increases in the development budgets, the game consoles have been developed and importantly the way of interaction with games has changed with Nintendo's motion control system, Wii remote control. Microsoft is also interested in developing Xbox 360's technology. Rapid evolution of computer tools have also been enabled other fields to implement these tools into their branches, including different fields such as computer graphics and film industry.

With the advances in computer graphics hardware and software, the human faces in verbal and non-verbal communication have become vital and have led to technological and scientific interest in computer facial animation. The first work with computer based facial animation was created by Frederick Parke in 1972 (Parke & Waters, 1996). Although the tools used for computer graphics have been started developing for facial expression and facial animation in the early 1970s, facial expression and facial animation of virtual characters have become well known and popular for animated films and computer games in the late 1980s with the major achievements in computer graphics. Therefore, facial expression and facial animation have been an integral part of the video games and film industry since late 1980s. The application of facial expression has also spread out to many other areas, like education, communication, science and so on. For instance, the illustrations of facial expressions have been used in the school children books. According to Dağ (2010), facial expressions in the illustrated pre-school children books are vital to shape the mind and the imagination of the children. To give an example for communication, facial expressions are used in the software applications that enable people to call or chat with their friends over the Internet, such as 'Msn' and 'Skype'. In addition, facial expressions have been used for online customer service representatives.

The study of facial expressions started with a major considerable effort of Darwin (1998, originally published in 1872). The emergence of facial coding systems has led to the development of facial emotion-specific expressions, such as Facial Action Scoring Technique (FAST) (Ekman, Friesen & Tomkins, 1971), Maximally Discriminative Facial Movement Coding System (MAX) (Izard, 1979) and Facial Action Coding System (FACS) (Ekman & Friesen, 1978). FACS was one of the most important facial coding system to describe facial emotion

specific expressions because of its descriptive power when compared to other facial coding systems. FACS has been used not only to determine facial movements but also to create desired facial emotion expression of virtual character.

Starting from the early 80s, there have been several developments of the techniques for computer facial animation, such as physical based muscle controlled face model by Platt in the early 80s, new muscle based model by Waters in the late 80s (Computer facial animation, n.d.). The increasing development of digital facial animation techniques in the 90s have been started using in animated films such as Toy Story, Shrek and video games such as Casper and Sims. The more realistic facial expressions have been created after 2000 with the development of the motion capture technique. For instance, in the movie "Polar Express", motion capture technique was used to track the points on the face in order to create realistic facial expressions although additional operation was needed to be able to make the data usable. FACS, one of the most important facial coding system, was also used in digital facial animation, pioneering by Mark Sagar. Facial animation systems based on FACS developed by Sagar were used in the films, King Kong, Monster House and recently a popular film directed by James Cameron, Avatar.

On the other hand, the virtual characters are vital for not only video games and films but also for different contents, such as story telling, conversational representatives, training applications, virtual therapy and so on. The virtual characters can convey a lot of information through verbal and nonverbal communication. Nonverbal communication is emotionally expressive so that it plays an important role in expressing emotions to the receiver. The face is one of the most important primary sources of emotions. While expressing emotions, facial expressions are very important in nonverbal communication because of its power to convey information about emotions.

The virtual characters are used to evoke people's responses as intended. Nonverbal features of a virtual character can also be used to create specific responses, such as facial expression, body posture, body movements or gestures. In other words, game designers use the nonverbal features of virtual

characters to evoke an intended response from people. In order to be able to create specific responses, it is vital for designers to know how emotional virtual characters influence users' task performance. However, it should be mentioned that there are few researches about the effect of emotion specific facial expressions of a virtual character on people's task performance. Therefore, this thesis will mainly investigate the effect of emotional facial expressions of a virtual character on people's performance for interactive digital tasks in a digital virtual environment. The research finds out the time effect and navigation effect of emotional facial expressions of a virtual character on people's task performance in a virtual digital environment. This thesis will provide empirical knowledge about how emotional facial expressions can influence people's task performance for interactive digital tasks for the fields in which the emotional virtual characters are used. In addition, the results can be easily applied to the fields in which the virtual characters with emotional facial expressions are used.

Although facial expressions of virtual characters are modeled with different techniques, thus there might exist the lack of reality and efficiency, FACS (Ekman & Friesen, 1978) can be used to create more effective facial expressions. According to Vinayagamoorthy et al. (2006b), realistic nonverbal communication is a vital medium to be able to create reliable and believable characters. According to Mori, if a robot behaves more like a human in its appearance, the emotional response from a human being to the robot will be more natural (Uncanny valley, n.d.). Facial expressions done according to FACS can be useful to build realistic and effective facial emotion specific expressions but it is also necessary to state that they might not be perfect because of the technique used to create facial expressions. There are many researches about FACS (Ekman & Friesen, 1978) whether it is efficient for facial expressions or not. There are some doubts about reliability of FACS. Moreover, there are some discussions about the universality of the recognition of emotional facial expressions, which will be mentioned in the universality section of the literature review. Therefore, within the thesis research, a study was conducted to validate the recognition of emotional facial expressions.

1.2 The Scope of the Study

This study aims to investigate the effect of emotion specific facial expressions of a virtual character on people's performance for digital interactive tasks in a virtual environment. A study was conducted in the Department of Industrial Design at Middle East Technical University and was evaluated to generate results and conclusions on the subject.

1.3 Research Questions

Main Question:

- How do emotional virtual characters influence people's task performance in a virtual environment?

Sub-Questions:

- How do emotion specific facial expressions influence people's performance for digital interactive tasks in a virtual environment?
- What are people's attitudes in response to emotional facial expressions of a virtual character in a virtual environment?
- How do emotional facial expressions of a virtual character influence people to navigate in a virtual environment?
- Do positive/negative emotions have a positive/negative effect on people's task performance?

1.4 The Structure of the Thesis

The thesis will mainly include three main parts; literature review about facial expressions and virtual characters, the results of the studies and the conclusion on the subject.

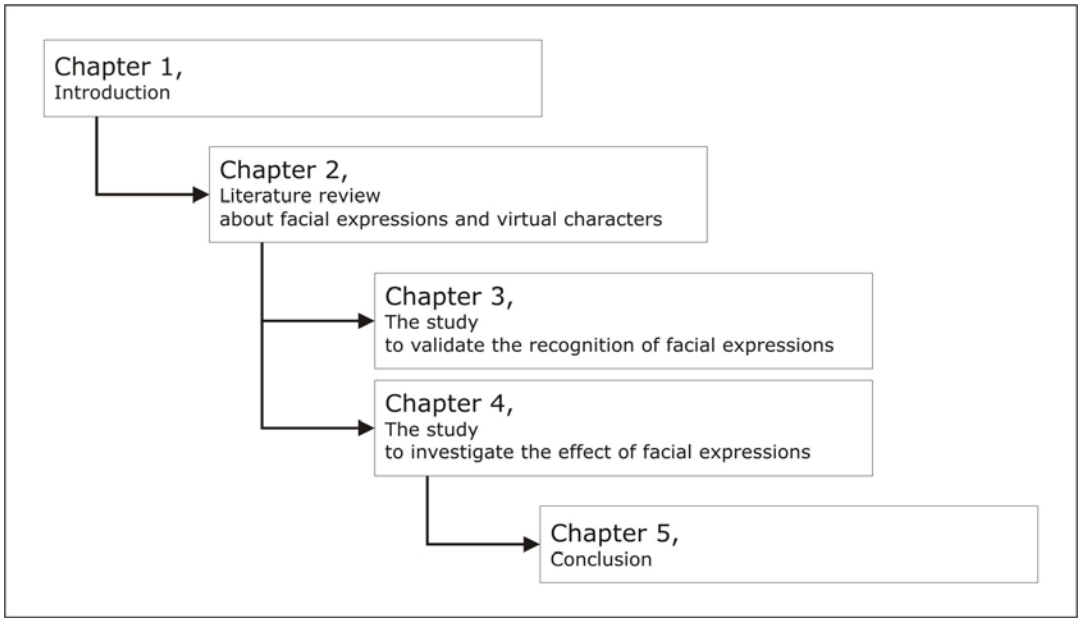

Figure 1.4.1: The structure of the thesis

Following this introduction, in the second chapter, the background to facial expressions will be mentioned and discussions about the universality of emotional facial expressions will be revealed. Methods to study facial expressions, the powerful system/s for facial expressions, emotion theories that these systems based on, and the reliability of these systems will be discussed by referring to the literature. Moreover, the importance of the virtual character, researches about nonverbal expressions of the virtual characters, and methods used for generating facial expressions will be explained.

In chapter 3, a study conducted in the Department of Industrial Design at Middle East Technical University will be presented and discussed. The results will be presented with reference to the statistics.

In the fourth chapter, a study of a digital interactive application involving several tasks, which was carried out at Middle East Technical University, Department of Industrial Design, will be presented and discussed. The setup and virtual environment of the application along with the procedure for the study will be presented and the results will be given.

In chapter 5, the conclusions of the study will be presented.

CHAPTER 2

FACIAL EXPRESSIONS

> Tradition, common sense, and science converge in seeing the face as a window with a view opening onto our emotions.
>
> J. A. Russell and J. M. Fernández-Dols, 1997, p.3

2.1 Facial Expressions

Facial expressions have become a great interest of researchers. Starting from Darwin, it has been thought that facial expressions can express emotions. Facial expressions are always in our daily life, influencing human being to find a meaning in all these facial expressions whether they are voluntary or artificial.

In the psychology field, the face is thought to be an important key to observe the emotions. "Linking faces to emotions may be common sense, but it has turned to be the single most important idea in the psychology of emotion" (Russell and Fernández-Dols, 1997, p.4). This link, between face and emotion, was questioned by several psychologists, such as Zajonc, Murphy and Inglehart (1989). Similarly, the nature of facial expression has been questioned with the help of researches based on theoretical perspectives.

Darwin's scientific work is considered to be the most important influence for facial expression. Darwin studied the actions of facial muscles that were involved in emotion and established a conclusion that facial expressions are universal (Darwin, 1998). As mentioned by Matsumoto and Ekman (2008), the perspective in psychology was the opposite; facial expressions were specific to culture until the studies conducted about universality. Associating facial expressions with emotions turned into an important research area by Tomkins as a modern theorist, who resurrected the Darwin's claims and "suggested that

emotion was the basis of human motivation, and that the seat of emotion was in the face" (Matsumoto and Ekman, 2008, p.4). Matsumoto and Ekman (2008) mentioned that Tomkins and Ekman conducted the original universality studies, which is known in the field today.

2.2 Facial Expression Program

Facial Expression Program is a term that includes the methods, theories and the assumptions about facial expressions. According to Russell and Fernández-Dols (1997), it is hard to find a set that includes all the statements because of the fact that each researcher presents a different program. Russell and Fernández-Dols (1997) wrote a prototypical version of facial expression program, presenting the program in a clear, heuristic and interesting form. Some of the assumptions and implications that were mentioned by Russell and Fernández-Dols (1997) are;

1. There exist a small number of basic emotions, (seven plus or minus two).
2. Each basic emotion is discrete and universal. Each one has a coherent pattern that consists of characteristic facial behavior.
3. The emotion that lacks facial signal is not a basic emotion. As a result, investigating facial expressions signaling the same emotions provides a list of basic emotions. So far, the seven basic emotions were found; *happiness, sadness, anger, disgust, fear, surprise and contempt*. Uncertainty about contempt and uncertainty between the recognition of fear and surprise exist.
4. All other emotions than the basic one are the mixtures of the basic emotions. For instance, the emotion 'anxiety' is a mixture of sadness, anger, and fear basic emotions, resulting in a mixture of facial expressions. In addition, 'anxiety' includes interest and shame. Voluntary facial expressions (conscious manipulation of the face muscles) could resemble spontaneous ones. Voluntary facial expressions are deceptive in nature.
5. Any facial expression diverging from the universal signs is a mixture or blend of the basic emotions.

6. Regardless of different human cultures, the seven facial expressions (plus or minus two) are easily recognized by all human beings.

These are the assumptions and premises that are mostly known and also stated by researchers (for a review of Facial Expression Program, see Russell and Fernández-Dols, 1997).

2.3 The Universality

Although Darwin mentioned in his book, *The Expressions of the Emotions in Man and Animals*, that regardless of culture and race both man and animals express some emotions by the same movements through their faces, it has been thought that facial expressions were learned; therefore can differentiate across human cultures until the 1960s (Facial Expression, n.d.). Studies conducted by Ekman, Sorenson and Friesen (1969) and other researchers such as Izard (1971), and Russell (1994) generated empirical data showing that facial expressions are not cultural but universal among different cultures.

Russell and Fernández-Dols (1997) mentioned about the universality that;

> *For many, the most convincing and exciting accomplishment of the Facial Expression Program was dramatic evidence for the universality of the facial expression of emotion. To establish this conclusion would require the establishment of three related propositions:*
>
> *1. The same patterns of facial movement occur in all human groups.*
> *2. Observers in different societies attribute the same specific emotions to those universal patterns.*
> 3. *Those same facial patterns are, indeed, manifestations of those very emotions in all human societies.*
>
> (Russell and Fernández-Dols, 1997, p.14)

A study done by Ekman, Sorenson and Friesen (1969) provides evidence for proposition 1. In this study, the participants from different cultures were given pictures of different facial expressions and were asked to judge the emotions in these facial expressions. The findings of the study provided evidence for six

emotional facial expressions; *happy, sadness, anger, fear, surprise and disgust*.

One of the major studies, which was also conducted by Ekman, Sorenson and Friesen, was the study with South Fore people of New Guinea (Izard, 1971 and (Facial Expression, n.d.). In this study, the participants among an isolated population were asked to match the stories describing one particular emotion with the pictures of facial expressions depicting the emotion in the story (Ekman and Friesen, 1971). The participants were 189 adults and 130 children among New Guinean and located subjects, who had never seen movies, had never spoken or understood English and had never lived in any Western settlement (Izard, 1971). The results showed evidence for universality; regardless of culture specific facial expressions associates with particular emotions. However, the study also concluded that fear and surprise were misidentified (Facial Expression, n.d.).

In another experiment, Ekman and his colleagues asked nine male new Guinean subjects to express emotional facial expressions of the stories expressing an emotion that were used in the first experiment, which is explained in previous paragraph (Izard, 1971). All the subjects were isolated from the Western Civilization. The expressions of the New Guinean subjects were recorded and then shown to American university students to judge the emotions. The results showed that they judged the emotions of happy, sadness, anger and disgust with high accuracy. However, they confused the fear with surprise. These two studies support the proposition 2.

According to Russell and Fernández-Dols (1997), proposition 3 has been ignored and evidence is needed to provide. This is because there exists no evidence providing that happy people smile, disgusted people wrinkle their noses or angry people frown in different cultures.

However, recent studies show that people from different cultures recognize facial expressions differently (Burns, 2009). For instance, East Asians were more likely to recognize the expression for fear as surprise, and disgust as

anger than Westerners. Facial expressions fear and surprise were confused by the participants as well as disgust and anger (Burns, 2009).

Basic and universal emotions that Ekman found includes happy, sadness, anger, fear, surprise and disgust. Although there is evidence that shows contempt facial expression is universally recognized, results are less clear (Facial Expression, n.d.).

2.4 Spontaneous and Voluntary Facial Expression

Many of the researches about facial expressions have been done with voluntary or posed facial expressions. Nonetheless, facial expressions occur spontaneously in our daily life whereas the posed facial expressions can be seen in movies, theater, TV series and so on. Spontaneous facial expressions are distinguished from voluntary one in scientific writings. According to Hager and Ekman (1985), spontaneous facial expressions are thought to have a more symmetry in the face when compared to voluntary facial expressions. Russell and Fernández-Dols (1997) mentioned that posed expressions are believed to be artificial, to be produced on demand and to be targeted to an audience while spontaneous one are assumed to be natural and involuntary. Posed, voluntary facial expressions might be extreme and hardly happens in daily life. It is necessary to mention that spontaneous facial expressions occur much more naturally in our daily life.

2.5 Methods to Study Facial Behavior

As mentioned by Wagner (1997), there are three general approaches that are most widely used to study facial behavior. One of them is the *judgment method*. The other two of these are measurement methods, *electromyography* and *coding systems*. Wagner (1997) defines the measurement studies that need methods including a measurement of a change in the face or description.

2.5.1 Judgment Method

Wagner mentioned (1997, p.35), "Judgment methodology is the most widely used in investigations of facial behavior". Judgment studies are used to answer

the questions related to the information that is conveyed by facial expressions. There are mainly two types of judgment method; *category judgment* (forced-choice method and free-response method), and *rating method* (Wagner, 1997).

Mostly, a list of response categories of emotions based on theoretical perspectives are given and the observers are shown pictures of emotional facial expressions, usually one each time, are asked to match each of facial expressions with an emotion label (Wagner, 1997). This method is known as the forced-choice method. Free-response method has been less frequently used. The observers are free to choose which label to assign to a facial expression. The second type of the judgment method is the rating method in which the observers are allowed to rate the each of properties given to them in facial expressions.

2.5.2 Electromyography

Electromyography (EMG) is a method to record and evaluate the electrical activities that are generated by skeletal muscles. EMG has a special device called electromyograph, which finds the electrical activities produced by activated muscles. The medical abnormalities or the biomechanics of human movement can be detected by analyzing the signals generated by electromyograph. According to Wagner (1997, p.32), "Electromyography (EMG) provides the most objective way we have of measuring behavior". How EMG is applied to the face is that the placement of the small electrodes over the muscles in the facial appearance.

One of the first experiments done with EMG was conducted by Francesco Redi in 1666 (Electromyography, n.d.). Redi discovered the electric ray fish, 'Electric Eel', which has specialized muscle and generates electricity. Since recording electrical activities during a voluntary action has been discovered by Emil du Bois-Reymond in the late 19th century, several recording electrical activities has been done. First recording techniques began to understand the animal motion. As mentioned by Ashley-Ross and Gillis (2002), Eadweard J. Muybridge is known for his important pioneering work in animal locomotion in the late 19th century, enabling him to take several pictures with use of multiple cameras.

Étienne-Jules Marey contributed to the technique with his invention, automatic recording events of animal motion (Ashley-Ross and Gillis, 2002), and introduced the term electromyography. The first recording electrical activities was also done by Étienne-Jules Marey in 1890 (Electromyography, n.d.).

With the improvements of electrodes for the study of muscles, the surface EMG technique was firstly used in clinical applications in the late 1960s (Ashley-Ross and Gillis, 2002). Surface EMG is increasingly used to record muscles activites in clinics, where deep muscles activities are investigated with the help of electrodes (Electromyography, n.d.). One of the first applications to facial expressions of this technique was done by Schwartz et al. (1976). The subjects imagined scenes including happy, sadness, anger; and Schwartz et al. (1976) found that recording from brow, jaw muscles, mouth corner and forehead, which were measured by EMG, produced different patterns of facial muscle activity. Facial electromyography can also provide a sensitive and objective way for facial behavior (Schwartz et al., 1976).

However, according to Wagner (1997), one of the disadvantage of the use of EMG is that person's facial movements might be influenced when the electrodes are stuck on his or her face. Another one is that sticking electrodes on face may also get his or her attention to the face, resulting in modification of his or her behavior.

2.5.3 Systems Describing Facial Coding Systems

These methods are grounded on the measurement of the visible changes in the facial behavior. Since 1970s, several coding systems have been developed to identify facial expressions. These methods describing facial coding systems include Facial Action Scoring Technique (FAST) (Ekman, Friesen, & Tomkins, 1971), Identifying Affect Expressions by Holistic Judgment (AFFEX) (Izard, Dougherty, & Hembree, 1983), and Facial Action Coding System (FACS) (Ekman & Friesen, 1978). These methods/techniques/systems are also associated with emotions (Sayette et al., 2001). Moreover, the systems that are directly associated with emotions was developed both based on discrete emotion theoretical perspective, such as Emotion Facial Action Coding System

(EMFACS) (Ekman & Friesen, 1982) and based on dimensional model of emotion such as Facial Expression Coding System (FACES) (Kring & Sloan, 1991). On the other hand, other systems have been developed in order to assess the specific aspects of facial movements such as Maximally Discriminative Facial Movement Coding System (MAX) (Izard, 1979) or to measure more general facial expressions such as Notarious & Levenson (1979).

EMFACS is a system based on FACS to assess only the facial movements that are thought to have a relation with emotional facial expressions. EMFACS (Ekman & Friesen, 1982) was developed when only the signals of facial emotions are interested to assess in order to reduce time. Ekman (1978) has mentioned that while FACS as a descriptive method for analyzing behavior includes assessing facial movements on the face, measuring the emotional facial expression is a process in which the predictions are made about the reasons behind mental states. To be able to use EMFACS, it requires adequate knowledge about FACS. Ekman and Friesen suggest EMFACS to individuals who have competence in using FACS.

Facial Expression Coding System (FACES) (Kring & Sloan, 1991) is a system that provides information about the frequency, intensity, valence (positive or negative) and duration of facial expressions (Kring & Sloan, 2007). Although FACES can enable to make judgments about these information, especially about the valence (positive or negative), it is not possible to define a discrete emotion label, such as happy, anger or fear. There is also another approach called the cultural informants approach (Gross & Levenson, 1995). The judgments about emotions are done whether they are positive or negative by the observers that are familiar with emotions in specific cultures. This is because observers' knowledge about emotions is assumed to have personal experience (Hubbard, 2001). The observers do not define a discrete emotion label, similar to FACES. This approach has been used in observational research of emotions, such as Gross and Levenson (1993).

Although, these two systems, EMFACS and FACES, associated with emotions based on different emotion theoretical perspectives, Kring and Sloan (2007)

mentioned that two systems can be related to each other because they are both developed in order to describe facial expressions. However, more detailed information about facial expressions can be revealed by using EMFACS (Kring & Sloan, 2007) because of the fact that EMFACS is derived from FACS (Ekman & Friesen, 1978), which has a power of descriptiveness.

Three of these coding systems were based on a theoretical perspective, which is about the patterns of facial movements that are thought to be associated with particular emotions believed to be 'universal' emotions (six emotions; happy, sadness, anger, fear, surprise and disgust), FAST (Ekman, Friesen, & Tomkins, 1971), AFFEX (Izard, Dougherty, & Hembree, 1983), FACS (Ekman & Friesen, 1978) (Wagner, 1997). According to Wagner (1997), although these systems have been used for the studies about the universality of the configurations of facial movements for specific facial expressions, they have a number of limitations. For instance, none of these systems enable to measure the intensity of behavior. Moreover, "MAX and AFFEX were developed for use with infants and omit configurations that might be relevant for those studying older children and adults" (Wagner, 1997, p.34).

More descriptive methods have become more effective in emotion science such as facial coding systems and among these facial coding systems, the effective systems are MAX and FACS (Sayette et al., 2001). FACS, which is deconstructed to 44 action units, has its power about descriptiveness when compared to MAX (Malatesta et al., 1989). Although the reliability of FACS coding is still problematic for individual action units about intensity and the assessment of the combination of action units, FACS based on discrete emotion theory can be used to code facial emotional expressions.

2.6 Emotion Theories

From an emotional perspective, the predictions about the prototypical facial expressions have been specified based on the two major positions (Scherer and Ellgring, 2007);

- Discrete emotion theories (Ekman, 1992; Izard 1992, 1994)
- Dimensional emotion models (Scherer, 1992; Roseman, 2001)

Discrete emotion theories assume that facial expressions express basic emotions (happy, sadness, anger, fear, surprise and disgust) through affect programs, while dimensional (componential) emotion models suppose that results of an appraisal process determines individual element of facial expressions (Scherer & Ellgring, 2007). Considering discrete emotion theories, the assumption for affect programs is specific conditions that trigger a pattern of reactions, especially in the face. Discrete emotion theories produce prototypical emotion specific facial expression configurations. Dimensional emotion models define facial expressions as a process of the components of the emotion process, *cognitive activity*, *motor expression*, *physiological arousal*, *action tendencies*, *and subjective feeling states* (Scherer & Ellgring, 2007). These components are connected to the emotion elicitation. In addition, a large number of differentiated emotions in overarching emotion families are suggested by dimensional emotion models. Scherer and Ellgring (2007) mentioned that "one of the major features of componential theories is the effort to render the link between the elicitation of emotion and the response patterning more explicit than has been the case in discrete emotion theories". According to Scherer (2001), it is suggested the result of an appraisal process generates the unique, context specific and individual specific response pattern in response to emotion.

As mentioned by most of the researchers (e.g. Kring and Sloan, 2007; Scherer, 1992; Scherer & Ellgring, 2007), the pioneering work for the study of emotion, especially emotional facial expressions, was done by Charles Darwin who is considered as the most influential theorists. Charles Darwin's book, The Expression of the Emotions in Man and Animals (1998, originally published in 1872), still remains as a vital source for emotional expressions. Scherer and Ellgring (2007, p.113) mentioned that "Darwin (1998) may have been the first and last scholar to develop a detailed set of functional principles to specify what facial configurations should be produced under certain circumstances (in part based on earlier work by Bell (1844) and Duchenne (1876/1999)", emphasizing the importance of the Darwin's work.

2.6.1 Discrete Emotion Theories

The assumption of the discrete emotion theories is that affect programs, which are evolved systems controlling the communication of emotions that take the form of universal signals, produce configurations about patterns of emotional facial expressions for basic emotions. As mentioned in the article by Scherer and Ellgring (2007), Tomkins proposed that affect system includes limited number of fundamental emotions, which are linked to the motivational system. Tomkins (1984) assumed that specific conditions can reveal pattern of reactions in muscular movements, particularly in the face. Ekman and Izard, who were influenced by Tomkins, have studied the patterns of prototypical facial expressions for basic emotions to obtain evidence.

According to Izard (1994), facial expressions of discrete emotions might be innate and universal. This issue has been studied in several researches by Izard and Ekman. It is importantly mentioned that this theory has emphasized the communicative function of facial expressions in social context (Izard, 1994). This can show that emotional expressions for a specific emotion lead to correct understanding of the expressed emotion (Scherer & Ellgring, 2007).

2.6.2 Dimensional Emotion Models

Dimensional (componential) emotion models assume that each element of facial expressions is determined by the results of appraisal. Emotion is defined as a process from cognitive activity to feelings in emotion process. When compared to discrete emotion theories, this theory does not suggest a small number of basic ideas. They agree for the notion of large number of differentiated emotions with overarching emotion families (Scherer & Ellgring, 2007). Scherer (1987) has defined the emotion model as patterns of appraisal universally occurred. Scherer and Ellgring (2007, p.115) mentioned that "componential models do not fundamentally question the idea that facial expressions mark differentiated emotional states; rather, they propose that emotions have an emergent character based on the interaction of different components driven by the appraisal of an eliciting event". These components were mentioned by Scherer (2001) in the component process model, which suggests that emotion is thought to consist of five functions;

1. *Evaluation of objects and events*
2. *System regulation*
3. *Preparation and direction of action*
4. *Communication of reaction and behavioral intention*
5. *Monitoring of internal state and organism-environment interaction*

(Scherer, 2001, p.93)

This model assumes that the results of continuous appraisal process produce appropriate response patterns (Scherer & Ellgring, 2007).

Dimensional emotion theory suggest a large number of variable emotional facial expressions, namely different cooccurences of set of Action Units (AUs), while discrete emotion theory propose a small number of prototypical patterns of facial expressions. However, according to Scherer and Ellgring (2007), there are few conflicting expectations about individual AUs considering both theories because they are both based on the pioneering work of Darwin.

Among these theorists, Ekman and Izard have studied on facial expressions. Izard has focused on the visual prototypes with MAX (Izard, 1979). Ekman have developed a descriptive system about the emotional meaning of individual Action Units with his colleagues, Facial Action Coding System (FACS) (Ekman and Friesen, 1978).

2.7 Facial Action Coding System (FACS)

Paul Ekman and Wallace Friesen announced Facial Action Coding System (FACS) in 1978 and by the pioneering work of Hjortsjö (1969). It is a system that is designed to categorize facial expressions of emotions systematically. FACS is very useful tool method for psychologists and human observers to describe facial expressions by observing the changes on the human face, while it is very effective technique for animators to generate emotional facial expressions. Each facial expression is described by deconstructing it into the specific Action Units (AUs), which are contraction or relaxation of one or more muscles. AU can be considered as basic element of facial movements. FACS basically includes 44 action units. However, Ekman and Friesen (1978) define

30 AUs and 14 miscellaneous actions. While AUs are representations of a specified anatomic basis facial movement, miscellaneous actions are the representation of the visible facial movements, which do not have anatomic basis.

FACS is a facial coding system that is linked to the anatomy of the face. The description of facial expression is universal and thus FACS has become a powerful tool among researchers. It has been used as measurement method of facial expressions or facial behavior in different fields such as computer graphics (Parke & Waters, 1996), development studies (Oster et al., 1992), social studies of emotion (Frank & Ekman, 1997) and so on. It is worthy to mention that FACS is a leading method used in facial expression studies. FACS is a descriptive system about facial expressions but it does not provide any biomechanical information about the degree of muscle activation.

2.7.1 Action Units (AUs)

The simplest facial movement that cannot be decomposed into basic one describes AU. Each action unit is defined by contraction or relaxation of one single muscle or a set of related muscles. Activation of an appropriate set of AUs describes facial expressions (Ekman & Friesen, 1978). Activation of an AU is the visible activity of the muscles that are observed on the face during facial expressions. Facial emotion specific expressions can be created by using an appropriate set of AUs. Ekman and Friesen introduced 44 AUs that defines the facial movements on the face, 8 AUs describing head movements and 6 AUs representing eye movement. AUs related to facial movements on the face are shown in the table 2.7.1. The AUs printed bold are the AUs that are selected to create emotional facial expressions, which will be discussed in the part 2.8. Images depicting each of these Action Units can be found in Appendix A.

Table 2.7.1: List of all Action Units (Aus)

AU	Description	AU	Description	AU	Description
AU1	**Inner brow raiser**	**AU17**	**Chin raiser**	AU32	Lip bite
AU2	**Outer brow raiser**	AU18	Lip Puckerer	AU33	Cheek blow
AU4	**Brow lowerer**	AU19	Tongue show	AU34	Cheek puff
AU5	**Upper lid raiser**	AU20	Lip stretcher	AU35	Cheek suck
AU6	**Cheek raiser**	AU21	Neck tightener	AU36	Tongue bulge
AU7	**Lid tightener**	AU22	Lip funneler	AU37	Lip wipe
AU8	Lips toward each other	**AU23**	**Lip tightener**	AU38	Nostril dilator
AU9	**Nose wrinkler**	AU24	Lip presser	AU39	Nostril compressor
AU10	**Upper lid raiser**	**AU25**	**Lips part**	AU41	Lid drop
AU11	Nasolabial furrow deepener	**AU26**	**Jaw drop**	AU42	Slit
AU12	**Lip corner puller**	**AU27**	**Mouth stretch**	AU43	Eyes closed
AU13	Cheek puffer	AU28	Lip suck	AU44	Squint
AU14	Dimpler	AU29	Jaw trust	AU45	Blink
AU15	**Lip corner depressor**	AU30	Jaw side to side	AU46	Wink
AU16	Lower lip depressor	AU31	Jaw clencher		

2.7.2 The reliability of Facial Action Coding System (FACS)

According to Ekman, Friesen and Hager (2002), description of facial movements with FACS requires four operations and thus four different reliabilities of these operations can be studied:

1. The AUs that are responsible for the facial movement
2. The intensity of the AUs
3. Symmetry of the AUs, whether an AU appears on only one part of the face rather than bilaterally
4. The position of the head and the eyes of the facial expression

Several studies have been carried out to investigate facial expressions associated to emotion prototypes such as Ekman et al. (1983). However, posed

or voluntary expressions have been used in the most of these studies done by FACS (Rosenberg, 1997). Although the studies proposed important findings about voluntary facial expressions, it might provide reliable results of spontaneous facial expressions (Ekman & Rosenberg, 1997). Moreover, the findings of the published studies done about FACS reliability (e.g. Ellgring, 1986) were failed or reported incomplete information about spontaneous expressions (Sayette et al., 2001).

Although less information about the reliability of FACS is known for individual action units and their intensity (Sayette et al., 2001), studies about reliability for FACS has showed evidence for individual AUs reliability (Ekman and Rosenberg, 1997). The studies about the intensity of facial movements revealed the differences in the intensity of AUs. According to Rosenberg and Ekman (1994), the difference in the intensity of action units was mostly stemmed from the differences of subjective experience. The reliability of the intensity of AU mostly depends on the coders' reliability on the agreement, resulting in unknown reliability of intensity of AUs (Sayette et al., 2001). To explain the asymmetries in facial expressions, Hager and Ekman (1985) measured the several facial movements and resulted that spontaneous facial actions were more symmetrical than deliberate actions. The reliability of the symmetry of the AUs depends on whether facial expressions are spontaneous or deliberate.

On the other hand, some studies discussed about reliability in a positive way. According to Sayette et al. (2001, p.174), "FACS had good to excellent reliability for spontaneously generated facial behavior". In addition to this, for almost all AUs experiments done by Sayette et al. (2001) revealed that reliability was good to excellent, resulting in that FACS can be used to code facial expressions.

2.8 The Results of Cooccurences of Action Units for Basic Emotions

As a summary of previously mentioned about facial expressions and FACS, predictions about prototypical emotion-specific facial expressions have been based on *discrete emotion theories* (Ekman, 1992; Izard 1992, 1994) and *dimensional emotion models* (Scherer, 1992; Roseman, 2001). Facial coding

systems have been enabled researchers to describe these facial expressions, especially FACS which is based on discrete emotions theoretical perspective (Ekman and Friesen, 1978). Although less information about the reliability of FACS is known for individual action units and their intensity (Sayette et al., 2001), researches about reliability for FACS has proved evidence for individual Action Units reliability (Ekman and Rosenberg, 1997). Nevertheless, the findings of the published studies done about FACS reliability (Ellgring, 1986) were failed or reported incomplete information (Sayette et al., 2001). According to Sayette et al. (2001), FACS can be used to code facial expressions.

The predictions and the patterns of the prototypical emotion-specific facial expressions have been researched in several studies to find out patterns for discrete basic emotions (happy, sadness, anger, fear, surprise and disgust) defined by Ekman (Carroll and Russell, 1997). It can be assumed that there are only few major differences on predictions and conflicting expectations about AUs for basic emotions between discrete emotion theory and dimensional emotion model (Scherer and Ellgring, 2007). However, discrete emotion theory is more powerful at predicting occurrences of AUs prototypical patterns of basic emotions, while dimensional appraisal theories should predict different cooccurrences of AUs for emotions resulting from specific appraisal results (Scherer and Ellgring, 2007). Significant differences were revealed to code different emotions by using configurations of AUs. To find out these important differences, the pattern of cooccurrences for different AUs and the assumptions about the association between the AUs and emotions have been analyzed in different studies (Sayette et al., 2001; Scherer and Ellgring, 2007). Major results taken from the studies are;

- One major cooccurrence with high frequency is the combination of AU 6 (cheek raiser) and AU 12 (lip corner puller), which is produced for positive emotions, especially happiness and can be accompanied by AU 26 (jaw drop).
- Another combination is AU 1 (inner brow raiser), AU 2 (outer brow raiser), AU 4 (brow lowerer), and AU 26 (jaw drop), which is found for

several negative emotions but mostly for panic fear and often accompanied by AU 5 (upper lid raiser).

- AU 5 (upper lid raiser) and AU 23 (lip tightener) co-occur in hot anger.
- The combination of AU 4 (brow lowerer) and AU 10 (upper lip raiser) is used frequently for disgust.
- The lack of AU 12 (lip corner puller) and the presence of at least one of the following action units; 9 (nose wrinkle), 10 (upper lip raise), 14 (dimpler), 15 (lip corner depress), 20 (lip stretch) and 1+4 (inner brow raiser and brow lowerer) can define the negative emotional expressions.
- Although Cohn et al. (2005) expressed that reliability for AU 7 (lid tightener) and AU 23 (lip tightener) was high and according to Sayette et al. (2001) AU 7 and AU 23 had fair reliability, "AU 7 is a relatively small appearance change that often is mistaken for AU 6, which is controlled by the same muscle". These cooccurrences influence the effective distinction of these AU.
- Similarly, AU 23 (lip tightener) and AU 24 (lip presser) can be mistaken because they mostly co-occur and are both controlled by the same muscle. Moreover, the emotions associated with AU 23 and AU 24 are specified with anger and confusion so that the level of description of these action units has little differences.
- The predictions showed that AU 1 (inner brow raiser) and AU 2 (outer brow raiser) could have a significant effect on emotions, fear, anxiety and despair. On the other hand, they can also occur for other emotions.
- AU 4 (brow lowerer) is frequently seen in emotions, sadness, panic fear, disgust and also despair and anxiety. No clue of AU 4 for positive emotions is found.
- AU 5 (upper lid raiser) frequently occurs with AU 1 (inner brow raiser) and AU 2 (outer brow raiser), resulting in emotions panic fear and despair.
- The combination of AU 5 (upper lid raiser) with AU 23 (lip tightener) can give a signal of frightening effect so that can be considered as anger.
- AU 7 (lid tightener) may give signals of cold anger and contempt.
- AU 13 (cheek puffed) in combination with AU 17 (chin raised) could signal joy but possibly limited to German Culture.

- AU 15 (lip corner depressor) and AU 17 (chin raised) are hard to understand, except disgust and also contempt.
- According to Sayette et al. (2001) the expression sadness occurred with enough frequency as defined in Ekman and Friesen (1978).

The minor effects are;

- AU 9 (nose wrinkled) can be rarely seen in facial expressions, disgust and hot anger.
- Although AU 10 (upper lid raiser) can give a strong effect of disgust, it can also signal other negative emotions but minor.
- AU 20 (lips parted) looks like minor for the emotion fear.
- AU 22 (lip funneled), which can be seen as a minor part of the anger are difficult to understand.
- AU 25 (lips parted) and AU 26 (jaw dropped) seem not to be distinctive because they might occur for all emotions.
- Although AU 27 (mouth stretching) appears only for three high intensity emotions (hot anger, panic fear and despair), they might be connected to vocalization.

There are also several predictions about action units that can appear while expressing facial expressions such as Scherer and Ellgring (2007). If the emotions created according to the results above do not reflect facial emotion expressions well enough, the minor effects and these predictions about AUs can be also applied into the emotions.

The table 2.8.1 shows the associations of Action Units with each of the basic emotions taken from the studies. Based on the results given above, the table 2.8.2 summarizes the selected Action Units for each basic emotion specific facial expressions. For the surprise, one of the prototypical facial expression was selected, which was defined by Ekman and Friesen (1978) (See Appendix B for other prototypical facial expressions defined by Ekman and Friesen). To find out whether the emotional facial expression created according to the selected AUs are recognized well enough or not, a study was conducted in the Department of Industrial Design at METU.

Table 2.8.1: The associations of Action Units with emotions
(adapted from Scherer & Ellgring, 2007)

	Happy	Sadness	Anger	Fear	Surprise	Disgust
AU 1		+		+		
AU 2				+		
AU 4		+		+		+
AU 5			+	+		
AU 6	+					
AU 7			+			
AU 9			+			+
AU 10						+
AU 12	+					
AU 15		+				+
AU 17		+				+
AU 20				+		
AU 23			+			
AU 26				+		

Table 2.8.2: The selected action units for each emotion specific facial expressions

Emotions	**Selected Action Units**
Happy	AU 6 + AU 12
Anger	AU 4 + AU 5 + AU 7 + AU 10 + AU 23 + AU 25
Sadness	AU 1 + AU 4 + AU 15 + AU 17
Fear	AU 1 + AU 2 + AU 4 + AU 5 + AU 25 + AU 26
Surprise	AU 1 + AU 2 + AU 5 + AU 27
Disgust	AU 4 + AU 9 + AU 10 + AU 17

VIRTUAL CHARACTERS

2.9 Virtual Characters

Virtual characters are very important element for most of the applications, such as entertainment games, training applications, story telling, virtual therapy and conversational representatives. Vinayagamoorthy and his colleagues (2006b) explained that in human machine interaction virtual characters are used to evoke people's responses as intended because virtual characters can give signals about a part of game or any application. By this way an interaction between the virtual character and people might emerge easily by enabling the user understand the scenario in an intended way.

There are two important issues for virtual characters stated by Vinayagamoorthy et al. (2006b), behavior realism and visual realism. There exist different perspectives about behavior and visual realism. It has been mentioned that behavior realism might be more significant than the visual realism for some applications (Blascovich et al., 2002; Vinayagamoorthy et al. 2006a). On the other hand, visuality of the virtual character might also overbalance the behavior realism. When you generate a virtual character whose behavior realism overweighs the virtuality of the character, it is hard to believe the character and respond as if they are real. It is also the same when a virtual character whose visuality is more important than the behavior is created. Another perspective can be considered more significant than the other others; there should be a balance between the behavior realism and visual realism of the virtual character (Garau et al., 2003; Vinayagamoorthy et al. 2006a). Examples of photo-realistic virtual human characters taken from Vinayagamoorthy et al. (2006b) can be seen in the figure 2.9.1.

It is important to create believable and reliable virtual characters for realistic nonverbal communication. In other words, the credibility of the virtual characters is vital to create more realistic and natural nonverbal communication between virtual characters and users. This is because Mori, who is known with his pioneering work about the emotional human responses

to non-humans, published in 1970 a hypothesis called 'Uncanny Valley' that shows if a robot behaves more like a human in its appearance and motion, the emotional response from a human being to the robot will be more natural (Masahiro Mori, n.d.). The 'Uncanny Valley' connected to the robotics field is the hypothesis, which holds that when robots look like human and act like almost humans, it can create a positive and emphatic response among human observers.

Figure 2.9.1: Examples of some photo-realistic virtual human characters taken from Vinayagamoorthy et al. (2006b)

What is important is to create believable and realistic character in order to create natural interaction between the user and the virtual character. In other words, it is necessary to construct believable character in order to get response from people as if the virtual characters are real. Although, Vinayagamoorthy et al. (2006b) mentioned that people interpret the virtual human characters as if they are not real at a high level of mental processing because of lack of visual plausibility of a virtual character. How people perceive and behave in response to the virtual character's behavior in a virtual environment did not change when they would behave in a similar real life scenario (Persky and McBride, as cited in Paschall et al., 2005).

The studies reveal that the virtual human characters may elicit the responses from participants. In a study conducted by Slater, Pertaub and Steed (1999) the participants were asked to rehearse a short talk in front of an audience of virtual human characters. The short talk of each subject was repeated in front of different audiences, one with a friendly audience, and one with a hostile audience. The nonverbal feedback of the audience used in the study can be seen in the Figure 2.9.2. At the end of their talk, the participants were asked to rate their own performance. The ratings showed that their performance was influenced by positive or negative nonverbal feedback given by the audience. When they perceive higher audience interest for a negative audience, their ratings were affected. However, the perceived interest of a positive audience has no effect on ratings.

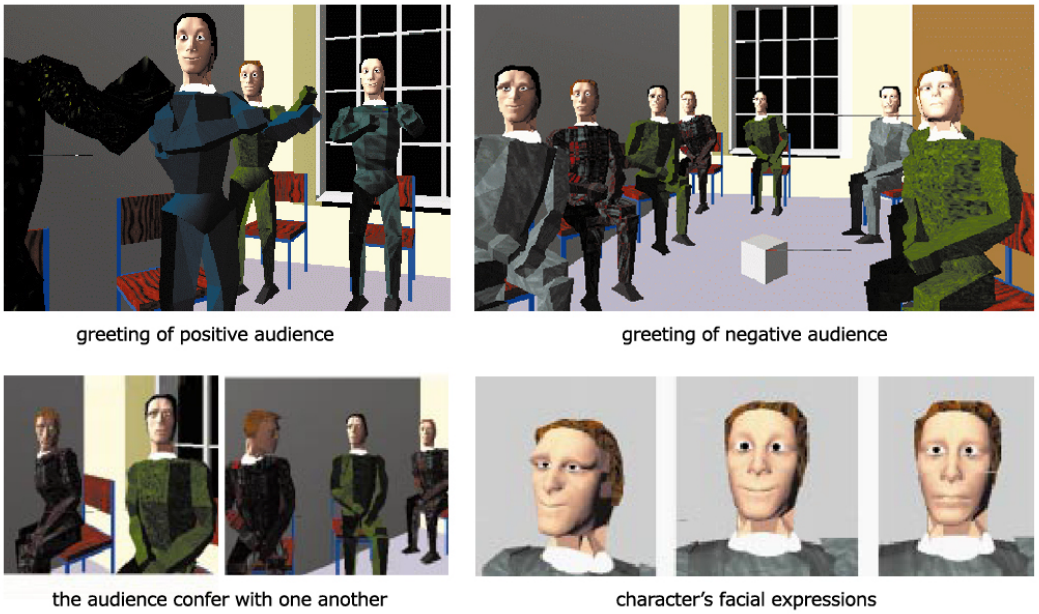

Figure 2.9.2: The nonverbal feedback used in the study conducted by Slater, Pertaub and Steed (1999)

Similarly, Pertaub (2001) found in an experiment in which the participants were asked to give a talk that negative audience of virtual characters can strongly influence speakers. According to Prendinger et al. (2005), a virtual character whose nonverbal expression express empathy can decrease the participants stress. In the study conducted by Predinger, it was reported that an emphatic virtual character had a positive effect on participants' task performance. Emotion specific facial expressions can also influence people's performance for digital interactive tasks. To find out the effects of emotional facial expressions, a study was conducted in the Department of Industrial Department at Middle East Technical University, which is presented in chapter 4.

Moreover, a study, in which the effect of emphatic characters on student perceptions of presence was investigated, conducted by McQuiggan et al. (2008) shows that empathetic characters increase the student's sense of involvement and control in learning environments. This study was conducted with middle school students and high school students. The results of this study also demonstrate that using empathetic characters contribute to an increased perception of presence in narrative centered learning environments.

2.10 Different Levels of Facial Expressions

The human face has a potential of producing twenty thousand different facial expressions, showing that the face is one of the most expressive part of the body (Birdwhistell, as cited in Vinayagamoorthy et al., 2006b). It was also mentioned that the face is the most closely observed part in the body during an interaction. As mentioned before, facial expressions have been studied and categorized in terms of basic emotions by researchers, such as Ekman and Friesen (1978).

According to Smith and Scott (1997) there are mainly three levels to describe facial expressions; the purely categorical model, the purely componential model and the componential model. In the purely categorical model, a set of facial patterns associated to basic and universal emotional facial expressions is defined. As mentioned before, Ekman and his colleagues, Izard and several

researches have studied the universality of facial expressions among different cultures. Universally recognized facial expressions were defined, such as six basic emotion identified by Ekman. While the purely componential model suggests that the meaning of facial expression is the sum of the meanings of parts of facial expression, componential model proposes that the whole meaning of the facial expression can be different than the meaning of its parts (Smith and Scott, 1997). In other words, facial actions in the human face can be recognized differently, whether all the facial actions are read together or separately.

According to Vinayagamoorthy et al. (2006b), facial expressions can be considered with four different levels; *static appearance, basic motion primitives, facial movements/signals* and *facial meanings*. Static appearance of facial description is the 2D or 3D mesh of a face whereas the basic motion primitives refer to the movements of the muscles. One of the vital contributions to these levels is the Facial Action Coding System (FACS) introduced by Ekman and Friesen (1978). As mentioned before, FACS is grounded on Action Units describing the facial changes on the face, which is very helpful to code facial expressions. Other famous methods are Facial Animation Markup Language (FAML) and the low level Facial Action Parameters (Vinayagamoorthy et al., 2006b). Facial movements/signals are based on the changes of the movements of the muscles over time. Facial meanings are refers to the meanings through face not the physical changes. The methods developed for facial meanings are the script languages.

2.11 Factors Influencing the Recognition of Facial Expressions

The most important factors that can influence the recognition of facial expressions include culture, interpersonal relationship and context (Vinayagamoorthy et al., 2006b). It has been discussed that facial expressions can be recognized differently in different cultures. However, the universality studies conducted by several researches, especially Ekman and his colleagues, found that there are six basic emotions universally recognized. Therefore, culture is not a very important factor for six basic emotions.

Similarly, behavior can be affected by different contexts. The results of some studies about facial and contextual information in the perception of emotion from facial expression show that context can dominate facial expressions of basic emotions (Carroll and Russell, 1996). On the other hand, the facial expression dominates the context in the perception of emotion (Wallbott, cited in Fernández-Dols and Carroll, 1997) and (Nakamura, Buck and Kenny, cited in Fernández-Dols and Carroll, 1997). Facial expressions can dominate the context or can be dominated by context.

The interpersonal relationship refers to the internal factors of an individual, such as their personality and emotional state. Vinayagamoorthy et al. (2006b) stated that nonverbal behavior is related to relationships between individuals; therefore, to increase the interaction between individuals it is important to build reliable and believable characters. The personality and emotional state of an individual, of course, can make differences in the recognition of facial expressions but not much difference for basic emotions.

2.12 The Methods Used for Generating facial expressions

The models of three-dimensional human head are vital for computer based facial animation and thus to create emotional facial expressions. As mentioned in the introduction chapter (part 1.1), one of the earliest works with computer based facial animation was done by Frederick Parke in 1972 (Parke & Waters, 1996).

Facial animations and facial expressions are created by altering the parameters that controls several facial movements in time. There are several approaches to build facial animation and traditional techniques include (Computer facial animation, n.d.);

1. Morph targets,
2. Skeleton or muscle systems,
3. Bone technique,
4. Motion capturing of the face and
5. Knowledge based solver deformations.

1. *Morph target* is a technique that stores the positions of vertexes of a 3D mesh for each different head model and the vertices are changed to different positions in order to create facial animation or facial expressions. This technique requires modeling of the 3D face mesh for each facial movement or for each facial expression and then controlling of these different 3D face meshes by slider parameters. Morph target technique, namely per vertex animation, can sometimes be used as an alternative method to skeleton or muscle systems. It provides high degree in accordance with facial expressions. To give an example of a character for which this technique was used, Gollum, The Lord of the Rings, is one of a well-known character. Autodesk 3ds Max, Autodesk Maya, Poser and several programs can be used for this technique.

2. *Skeleton or muscle system* is a technique in which a series of bones are constructed. Virtual characters that are modeled with skeleton system are simulated with a surface representation (skin and tissues) and hierarchical set of bones (skeleton) in order to reach more realistic appearance. Each bone has a three dimensional transformation within a hierarchy. Although this method might be very to create realistic facial expressions but the complexity of facial structures makes computational process expensive, and difficult to create, it is necessary to mention that physical models based on skeleton system are not a proper and efficient technique in many applications. Programs which require high skills for this technique are used, especially Maya.

3. *Bone technique*, namely 'Envelope' or 'Cages' are mostly used in games because simple and fast facial expressions can be produced by using this technique. However, the results are inconspicuous and hard to perceive.

4. *Motion capture* is a technique that uses several cameras placed around face. This technique determines the points placed on the face and their position. The data recorded by camera is converted into 3D computer model of the face. The development of the detectors in terms of size has enabled to use motion capture method for computer facial animation as a

vital tool. Well-known companies, such as Dreamworks and Imageworks, used facial motion capture extensively.

5. *Knowledge based solver deformation system* is an application that enables to construct facial motion capture into a structured set of face clusters, resulting in a high level animation system. An advantage of such a system is that it provides the animator to create complex facial movements or expressions with minimal effort. Most well-known systems based on knowledge deformations are Autodesk Softimage Face Robot and Facial Animation Toolset, an extension for Maya. These programs allow the animator to control over all facial parts. In these softwares, there is a library of facial deformations based on motion capture technique. An adjustment for deformation has to be done to the 3D model or face, which is animated.

Depending on the accessibility to the softwares and the skill required to build facial expressions, it was thought that morph target method is more suitable way when compared to other methods. In this present research, software called Poser was used to create emotion specific facial expressions based on the results of the cooccurences of Action Units for basic emotions.

CHAPTER 3

STUDY 1 – VALIDATION OF FACIAL EXPRESSIONS

3.1 The Aim of the Study 1

This study is mainly part of the study 2. As discussed in the literature review less known about reliability of FACS and the problems in the recognition of emotional facial expressions, a study is carried out in the Department of Industrial Design at Middle East Technical University (METU, Ankara, TURKEY) in order to validate the recognition of emotion specific facial expressions by a virtual agent (neutral, happy, sad, anger, fear, surprise, and disgust) generated according to the FACS descriptions and the results of cooccurences of the Action Units. The aim of Study 1 is to validate the recognition of emotional facial expressions and to investigate the perceived expressive intensity of these facial expressions in order to select the proper intensity to be used for the second study.

3.2 Methodology of the Study

In this study, an online questionnaire (See Appendix C for paper version) method is used with 5 point likert scaling. At the beginning of the questionnaire, the participants were instructed about the study. The participants were asked to rate about facial emotion specific expressions how well they recognize the emotions. In this study, they were given 19 emotional facial expressions, 1 neutral facial expression and 6 different emotion specific facial expressions (happy, sadness, anger, fear, surprise, disgust) with 3 different intensities (low, medium and high). We asked them to rate each 19 facial expressions according to how well the character expresses specific emotions. They have to rate the expressions on a scale of 1 to 5 for each of the six emotions. 1 means no expression of this emotion, 5 means a very good expression of this emotion. For instance, if they find the stimulus face express

happiness very well, sadness poorly, anger moderate, etc.; they can rate 5 for happiness, 2 for sadness, 3 for anger. It took approximately 10 minutes.

3.3 The Generated Facial Expressions for Each Basic Emotion

One neutral and 6 basic emotions were created by using Poser software. To conduct the study 1, each basic emotion was also built with 3 different intensities, low, medium and high. As mentioned before the reliability of FACS and the universality, less information about the reliability is known for the intensity (Sayette et al., 2001) and there are discussions about the universality of the basic emotions, it is important to validate emotional facial expressions and to find out the proper level of the intensity of the emotions how well the participants recognize them. The each facial expression created by software called Poser is given in the figures 3.3.1-3.3.7.

Figure 3.3.1: The neutral facial expression

Figure 3.3.2: Happy facial expressions (low, medium and high)

Figure 3.3.3: Sadness facial expressions (low, medium and high)

Figure 3.3.4: Anger facial expressions (low, medium and high)

Figure 3.3.5: Fear facial expressions (low, medium and high)

Figure 3.3.6: Surprise facial expressions (low, medium and high)

Figure 3.3.7: Disgust facial expressions (low, medium and high)

3.4 Participants of the Study

Participants of the Study 1 were the students from Industrial Design Department at METU. 93 participants, 25 male, 63 female and 5 participants without gender and age information, were volunteered to participate in this study, ranging from 18 years old to 28 years old. Their average age was 23 years old. 5 participants without gender and age were excluded. In addition, 3 male and 3 female participants were excluded because of incomplete information or wrong information. Therefore, 22 male and 60 female participants were analyzed. None of the students were native speaker of English so that the study was given them in their own language, Turkish.

3.5 Limitations of the Study

The online questionnaire was planned to place each of 19 facial expressions in a different page in the website because while looking at each of these facial expression, the participants would not be affected by the other facial expressions. In other words, they would focus on just one facial expression in each page of the online questionnaire. However, there was a problem to get the data from different web pages because of the limited coding knowledge of the researcher. Therefore, depending on the knowledge of the researcher, all facial expressions were placed in one page. The space between facial expressions was adjusted in a way that the participants could see just one facial expression in the screen and they should scroll down to see and rate the other facial expressions. In this way, to be affected by the other facial expressions was minimized.

3.6 The results of the Study

The data was analyzed in both Microsoft Excel and SPSS software. For this study, the mean values were calculated and ANOVA analysis was done. While the mean values was calculated by using Microsoft Excel and SPSS software, ANOVA (Tukey post-hoc) analysis for each emotion with different intensities was evaluated by using SPSS. In the results of Tukey post-hoc tables, the most important parts are given (for complete Tukey post-hoc tables, see Appendix D). In this section, the results of each emotion will be given separately, in sub-

sections, respectively, neutral, happy, sadness, anger, fear, surprise and disgust.

3.6.1 The Results of Neutral Facial Expression

The below is the table presenting the mean values, when the participants were asked to rate the neutral facial expression. The table 3.6.1 shows that the ratings for each emotion (happy mean score=1.77, sadness mean score=2.21, anger mean score=1.46, fear mean score=1.89, surprise mean score=2.31, disgust mean score=1.21) are low enough to consider neutral facial expression as neutral.

Table 3.6.1: The results of the neutral facial expression

	Happy	Sadness	Anger	Fear	Surprise	Disgust
Neutral	1,78	2,21	1,45	1,86	2,28	1,18

3.6.2 The Results of Happy Facial Expressions

Analysis of the responses given to happy expressions (low intensity, medium intensity and high intensity) shows that the virtual human character expresses the happy emotion adequately. Tukey post-hoc tables below show the significant differences between happy and all other emotions, when the participants were asked to rate for the happy low, medium and high intensity. Tukey post-hoc tests confirm that happy facial expressions for 3 different intensities are significantly more attributed to happy expressions than to other expressions (see table 3.6.2 for low intensity, see 3.6.3 for medium intensity, see 3.6.4 for high intensity).

Table 3.6.2: Tukey post-hoc results of low intensity happy facial expression

(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Happy	Sadness	2,52439*	0,07748	,000*	2,3027	2,7461
	Anger	2,68293*	0,07748	,000*	2,4613	2,9046
	Fear	2,70732*	0,07748	,000*	2,4856	2,929
	Surprise	2,65854*	0,07748	,000*	2,4369	2,8802
	Disgust	2,71951*	0,07748	,000*	2,4978	2,9412

Table 3.6.3: Tukey post-hoc results of medium intensity happy facial expression

(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Happy	Sadness	2,46341*	0,11262	,000*	2,1412	2,7856
	Anger	2,26829*	0,11262	,000*	1,9461	2,5905
	Fear	2,75610*	0,11262	,000*	2,4339	3,0783
	Surprise	2,63415*	0,11262	,000*	2,3119	2,9564
	Disgust	2,34146*	0,11262	,000*	2,0193	2,6637

Table 3.6.4: Tukey post-hoc results of high intensity happy facial expression

(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Happy	Sadness	2,89024*	0,09517	,000*	2,6179	3,1625
	Anger	2,96341*	0,09517	,000*	2,6911	3,2357
	Fear	3,19512*	0,09517	,000*	2,9228	3,4674
	Surprise	3,07317*	0,09517	,000*	2,8009	3,3455
	Disgust	2,95122*	0,09517	,000*	2,6789	3,2235

The table 3.6.5 presents the estimated mean values, when the participants were asked to rate the happy facial expressions. As it can be seen from the table, estimated happy mean scores are the highest (happy mean score for low intensity=3.74, happy mean score for medium intensity=3.81, and happy

mean score for high intensity=4.2). The other emotions (sadness, anger, fear, surprise and disgust) have lower estimated mean scores.

Table 3.6.5: The results of estimated mean values for happy facial expressions

	Happy	Sadness	Anger	Fear	Surprise	Disgust
Happy Low	**3,74**	1,21	1,06	1,03	1,08	1,02
Happy Medium	**3,81**	1,35	1,54	1,06	1,18	1,47
Happy High	***4,2***	1,31	1,24	1,01	1,13	1,25

Concerning the intensity effect, figure 3.6.1 illustrates that more intense happy expressions are better recognized than less intense happy expressions. While the estimated mean value of happy emotion for high intensity (4.2) is higher than the low intensity (3,74) and medium intensity (3,81), the estimated mean scores of other emotions for high intensity are lower than medium intensity and are closer to low intensity. The differences between the estimated mean scores of the other emotions (sadness, anger, fear, surprise and disgust) are not too important for recognition of the happy facial expression. As a result, high intensity happy facial expression was selected for the study 2.

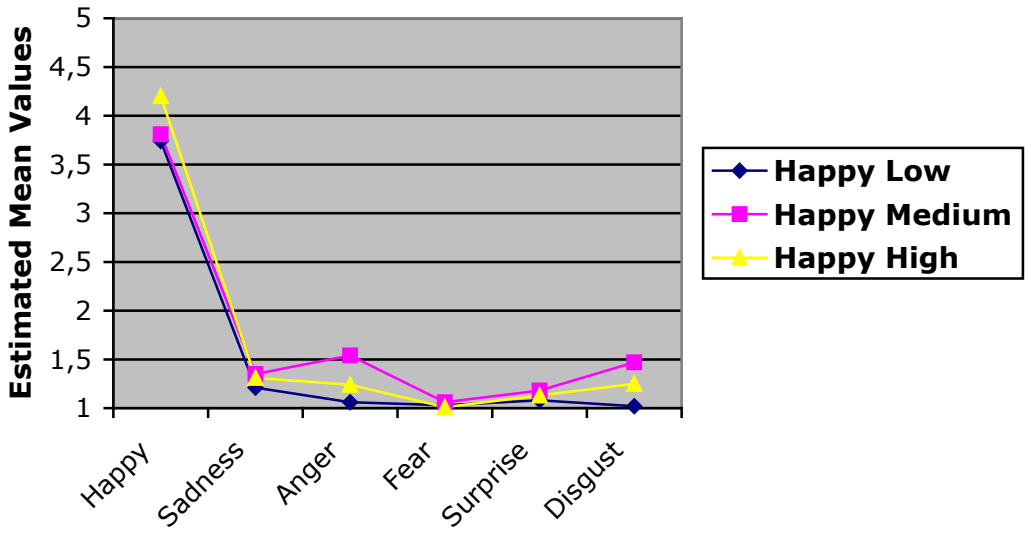

Figure 3.6.1: The graph of the estimated mean scores for happy facial expressions

3.6.3 The Results of Sadness Facial Expressions

The responses of the participants to sadness facial expressions (low intensity, medium intensity and high intensity) confirm that the virtual human character expresses the sadness emotion sufficiently. The below are Tukey post-hoc tables presenting the significant differences when we asked for the sadness low, medium, and high intensity. For each of 3 intensities, the differences between sadness and all other emotions (happy, anger, fear, surprise, and disgust) are significant (see table 3.6.6 for low intensity, see table 3.6.7 for medium intensity, and see table 3.6.8 for high intensity). Tukey post-hoc tests confirm that all sadness facial expressions (low, medium and high intensity) are significantly linked to sadness emotion.

Table 3.6.6: Tukey post-hoc results of low intensity sadness facial expression

(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Sadness	Happy	3,59756*	0,08227	,000*	3,3622	3,8329
	Anger	3,43902*	0,08227	,000*	3,2036	3,6744
	Fear	3,13415*	0,08227	,000*	2,8988	3,3695
	Surprise	3,25610*	0,08227	,000*	3,0207	3,4915
	Disgust	3,53659*	0,08227	,000*	3,3012	3,772

Table 3.6.7: Tukey post-hoc results of medium intensity sadness facial expression

(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Sadness	Happy	3,56098*	0,10173	,000*	3,2699	3,852
	Anger	3,34146*	0,10173	,000*	3,0504	3,6325
	Fear	2,91463*	0,10173	,000*	2,6236	3,2057
	Surprise	3,19512*	0,10173	,000*	2,9041	3,4862
	Disgust	3,41463*	0,10173	,000*	3,1236	3,7057

Table 3.6.8: Tukey post-hoc results of high intensity sadness facial expression

(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Sadness	Happy	3,85366*	0,09084	,000*	3,5938	4,1136
	Anger	3,58537*	0,09084	,000*	3,3255	3,8453
	Fear	3,47561*	0,09084	,000*	3,2157	3,7355
	Surprise	3,50000*	0,09084	,000*	3,2401	3,7599
	Disgust	3,63415*	0,09084	,000*	3,3743	3,894

The estimated mean values of each emotion are presented in the table 3.6.9, when the participants were asked to rate the sadness facial expressions with different intensities (low, medium and high). As it can be seen from the table, the estimated sadness mean scores are the highest (sadness mean score for low intensity=4.6, sadness mean score for medium intensity=4.58, sadness mean score for high intensity=4.85). All the other emotions (sadness, anger, fear, surprise and disgust) have lower estimated mean scores.

Table 3.6.9: The results of estimated mean values for sadness facial expression

	Happy	Sadness	Anger	Fear	Surprise	Disgust
Sadness Low	1,01	***4,6***	1,17	1,47	1,35	1,07
Sadness Medium	1,02	**4,58**	1,24	1,67	1,39	1,17
Sadness High	1	**4,85**	1,26	1,37	1,35	1,21

When looking at the intensity effect, figure 3.6.2 shows that each of sadness facial expressions (low, medium, and high intensity) is recognized sufficiently. Although the estimated mean value of sadness emotion for low intensity is lower than the scores given for high intensity, almost all the estimated mean scores of other emotions for low intensity are lower than the mean values of other emotions for given both high intensity and medium intensity. Even though the differences between the mean scores between all emotions are not

crucial to have an effect on recognition of the sadness facial expression, the low intensity sadness expression is better to select for study 2.

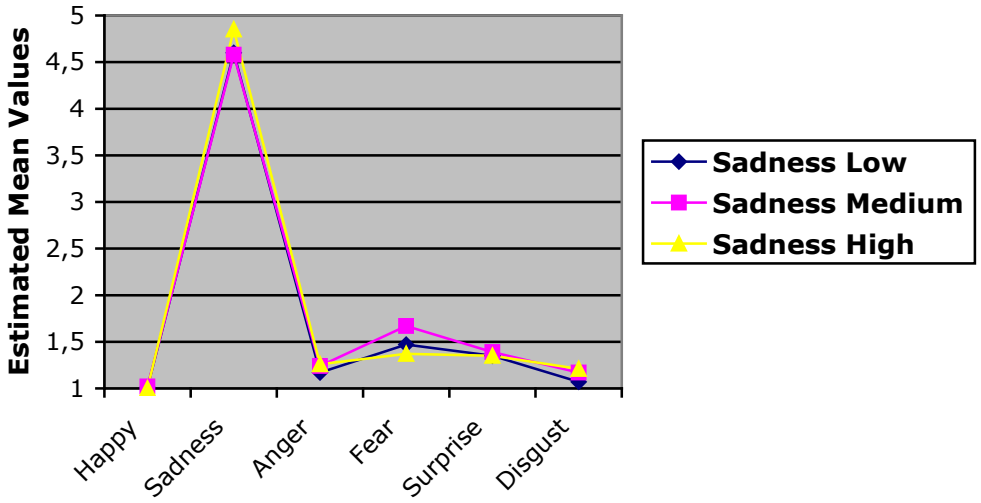

Figure 3.6.2: The graph of the estimated mean scores for sadness facial expressions

3.6.4 The Results of Anger Facial Expressions

The responses to anger facial expressions (low intensity, medium intensity and high intensity) given by the participants prove that the anger emotion is sufficiently expressed by the virtual human character. Tukey post-hoc tests show that anger facial expressions for low, medium and high intensity are significantly more ascribed to anger emotion than to other emotions (see table 3.6.10 for low intensity, see 3.6.11 for medium intensity, see 3.6.12 for high intensity).

Table 3.6.10: Tukey post-hoc results of low intensity anger facial expression

(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Anger	Happy	2,40244*	0,13542	,000*	2,015	2,7899
	Sadness	1,43902*	0,13542	,000*	1,0516	1,8265
	Fear	2,01220*	0,13542	,000*	1,6248	2,3996
	Surprise	1,93902*	0,13542	,000*	1,5516	2,3265
	Disgust	1,62195*	0,13542	,000*	1,2345	2,0094

Table 3.6.11: Tukey post-hoc results of medium intensity anger facial expression

(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Anger	Happy	3,45122*	0,10853	,000*	3,1407	3,7617
	Sadness	2,93902*	0,10853	,000*	2,6285	3,2495
	Fear	3,24390*	0,10853	,000*	2,9334	3,5544
	Surprise	3,24390*	0,10853	,000*	2,9334	3,5544
	Disgust	2,53659*	0,10853	,000*	2,2261	2,8471

Table 3.6.12: Tukey post-hoc results of high intensity anger facial expression

(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Anger	Happy	3,24390*	0,14788	,000*	2,8208	3,667
	Sadness	2,34146*	0,14788	,000*	1,9184	2,7646
	Fear	2,76829*	0,14788	,000*	2,3452	3,1914
	Surprise	2,81707*	0,14788	,000*	2,394	3,2402
	Disgust	1,63415*	0,14788	,000*	1,211	2,0573

The table 3.6.13 presents the estimated mean values of each emotion, when the participants were asked to rate the anger facial expressions. As it can be seen from the table, anger emotion has the highest estimated mean scores (sadness mean score for low intensity=3.45, sadness mean score for medium intensity=4.47, and sadness mean score for high intensity=4.2). The estimated

mean scores for other emotions (sadness, anger, fear, surprise and disgust) is lower than anger mean score.

Table 3.6.13: The results of estimated mean values for anger facial expression

	Happy	Sadness	Anger	Fear	Surprise	Disgust
Anger Low	1,04	2,01	**3,45**	1,43	1,51	1,82
Anger Medium	1,02	1,53	***4,47***	1,23	1,23	1,93
Anger High	1,03	1,93	**4,28**	1,51	1,46	2,64

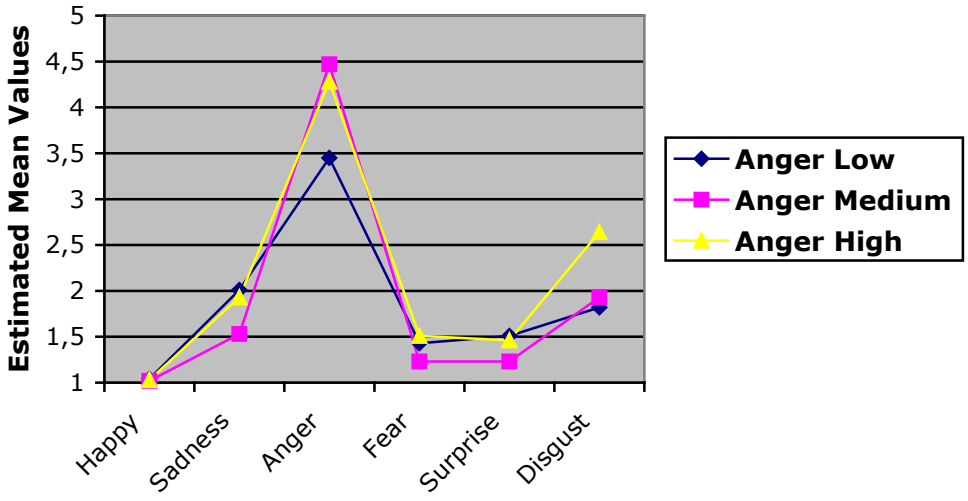

Figure 3.6.3: The graph of the estimated mean scores for anger facial expressions

The figure 3.6.3 illustrates that medium intensity anger expression can be more easily recognized than low and high intensity anger expressions. The estimated mean value of anger emotion for medium intensity (4.47) is higher than the low intensity (3.45) and high intensity (4.28), whereas the estimated mean scores of other emotions (happy, sadness, fear, surprise, and disgust) for medium intensity are lower than the mean scores of low and high intensity. While looking at medium and high intensity of anger facial expression, although the estimated anger mean scores of both intensities are enough to

recognize anger facial expression, the estimated disgust mean scores might be important to decide which intensity should be used in the study 2. The estimated disgust mean score of high intensity (2.64) is higher than the mean score of medium intensity (1.93). Therefore, medium intensity anger facial expression is better to use in the study 2.

3.6.5 The Results of Fear Facial Expressions

Analysis of the responses that were given to fear expressions for 3 different intensities (low, medium, and high intensity) shows that fear facial expressions were recognized as both fear and surprise. Tukey post-hoc tables below presents the significant differences not only between fear and all other emotions but also surprise and all other emotions. When the participants were asked to rate for the fear low intensity facial expression, Tukey post-hoc test, table 3.6.14, shows that it is significantly more attributed to surprise and fear emotions. In addition, the attribution to surprise is obviously more than the attribution to fear.

Table 3.6.14: Tukey post-hoc results of low intensity fear facial expression

(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Fear	Happy	1,90244*	0,13381	,000*	1,5196	2,2853
	Sadness	1,53659*	0,13381	,000*	1,1537	1,9194
	Anger	1,74390*	0,13381	,000*	1,3611	2,1267
	Surprise	-,74390*	0,13381	,000*	-1,1267	-0,3611
	Disgust	1,74390*	0,13381	,000*	1,3611	2,1267
Surprise	Happy	2,64634*	0,13381	,000*	2,2635	3,0292
	Sadness	2,28049*	0,13381	,000*	1,8976	2,6633
	Anger	2,48780*	0,13381	,000*	2,105	2,8706
	Fear	,74390*	0,13381	,000*	0,3611	1,1267
	Disgust	2,48780*	0,13381	,000*	2,105	2,8706

For medium intensity fear facial expression, the table 3.6.15 is Tukey post-hoc table presenting the significant differences and there are significant differences between fear and all other emotions except surprise. There are also significant

differences between surprise and all other emotions except fear. Similarly, it can be said that medium intensity fear facial expression is significantly ascribed to fear and surprise emotion. When the participants were asked to rate for the high intensity fear facial expression, the results shows that high intensity is also attributed to both fear and surprise emotion. Tukey post-hoc test, table 3.6.16, presents the significant differences not only between fear and all other emotions except surprise but also surprise and all other emotions except fear. Briefly, 3 different intensities were recognized as both fear and surprise. Therefore, fear facial expression needed to be readjusted and validated in another study.

Table 3.6.15: Tukey post-hoc results of medium intensity fear facial expression

(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Fear	Happy	1,98780*	0,15753	,000*	1,5371	2,4385
	Sadness	1,64634*	0,15753	,000*	1,1956	2,097
	Anger	,51220*	0,15753	,015*	0,0615	0,9629
	Surprise	-0,2561	0,15753	0,582	-0,7068	0,1946
	Disgust	1,59756*	0,15753	,000*	1,1469	2,0483
Surprise	Happy	2,24390*	0,15753	,000*	1,7932	2,6946
	Sadness	1,90244*	0,15753	,000*	1,4517	2,3531
	Anger	,76829*	0,15753	,000*	0,3176	1,219
	Fear	0,2561	0,15753	0,582	-0,1946	0,7068
	Disgust	1,85366*	0,15753	,000*	1,403	2,3044

Table 3.6.16: Tukey post-hoc results of high intensity fear facial expression

(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Fear	Happy	3,09756*	0,1554	,000*	2,6529	3,5422
	Sadness	1,98780*	0,1554	,000*	1,5432	2,4324
	Anger	2,62195*	0,1554	,000*	2,1773	3,0666
	Surprise	0,18293	0,1554	0,848	-0,2617	0,6275
	Disgust	2,28049*	0,1554	,000*	1,8359	2,7251
Surprise	Happy	2,91463*	0,1554	,000*	2,47	3,3593
	Sadness	1,80488*	0,1554	,000*	1,3603	2,2495
	Anger	2,43902*	0,1554	,000*	1,9944	2,8836
	Fear	-0,18293	0,1554	0,848	-0,6275	0,2617
	Disgust	2,09756*	0,1554	,000*	1,6529	2,5422

The estimated mean values of each emotion are presented in the table 3.6.17, when the participants were asked to rate the fear facial expressions. The estimated surprise mean scores for the low intensity (3.79) and medium intensity (3.26) are the higher than the estimated fear mean score for low (3.04) and medium intensity (3.01) For the high intensity, the estimated fear mean value (4.13) is higher than the score given for surprise emotion (3.93).

Table 3.6.17: The results of estimated mean values for fear facial expression

	Happy	Sadness	Anger	Fear	Surprise	Disgust
Fear Low	1,14	1,51	1,3	**3,04**	**3,79**	1,3
Fear Medium	1,02	1,36	2,5	**3,01**	**3,26**	1,41
Fear High	1,03	2,14	1,51	**4,13**	**3,93**	1,85

However the scores given for fear and surprise emotion for 3 different intensities are closer (figure 3.6.4), resulting in the recognition of both fear and surprise. Thus, it can be easily concluded that it is essential to readjust fear facial expression and to validate with a study, which will be presented in the section 3.6.8.

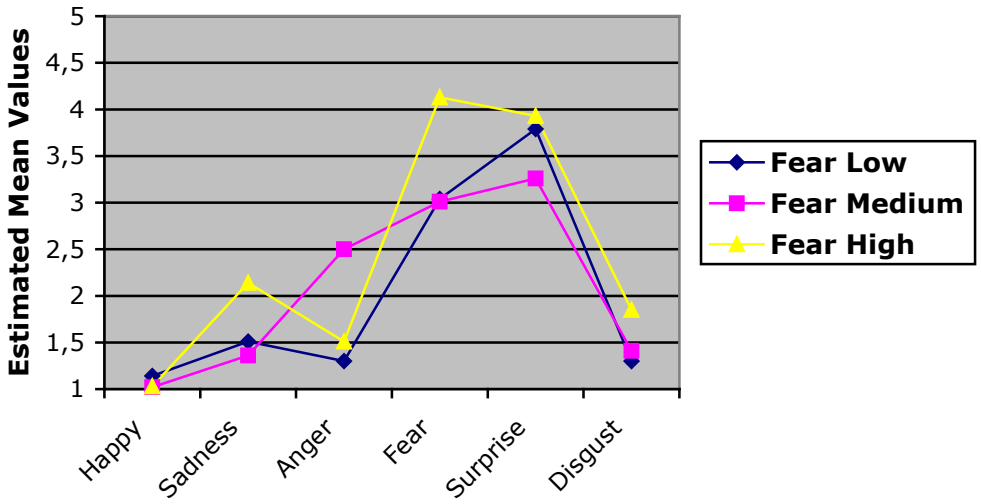

Figure 3.6.4: The graph of the estimated mean scores for fear facial expressions

3.6.6 The Results of Surprise Facial Expressions

The responses that are given to surprise facial expressions by the participants show that the virtual human character expresses the surprise emotion sufficiently but surprise facial expressions can also be recognized as fear emotion in addition to surprise, especially for low and high intensity. The below are Tukey post-hoc tables (table 3.6.18, 3.6.19, and 3.6.20) presenting the significant differences when we asked for the low, medium, and high intensity surprise facial expressions. For low and high intensity, the differences between surprise and all other emotions (happy, sadness, anger, fear, and disgust) are significant but the differences between fear and all other emotions are also significant (see table 3.6.18 for low intensity, and see table 3.6.19 for high intensity). Tukey post-hoc tests prove that low and high intensity surprise facial expressions are linked to both surprise and fear emotion. It is necessary to say that the attribution to surprise is higher than the attribution to fear.

Table 3.6.18: Tukey post-hoc results of low intensity surprise facial expression

(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Fear	Happy	1,86585*	0,12055	,000*	1,521	2,2107
	Sadness	1,71951*	0,12055	,000*	1,3746	2,0644
	Anger	1,98780*	0,12055	,000*	1,6429	2,3327
	Surprise	-1,41463*	0,12055	,000*	-1,7595	-1,0697
	Disgust	1,90244*	0,12055	,000*	1,5575	2,2473
Surprise	Happy	3,28049*	0,12055	,000*	2,9356	3,6254
	Sadness	3,13415*	0,12055	,000*	2,7893	3,479
	Anger	3,40244*	0,12055	,000*	3,0575	3,7473
	Fear	1,41463*	0,12055	,000*	1,0697	1,7595
	Disgust	3,31707*	0,12055	,000*	2,9722	3,662

Table 3.6.19: Tukey post-hoc results of high intensity surprise facial expression

(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Fear	Hap	1,35366*	0,12523	,000*	0,9954	1,712
	Sadness	1,79268*	0,12523	,000*	1,4344	2,151
	Anger	1,81707*	0,12523	,000*	1,4588	2,1754
	Surprise	-1,84146*	0,12523	,000*	-2,1998	-1,4832
	Disgust	1,79268*	0,12523	,000*	1,4344	2,151
Surprise	Hap	3,19512*	0,12523	,000*	2,8368	3,5534
	Sadness	3,63415*	0,12523	,000*	3,2758	3,9925
	Anger	3,65854*	0,12523	,000*	3,3002	4,0168
	Fear	1,84146*	0,12523	,000*	1,4832	2,1998
	Disgust	3,63415*	0,12523	,000*	3,2758	3,9925

Tukey post-hoc table 3.6.20 presents the significant differences when we asked for the surprise medium intensity facial expression. There are significant differences between surprise and all other emotions (happy, sadness, anger, fear, and disgust) but the differences between fear and all other emotions except happy are also significant (see table 3.6.20). Tukey post-hoc tests confirm that medium intensity surprise facial expressions are more significantly attributed to surprise emotion than fear and all other emotions.

Table 3.6.20: Tukey post-hoc results of medium intensity surprise facial expression

(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Fear	Happy	0,21951	0,12086	0,456	-0,1263	0,5653
	Sadness	,97561*	0,12086	,000*	0,6298	1,3214
	Anger	1,04878*	0,12086	,000*	0,703	1,3946
	Surprise	-2,51220*	0,12086	,000*	-2,858	-2,1664
	Disgust	,97561*	0,12086	,000*	0,6298	1,3214
Surprise	Happy	2,73171*	0,12086	,000*	2,3859	3,0775
	Sadness	3,48780*	0,12086	,000*	3,142	3,8336
	Anger	3,56098*	0,12086	,000*	3,2152	3,9068
	Fear	2,51220*	0,12086	,000*	2,1664	2,858
	Disgust	3,48780*	0,12086	,000*	3,142	3,8336

The estimated mean values of each emotion for surprise facial expressions (low, medium, and high intensity) are presented in the table 3.6.21. As it can be seen from the table, the estimated surprise mean scores for each of 3 intensities are the highest (surprise mean score for low intensity=4.59, surprise mean score for medium intensity=4.62, surprise mean score for high intensity=4.75).

Table 3.6.21: The results of estimated mean values for surprise facial expression

	Happy	Sadness	Anger	Fear	Surprise	Disgust
Surprise Low	1,31	1,46	1,19	3,18	**4,59**	1,28
Surprise Medium	1,89	1,13	1,06	2,1	***4,62***	1,13
Surprise High	1,56	1,12	1,09	2,91	**4,75**	1,12

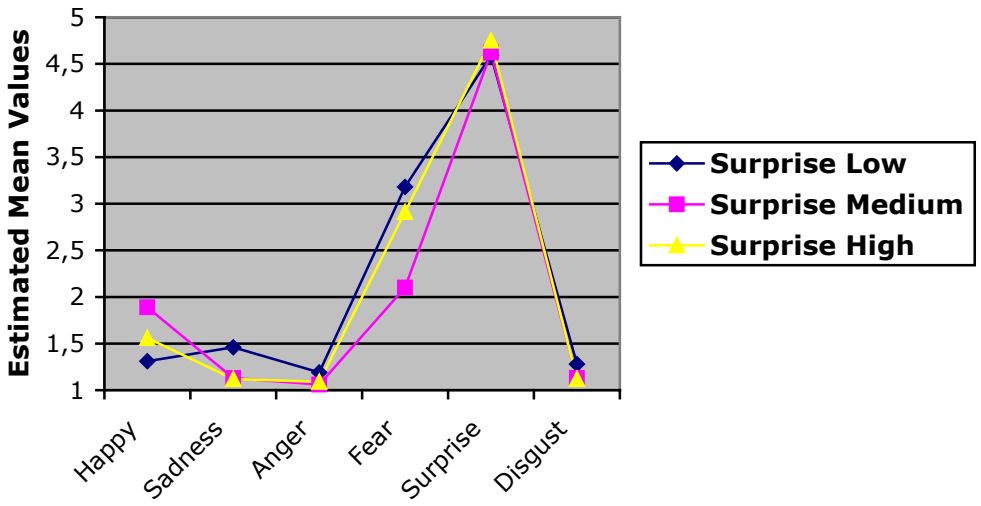

Figure 3.6.5: The graph of the estimated mean scores for surprise facial expression

While looking at 3 different intensities in the figure 3.6.5, although the estimated surprise mean scores are enough to recognize surprise facial expression as surprise emotion, fear emotion can also be recognized (fear mean score for surprise low intensity=3.18, fear mean score for surprise medium intensity=2.1, and fear mean score for surprise high intensity=2.91).

Therefore, it is better to select medium intensity. This is because while each of 3 different intensities has a closer estimated mean score of surprise emotion, medium intensity surprise facial expression has the lowest fear mean value.

3.6.7 The Results of Disgust Facial Expressions

The responses to disgust facial expressions (low, medium, and high intensity) given by the participants prove that the disgust emotion is sufficiently expressed by the virtual human character for medium and high intensity. In addition to disgust emotion, sadness emotion can also be recognized when looking at disgust facial expressions. Tukey post-hoc tables below shows the significant differences not only between disgust and all other emotions but also sadness and all other emotions. When the participants were asked to rate for the low intensity disgust facial expression, Tukey post-hoc test, table 3.6.22, shows that there are significant differences between disgust and other emotions except sadness. In addition, the differences between sadness and other emotions except disgust are significant. However, it is hard to say that low intensity disgust facial expression can be attributed either disgust or sadness emotion.

Table 3.6.22: Tukey post-hoc results of low intensity disgust facial expression

(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Sadness	Happy	1,09756*	0,13444	,000*	0,7129	1,4822
	Anger	,58537*	0,13444	,000*	0,2007	0,97
	Fear	,97561*	0,13444	,000*	0,5909	1,3603
	Surprise	1,00000*	0,13444	,000*	0,6153	1,3847
	Disgust	-0,31707	0,13444	0,173	-0,7017	0,0676
Disgust	Happy	1,41463*	0,13444	,000*	1,03	1,7993
	Sadness	0,31707	0,13444	0,173	-0,0676	0,7017
	Anger	,90244*	0,13444	,000*	0,5178	1,2871
	Fear	1,29268*	0,13444	,000*	0,908	1,6773
	Surprise	1,31707*	0,13444	,000*	0,9324	1,7017

For high intensity disgust facial expression, the table 3.6.23 is Tukey post-hoc table presenting the significant differences and there are significant differences between disgust and all other emotions. There also exist significant differences between sadness and all other emotions. It can be said that high intensity disgust facial expression is significantly ascribed to disgust and sadness emotion. However, the attribution to disgust is more than the attribution to sadness emotion.

Table 3.6.23: Tukey post-hoc results of high intensity disgust facial expression

(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Sadness	Happy	2,10976*	0,15261	,000*	1,6731	2,5464
	Anger	1,30488*	0,15261	,000*	0,8683	1,7415
	Fear	1,62195*	0,15261	,000*	1,1853	2,0586
	Surprise	1,70732*	0,15261	,000*	1,2707	2,1439
	Disgust	-1,13415*	0,15261	,000*	-1,5708	-0,6975
Disgust	Happy	3,24390*	0,15261	,000*	2,8073	3,6805
	Sadness	1,13415*	0,15261	,000*	0,6975	1,5708
	Anger	2,43902*	0,15261	,000*	2,0024	2,8756
	Fear	2,75610*	0,15261	,000*	2,3195	3,1927
	Surprise	2,84146*	0,15261	,000*	2,4048	3,2781

When the participants were asked to rate for the medium intensity disgust facial expression, the results shows that medium intensity disgust facial expression is more attributed to disgust emotion than other emotions. Tukey post-hoc table 3.6.24 presents that the differences between disgust and all other emotions are significant. Although there are significant differences between sadness and other emotions except anger, the medium intensity disgust emotion is more linked to disgust emotion.

Table 3.6.24: Tukey post-hoc results of medium intensity disgust facial expression

(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Sadness	Happy	1,40244*	0,14913	,000*	0,9758	1,8291
	Anger	0,26829	0,14913	0,467	-0,1584	0,695
	Fear	,97561*	0,14913	,000*	0,5489	1,4023
	Surprise	,89024*	0,14913	,000*	0,4636	1,3169
	Disgust	-1,78049*	0,14913	,000*	-2,2072	-1,3538
Disgust	Happy	3,18293*	0,14913	,000*	2,7563	3,6096
	Sadness	1,78049*	0,14913	,000*	1,3538	2,2072
	Anger	2,04878*	0,14913	,000*	1,6221	2,4754
	Fear	2,75610*	0,14913	,000*	2,3294	3,1828
	Surprise	2,67073*	0,14913	,000*	2,2441	3,0974

The table 3.6.25 presents the estimated mean values of each emotion, when the participants were asked to rate the disgust facial expressions. While disgust emotion for low intensity has lower estimated mean score (2.62), when compared to estimated mean score of disgust for medium and high intensity (disgust mean score for medium intensity=4.2 and disgust mean score for high intensity=4.25).

Table 3.6.25: The results of estimated mean values for disgust facial expression

	Happy	Sadness	Anger	Fear	Surprise	Disgust
Disgust Low	1,2	2,3	1,71	1,32	1,3	**2,62**
Disgust Medium	1,02	2,42	2,15	1,45	1,53	***4,2***
Disgust High	1,01	3,12	1,81	1,5	1,41	**4,25**

Figure 3.6.6 illustrates that medium intensity disgust facial expression can be more easily recognized than low and high intensity disgust expressions. The estimated mean value of disgust emotion for medium intensity (4.2) is closer to the high intensity (4.25), whereas the estimated mean score of sadness

emotion for medium intensity (2.42) are lower than the mean scores of high intensity (3.12). Therefore, medium intensity disgust facial expression is better to use for the second study.

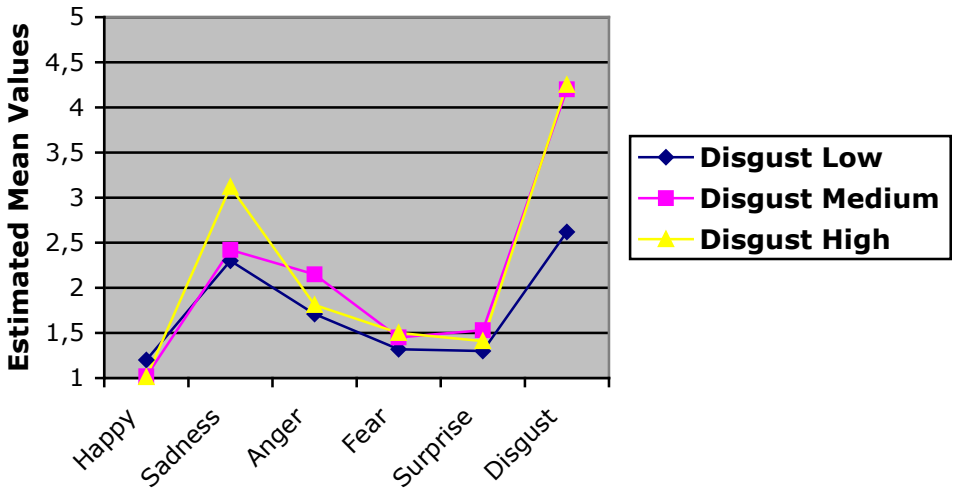

Figure 3.6.6: The graph of the estimated mean scores for disgust facial expression

3.6.8 The Readjusted (new) Fear Facial Expression Study

According to the results of fear facial expression, fear expression of the virtual human character can be recognized as both fear and surprise emotion. In other words, fear expressions for 3 different intensities are mainly attributed to both fear and surprise expressions. As a result of this, fear facial expression was readjusted and another study for new fear expression was carried out in the Department of Industrial Design at Middle East Technical University (METU, Ankara, TURKEY). The readjusted fear facial expression can be seen in the figure 3.6.7.

The aim of this study is to validate the recognition of new fear facial expressions by a virtual agent and to investigate the perceived expressive intensity of new fear facial expression.

Figure 3.6.7: The readjusted fear facial expressions

3.6.8.1 The Methodology of the Study

Similarly, an online questionnaire (See Appendix F for paper version) method is used with 5 point likert scaling. At the beginning of the questionnaire, the participants were instructed about the study. The participants were asked to rate about facial expressions how well the virtual character express the emotions. In this study, they were given 3 emotional facial expressions, 1 fear facial expression with 3 different intensities (low, medium and high). We asked them to rate each 3 facial expressions according to how well the character expresses specific emotions. How to rate facial expressions is the same, like described in the section 3.2. It took approximately 2 minutes.

3.6.8.2 The Participants of the Study

Participants of the adjusted fear facial expression study were the students from Industrial Design Department at METU. 41 participants, 20 male, 21 female were volunteered to participate in this study, ranging from 20 years old to 28 years old. Their average age was 24 years old. All the participants filled the online questionnaire completely, thus none of the participants were excluded. 20 male and 21 female participants were analyzed. None of the students were native speaker of English so that the study was given them in their own language, Turkish.

3.6.8.3 The Results of Readjusted (new) Fear Facial Expressions

Analysis of the responses given to fear facial expressions shows that readjusted fear facial expressions for each of 3 intensities were again recognized as both fear and surprise. Tukey post-hoc tables below shows the significant differences not only between fear and all other emotions but also surprise and all other emotions. When the participants were asked to rate for the fear facial expressions, Tukey post-hoc tests show that there are significant differences between fear and all other emotions except surprise and also there exist significant differences between surprise and all other emotions except fear (see table 3.6.26 for low intensity, see table 3.6.27 for medium intensity, and see table 3.6.28 for high intensity). The results prove that fear facial expressions are significantly more ascribed to surprise and fear emotions than other emotions. In addition, the attribution to fear is obviously more than the attribution to surprise for high intensity.

Table 3.6.26: Tukey post-hoc results of low intensity readjusted fear facial expression

(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Fear	Happy	1,85366*	0,20206	,000*	1,2732	2,4342
	Sadness	1,63415*	0,20206	,000*	1,0536	2,2146
	Anger	1,07317*	0,20206	,000*	0,4927	1,6537
	Surprise	-0,56098	0,20206	0,065	-1,1415	0,0195
	Disgust	1,75610*	0,20206	,000*	1,1756	2,3366
Surprise	Happy	2,41463*	0,20206	,000*	1,8341	2,9951
	Sadness	2,19512*	0,20206	,000*	1,6146	2,7756
	Anger	1,63415*	0,20206	,000*	1,0536	2,2146
	Fear	0,56098	0,20206	0,065	-0,0195	1,1415
	Disgust	2,31707*	0,20206	,000*	1,7366	2,8976

Table 3.6.27: Tukey post-hoc results of medium intensity readjusted fear facial expression

(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Fear	Happy	2,82927*	0,19697	,000*	2,2634	3,3951
	Sadness	1,85366*	0,19697	,000*	1,2878	2,4195
	Anger	1,39024*	0,19697	,000*	0,8244	1,9561
	Surprise	-0,02439	0,19697	1	-0,5903	0,5415
	Disgust	2,39024*	0,19697	,000*	1,8244	2,9561
Surprise	Happy	2,85366*	0,19697	,000*	2,2878	3,4195
	Sadness	1,87805*	0,19697	,000*	1,3122	2,4439
	Anger	1,41463*	0,19697	,000*	0,8488	1,9805
	Fear	0,02439	0,19697	1	-0,5415	0,5903
	Disgust	2,41463*	0,19697	,000*	1,8488	2,9805

Table 3.6.28: Tukey post-hoc results of high intensity readjusted fear facial expression

(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Fear	Happy	3,00000*	0,23904	,000*	2,3133	3,6867
	Sadness	1,70732*	0,23904	,000*	1,0206	2,394
	Anger	1,80488*	0,23904	,000*	1,1182	2,4916
	Surprise	0,53659	0,23904	0,221	-0,1501	1,2233
	Disgust	2,00000*	0,23904	,000*	1,3133	2,6867
Surprise	Happy	2,46341*	0,23904	,000*	1,7767	3,1501
	Sadness	1,17073*	0,23904	,000*	0,484	1,8575
	Anger	1,26829*	0,23904	,000*	0,5816	1,955
	Fear	-0,53659	0,23904	0,221	-1,2233	0,1501
	Disgust	1,46341*	0,23904	,000*	0,7767	2,1501

The estimated mean values of each emotion are presented in the table 3.6.17, when the participants were asked to rate the readjusted fear facial expressions. The estimated surprise mean score for the low intensity (3.7) is higher than the estimated fear mean score for low intensity (3.14). The estimated surprise and fear mean scores for medium intensity are closer to each other (fear mean score for medium intensity=3.85 and surprise mean

score for medium intensity=3.87). For the high intensity, the estimated fear mean value (4) is higher than the score given for surprise emotion (3.46).

Table 3.6.29: The results of estimated mean values for readjusted fear facial expression

	Happy	Sadness	Anger	Fear	Surprise	Disgust
Fear Low	1,29	1,51	2,07	**3,14**	**3,7**	1,39
Fear Medium	1,02	2	2,46	**3,85**	**3,87**	1,46
Fear High	1	2,29	2,19	**4**	**3,46**	2

It is obvious that the scores given for fear and surprise emotion for 3 different intensities are closer (figure 3.6.8), resulting in the recognition of both fear and surprise emotions. Although the estimated mean score of fear emotion (4) is high than surprise emotion (3.46), the difference between these emotions is not enough. Nevertheless, high intensity fear facial expression was selected for the second study.

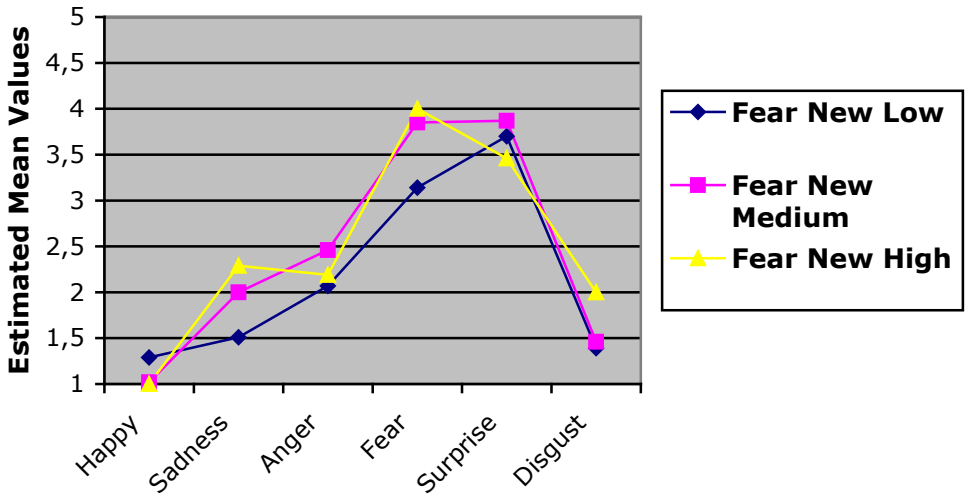

Figure 3.6.8: The graph of the estimated mean scores for readjusted fear facial expression

3.7 The Selected Intensities for Each of Basic Emotions

In brief, the table 3.7.1 shows the selected intensities for each of facial expressions with their estimated mean values. While high intensity was selected for happy and fear emotions, it was decided to use medium intensity for anger, surprise and disgust emotions. For sadness facial expression, low intensity was selected to use in the study 2. Selected facial expressions are given in the figures 3.7.1-3.7.6.

Table 3.7.1: The selected intensities for each facial expression

	Happy	Sadness	Anger	Fear	Surprise	Disgust
Low		4,6				
Medium			4,47		4,62	4,2
High	4,2			4		

Figure 3.7.1: The high intensity happy facial expression

Figure 3.7.2: The low intensity sadness facial expression

Figure 3.7.3: The medium intensity anger facial expression

Figure 3.7.4: The high intensity fear facial expression

Figure 3.7.5: The medium intensity surprise facial expression

Figure 3.7.6: The medium intensity disgust facial expression

3.8 The Conclusions about the Effect of Action Units

Although the aim of this study is not to make conclusions about the effect of Action Units, some conclusions or remarks can be mentioned. The table 3.8.1 shows the estimated mean values of their own emotions for all emotional facial expressions, which can be used to reach conclusions about the effect of Action Units. Firstly, the mean scores of happy, fear, and disgust emotions are mainly lower than the other emotions (sadness, anger, and surprise). For happy facial expression, the mean scores of happy emotion are unexpectedly lower. With regard to the verbal feedback in the second study about the recognition of the happy facial expression, although the virtual character smiles, he does not express real happy emotion. This might stem from that it is hard to see such a happy facial expression in our daily life. It is more natural to see happy emotion with mouth opening when facing with happy people.

Table 3.8.1: The estimated mean values for all emotional facial expressions

	Happy	Sadness	Anger	Fear	Surprise	Disgust
Low	3,74	***4,6***	3,45	3,14	4,59	2,62
Medium	3,81	4,58	***4,47***	3,85	***4,62***	***4,2***
High	***4,2***	4,85	4,28	***4***	4,75	4,25

As mentioned in the universality section 2.3, fear facial expression can be recognized as both fear and surprise emotion. Action Units for fear facial expressions are not enough to express fear emotion. In order to distinguish fear emotion from surprise, additional techniques should be used, such as hair can become steep.

On the other hand, Action Units are useful for modeling sadness, anger, and surprise facial expressions. Modelers can use the prototypical patterns of these emotions. Particularly, modelers need to divert Action Units for happy and fear facial expressions.

CHAPTER 4

STUDY 2 – THE EFFECT OF EMOTIONAL FACIAL EXPRESSIONS ON DIGITAL INTERACTIVE TASKS

4.1 The Aim of the Study 2

What is also important for the fields in which the virtual characters are used is that how facial expressions of virtual characters affect the task performance of the user in a virtual environment. It should be stated that there are few researches about the effect of emotion specific facial expressions on task performance in a digital virtual environment.

The aim of study 2 is to investigate the effects of emotion specific facial expressions of a virtual character (happy, sad, anger, fear, surprise, and disgust) on people's performance for interactive digital tasks in a virtual environment. A digital interactive application was created by using software called Unity. A study was conducted in the Department of Industrial Design at Middle East Technical University and was analyzed and evaluated to come up with results and conclusions on the subject. In this study, the emotion expressions through facial expressions, which were validated in the study 1, were the focus.

4.2 Methodology of the Study

Methods utilized in this study are video recordings of the digital interactive application, questionnaire and personal observation of the researcher. Before the study, the participants were instructed about the study. During the study, the performance of the participants in response to emotional facial expressions and their reactions were analyzed with the help of the video recordings and observations of the researcher. After conducting the study, a small questionnaire was conducted with the participants with some questions to get

data about their experience during the study, their acquaintance with the virtual characters and their recognition about emotional facial expressions.

4.2.1 3D Digital Interactive Application of the Study

A digital interactive application in which emotional facial expressions were placed was created by using software called Unity. The participants navigate, get into contact with the virtual human character and do the tasks given by the character, which is controlled by computer. Digital interactive application is a kind of game in which the participants use keyboard and mouse to control the player.

4.2.2 Virtual Environment of the Digital Environment

The setup of the virtual environment is given in the figure 4.2-1. This set-up has been adapted from a study carried out by Goerke and Krieg in 2005. In this study, similarly the effect of nonverbal communications, such as head shaking to sign 'no' or applaud, of virtual character has been evaluated.

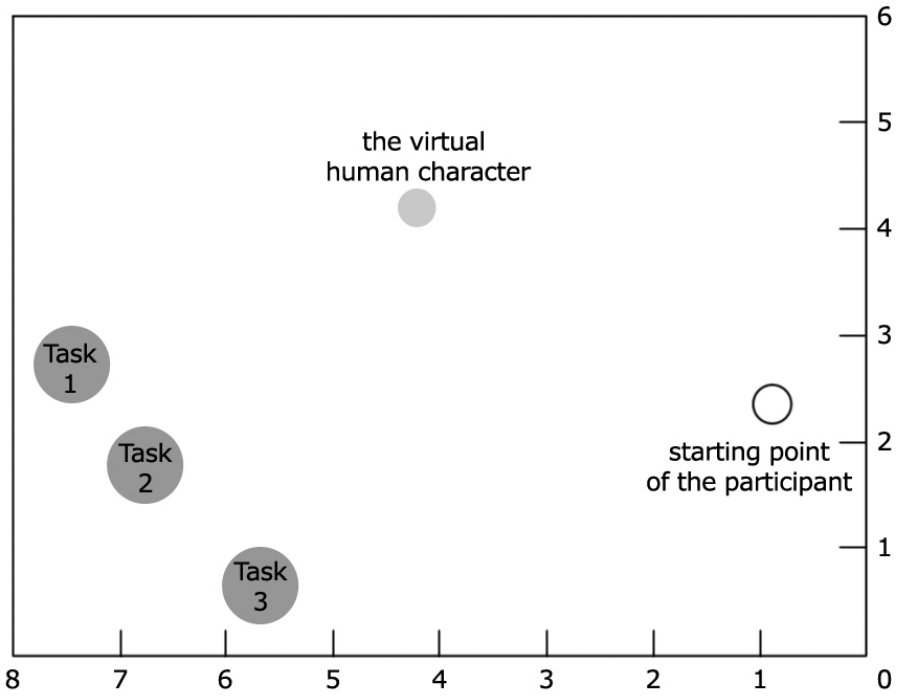

Figure 4.2.1: The setup of the digital interactive application

The placement of the player and the virtual human character were placed like in the figure 4.2.1. The participants cannot see themselves in the computer screen; their focuses are the emotional virtual human character. The virtual human character is static in the application. The participants were instructed that the computer controls the virtual human character. This is because it is important that virtual character is agent or avatar. According to Goerke and Krieg (2005), agent is considered as virtual character controlled by computer while avatar is regarded as virtual character controlled by another human. Therefore, the response to the virtual human character could be different when the participants are instructed differently. It was decided to instruct the participants about the virtual human character as agent, the virtual character controlled by computer. The setup of the application given in the figure 4.2.1 is the top view. The computer screen views of the digital interactive application are given in the figures 4.2.2 and 4.2.3. There exist only the facial emotion expressions as a nonverbal signal and no other signals in the environment.

Figure 4.2.2: The computer screen view of the digital interactive application

Figure 4.2.3: First screen of the application when the participants start a task

4.2.3 The Tasks Given to the Participants in the Application

The tasks defined in the digital interactive application are; opening the television, opening the subwoofer, and opening the balcony door. The task objects can be seen in the figure 4.2.2. Each of these objects has a specific shaped key (see figure 4.2.4). As it can be seen from the figure 4.2.4, the keys are hanged on the neck of the virtual character. The participants have to approach closer to the virtual human character to get the key from the character in order to be able to complete the task. Although these three tasks are similar to each other, the differentiation in three tasks was purely for the experiment in order not to bore the participants. It is necessary to state that we were not investigating the effects of emotional facial expressions for different situations, such as holding the key in a transparent box or different situations.

Figure 4.2.4: The specific shaped keys for each task

The way how to complete the task is; first the participants have to approach the character closer to get the key and then they navigate to task object after getting the key from the character (figure 4.2.5). Although the keys disappear after taking the key, it is also important to give feedback when the participants get the key in order to make them aware of that they have the key. The figure 4.2.6 shows the visual feedback of getting the key from the virtual human character. When the participant gets the key, it disappears and the specific shaped key emerges in the interactive user interface, which can be seen on the right bottom part of the figure 4.2.6.

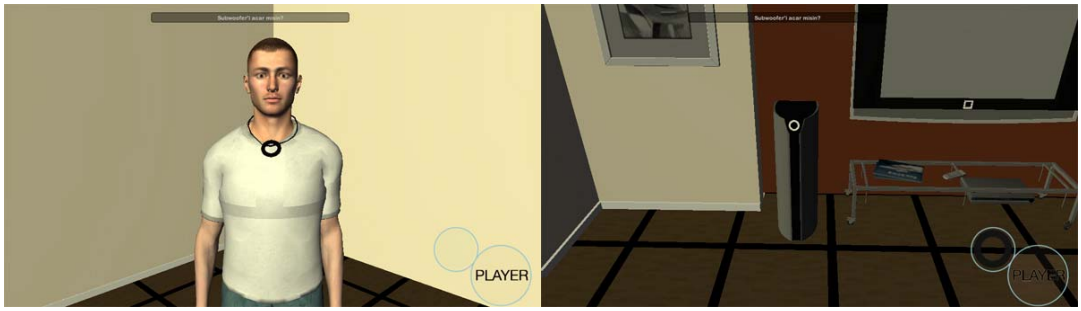

Figure 4.2.5: The way how to accomplish the task

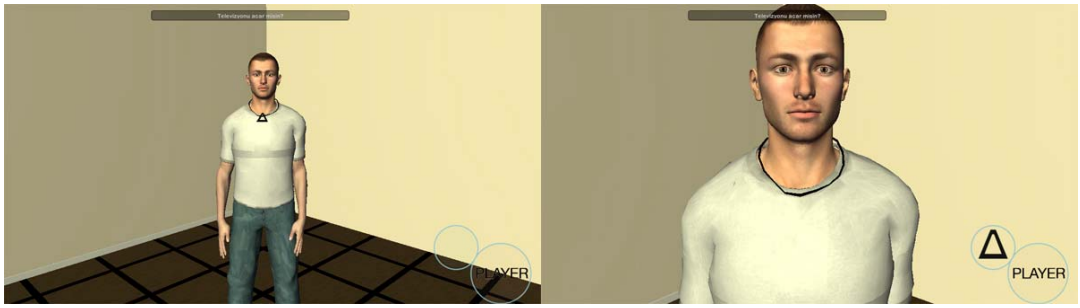

Figure 4.2.6: The visual feedback of getting the key

The independent variables are emotional facial expressions and the tasks. Each of the tasks was matched with each emotion in different setups, which can be seen in the figure 4.2.7. However, only the effect of emotional facial expressions was measured as an dependent variable. The order of emotional facial expressions was randomized for each of the participants. An example task as a warming up exercise was also included. This is because it was thought that there is a learning process in games, such as how to control the player or learning process of the interactive user interface. Therefore, an example task could minimize the learning effect. The example task was given to the participants with a different virtual human character, which expressed neutral emotion.

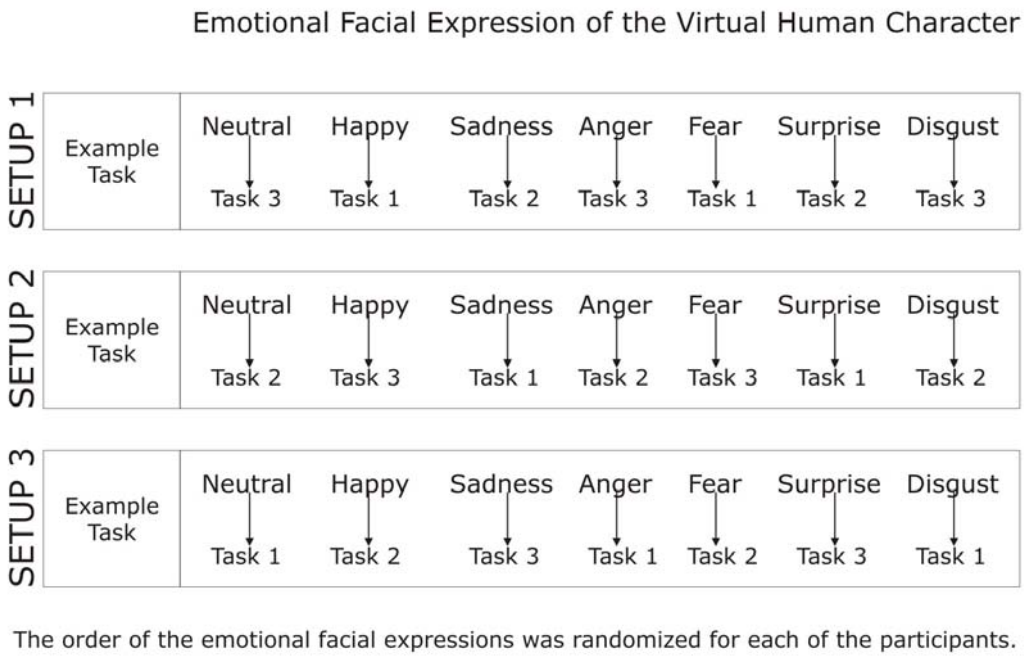

Figure 4.2.7: Three different setups for the digital interactive application

4.2.4 Participants of the Study

Participants of the Study 2 were the students from Industrial Design Department at METU. 30 participants, 15 male, 15 female were volunteered to participate in this study, ranging from 21 years old to 28 years old. Their average age was 24 years old. None of the students were native speaker of English so that the study was conducted in their own language, Turkish.

4.2.5 Data Collection

As mentioned before, three different data sources were employed for the digital interactive application study; video recordings, questionnaires, and personal observations. Close-ended questions in the questionnaire provided quantitative data as well as video recordings. Video recordings also provided qualitative data as well as observations. There are mainly two different data analyzed from the video recordings; time analysis and navigation path analysis. Statistics were used to calculate the means of quantitative data and ANOVA analysis was used to find the significant differences. The results of the video recordings, questionnaires and personal observations will be mentioned in the next sections.

4.3 Limitations of the Study

In the digital interactive application, navigating with keyboard and mouse was not very sensitive, especially the sensitivity of the mouse because of the coding skills of the researcher. The sensitivity of the mouse also depends on how fast computer works and the recording of the screen of the computer affected the working performance of the computer. Therefore, the sensitivity of the mouse was adjusted in order to minimize these effects. The participants used the mouse given to them, which might influence the navigation of the participants in the application. Their familiarity with the mouse is important because individuals use different mouse with different sensitivity. However, the subjects used the same mouse with same intensity.

4.4 Post Experiment Questionnaire

The aim of the post experiment questionnaire (See Appendix G) was to assess their game experience and also to assess their acquaintance with avatars, virtual human characters or games in which the virtual characters are used and to assess the recognition of facial expressions of virtual human character. Their game experience and their familiarity with the virtual characters were assessed with close and open-ended questions. The questionnaire was given to the participants in their own language, Turkish. The questionnaire is composed of demographic information of the participants, experiment difficulty, their game experience, and the recognition of emotional facial expressions of the virtual character. Although emotional facial expressions of the virtual character were selected according to the results of the first study, it is also important to find out the recognition of emotional facial expressions by the participants in this study. While presenting the results, it is necessary to know the responses to emotional facial expressions about how well the virtual character expresses specific emotions. By this way, we can make sure that emotion specific facial expressions are recognized sufficiently by the participants.

4.4.1 Demographic Information

The gender ratio of the participants was 15 male to 15 female, ranging from 21 years old to 28 years old. Their average age was 24. Twelve of the 30 participants (40%) were graduate students, fifteen of the 30 participants (50%) were undergraduate students and the remaining three of the 30 participants PHD students. All the participants were from Industrial Design Department at METU.

4.4.2 The Game Experience

The participants were asked how often they play computer games. Five of the 30 participants (16.6%) reported that they never play computer games. Among the 30 participants who play computer games, 12 participants (40%) rarely play computer games, 6 participants (20%) often play computer games, 6 participants (20%) usually play computer games and, one of the participants always play computer games.

The question, 'what kind of games do you play' was asked to the participants. Among the gamers, some of the participants reported that they play first person shooter games such as 'call of duty', 'counter strike' and 'half-life', sports games such as 'soccer', 'basketball' and entertainment games such as 'Sims'. These are the games in which you navigate and get into communication with the virtual human characters. They also reported that they play strategic games such as age of empires in which the player are faced with avatars. In addition, they mentioned about games in which different characters are used, such as 'facebook applications' and 'worms'.

The participants were asked how they define themselves as a game player on a scale 1 (very bad) to 5 (very good). 10 of the 30 participants (33.3%) defined themselves very bad player, 1 on a scale of 5. 7 of the participants (23.3%) reported that they are bad player, 2 over 5. 10 of the participants (33.3%) defined themselves normal player (3 on a scale of 5) and 3 of the participants reported that they are good player (4 over 5). None of the participants defined themselves as very good player.

When the participants were asked to rate the difficulty to navigate in the virtual room on a scale of 1 (very easy) to 5 (very difficult), 12 of the 30 participants (40%) reported that it was not difficult to navigate in the virtual room. Among the 18 participants who had difficulty of navigating in the virtual room, 9 of the participants (30%) found the difficulty 2 on a scale of 5 to navigate in the room, 7 participants reported that the difficulty to navigate in the virtual room is 3 on a scale of 5 and 2 participant found the difficulty 4 on a scale of 5.

4.4.3 Recognition of Emotional Facial Expressions

According to the analysis of the responses given to happy expressions, it can be concluded that the virtual character expresses the happy emotion sufficiently. Tukey post-hoc table 4.4.1 show the significant differences between happy and all other emotions, when the participants were asked to rate for the happy facial expression. Tukey post-hoc test proves that the happy

facial expression is significantly more attributed to happy emotion than to other emotions.

Table 4.4.1: Tukey post-hoc results of happy facial expression

(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Happy	Sadness	3,06667*	0,18445	,000*	2,5351	3,5982
	Anger	3,00000*	0,18445	,000*	2,4685	3,5315
	Fear	3,30000*	0,18445	,000*	2,7685	3,8315
	Surprise	3,10000*	0,18445	,000*	2,5685	3,6315
	Disgust	3,06667*	0,18445	,000*	2,5351	3,5982

The responses of the participants to sadness facial expression prove that the virtual human character expresses the sadness emotion sufficiently. Tukey post-hoc table 4.4.2 presents the significant differences when the participants were asked to rate the sadness facial expression. The differences between sadness and all other emotions (happy, anger, fear, surprise, and disgust) are significant (see table 4.4.2). Tukey post-hoc test confirms that sadness facial expression is significantly more ascribed to sadness emotion than to other emotions.

Table 4.4.2: Tukey post-hoc results of sadness facial expression

(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Sadness	Happy	3,43333*	0,15288	,000*	2,9928	3,8739
	Anger	3,33333*	0,15288	,000*	2,8928	3,7739
	Fear	2,70000*	0,15288	,000*	2,2594	3,1406
	Surprise	3,16667*	0,15288	,000*	2,7261	3,6072
	Disgust	3,50000*	0,15288	,000*	3,0594	3,9406

The responses to anger facial expression given by the participants confirm that the virtual human character adequately expresses the anger emotion. Tukey post-hoc test show that anger facial expression is significantly more attributed to anger emotion than to other emotions (see table 4.4.3).

Table 4.4.3: Tukey post-hoc results of anger facial expression

(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Anger	Happy	3,60000*	0,17023	,000*	3,1094	4,0906
	Sadness	2,96667*	0,17023	,000*	2,4761	3,4572
	Fear	3,20000*	0,17023	,000*	2,7094	3,6906
	Surprise	3,46667*	0,17023	,000*	2,9761	3,9572
	Disgust	2,80000*	0,17023	,000*	2,3094	3,2906

Analysis of the responses given to fear facial expression show that fear facial expression were recognized as both fear and surprise. Tukey post-hoc table 4.4.4 shows the significant differences not only between fear and all other emotions but also surprise and all other emotions. When the participants were asked to rate the fear facial expression, Tukey post-hoc test shows that there are significant differences between fear and all other emotions and also there exist significant differences between surprise and all other emotions. The results prove that fear facial expressions are significantly more ascribed to fear and surprise emotions than to other emotions. In addition, the attribution to fear is obviously more than the attribution to surprise.

Table 4.4.4: Tukey post-hoc results of fear facial expression

(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Fear	Happy	3,36667*	0,22384	,000*	2,7216	4,0117
	Sadness	2,10000*	0,22384	,000*	1,455	2,745
	Anger	3,03333*	0,22384	,000*	2,3883	3,6784
	Surprise	1,06667*	0,22384	,000*	0,4216	1,7117
	Disgust	3,00000*	0,22384	,000*	2,355	3,645
Surprise	Happy	2,30000*	0,22384	,000*	1,655	2,945
	Sadness	1,03333*	0,22384	,000*	0,3883	1,6784
	Anger	1,96667*	0,22384	,000*	1,3216	2,6117
	Fear	-1,06667*	0,22384	,000*	-1,7117	-0,4216
	Disgust	1,93333*	0,22384	,000*	1,2883	2,5784

The responses that are given to surprise facial expression by the participants show that the virtual human character expresses the surprise emotion sufficiently. Tukey post-hoc table 4.4.5 presents the significant differences when we asked for the surprise facial expression. There are significant differences between surprise and all other emotions. Tukey post-hoc test proves that surprise facial expression is more attributed to surprise emotion than to other emotions.

Table 4.4.5: Tukey post-hoc results of surprise facial expression

(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Surprise	Happy	2,60000*	0,19338	,000*	2,0427	3,1573
	Sadness	3,56667*	0,19338	,000*	3,0094	4,1239
	Anger	3,56667*	0,19338	,000*	3,0094	4,1239
	Fear	2,56667*	0,19338	,000*	2,0094	3,1239
	Disgust	3,63333*	0,19338	,000*	3,0761	4,1906

According to the responses to disgust facial expression given by the participants, it was proven that the disgust emotion is sufficiently expressed by the virtual human character. Tukey post-hoc table 4.4.6 presents the significant differences between disgust and all other emotions. When the participants were asked to rate for disgust facial expression, Tukey post-hoc test 4.4.6 shows that there are significant differences between disgust and all other emotions. It can be concluded that disgust facial expression is more attributed to disgust emotion than to other emotions.

Table 4.4.6: Tukey post-hoc results of disgust facial expression

(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Disgust	Happy	3,30000*	0,21673	,000*	2,6754	3,9246
	Sadness	2,00000*	0,21673	,000*	1,3754	2,6246
	Anger	2,50000*	0,21673	,000*	1,8754	3,1246
	Fear	2,80000*	0,21673	,000*	2,1754	3,4246
	Surprise	3,00000*	0,21673	,000*	2,3754	3,6246

The table 4.4.7 presents the estimated mean values of each emotion for all facial expressions. When the participants were asked to rate the neutral facial expression, the ratings for each emotion are; happy mean score=2.2, sadness mean score=1.7, anger mean score=1.13, fear mean score=1.47, surprise mean score=1.43, and disgust mean score=1.1, resulting in that the scores are low enough to consider neutral facial expression as neutral.

When the participants were asked to rate the happy facial expression, as it can be seen from the table 4.4.7, estimated happy mean scores are the highest (4.43) and the other emotions have lower estimated mean scores. The estimated mean values for sadness facial expression presented in the table 4.4.7 shows that the estimated sadness mean scores are the highest (4.5) while the mean scores of other emotions are lower. For anger facial expression, the score given for anger emotion is the highest (4.6).

The estimated mean scores for fear facial expression given in the table 4.4.7 shows that the rating given for fear emotion is 4.37 and the mean score of surprise emotion is 3.3, resulting in that although fear emotion is recognized, surprise emotion can also be recognized for fear facial expression. However, there is a significant difference between fear and surprise emotion (see table 4.4.4). For surprise emotion, as it can be seen from the table 4.4.7, the estimated surprise mean score is the highest (4.67), whereas the mean scores for other emotions are lower. When the participants were asked to rate the disgust facial expression, the mean score for disgust emotion (4.33) is higher than the other emotions (table 4.4.7).

Table 4.4.7: The estimated mean values for all facial expressions

		emotions rated					
		happy	sadness	anger	fear	surprise	disgust
Facial Expressions	**neutral**	2,2	1,7	1,13	1,47	1,43	1,1
	happy	**4,43**	1,37	1,43	1,13	1,33	1,37
	sadness	1,07	**4,5**	1,17	1,8	1,33	1
	anger	1	1,63	**4,6**	1,4	1,13	1,8
	fear	1	2,07	1,33	**4,37**	**3,3**	1,37
	surprise	2,27	1,1	1,1	2,1	**4,67**	1,03
	disgust	1,03	2,33	1,83	1,53	1,33	**4,33**

As it can be seen from the figure 4.4.1, the estimated mean scores of emotions for their own facial expressions, such as happy mean score for happy facial expression or surprise mean score for surprise facial expression, are higher than 4.33 and lower than 4.67. In other words, the mean scores are between 4.33 and 4.67, which shows that each emotion is recognized well enough.

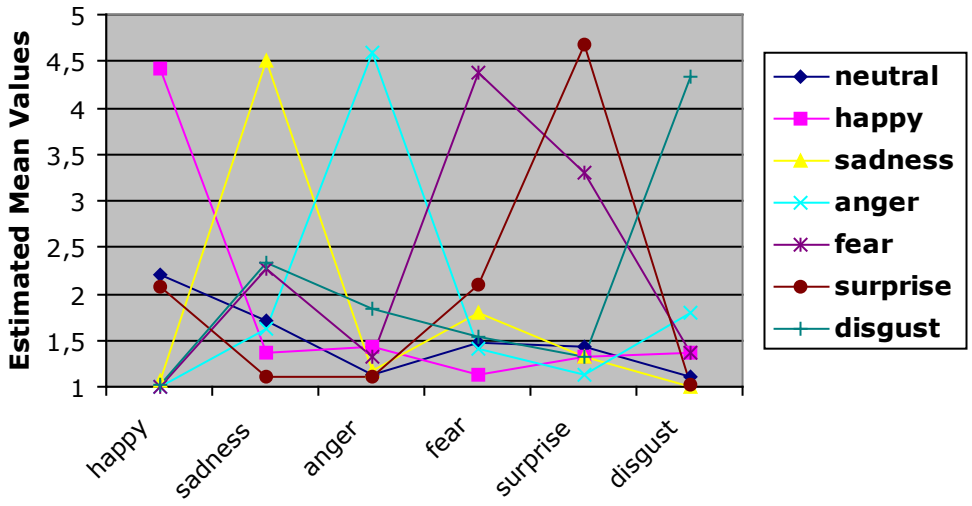

Figure 4.4.1: The graph of the estimated mean scores for all facial expressions

4.5 The Results of the Study 2

In this section, the results of time results and navigation paths will be given separately. While the time results will be presented task by task, the navigation paths will be given emotion by emotion in sub-sections, respectively, neutral, happy, sadness, anger, fear, surprise and disgust.

4.5.1 Time Results of the Study 2

When the participants were asked to do the first task, the table 4.5.1 shows the time results for each of facial expressions (average time to approach the character, average time to move towards the task object and total time). The participants approached the virtual character in 5.91 seconds and move towards the task object in 6.74 seconds in order to finish the task, resulting in 12.65 seconds in total time, when faced with the neutral facial expression. For happy facial expression, the time results are closer to the results of neutral emotion. The mean score of the time to approach the virtual character is 5.76 seconds while time to move towards the task object after getting the key from the virtual character is 6.98 seconds (in total 12.75 seconds). As it can be seen from the table 4.5.1, the participants completed the first task in 14.38 seconds when they were encountered with sadness facial expressions (time to approach the character=6.25 and time to move towards the task object=8.13).

Table 4.5.1: The time results of the first task

		neutral	happy	sadness	anger	fear	surprise	disgust
TASK 1	**meanA**	5,91	5,76	6,25	7,29	7,98	5,84	6,18
	meanB	6,74	6,98	8,13	13,2	12,3	9,08	10,31
	meanC	12,65	12,75	14,38	20,5	20,3	14,92	16,5
A: Time to approach the virtual character until getting the key B: Time to move towards the task object after getting the key C: Total time (from starting task to finishing the task) All the scores are given in second unit.								

Similarly, the total time to finish the task when faced with the surprise emotion is 14.92 seconds, while the approaching time to character is 5.84 and the mean time to move to the task object 9.08 seconds. The mean time scores of anger and fear emotions are higher than the other emotions. For anger facial expression, the mean time to approach the virtual character is 7.29 seconds while time to move towards the task object after getting the key from the virtual character is 13.2 seconds (in total 20.5 seconds). Likewise, the participants completed the first task in 20.3 seconds when they came against

sadness facial expressions (time to approach the character=7.98 and time to move to the task object=12.3). The participants approached the virtual character in 6.18 seconds and move towards the task object in 10.31 seconds in order to finish the task, 16.5 seconds in total time, when the virtual character expressed disgust facial expression.

The table 4.5.2 shows the time results to approach the character, to navigate to the task object, and total time, when the participants were asked to do the second task. For neutral facial expression, the average time to come against the virtual human character is 5.81 seconds while the average time to move towards the task object after getting the key from the virtual character is 8.98 seconds (in total 14.80 seconds). The participants approached the virtual human character to get the key in 5.73 seconds and go to the task object to finish the task in 6.74 seconds, resulting in 13.6 seconds in total time, when faced with the happy facial expression. Similar to the happy facial expression, the average time results of sadness facial expression are closer to the results of neutral emotion. The average score of the time to approach the virtual character is 5.84 seconds while time to move towards the task object after getting the key from the virtual character is 8.43 seconds (in total 14.28 seconds).

Table 4.5.2: The time results of the second task

		neutral	happy	sadness	anger	fear	surprise	disgust
TASK 2	**meanA**	5,81	5,73	5,84	6,95	7,61	5,67	6,14
	meanB	8,98	7,87	8,43	13,03	14,05	8,65	10,33
	meanC	14,80	13,6	14,28	19,98	21,67	14,32	16,48
A: Time to approach the virtual character until getting the key B: Time to move towards the task object after getting the key C: Total time (from starting task to finishing the task) All the scores are given in second unit.								

As it can be seen from the table 4.5.2, the participants completed the second task in 19.98 seconds when they were faced with anger facial expression (time to approach the character=6.95 and time to navigate to the task

object=13.03). Similar to the anger facial expression, the total time to finish the task when encountered with the fear emotion is 21.67 seconds while the approaching time to character is 7.61 and the average time to move towards the task object 14.05 seconds. It is obvious that the average time scores of anger and fear emotions are higher than the other emotions, similar to first task. For the surprise facial expression, the average time to approach the virtual character is 5.67 seconds while time to move towards the task object after getting the key from the virtual character is 8.65 seconds (in total 14.32 seconds). The participants finished the second task in 16.48 seconds when they are faced with disgust facial expression (time to approach the character=6.14 and time to move the task object=10.33).

When the third task was given to the participants, the table 4.5.3 shows the average time results to approach the virtual human character, to move towards the task object and total time for each facial expression. As it can be seen from the table 4.5.3, the participants finished the third task in 15.91 seconds when they were faced with neutral facial expression (average time to approach the character=5.77 and time to move towards the task object=10.14). . For happy and sadness facial expressions, the time results are closer to the results of neutral emotion. When faced with the happy facial expression, the participants approached the virtual character in 6.14 seconds and navigate to the task object in 10.66 seconds in order to finish the task, resulting in 16.80 seconds in total time. For sadness facial expression, the average time result to approach the virtual character is 5.98 seconds while time to move towards the task object after getting the key from the virtual character is 10.85 seconds (in total 16.83 seconds).

Table 4.5.3: The time results of the third task

		neutral	happy	sadness	anger	fear	surprise	disgust
TASK 3	**meanA**	5,77	6,14	5,98	6,93	7,53	5,92	6,13
	meanB	10,14	10,66	10,85	16,47	15,87	10,03	11,49
	meanC	15,91	16,80	16,83	23,4	23,41	15,95	17,62
A: Time to approach the virtual character until getting the key B: Time to move towards the task object after getting the key C: Total time (from starting task to finishing the task) All the scores are given in second unit.								

Similar to first task and second task, the average time results of anger and fear emotions are higher than the other emotions. The total time to finish the task when faced with the anger facial expression is 23.4 seconds, while the approaching time to character is 6.93 and the mean time to navigate to the task object 16.47 seconds. For the fear facial expression, the mean time to approach the virtual character is 7.53 seconds while average time to move towards the task object after getting the key is 15.87 seconds (in total 23.41 seconds). The participants completed the third task in 15.95 seconds when the virtual character expressed surprise facial expression (time to approach the character=5.92 and time to move towards the task object=10.03). The participants approached the virtual character in 6.13 seconds and move the task object in 11.49 seconds in order to complete the task, 17.62 seconds in total time, when they came against the surprise facial expression.

As it can be seen from the figures, 4.5.1, 4.5.2 and 4.5.3, it can be concluded that negative emotions, especially anger and fear facial expressions delay the users' actions. Similarly, disgust emotion slows down users' performance for digital interactive tasks but not as much as anger and fear emotions. On the other hand, happy facial expression has an effect of direct actions of users' performance. In other words, happy emotion affects users act directly. The closeness of average time results of the happy facial expression to neutral results proves this direct action. Similar to happy facial expression, sadness and surprise facial expressions can also influence the users do the actions directly. It is important to mention that the users act responsibly or treat sensitively when they are faced with the sadness facial expression. The verbal and nonverbal responses of the participants showed that they became sensitive in response to the sadness facial expression, resulting in direct actions of the users performance. For the surprise facial expression, the participants also mentioned that the virtual human character is positively surprised, leading to the effect of a positive emotion, like happy. Although the happy emotion recognized from surprise facial expression is not as high as surprise (table 4.4.7) and there is a significant difference between surprise and happy emotions (table 4.4.5), the average score of happy emotion is higher than other emotions except surprise. It shows that the main attribution is to the surprise emotion but also in addition to surprise, there might be an attribution

to happy emotion, which was supported by the verbal feedback of the participant. In brief, positively recognized surprise emotion has an impact on direct users' actions. Similarly, it can also be said that while the negative emotions, anger, fear and disgust, discourage the users' act immediately, happy, sadness and positively surprise emotions encourage the users' start acting directly.

In summary, the main conclusions from the analysis of the time results are;

- Negative emotions, anger, fear, and disgust, delay the users' actions, especially fear and anger. It is necessary to state that disgust emotion slows down users' performance but not as much as anger and fear emotions.
- Happy, sadness, and surprise emotions have an effect of direct actions of users' performance. It is essential to mention that treating sensitively to the sadness facial expression and positively surprised virtual character lead to direct users' actions.

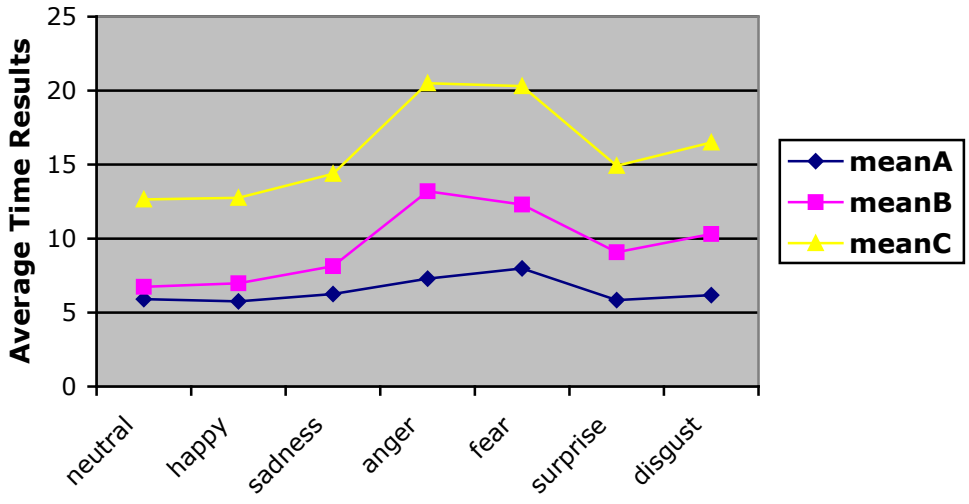

Figure 4.5.1: The graph of the time results for first task

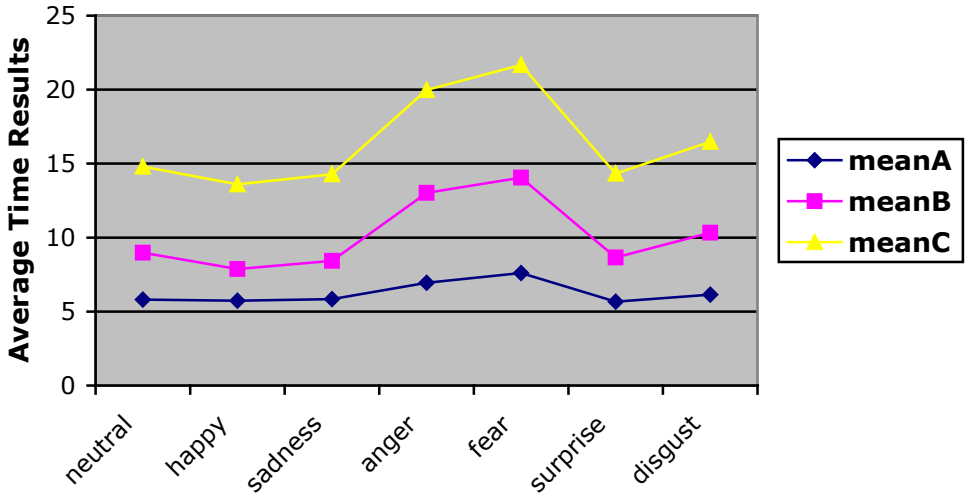

Figure 4.5.2: The graph of the time results for second task

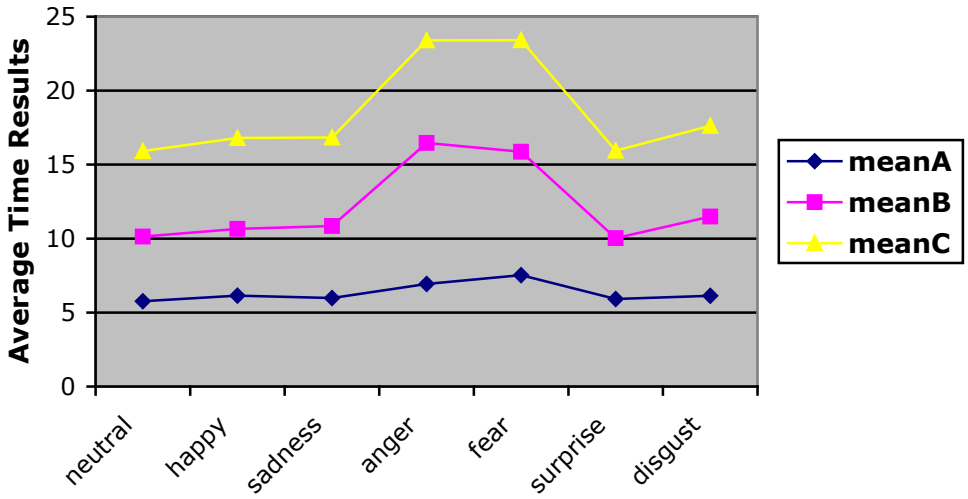

Figure 4.5.3: The graph of the time results for third task

4.5.2 The Navigation Paths Results of the Study 2

In this section, the results of navigation paths will be presented emotion by emotion in sub-sections, respectively, neutral, happy, sadness, anger, fear, surprise and disgust.

4.5.2.1 The Navigation Paths Results for Neutral Emotion

Analysis of the navigation paths for three different tasks shows that there is just one path when looking at how the users approached to the virtual human character. The figure 4.5.4 shows that the users got closer to the character directly. For the paths that show the navigation between the character and the task object after taking the key, there exist mainly two different patterns. First one is that the users moved towards the task object in a direct way in order to complete the task. Secondly, after getting the key from the virtual human character the users went to the task object in a curvy path with or without retreat step.

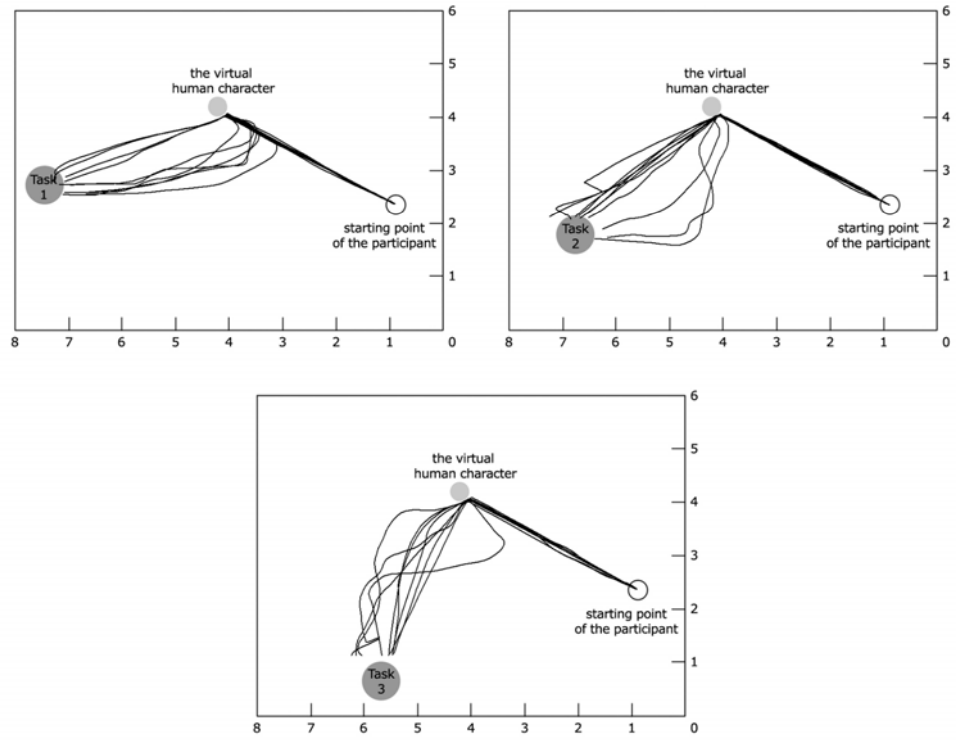

Figure 4.5.4: The navigation paths results for neutral emotion

4.5.2.2 The Navigation Paths Results for Happy Emotion

The navigation paths of the participants how to approach to the happy virtual human character confirm that there exists one path; they came against the character in a direct way in order to get the key (figure 4.5.5). According to the paths that present the navigation between the virtual human character and the task object, there exists a pattern that shows the users move towards the task object directly in order to complete the task, when faced with happy facial expression. It can be also seen that there are some curvy paths. However, when looking at the curvy lines it is hard to say that a pattern is emerged. These curvy lines might stem from either the sensitivity of the navigation or the acquaintance with the mouse given to the participants.

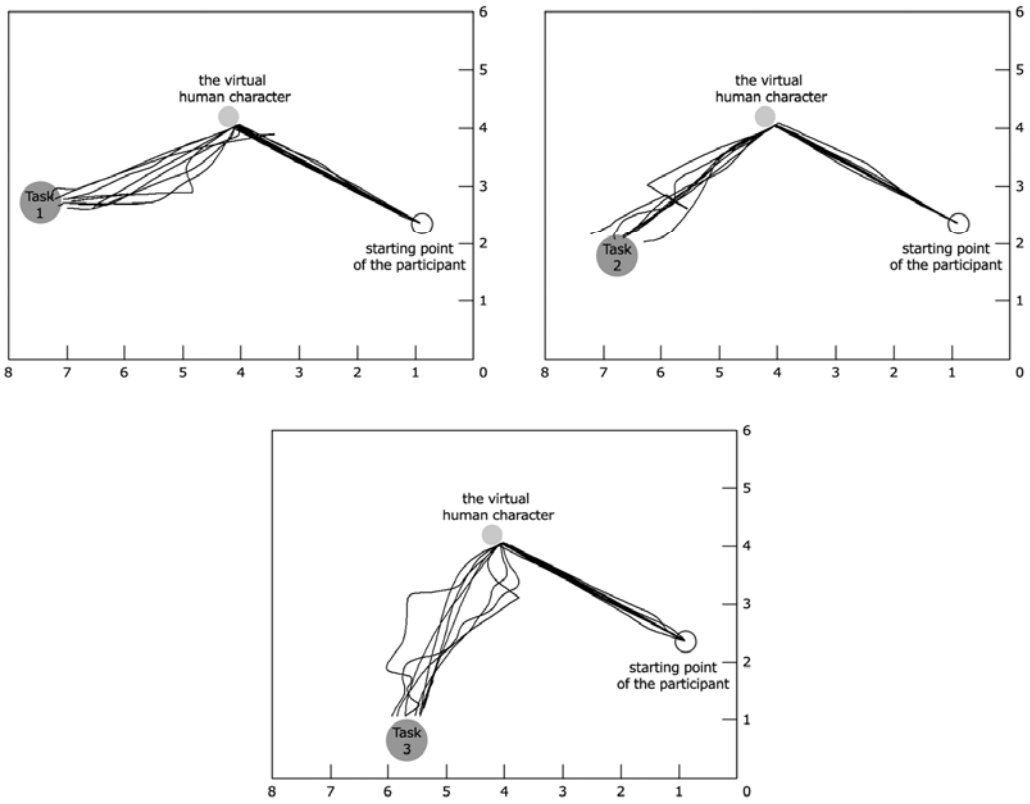

Figure 4.5.5: The navigation paths results for happy emotion

4.5.2.3 The Navigation Paths Results for Sadness Emotion

The navigation paths are presented in the figure 4.5.6, when the participants were asked to do the tasks with the sadness facial expression. As it can be seen from the figure, the participants approached to the virtual human character directly, similar to happy emotion. When looking at the navigation paths that illustrate moving towards the task object after taking the key from the character, although some lines seem to be different than others, it can be concluded that there seem to be two different patterns. Firstly, the users went to the task object in order to finish the task in a direct way. As mentioned in the time results, the participants treat sensitively to the sadness emotion, which this direct action of the users can stem from. Second one is that they followed a curvy path after getting the key from the virtual human character.

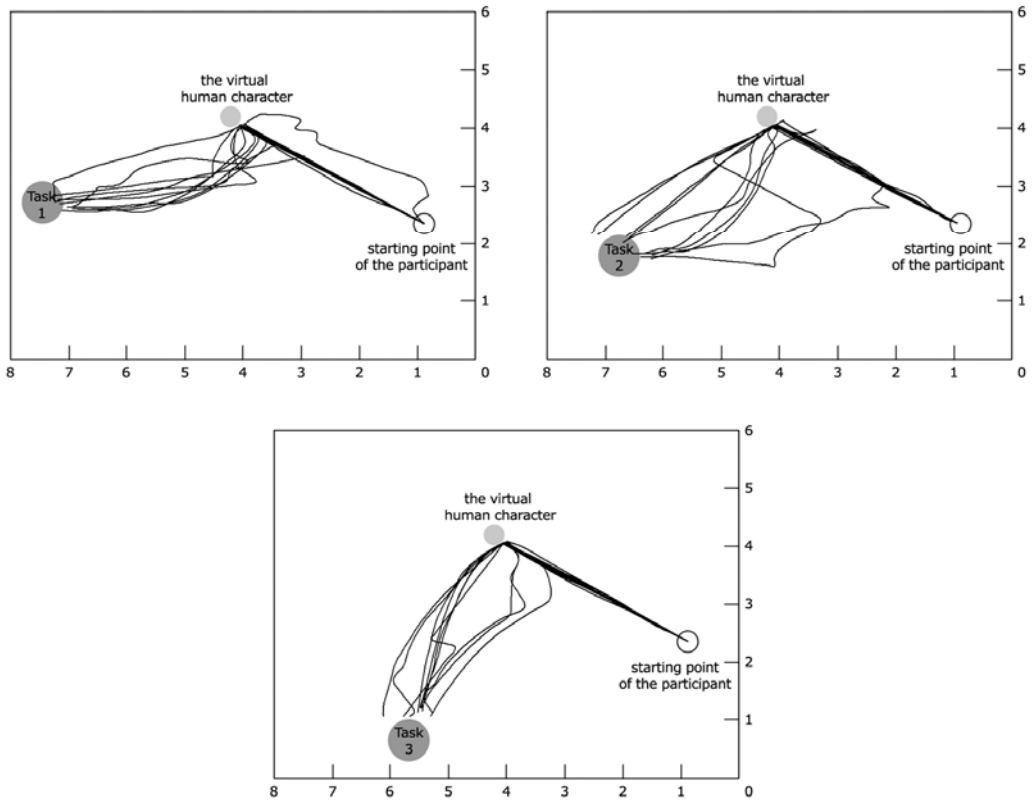

Figure 4.5.6: The navigation paths results for sadness emotion

4.5.2.4 The Navigation Paths Results for Anger Emotion

The figure 4.5.7 illustrates the navigation paths of the participants while approaching to the virtual human character and moving towards the task object after taking the key from the character. The navigation paths confirm that how the users came closer to the character in order to get the key is the same pattern, like the other emotions presented. They approached to the virtual human character in a direct way. On the other hand, it is hard to conclude that either a pattern or patterns are emerged concerning the navigation paths between the virtual character and the task object. All these navigation paths are almost excursive, different from each other. However, it can be said that the anger emotion has an effect on the navigation of the users, resulting in large variation of indirect, curved navigation paths between collecting the key and completing the task, namely unpredictable navigation paths.

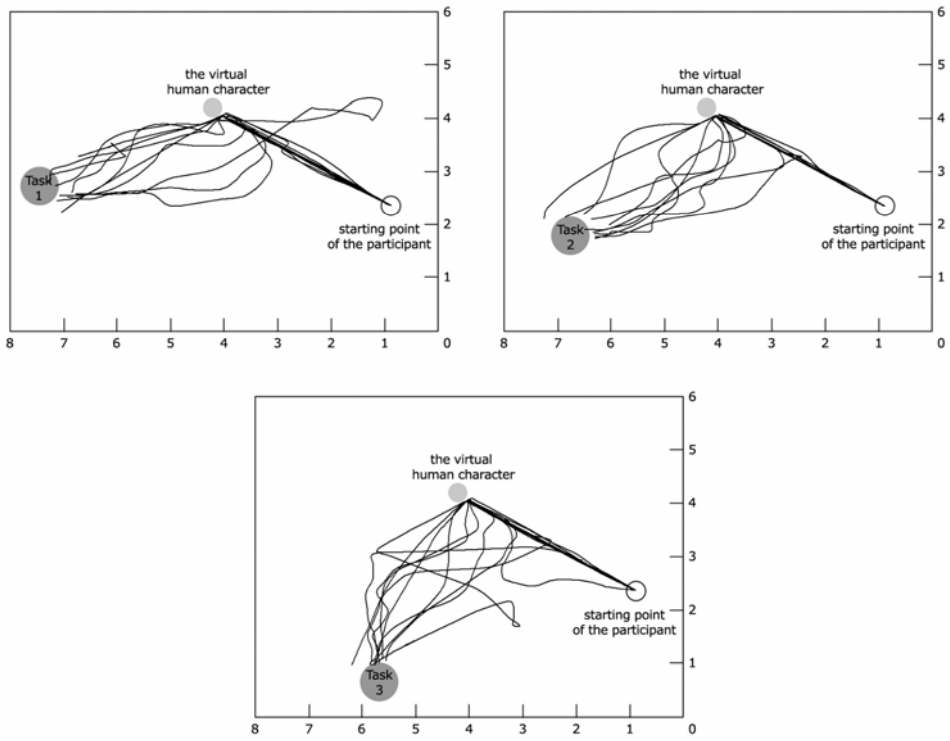

Figure 4.5.7: The navigation paths results for anger emotion

4.5.2.5 The Navigation Paths Results for Fear Emotion

According to the analysis of the navigation paths that illustrate the approaching paths to the virtual character, it is easy to conclude that the users came against the character in a direct way (see figure 4.5.8). After getting the key from the virtual human character, the participants mostly stepped backwards firstly and then moved towards the task object in a direct way. There are also some navigation paths that show the users followed a curvy path with retreat steps or without retreat step. The most significant conclusion for fear emotion is that fear facial expression influence the users step back and move towards the task object directly. The average back steps seem to be more than the half of the distance between the starting point of the user and the virtual human character.

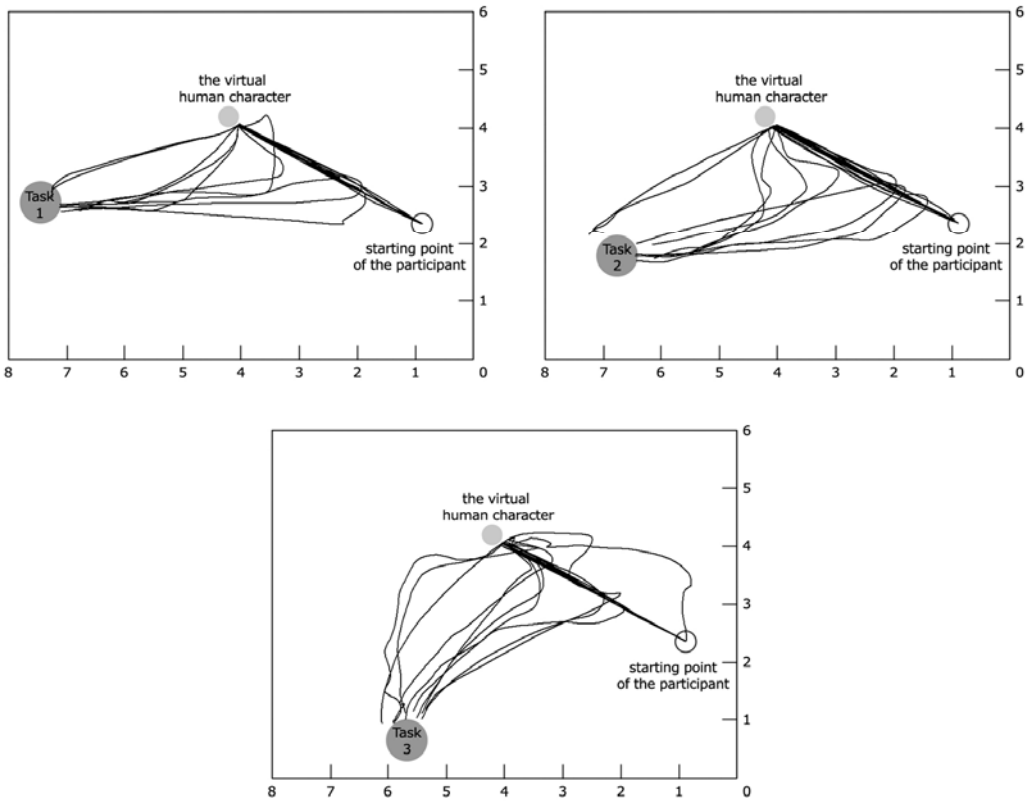

Figure 4.5.8: The navigation paths results for fear emotion

4.5.2.6 The Navigation Paths Results for Surprise Emotion

The navigation paths in the figure 4.5.9 that are illustrated for surprise emotion confirm that the users approached to the virtual human character in order to get the key in a direct path, like the other emotions. According to the paths that show the navigation of the users after getting the key from the character, there exists a pattern that shows the users move towards the task object directly in order to complete the task, when faced with surprise facial expression. As mentioned in surprise time results, the participants stated that the virtual character expressed positive surprise emotion. Thus, the pattern of direct paths are the result of positively recognized surprise emotion. In addition, it can be also seen in the figure 4.5.9 that there are some curvy paths with or without retreat steps and circulating paths around the character. Although these lines seem to be excursive, they have something in common.

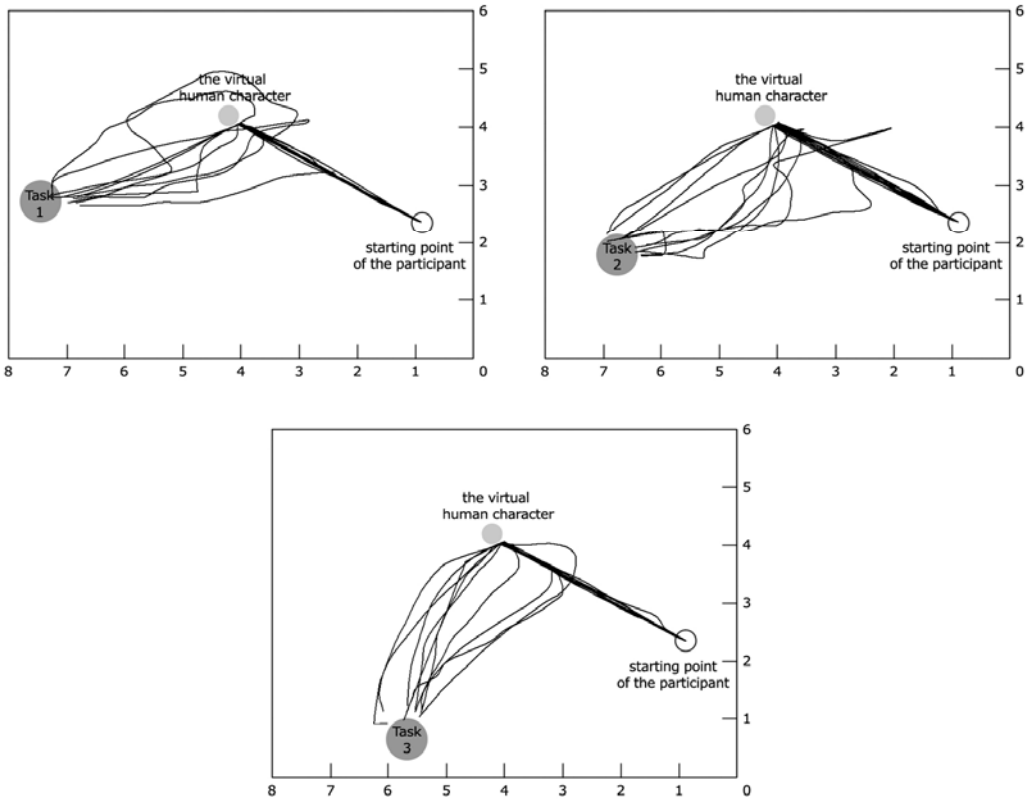

Figure 4.5.9: The navigation paths results for surprise emotion

The participants who followed the circulating paths around the character and the participants who stepped back by looking at where the character was looking mentioned that they wondered about what made the virtual human character be surprised so that they turn the view of the computer screen and head towards the view of the character. It can be concluded that surprise emotion influences the users turn towards the view of the character.

4.5.2.7 The Navigation Paths Results for Disgust Emotion

The figure 4.5.10 presents the navigation paths of the participants when the participants were asked to do the tasks with disgust facial expression. As it can be seen from the table, the navigation paths prove that approaching to the virtual human character to take the key is the same pattern, like the other emotions. The users came closer to the character in a direct way.

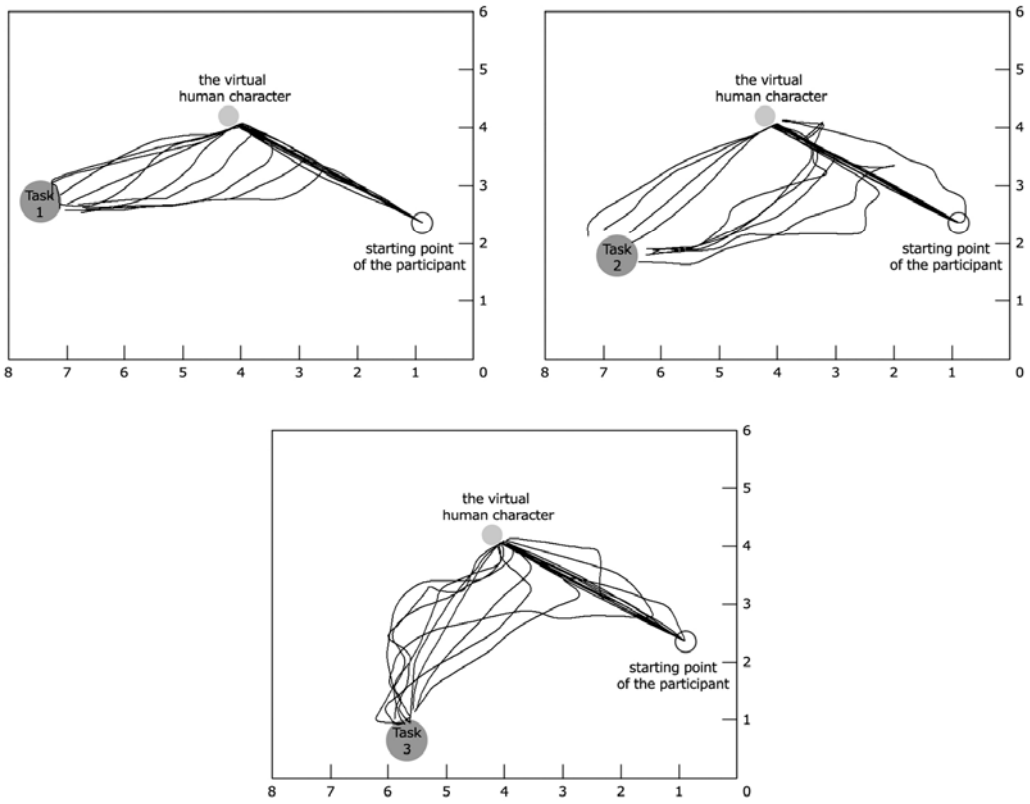

Figure 4.5.10: The navigation paths results for disgust emotion

When looking at the navigation paths that present moving towards the task object from the virtual character, although some paths might not be enough to make a pattern or patterns, it can be concluded that there might be two patterns. One is that the participants approached to the task object in a direct way. Another one is that the users firstly stepped back and then followed a curvy line to complete the task. Moreover, it is also important to state that some of navigation paths are excursive, different from each other. Similar to anger emotion, the disgust emotion affects the users navigate in virtual environment with a large variation of indirect, curved navigation paths.

4.5.2.8 The Main Conclusions from the Analysis of Navigation Paths

In brief, the main conclusions from the analysis of the navigation paths are;

- For all emotions (neutral, happy, sadness, anger, fear, surprise and disgust), the paths how to approach to the emotional virtual character are the same. The participants approached to the emotional virtual human character in a direct way.
- However, the paths showing the navigation between the virtual character and task object confirm that how to navigate towards the task object from the virtual character differentiated for each emotion.
- For neutral emotion, the users followed two different patterns in order to complete the task; a direct way or a curvy path with/without retreat steps.
- When faced with happy facial expression, there exists only one pattern that shows the users move towards the task object directly from the virtual human character.
- Navigation paths between the task object and the character for sadness emotion confirms that there seem to be two different patterns in order to finish the task; a direct way or a curvy path.
- For anger emotion, navigation paths are excursive, different from each other, resulting in large variation of indirect, curved navigation paths between getting the key and completing the task, namely unpredictable navigation, in a virtual environment.

- The most significant conclusion for fear emotion is that fear facial expression affect the users step back and then move towards the task object. The average back steps seem to be more than the half of the distance between the starting point of the user and the virtual human character.
- There exists a pattern that shows the users move towards the task object directly, when faced with surprise facial expression. The pattern of direct paths might be the result of positively recognized surprise emotion. Moreover, surprise emotion influences the users turn towards the view of the character while navigating.
- Although some paths for disgust emotion are not enough to make a pattern, it can be stated that there might be two patterns between the virtual character and task object; approaching to the task object in a direct way and stepping back firstly, then following a curvy line to complete the task. The disgust emotion also affects the users navigate in virtual environment unpredictably, like the anger emotion.

In fact, directly moving towards the task object from the virtual character shows that emotional facial expressions that have an effect of direct navigation increase the users performance for interactive digital task. These emotions are happy, sadness and surprise. While the reason why surprise emotion increased the users performance is similar to happy emotion, sadness emotion has a different effect. Happy emotion encouraged the users because of the fact that it is a positive emotion. Similarly, positively recognized surprise emotion has a positive effect on users' performance. However, the users acted responsibly or treat sensitively when faced with the sadness emotion, resulting in direct actions of the users performance.

On the other hand, negative emotions, anger, fear and disgust, decrease users' performance, especially fear and anger. It is essential to state that disgust emotion slows down users' performance but not as much as anger and fear emotions. Their effects in virtual environment are different. While anger emotion causes unpredictable users' actions, fear emotion has a detractive effect. Fear emotion can alienates or forfends the user from the virtual human character.

CHAPTER 5

CONCLUSION

In conclusion, a pre-study for the second study was conducted to validate the recognition of emotional facial expressions (neutral, happy, sad, anger, fear, surprise, and disgust) generated according to the FACS descriptions and to find out the perceived expressive intensity of these facial expressions. As it is mentioned in the third chapter, each emotion was created with 3 different intensities; low, medium, and high. Analysis of the responses given to emotional facial expressions except fear emotion shows that the virtual human character expresses these emotions adequately. However, the responses that are given to fear facial expressions for 3 different intensities by the participants show that fear facial expressions can be recognized as both fear and surprise. According to the results of the pre-study, the proper intensity for each of emotional facial expressions was selected to be used in the study.

In the second and final study, emotional facial expressions with selected intensities were used to investigate the effects of emotional facial expressions of a virtual character on people's performance for interactive digital tasks in a virtual environment. Mainly, it was found that the emotional virtual characters either delay or speed up the user interaction with characters. In addition, concerning the time effect, while negative emotions anger, fear, and disgust, delay user interaction, happy, sadness, and positively recognized surprise emotions have an impact of direct actions of user interaction.

Concerning the navigation in the virtual environment, the users approach to the emotional virtual character in a linear path. However, the navigation paths between the virtual character and task object confirm that how to navigate towards the task object from the virtual character differentiates for each emotion, which can be seen briefly in the section 4.5.2.8.

Following this summary of the first and second study, in this chapter, how the results can be implemented into the fields in which emotional virtual characters are used will be mentioned. In addition, the research questions will be revisited by answering them according to the results taken from the second study. Lastly, the possibilities for further studies will be revealed.

5.1 The Implications of the Results

As it is mentioned in the chapter 1, the results of the thesis provide empirical knowledge about the effect of emotional facial expressions of a virtual character on people's performance for interactive digital tasks for the fields in which emotional virtual characters are used. This is mainly because designers use the nonverbal features of virtual characters to evoke an intended response from people. In order to create specific responses, it is important to know how emotional virtual character influences users' performance. This thesis mainly investigated the time effect and navigation effect of emotional facial expressions of a virtual character in a virtual digital environment.

In addition, the results can be implemented into different fields, such as entertainment games, training applications, or virtual therapy. For instance, if the way to amuse users in an entertainment game is to guide the users to complete a task directly, happy, sadness and positively recognized surprise emotions can be used to encourage the users. On the contrary, if it is intended to delay the users' actions, anger and fear emotions can slow down users' performance. Surprise emotion of a virtual human character can also be used to direct the users' view to the intended view. This is because surprise emotion of a character arouses the users' curiosity about what makes the character surprised so that the users head towards the view of the character. In a virtual environment of an entertainment game, if it is planned to guide the users move towards a specific point or look at a specific point in order to show them a specific object in the virtual environment, surprise emotion can engender the planned situation. Fear emotion in these applications can be used as a detractive effect for the users, which may alienate or forfend the user from the virtual human character.

The navigation effects of emotional facial expressions of a virtual character in a virtual environment can be important input to design the story of the application or game as intended. For example, an object is planned to be placed in the environment and it is desired that the users have to come closer to the object in order to interact with it in the story. To realize such a situation, it is important to know how the users navigate in the virtual environment. When the users have to interact with the virtual human character, they approach to the character in a direct way regardless of the emotional facial expression. One way might be to place the object between the starting point of the users and the virtual human character. It is important to know that although they come closer to the virtual character in a direct way regardless of emotional expressions, the approaching time to the character differs for emotions. While happy, sadness and surprise emotions decrease the time to approach, anger, fear and disgust emotions increase the time to come closer to the virtual character. This is because an object can be also planned to fade away in time and the story might require the interaction between the user and the virtual human character possessing the object and the users have to take the object from the virtual character in order to complete a task or a level. If the fade away time is lower than the time required for users to approach the virtual character, there will be no chance to finish the task. In addition to navigation effect, time effect might be vital knowledge to use emotional facial expressions as intended.

Similarly, the patterns of navigation paths between the emotional virtual human character and the task object or end point of the task emerged for especially happy, sadness, fear and surprise emotion. These results can also be implemented. The users followed a direct path when faced with happy, sadness and surprise emotion. For instance, the users have to interact with an object designed in the story of the application or game. It is important to know where to place the object in the environment because the users have to approach to the object in the game flow. Knowing that happy, sadness and surprise emotions can lead to direct navigation in virtual environment help to place the object in proper part of the virtual environment. In brief, the time effect and the navigation effect provide significant empirical knowledge about the effect of emotional facial expressions of a virtual character on people’s performance for

interactive digital tasks for the fields in which emotional virtual characters are used and the users interact with them.

Some of the knowledge might be also used in different fields, such as website in which online customer service representatives are used. Emotional virtual characters are also used in agent based systems. One of the major implementations of the effect of emotional facial expressions might be the use of surprise emotion to direct the users to the intended page. Surprise emotion might influence the users turn towards the view of the character. Similarly, in a web page or a banner, surprise emotion might easily get the attraction of people and arouse their curiosity, resulting in directing them to the desired web page. In contrast, anger or fear emotion might have a detractive effect to a web page.

5.2 Research Questions Revisited

- How do emotion specific facial expressions influence people's performance for digital interactive tasks in a virtual environment?

In general, while happy, sadness and surprise facial expressions encourage the users and increase their performance, anger, fear and disgust facial expressions discourage the users and decrease their performance for digital interactive tasks. It is necessary to state that disgust facial expression slows down users' performance but not as much as anger and fear facial expressions. As it is mentioned before, how surprise emotion increases users' performance is similar to happy emotion. Happy emotion encourages users because of the fact that it is a positive emotion. Similarly, positively recognized surprise emotion gives courage to the users, resulting in increase on users' performance. On the other hand, sadness emotion influenced users' performance in a different way. The users tended to treat sensitively to the virtual human character, which expressed sadness emotion. The effects of anger, fear and disgust facial expressions in virtual environment are different. While anger facial expression leads to unpredictable users' performance, fear facial expression has a detractive effect on users. In other words, people can be alienated from the virtual human character expressing the fear emotion.

The disgust emotion influences people's performance in a similar way to anger and facial expression. The disgust facial expression affects people perform in virtual environment unpredictably, like the anger emotion. Moreover, similar to fear facial expression, people want to be alienated from the character that expresses the disgust emotion.

- What are people's attitudes in response to emotional facial expressions of a virtual character in a virtual environment?

In the study in which the effects of emotional facial expressions are investigated, the time effects and the navigation effects in virtual environment were found. Although the approaching directly to the character shows that regardless of emotional facial expressions, people react to emotional facial expressions of a virtual character in the same manner, the results of time effects and the verbal feedback of the participants confirm that there are differences in people's reactions in response to emotional facial expressions. The major difference is whether people react to emotional virtual character willingly or unwillingly. While people respond to negative emotions, especially anger and fear emotions, unwillingly, they react to happy, sadness and surprise emotion willingly. People's reactions in response to disgust facial expression are similar to anger and fear emotion but not as much as anger and fear emotions. It is essential to mention that the users treat the virtual human character sensitively when they are faced with the sadness facial expression. The verbal responses of the participants confirmed that they became sensitive in response to the sadness facial expression. For the surprise facial expression, the participants also stated that the virtual human character is positively surprised, leading to the positive reaction, like happy.

- How do emotional facial expressions of a virtual character influence people to navigate in a virtual environment?

All emotional facial expressions (neutral, happy, sadness, anger, fear, surprise and disgust) affect people approach to the virtual character in the same way.

In other words, the way to come against the emotional virtual character is the same regardless of the emotional facial expression. The participants approached to the emotional virtual human character in a straight way. However, emotional facial expressions influence people navigate differently in the virtual environment, once they have come face to face with the virtual character. For neutral facial expression, the users are influenced to follow a direct path or a curvy path with/without retreat steps while moving towards an object. Happy, sadness and surprise facial expressions affect people to move towards the task object directly from the virtual human character. Sadness facial expression also influences the users to navigate with a curvy path. For anger emotion, how people are influenced to navigate in a virtual environment with the effect of emotional facial expressions is unpredictable. This is because the navigation paths for anger emotion of the participants analyzed in the second study are different from each other. Fear facial expression influences the users to step back from the virtual character and move towards the task object. The average back steps were found to be more than the half of the distance between the starting point of the user and the virtual human character. Fear facial expression influences people be alienated from the virtual human character, which would explain the back tracking.

- Do positive/negative emotions have a positive/negative effect on people's task performance?

Firstly, it is necessary to define the positive and negative emotions. Happy emotion is considered as a positive emotion whereas sadness, anger, fear and disgust can be considered as negative emotions. Surprise emotion can be regarded as either positive or negative. In this study, surprise emotion was regarded as positive. It is logical that an individual can be positively or negatively surprised. It can be concluded that while positive emotions have a positive effect on people's task performance, negative emotions have negative impact on people's performance. This is on the basis that negative effect on performance is derived as both time for task completion and paths taken during navigation. Moreover, the negative emotions affect people's performance positively. However, the reverse was not found according to the results of the second study, it cannot be stated that the positive emotions have

a negative impact. While happy emotion as positive emotion, sadness as negative emotion and positively recognized surprise emotion affect people's performance positively for interactive digital tasks, anger, fear and disgust emotion as negative emotions have negative impact on people's task performance.

5.3 Further Studies

To investigate the effects of emotional facial expression of a virtual character on people's performance for interactive digital tasks, a digital interactive application study was conducted in the Department of Industrial Design at Middle East Technical University, involving 30 participants ranging from 21 years old to 28 years old. All of the participants were university students. Future studies conducted with participants from different age group, such as teenagers, participants from different background or gamers as participants might provide similar or different knowledge about the effect of emotional facial expression.

In the second study, the context that was employed in the interactive digital tasks can be considered as 'neutral' context. People's performance in response to emotional facial expressions can be affected by different contexts. As mentioned in section 2.11, facial and contextual information in the perception of emotional facial expression show that context can dominate the interpretations of facial expressions of basic emotions (Carroll and Russell, 1996) and the facial expression dominates the context in the perception of emotion (Wallbott, cited in Fernández-Dols and Carroll, 1997) and (Nakamura, Buck and Kenny, cited in Fernández-Dols and Carroll, 1997). Emotional facial expressions in different contexts could create different effects on people's performance for interactive digital tasks.

For instance, virtual therapy has different implementations of context. For instance, the military is using the virtual environment to treat traumatized veterans of war, giving troops a way to overcome their mental war wounds (Ziezulewicz, 2009). This application, which looks like a game, is used to help people who suffer from stress disorder by creating the environment. It is

desired to create the virtual environment in which people are helped to confront the memory of trauma. Therefore people become less afraid of a situation that reminds them bad memories, resulting in looking at the situation differently. How people perceive and behave in response to the virtual character's behavior in a virtual environment was not different from when they would behave in a similar real life scenario (Persky and McBride, as cited in Paschall et al., 2005). A further study that might be conducted with participants from military in a war environment might provide empirical knowledge for military implementation of virtual therapy.

In this present study, emotional facial expressions created according to FACS were used. Other nonverbal emotional expressions can also be studied in the future, such as body posture or body movements. Other nonverbal emotional expressions might also convey emotions. For instance, there are a number of sources that provide descriptions about emotional body posture such as Darwin (1872) and Boone and Cunningham (2001). Coulson (2004) found in his research that anatomical features could be used to produce the emotional body postures. Until Coulson's study, gestures were recorded and presented descriptively. Together with emotional facial expressions, body postures expressing emotions can also be another subject to find out the effects of body postures and emotional facial expressions of a virtual character on people's performance. In addition, only the effects of body postures on people's performance for digital interactive tasks can be investigated.

Lastly, another interesting subject for further studies might be the effect of the gender of the virtual character. The gender used for the emotional virtual human character in this thesis was male. People might perform differently in response to different genders of the emotional characters. For instance, an interaction between a male participant and a male virtual character might be strong, as well as the interaction between a female user and a female virtual human character.

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APPENDIX A

DESCRIPTIONS AND IMAGES OF ACTION UNITS DEFINED IN THE FACIAL ACTION CODING SYSTEM

(retrieved from http://www.cs.cmu.edu/afs/cs/project/face/www/facs.htm)

Table A1.1: Descriptions and images of Action Units

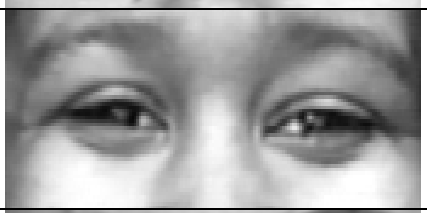
Action Unit	Description	Example image
AU 1	Inner Brow Raiser	
AU 2	Outer Brow Raiser	
AU 4	Brow Lowerer	
AU 5	Upper Lid Raiser	
AU 6	Cheek Raiser	
AU 7	Lid Tightener	

Table A1.1 (continued) : The description and the images of Action Units

Action Unit	Description	Example image
AU 9	Nose Wrinkler	
AU 10	Upper Lip Raiser	
AU 11	Nasolabial Deepener	
AU 12	Lip Corner Puller	
AU 13	Cheek Puffer	
AU 14	Dimpler	
AU 15	Lip Corner Depressor	

Table A1.1 (continued) : The description and the images of Action Units

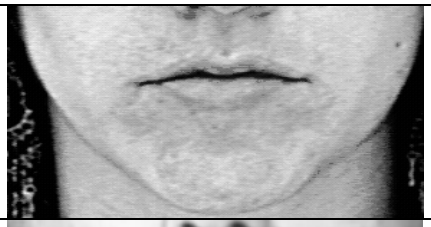
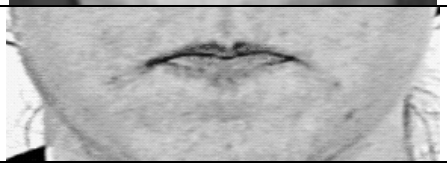
Action Unit	Description	Example image
AU 16	Lower Lip Depressor	
AU 17	Chin Raiser	
AU 18	Lip Puckerer	
AU 20	Lip stretcher	
AU 22	Lip Funneler	
AU 23	Lip Tightener	
AU 24	Lip Pressor	

Table A1.1 (continued) : The description and the images of Action Units

Action Unit	Description	Example image
AU 25	Lips part	
AU 26	Jaw Drop	
AU 27	Mouth Stretch	
AU 28	Lip Suck	
AU 41	Lid droop	
AU 42	Slit	
AU 43	Eyes Closed	
AU 44	Squint	

APPENDIX B

PROTOTYPICAL PATTERNS OF FACIAL EXPRESSIONS

Table B1.1: Prototypical patterns of facial expressions (Ekman & Friesen, 1978)

Emotions	**Prototypical Patterns of Facial Expressions**
Happy	AU 6 + AU 12 AU 12
Anger	AU 4 + AU 5 + AU 7 + AU 10 + AU 22 + AU 23 + AU 25, 26 AU 4 + AU 5 + AU 7 + AU 10 + AU 23 + AU 25, 26 AU 4 + AU 5 + AU 7 + AU 23 + AU 25, 26 AU 4 + AU 5 + AU 7 + AU 17 + AU 23 AU 4 + AU 5 + AU 7 + AU 17 + AU 24 AU 4 + AU 5 + AU 7 + AU 23 AU 4 + AU 5 + AU 7 + AU 24
Sadness	AU 1 + AU 4 + AU 11 + AU 15 with or without AU 54 + AU 65 AU 1 + AU 4 + AU 15 with or without AU 54 + AU 65 AU 6 + AU 15 with or without AU 54 + AU 65 AU 25 & AU 26 may occur with all prototypes
Fear	AU 1 + AU 2 + AU 4 + AU 5 + AU 20 + AU 25 + AU 26 or 27 AU 1 + AU 2 + AU 4 + AU 5 + AU 25 + AU 26 or 27
Surprise	AU 1 + AU 2 + AU 5 + AU 26 AU 1 + AU 2 + AU 5 + AU 27
Disgust	AU 9 AU 9 + AU 16 + AU 25, 26 AU 9 + AU 17 AU 10 AU 10 + AU 16 + AU 25, 26 AU 10 + AU 17

APPENDIX C (a)

THE PAPER VERSION OF THE ONLINE QUESTIONNAIRE OF THE RECOGNITION OF THE FACIAL EXPRESSIONS (In Turkish)

GİRİŞ

Bu çalışma Orta Doğu Teknik Üniversitesi, Mimarlık Fakültesi, Endüstri Ürünleri Tasarımı bölümünde yürütülen 'ETKİLEŞİMLİ DİJİTAL GÖREVLERDE KULLANILAN SANAL KARAKTERLERİN DUYGUSAL YÜZ İFADELERİNİN İNSANLARIN PERFORMANSI ÜZERİNDEKİ ETKİSİ' konulu yüksek lisans tezi çalışması için kullanılacaktır. Bu çalışmada insanların belirli duygusal yüz ifadelerini hangi yoğunlukta algıladığını araştırıyorum.

Bu araştırmam için sizden aşağıdaki çalışmayı doldurmanızı istiyorum.

Bu çalışma yaklaşık olarak **10 dakikanızı** alacaktır.

Çalışmama yardımcı olduğunuz için çok teşekkür ederim.

Alper Karadoğaner

Bu çalışmada size 19 adet duygusal yüz ifadeleri verilecektir. Sizden bu 19 duygusal yüz ifadelerinin her biri için karakterin hangi duygusal ifadeyi ne kadar iyi yansıttığına göre 1'den 5'e kadar değerlendirmenizi istiyoruz. Eğer karakterin bir duygusal yüz ifadesini çok iyi yansıttığını düşünüyorsanız 5 puan; eğer hiç yansıtmadığını düşünüyorsanız 1 puan verebilirsiniz. Örnek olarak, eğer karakterin duygusal yüz ifadesinin çok iyi derecede mutluluk, az derecede üzgünlük ve orta derecede kızgınlık ifadesini yansıttığını düşünüyorsanız, mutluluk için 5 puan, üzgün için 2 puan, kızgınlık için 3 puan ve diğer ifadeler için 1 puan vererek değerlendirebilirsiniz.

Çalışmaya başlamadan önce, bu çalışmada doğru veya yanlış cevap olmadığını ve çalışmanın amacının karakterin duygusal ifadeleri ne kadar iyi yansıtıp yansıtmadığını öğrenmek olduğunu belirtmek isteriz.

Anket

Sağdaki kutuyu ‘X’ ile işaretleyiniz.

Yaş: ....
Cinsiyet: ☐ **Erkek** ☐ **Kadın**

Table C1.1: The facial expressions used in the online questionnaire

	Hiç 1	2	orta 3	4	çok iyi 5
MUTLU	[ ]	[ ]	[ ]	[ ]	[ ]
ÜZGÜN	[ ]	[ ]	[ ]	[ ]	[ ]
KIZGIN	[ ]	[ ]	[ ]	[ ]	[ ]
KORKU	[ ]	[ ]	[ ]	[ ]	[ ]
ŞAŞIRMA	[ ]	[ ]	[ ]	[ ]	[ ]
İĞRENME	[ ]	[ ]	[ ]	[ ]	[ ]

	Hiç 1	2	orta 3	4	çok iyi 5
MUTLU	[ ]	[ ]	[ ]	[ ]	[ ]
ÜZGÜN	[ ]	[ ]	[ ]	[ ]	[ ]
KIZGIN	[ ]	[ ]	[ ]	[ ]	[ ]
KORKU	[ ]	[ ]	[ ]	[ ]	[ ]
ŞAŞIRMA	[ ]	[ ]	[ ]	[ ]	[ ]
İĞRENME	[ ]	[ ]	[ ]	[ ]	[ ]

	Hiç 1	2	orta 3	4	çok iyi 5
MUTLU	[ ]	[ ]	[ ]	[ ]	[ ]
ÜZGÜN	[ ]	[ ]	[ ]	[ ]	[ ]
KIZGIN	[ ]	[ ]	[ ]	[ ]	[ ]
KORKU	[ ]	[ ]	[ ]	[ ]	[ ]
ŞAŞIRMA	[ ]	[ ]	[ ]	[ ]	[ ]
İĞRENME	[ ]	[ ]	[ ]	[ ]	[ ]

	Hiç 1	2	orta 3	4	çok iyi 5
MUTLU	[ ]	[ ]	[ ]	[ ]	[ ]
ÜZGÜN	[ ]	[ ]	[ ]	[ ]	[ ]
KIZGIN	[ ]	[ ]	[ ]	[ ]	[ ]
KORKU	[ ]	[ ]	[ ]	[ ]	[ ]
ŞAŞIRMA	[ ]	[ ]	[ ]	[ ]	[ ]
İĞRENME	[ ]	[ ]	[ ]	[ ]	[ ]

Table C1.1 (continued): The facial expressions used in the online questionnaire

	Hiç 1	2	orta 3	4	çok iyi 5
MUTLU	[ ]	[ ]	[ ]	[ ]	[ ]
ÜZGÜN	[ ]	[ ]	[ ]	[ ]	[ ]
KIZGIN	[ ]	[ ]	[ ]	[ ]	[ ]
KORKU	[ ]	[ ]	[ ]	[ ]	[ ]
ŞAŞIRMA	[ ]	[ ]	[ ]	[ ]	[ ]
İĞRENME	[ ]	[ ]	[ ]	[ ]	[ ]

	Hiç 1	2	orta 3	4	çok iyi 5
MUTLU	[ ]	[ ]	[ ]	[ ]	[ ]
ÜZGÜN	[ ]	[ ]	[ ]	[ ]	[ ]
KIZGIN	[ ]	[ ]	[ ]	[ ]	[ ]
KORKU	[ ]	[ ]	[ ]	[ ]	[ ]
ŞAŞIRMA	[ ]	[ ]	[ ]	[ ]	[ ]
İĞRENME	[ ]	[ ]	[ ]	[ ]	[ ]

	Hiç 1	2	orta 3	4	çok iyi 5
MUTLU	[ ]	[ ]	[ ]	[ ]	[ ]
ÜZGÜN	[ ]	[ ]	[ ]	[ ]	[ ]
KIZGIN	[ ]	[ ]	[ ]	[ ]	[ ]
KORKU	[ ]	[ ]	[ ]	[ ]	[ ]
ŞAŞIRMA	[ ]	[ ]	[ ]	[ ]	[ ]
İĞRENME	[ ]	[ ]	[ ]	[ ]	[ ]

	Hiç 1	2	orta 3	4	çok iyi 5
MUTLU	[ ]	[ ]	[ ]	[ ]	[ ]
ÜZGÜN	[ ]	[ ]	[ ]	[ ]	[ ]
KIZGIN	[ ]	[ ]	[ ]	[ ]	[ ]
KORKU	[ ]	[ ]	[ ]	[ ]	[ ]
ŞAŞIRMA	[ ]	[ ]	[ ]	[ ]	[ ]
İĞRENME	[ ]	[ ]	[ ]	[ ]	[ ]

Table C1.1 (continued): The facial expressions used in the online questionnaire

	Hiç 1	2	orta 3	4	çok iyi 5
MUTLU	[ ]	[ ]	[ ]	[ ]	[ ]
ÜZGÜN	[ ]	[ ]	[ ]	[ ]	[ ]
KIZGIN	[ ]	[ ]	[ ]	[ ]	[ ]
KORKU	[ ]	[ ]	[ ]	[ ]	[ ]
ŞAŞIRMA	[ ]	[ ]	[ ]	[ ]	[ ]
İĞRENME	[ ]	[ ]	[ ]	[ ]	[ ]

	Hiç 1	2	orta 3	4	çok iyi 5
MUTLU	[ ]	[ ]	[ ]	[ ]	[ ]
ÜZGÜN	[ ]	[ ]	[ ]	[ ]	[ ]
KIZGIN	[ ]	[ ]	[ ]	[ ]	[ ]
KORKU	[ ]	[ ]	[ ]	[ ]	[ ]
ŞAŞIRMA	[ ]	[ ]	[ ]	[ ]	[ ]
İĞRENME	[ ]	[ ]	[ ]	[ ]	[ ]

	Hiç 1	2	orta 3	4	çok iyi 5
MUTLU	[ ]	[ ]	[ ]	[ ]	[ ]
ÜZGÜN	[ ]	[ ]	[ ]	[ ]	[ ]
KIZGIN	[ ]	[ ]	[ ]	[ ]	[ ]
KORKU	[ ]	[ ]	[ ]	[ ]	[ ]
ŞAŞIRMA	[ ]	[ ]	[ ]	[ ]	[ ]
İĞRENME	[ ]	[ ]	[ ]	[ ]	[ ]

	Hiç 1	2	orta 3	4	çok iyi 5
MUTLU	[ ]	[ ]	[ ]	[ ]	[ ]
ÜZGÜN	[ ]	[ ]	[ ]	[ ]	[ ]
KIZGIN	[ ]	[ ]	[ ]	[ ]	[ ]
KORKU	[ ]	[ ]	[ ]	[ ]	[ ]
ŞAŞIRMA	[ ]	[ ]	[ ]	[ ]	[ ]
İĞRENME	[ ]	[ ]	[ ]	[ ]	[ ]

Table C1.1 (continued): The facial expressions used in the online questionnaire

	Hiç		orta	çok iyi	
	1	2	3	4	5
MUTLU	[ ]	[ ]	[ ]	[ ]	[ ]
ÜZGÜN	[ ]	[ ]	[ ]	[ ]	[ ]
KIZGIN	[ ]	[ ]	[ ]	[ ]	[ ]
KORKU	[ ]	[ ]	[ ]	[ ]	[ ]
ŞAŞIRMA	[ ]	[ ]	[ ]	[ ]	[ ]
İĞRENME	[ ]	[ ]	[ ]	[ ]	[ ]

	Hiç		orta	çok iyi	
	1	2	3	4	5
MUTLU	[ ]	[ ]	[ ]	[ ]	[ ]
ÜZGÜN	[ ]	[ ]	[ ]	[ ]	[ ]
KIZGIN	[ ]	[ ]	[ ]	[ ]	[ ]
KORKU	[ ]	[ ]	[ ]	[ ]	[ ]
ŞAŞIRMA	[ ]	[ ]	[ ]	[ ]	[ ]
İĞRENME	[ ]	[ ]	[ ]	[ ]	[ ]

	Hiç		orta	çok iyi	
	1	2	3	4	5
MUTLU	[ ]	[ ]	[ ]	[ ]	[ ]
ÜZGÜN	[ ]	[ ]	[ ]	[ ]	[ ]
KIZGIN	[ ]	[ ]	[ ]	[ ]	[ ]
KORKU	[ ]	[ ]	[ ]	[ ]	[ ]
ŞAŞIRMA	[ ]	[ ]	[ ]	[ ]	[ ]
İĞRENME	[ ]	[ ]	[ ]	[ ]	[ ]

	Hiç		orta	çok iyi	
	1	2	3	4	5
MUTLU	[ ]	[ ]	[ ]	[ ]	[ ]
ÜZGÜN	[ ]	[ ]	[ ]	[ ]	[ ]
KIZGIN	[ ]	[ ]	[ ]	[ ]	[ ]
KORKU	[ ]	[ ]	[ ]	[ ]	[ ]
ŞAŞIRMA	[ ]	[ ]	[ ]	[ ]	[ ]
İĞRENME	[ ]	[ ]	[ ]	[ ]	[ ]

Table C1.1 (continued): The facial expressions used in the online questionnaire

	Hiç 1	2	orta 3	4	çok iyi 5
MUTLU	[ ]	[ ]	[ ]	[ ]	[ ]
ÜZGÜN	[ ]	[ ]	[ ]	[ ]	[ ]
KIZGIN	[ ]	[ ]	[ ]	[ ]	[ ]
KORKU	[ ]	[ ]	[ ]	[ ]	[ ]
ŞAŞIRMA	[ ]	[ ]	[ ]	[ ]	[ ]
İĞRENME	[ ]	[ ]	[ ]	[ ]	[ ]

	Hiç 1	2	orta 3	4	çok iyi 5
MUTLU	[ ]	[ ]	[ ]	[ ]	[ ]
ÜZGÜN	[ ]	[ ]	[ ]	[ ]	[ ]
KIZGIN	[ ]	[ ]	[ ]	[ ]	[ ]
KORKU	[ ]	[ ]	[ ]	[ ]	[ ]
ŞAŞIRMA	[ ]	[ ]	[ ]	[ ]	[ ]
İĞRENME	[ ]	[ ]	[ ]	[ ]	[ ]

	Hiç 1	2	orta 3	4	çok iyi 5
MUTLU	[ ]	[ ]	[ ]	[ ]	[ ]
ÜZGÜN	[ ]	[ ]	[ ]	[ ]	[ ]
KIZGIN	[ ]	[ ]	[ ]	[ ]	[ ]
KORKU	[ ]	[ ]	[ ]	[ ]	[ ]
ŞAŞIRMA	[ ]	[ ]	[ ]	[ ]	[ ]
İĞRENME	[ ]	[ ]	[ ]	[ ]	[ ]

APPENDIX C (b)

THE PAPER VERSION OF THE ONLINE QUESTIONNAIRE OF THE RECOGNITION OF THE FACIAL EXPRESSIONS (In English)

Introduction

For the master thesis, the effect of emotional facial expressions on people's performance, I am conducting a study to find out the perceived intensity of people in response to the emotion specific facial expression in the Department of Industrial Design at the faculty of Architecture at the Middle East Technical University.

In order to investigate the perceived intensity of facial expressions, I would like to ask you to fill in this study.

It will take you about **10 minutes**.

Thank you very much for helping me!

Alper Karadoğaner

We want you to rate each 19 facial expressions according to how well the character expresses specific emotions. You have to rate the expressions on a scale of 1 to 5 for each of the six emotions. 1 means no expression of this emotion, 5 means a very good expression of this emotion. So, if you find the stimulus face express happiness very well, sadness poorly, anger moderate, etc.; rate 5 for happiness, 2 for sadness, 3 for anger.

Before starting the survey, we would like to remember you that there is no right or wrong answer in this survey. Our aim is to investigate how well you recognize emotional facial expressions.

Questionnaire

Put an X in the right box.

Age: ....
Gender: ☐ **Male** ☐ **Female**

Table C2.1 The facial expressions used in the online questionnaire

	slightly			extremely	
	1	**2**	**3**	**4**	**5**
HAPPY	[ ]	[ ]	[ ]	[ ]	[ ]
SADNESS	[ ]	[ ]	[ ]	[ ]	[ ]
ANGER	[ ]	[ ]	[ ]	[ ]	[ ]
FEAR	[ ]	[ ]	[ ]	[ ]	[ ]
SURPRISE	[ ]	[ ]	[ ]	[ ]	[ ]
DISGUST	[ ]	[ ]	[ ]	[ ]	[ ]

	slightly			extremely	
	1	**2**	**3**	**4**	**5**
HAPPY	[ ]	[ ]	[ ]	[ ]	[ ]
SADNESS	[ ]	[ ]	[ ]	[ ]	[ ]
ANGER	[ ]	[ ]	[ ]	[ ]	[ ]
FEAR	[ ]	[ ]	[ ]	[ ]	[ ]
SURPRISE	[ ]	[ ]	[ ]	[ ]	[ ]
DISGUST	[ ]	[ ]	[ ]	[ ]	[ ]

	slightly			extremely	
	1	**2**	**3**	**4**	**5**
HAPPY	[ ]	[ ]	[ ]	[ ]	[ ]
SADNESS	[ ]	[ ]	[ ]	[ ]	[ ]
ANGER	[ ]	[ ]	[ ]	[ ]	[ ]
FEAR	[ ]	[ ]	[ ]	[ ]	[ ]
SURPRISE	[ ]	[ ]	[ ]	[ ]	[ ]
DISGUST	[ ]	[ ]	[ ]	[ ]	[ ]

	slightly			extremely	
	1	**2**	**3**	**4**	**5**
HAPPY	[ ]	[ ]	[ ]	[ ]	[ ]
SADNESS	[ ]	[ ]	[ ]	[ ]	[ ]
ANGER	[ ]	[ ]	[ ]	[ ]	[ ]
FEAR	[ ]	[ ]	[ ]	[ ]	[ ]
SURPRISE	[ ]	[ ]	[ ]	[ ]	[ ]
DISGUST	[ ]	[ ]	[ ]	[ ]	[ ]

Table C2.1 (continued): The facial expressions used in the online questionnaire

	slightly			extremely	
	1	2	3	4	5
HAPPY	[ ]	[ ]	[ ]	[ ]	[ ]
SADNESS	[ ]	[ ]	[ ]	[ ]	[ ]
ANGER	[ ]	[ ]	[ ]	[ ]	[ ]
FEAR	[ ]	[ ]	[ ]	[ ]	[ ]
SURPRISE	[ ]	[ ]	[ ]	[ ]	[ ]
DISGUST	[ ]	[ ]	[ ]	[ ]	[ ]

	slightly			extremely	
	1	2	3	4	5
HAPPY	[ ]	[ ]	[ ]	[ ]	[ ]
SADNESS	[ ]	[ ]	[ ]	[ ]	[ ]
ANGER	[ ]	[ ]	[ ]	[ ]	[ ]
FEAR	[ ]	[ ]	[ ]	[ ]	[ ]
SURPRISE	[ ]	[ ]	[ ]	[ ]	[ ]
DISGUST	[ ]	[ ]	[ ]	[ ]	[ ]

	slightly			extremely	
	1	2	3	4	5
HAPPY	[ ]	[ ]	[ ]	[ ]	[ ]
SADNESS	[ ]	[ ]	[ ]	[ ]	[ ]
ANGER	[ ]	[ ]	[ ]	[ ]	[ ]
FEAR	[ ]	[ ]	[ ]	[ ]	[ ]
SURPRISE	[ ]	[ ]	[ ]	[ ]	[ ]
DISGUST	[ ]	[ ]	[ ]	[ ]	[ ]

	slightly			extremely	
	1	2	3	4	5
HAPPY	[ ]	[ ]	[ ]	[ ]	[ ]
SADNESS	[ ]	[ ]	[ ]	[ ]	[ ]
ANGER	[ ]	[ ]	[ ]	[ ]	[ ]
FEAR	[ ]	[ ]	[ ]	[ ]	[ ]
SURPRISE	[ ]	[ ]	[ ]	[ ]	[ ]
DISGUST	[ ]	[ ]	[ ]	[ ]	[ ]

Table C2.1 (continued): The facial expressions used in the online questionnaire

	slightly			extremely	
	1	2	3	4	5
HAPPY	[ ]	[ ]	[ ]	[ ]	[ ]
SADNESS	[ ]	[ ]	[ ]	[ ]	[ ]
ANGER	[ ]	[ ]	[ ]	[ ]	[ ]
FEAR	[ ]	[ ]	[ ]	[ ]	[ ]
SURPRISE	[ ]	[ ]	[ ]	[ ]	[ ]
DISGUST	[ ]	[ ]	[ ]	[ ]	[ ]

	slightly			extremely	
	1	2	3	4	5
HAPPY	[ ]	[ ]	[ ]	[ ]	[ ]
SADNESS	[ ]	[ ]	[ ]	[ ]	[ ]
ANGER	[ ]	[ ]	[ ]	[ ]	[ ]
FEAR	[ ]	[ ]	[ ]	[ ]	[ ]
SURPRISE	[ ]	[ ]	[ ]	[ ]	[ ]
DISGUST	[ ]	[ ]	[ ]	[ ]	[ ]

	slightly			extremely	
	1	2	3	4	5
HAPPY	[ ]	[ ]	[ ]	[ ]	[ ]
SADNESS	[ ]	[ ]	[ ]	[ ]	[ ]
ANGER	[ ]	[ ]	[ ]	[ ]	[ ]
FEAR	[ ]	[ ]	[ ]	[ ]	[ ]
SURPRISE	[ ]	[ ]	[ ]	[ ]	[ ]
DISGUST	[ ]	[ ]	[ ]	[ ]	[ ]

	slightly			extremely	
	1	2	3	4	5
HAPPY	[ ]	[ ]	[ ]	[ ]	[ ]
SADNESS	[ ]	[ ]	[ ]	[ ]	[ ]
ANGER	[ ]	[ ]	[ ]	[ ]	[ ]
FEAR	[ ]	[ ]	[ ]	[ ]	[ ]
SURPRISE	[ ]	[ ]	[ ]	[ ]	[ ]
DISGUST	[ ]	[ ]	[ ]	[ ]	[ ]

Table C2.1 (continued): The facial expressions used in the online questionnaire

	slightly			extremely	
	1	2	3	4	5
HAPPY	[ ]	[ ]	[ ]	[ ]	[ ]
SADNESS	[ ]	[ ]	[ ]	[ ]	[ ]
ANGER	[ ]	[ ]	[ ]	[ ]	[ ]
FEAR	[ ]	[ ]	[ ]	[ ]	[ ]
SURPRISE	[ ]	[ ]	[ ]	[ ]	[ ]
DISGUST	[ ]	[ ]	[ ]	[ ]	[ ]

	slightly			extremely	
	1	2	3	4	5
HAPPY	[ ]	[ ]	[ ]	[ ]	[ ]
SADNESS	[ ]	[ ]	[ ]	[ ]	[ ]
ANGER	[ ]	[ ]	[ ]	[ ]	[ ]
FEAR	[ ]	[ ]	[ ]	[ ]	[ ]
SURPRISE	[ ]	[ ]	[ ]	[ ]	[ ]
DISGUST	[ ]	[ ]	[ ]	[ ]	[ ]

	slightly			extremely	
	1	2	3	4	5
HAPPY	[ ]	[ ]	[ ]	[ ]	[ ]
SADNESS	[ ]	[ ]	[ ]	[ ]	[ ]
ANGER	[ ]	[ ]	[ ]	[ ]	[ ]
FEAR	[ ]	[ ]	[ ]	[ ]	[ ]
SURPRISE	[ ]	[ ]	[ ]	[ ]	[ ]
DISGUST	[ ]	[ ]	[ ]	[ ]	[ ]

	slightly			extremely	
	1	2	3	4	5
HAPPY	[ ]	[ ]	[ ]	[ ]	[ ]
SADNESS	[ ]	[ ]	[ ]	[ ]	[ ]
ANGER	[ ]	[ ]	[ ]	[ ]	[ ]
FEAR	[ ]	[ ]	[ ]	[ ]	[ ]
SURPRISE	[ ]	[ ]	[ ]	[ ]	[ ]
DISGUST	[ ]	[ ]	[ ]	[ ]	[ ]

Table C2.1 (continued): The facial expressions used in the online questionnaire

	slightly			extremely	
	1	2	3	4	5
HAPPY	[ ]	[ ]	[ ]	[ ]	[ ]
SADNESS	[ ]	[ ]	[ ]	[ ]	[ ]
ANGER	[ ]	[ ]	[ ]	[ ]	[ ]
FEAR	[ ]	[ ]	[ ]	[ ]	[ ]
SURPRISE	[ ]	[ ]	[ ]	[ ]	[ ]
DISGUST	[ ]	[ ]	[ ]	[ ]	[ ]

	slightly			extremely	
	1	2	3	4	5
HAPPY	[ ]	[ ]	[ ]	[ ]	[ ]
SADNESS	[ ]	[ ]	[ ]	[ ]	[ ]
ANGER	[ ]	[ ]	[ ]	[ ]	[ ]
FEAR	[ ]	[ ]	[ ]	[ ]	[ ]
SURPRISE	[ ]	[ ]	[ ]	[ ]	[ ]
DISGUST	[ ]	[ ]	[ ]	[ ]	[ ]

	slightly			extremely	
	1	2	3	4	5
HAPPY	[ ]	[ ]	[ ]	[ ]	[ ]
SADNESS	[ ]	[ ]	[ ]	[ ]	[ ]
ANGER	[ ]	[ ]	[ ]	[ ]	[ ]
FEAR	[ ]	[ ]	[ ]	[ ]	[ ]
SURPRISE	[ ]	[ ]	[ ]	[ ]	[ ]
DISGUST	[ ]	[ ]	[ ]	[ ]	[ ]

APPENDIX D

TUKEY POST-HOC RESULTS OF EMOTIONAL FACIAL EXPRESSION FOR THE FIRST STUDY

D1: Happy Facial Expressions (low, medium and high)

Table D1.1: Tukey post-hoc results of low intensity happy facial expression

Multiple Comparisons						
Happy Low Intensity						
Tukey HSD						
(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Happy	Sadness	2,52439*	0,07748	,000*	2,3027	2,7461
	Anger	2,68293*	0,07748	,000*	2,4613	2,9046
	Fear	2,70732*	0,07748	,000*	2,4856	2,929
	Surprise	2,65854*	0,07748	,000*	2,4369	2,8802
	Disgust	2,71951*	0,07748	,000*	2,4978	2,9412
Sadness	Happy	-2,52439*	0,07748	,000*	-2,7461	-2,3027
	Anger	0,15854	0,07748	0,318	-0,0631	0,3802
	Fear	0,18293	0,07748	0,172	-0,0387	0,4046
	Surprise	0,13415	0,07748	0,512	-0,0875	0,3558
	Disgust	0,19512	0,07748	0,121	-0,0265	0,4168
Anger	Happy	-2,68293*	0,07748	,000*	-2,9046	-2,4613
	Sadness	-0,15854	0,07748	0,318	-0,3802	0,0631
	Fear	0,02439	0,07748	1	-0,1973	0,2461
	Surprise	-0,02439	0,07748	1	-0,2461	0,1973
	Disgust	0,03659	0,07748	0,997	-0,1851	0,2583
Fear	Happy	-2,70732*	0,07748	,000*	-2,929	-2,4856
	Sadness	-0,18293	0,07748	0,172	-0,4046	0,0387
	Anger	-0,02439	0,07748	1	-0,2461	0,1973
	Surprise	-0,04878	0,07748	0,989	-0,2705	0,1729
	Disgust	0,0122	0,07748	1	-0,2095	0,2339
Surprise	Happy	-2,65854*	0,07748	,000*	-2,8802	-2,4369
	Sadness	-0,13415	0,07748	0,512	-0,3558	0,0875
	Anger	0,02439	0,07748	1	-0,1973	0,2461
	Fear	0,04878	0,07748	0,989	-0,1729	0,2705
	Disgust	0,06098	0,07748	0,97	-0,1607	0,2826
Disgust	Happy	-2,71951*	0,07748	,000*	-2,9412	-2,4978
	Sadness	-0,19512	0,07748	0,121	-0,4168	0,0265
	Anger	-0,03659	0,07748	0,997	-0,2583	0,1851
	Fear	-0,0122	0,07748	1	-0,2339	0,2095
	Surprise	-0,06098	0,07748	0,97	-0,2826	0,1607
*. The mean difference is significant at the 0.05 level.						

Table D1.2: Tukey post-hoc results of medium intensity happy facial expression

Multiple Comparisons						
Happy Medium Intensity						
Tukey HSD						
(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Happy	Sadness	2,46341*	0,11262	,000*	2,1412	2,7856
	Anger	2,26829*	0,11262	,000*	1,9461	2,5905
	Fear	2,75610*	0,11262	,000*	2,4339	3,0783
	Surprise	2,63415*	0,11262	,000*	2,3119	2,9564
	Disgust	2,34146*	0,11262	,000*	2,0193	2,6637
Sadness	Happy	-2,46341*	0,11262	,000*	-2,7856	-2,1412
	Anger	-0,19512	0,11262	0,511	-0,5173	0,1271
	Fear	0,29268	0,11262	0,099	-0,0295	0,6149
	Surprise	0,17073	0,11262	0,654	-0,1515	0,4929
	Disgust	-0,12195	0,11262	0,888	-0,4442	0,2003
Anger	Happy	-2,26829*	0,11262	,000*	-2,5905	-1,9461
	Sadness	0,19512	0,11262	0,511	-0,1271	0,5173
	Fear	,48780*	0,11262	,000*	0,1656	0,81
	Surprise	,36585*	0,11262	,016*	0,0436	0,6881
	Disgust	0,07317	0,11262	0,987	-0,249	0,3954
Fear	Happy	-2,75610*	0,11262	,000*	-3,0783	-2,4339
	Sadness	-0,29268	0,11262	0,099	-0,6149	0,0295
	Anger	-,48780*	0,11262	,000*	-0,81	-0,1656
	Surprise	-0,12195	0,11262	0,888	-0,4442	0,2003
	Disgust	-,41463*	0,11262	,003*	-0,7368	-0,0924
Surprise	Happy	-2,63415*	0,11262	,000*	-2,9564	-2,3119
	Sadness	-0,17073	0,11262	0,654	-0,4929	0,1515
	Anger	-,36585*	0,11262	,016*	-0,6881	-0,0436
	Fear	0,12195	0,11262	0,888	-0,2003	0,4442
	Disgust	-0,29268	0,11262	0,099	-0,6149	0,0295
Disgust	Happy	-2,34146*	0,11262	,000*	-2,6637	-2,0193
	Sadness	0,12195	0,11262	0,888	-0,2003	0,4442
	Anger	-0,07317	0,11262	0,987	-0,3954	0,249
	Fear	,41463*	0,11262	,003*	0,0924	0,7368
	Surprise	0,29268	0,11262	0,099	-0,0295	0,6149
*. The mean difference is significant at the 0.05 level.						

Table D1.3: Tukey post-hoc results of high intensity happy facial expression

Multiple Comparisons						
Happy High Intensity						
Tukey HSD						
(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Happy	Sadness	2,89024*	0,09517	,000*	2,6179	3,1625
	Anger	2,96341*	0,09517	,000*	2,6911	3,2357
	Fear	3,19512*	0,09517	,000*	2,9228	3,4674
	Surprise	3,07317*	0,09517	,000*	2,8009	3,3455
	Disgust	2,95122*	0,09517	,000*	2,6789	3,2235
Sadness	Happy	-2,89024*	0,09517	,000*	-3,1625	-2,6179
	Anger	0,07317	0,09517	0,973	-0,1991	0,3455
	Fear	,30488*	0,09517	,018*	0,0326	0,5772
	Surprise	0,18293	0,09517	0,39	-0,0894	0,4552
	Disgust	0,06098	0,09517	0,988	-0,2113	0,3333
Anger	Happy	-2,96341*	0,09517	,000*	-3,2357	-2,6911
	Sadness	-0,07317	0,09517	0,973	-0,3455	0,1991
	Fear	0,23171	0,09517	0,146	-0,0406	0,504
	Surprise	0,10976	0,09517	0,859	-0,1625	0,3821
	Disgust	-0,0122	0,09517	1	-0,2845	0,2601
Fear	Happy	-3,19512*	0,09517	,000*	-3,4674	-2,9228
	Sadness	-,30488*	0,09517	,018*	-0,5772	-0,0326
	Anger	-0,23171	0,09517	0,146	-0,504	0,0406
	Surprise	-0,12195	0,09517	0,795	-0,3943	0,1504
	Disgust	-0,2439	0,09517	0,109	-0,5162	0,0284
Surprise	Happy	-3,07317*	0,09517	,000*	-3,3455	-2,8009
	Sadness	-0,18293	0,09517	0,39	-0,4552	0,0894
	Anger	-0,10976	0,09517	0,859	-0,3821	0,1625
	Fear	0,12195	0,09517	0,795	-0,1504	0,3943
	Disgust	-0,12195	0,09517	0,795	-0,3943	0,1504
Disgust	Happy	-2,95122*	0,09517	,000*	-3,2235	-2,6789
	Sadness	-0,06098	0,09517	0,988	-0,3333	0,2113
	Anger	0,0122	0,09517	1	-0,2601	0,2845
	Fear	0,2439	0,09517	0,109	-0,0284	0,5162
	Surprise	0,12195	0,09517	0,795	-0,1504	0,3943
*. The mean difference is significant at the 0.05 level.						

D2: Sadness Facial Expressions (low, medium and high)

Table D2.1: Tukey post-hoc results of low intensity sadness facial expression

Multiple Comparisons						
Sadness Low Intensity						
Tukey HSD						
(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Happy	Sadness	-3,59756*	0,08227	,000*	-3,8329	-3,3622
	Anger	-0,15854	0,08227	0,387	-0,3939	0,0768
	Fear	-,46341*	0,08227	,000*	-0,6988	-0,228
	Surprise	-,34146*	0,08227	,001*	-0,5768	-0,1061
	Disgust	-0,06098	0,08227	0,977	-0,2964	0,1744
Sadness	Happy	3,59756*	0,08227	,000*	3,3622	3,8329
	Anger	3,43902*	0,08227	,000*	3,2036	3,6744
	Fear	3,13415*	0,08227	,000*	2,8988	3,3695
	Surprise	3,25610*	0,08227	,000*	3,0207	3,4915
	Disgust	3,53659*	0,08227	,000*	3,3012	3,772
Anger	Happy	0,15854	0,08227	0,387	-0,0768	0,3939
	Sadness	-3,43902*	0,08227	,000*	-3,6744	-3,2036
	Fear	-,30488*	0,08227	0,003	-0,5403	-0,0695
	Surprise	-0,18293	0,08227	0,229	-0,4183	0,0525
	Disgust	0,09756	0,08227	0,844	-0,1378	0,3329
Fear	Happy	,46341*	0,08227	,000*	0,228	0,6988
	Sadness	-3,13415*	0,08227	,000*	-3,3695	-2,8988
	Anger	,30488*	0,08227	0,003	0,0695	0,5403
	Surprise	0,12195	0,08227	0,676	-0,1134	0,3573
	Disgust	,40244*	0,08227	,000*	0,1671	0,6378
Surprise	Happy	,34146*	0,08227	,001*	0,1061	0,5768
	Sadness	-3,25610*	0,08227	,000*	-3,4915	-3,0207
	Anger	0,18293	0,08227	0,229	-0,0525	0,4183
	Fear	-0,12195	0,08227	0,676	-0,3573	0,1134
	Disgust	,28049*	0,08227	,009*	0,0451	0,5159
Disgust	Happy	0,06098	0,08227	0,977	-0,1744	0,2964
	Sadness	-3,53659*	0,08227	,000*	-3,772	-3,3012
	Anger	-0,09756	0,08227	0,844	-0,3329	0,1378
	Fear	-,40244*	0,08227	,000*	-0,6378	-0,1671
	Surprise	-,28049*	0,08227	0,009	-0,5159	-0,0451
*. The mean difference is significant at the 0.05 level.						

Table D2.2: Tukey post-hoc results of medium intensity sadness facial expression

Multiple Comparisons						
Sadness Medium Intensity						
Tukey HSD						
(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Happy	Sadness	-3,56098*	0,10173	,000*	-3,852	-3,2699
	Anger	-0,21951	0,10173	0,26	-0,5106	0,0715
	Fear	-,64634*	0,10173	,000*	-0,9374	-0,3553
	Surprise	-,36585*	0,10173	,005*	-0,6569	-0,0748
	Disgust	-0,14634	0,10173	0,703	-0,4374	0,1447
Sadness	Happy	3,56098*	0,10173	,000*	3,2699	3,852
	Anger	3,34146*	0,10173	,000*	3,0504	3,6325
	Fear	2,91463*	0,10173	,000*	2,6236	3,2057
	Surprise	3,19512*	0,10173	,000*	2,9041	3,4862
	Disgust	3,41463*	0,10173	,000*	3,1236	3,7057
Anger	Happy	0,21951	0,10173	0,26	-0,0715	0,5106
	Sadness	-3,34146*	0,10173	,000*	-3,6325	-3,0504
	Fear	-,42683*	0,10173	,000*	-0,7179	-0,1358
	Surprise	-0,14634	0,10173	0,703	-0,4374	0,1447
	Disgust	0,07317	0,10173	0,98	-0,2179	0,3642
Fear	Happy	,64634*	0,10173	,000*	0,3553	0,9374
	Sadness	-2,91463*	0,10173	,000*	-3,2057	-2,6236
	Anger	,42683*	0,10173	,000*	0,1358	0,7179
	Surprise	0,28049	0,10173	0,066	-0,0106	0,5715
	Disgust	,50000*	0,10173	,000*	0,2089	0,7911
Surprise	Happy	,36585*	0,10173	,005*	0,0748	0,6569
	Sadness	-3,19512*	0,10173	,000*	-3,4862	-2,9041
	Anger	0,14634	0,10173	0,703	-0,1447	0,4374
	Fear	-0,28049	0,10173	0,066	-0,5715	0,0106
	Disgust	0,21951	0,10173	0,26	-0,0715	0,5106
Disgust	Happy	0,14634	0,10173	0,703	-0,1447	0,4374
	Sadness	-3,41463*	0,10173	,000*	-3,7057	-3,1236
	Anger	-0,07317	0,10173	0,98	-0,3642	0,2179
	Fear	-,50000*	0,10173	,000*	-0,7911	-0,2089
	Surprise	-0,21951	0,10173	0,26	-0,5106	0,0715
*. The mean difference is significant at the 0.05 level.						

Table D2.3: Tukey post-hoc results of high intensity sadness facial expression

Multiple Comparisons						
Sadness High Intensity						
Tukey HSD						
(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Happy	Sadness	-3,85366*	0,09084	,000*	-4,1136	-3,5938
	Anger	-,26829*	0,09084	,038*	-0,5282	-0,0084
	Fear	-,37805*	0,09084	,001*	-0,6379	-0,1182
	Surprise	-,35366*	0,09084	,002*	-0,6136	-0,0938
	Disgust	-0,21951	0,09084	0,153	-0,4794	0,0404
Sadness	Happy	3,85366*	0,09084	,000*	3,5938	4,1136
	Anger	3,58537*	0,09084	,000*	3,3255	3,8453
	Fear	3,47561*	0,09084	,000*	3,2157	3,7355
	Surprise	3,50000*	0,09084	,000*	3,2401	3,7599
	Disgust	3,63415*	0,09084	,000*	3,3743	3,894
Anger	Happy	,26829*	0,09084	,038*	0,0084	0,5282
	Sadness	-3,58537*	0,09084	,000*	-3,8453	-3,3255
	Fear	-0,10976	0,09084	0,833	-0,3697	0,1501
	Surprise	-0,08537	0,09084	0,936	-0,3453	0,1745
	Disgust	0,04878	0,09084	0,995	-0,2111	0,3087
Fear	Happy	,37805*	0,09084	,001*	0,1182	0,6379
	Sadness	-3,47561*	0,09084	,000*	-3,7355	-3,2157
	Anger	0,10976	0,09084	0,833	-0,1501	0,3697
	Surprise	0,02439	0,09084	1	-0,2355	0,2843
	Disgust	0,15854	0,09084	0,502	-0,1014	0,4184
Surprise	Happy	,35366*	0,09084	,002*	0,0938	0,6136
	Sadness	-3,50000*	0,09084	,000*	-3,7599	-3,2401
	Anger	0,08537	0,09084	0,936	-0,1745	0,3453
	Fear	-0,02439	0,09084	1	-0,2843	0,2355
	Disgust	0,13415	0,09084	0,679	-0,1257	0,394
Disgust	Happy	0,21951	0,09084	0,153	-0,0404	0,4794
	Sadness	-3,63415*	0,09084	,000*	-3,894	-3,3743
	Anger	-0,04878	0,09084	0,995	-0,3087	0,2111
	Fear	-0,15854	0,09084	0,502	-0,4184	0,1014
	Surprise	-0,13415	0,09084	0,679	-0,394	0,1257
*. The mean difference is significant at the 0.05 level.						

D3: Anger Facial Expressions (low, medium and high)

Table D3.1: Tukey post-hoc results of low intensity anger facial expression

Multiple Comparisons						
Anger Low Intensity						
Tukey HSD						
(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Happy	Sadness	-,96341*	0,13542	,000*	-1,3509	-0,576
	Anger	-2,40244*	0,13542	,000*	-2,7899	-2,015
	Fear	-,39024*	0,13542	,047*	-0,7777	-0,0028
	Surprise	-,46341*	0,13542	,009*	-0,8509	-0,076
	Disgust	-,78049*	0,13542	,000*	-1,1679	-0,393
Sadness	Happy	,96341*	0,13542	,000*	0,576	1,3509
	Anger	-1,43902*	0,13542	,000*	-1,8265	-1,0516
	Fear	,57317*	0,13542	,000*	0,1857	0,9606
	Surprise	,50000*	0,13542	,003*	0,1126	0,8874
	Disgust	0,18293	0,13542	0,756	-0,2045	0,5704
Anger	Happy	2,40244*	0,13542	,000*	2,015	2,7899
	Sadness	1,43902*	0,13542	,000*	1,0516	1,8265
	Fear	2,01220*	0,13542	,000*	1,6248	2,3996
	Surprise	1,93902*	0,13542	,000*	1,5516	2,3265
	Disgust	1,62195*	0,13542	,000*	1,2345	2,0094
Fear	Happy	,39024*	0,13542	,047*	0,0028	0,7777
	Sadness	-,57317*	0,13542	,000*	-0,9606	-0,1857
	Anger	-2,01220*	0,13542	,000*	-2,3996	-1,6248
	Surprise	-0,07317	0,13542	0,994	-0,4606	0,3143
	Disgust	-,39024*	0,13542	,047*	-0,7777	-0,0028
Surprise	Happy	,46341*	0,13542	,009*	0,076	0,8509
	Sadness	-,50000*	0,13542	,003*	-0,8874	-0,1126
	Anger	-1,93902*	0,13542	,000*	-2,3265	-1,5516
	Fear	0,07317	0,13542	0,994	-0,3143	0,4606
	Disgust	-0,31707	0,13542	0,18	-0,7045	0,0704
Disgust	Happy	,78049*	0,13542	,000*	0,393	1,1679
	Sadness	-0,18293	0,13542	0,756	-0,5704	0,2045
	Anger	-1,62195*	0,13542	,000*	-2,0094	-1,2345
	Fear	,39024*	0,13542	,047*	0,0028	0,7777
	Surprise	0,31707	0,13542	0,18	-0,0704	0,7045
*. The mean difference is significant at the 0.05 level.						

Table D3.2: Tukey post-hoc results of medium intensity anger facial expression

Multiple Comparisons						
Anger Medium Intensity						
Tukey HSD						
(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Happy	Sadness	-,51220*	0,10853	,000*	-0,8227	-0,2017
	Anger	-3,45122*	0,10853	,000*	-3,7617	-3,1407
	Fear	-0,20732	0,10853	0,397	-0,5178	0,1032
	Surprise	-0,20732	0,10853	0,397	-0,5178	0,1032
	Disgust	-,91463*	0,10853	,000*	-1,2251	-0,6041
Sadness	Happy	,51220*	0,10853	,000*	0,2017	0,8227
	Anger	-2,93902*	0,10853	,000*	-3,2495	-2,6285
	Fear	0,30488	0,10853	0,058	-0,0056	0,6154
	Surprise	0,30488	0,10853	0,058	-0,0056	0,6154
	Disgust	-,40244*	0,10853	,003*	-0,7129	-0,0919
Anger	Happy	3,45122*	0,10853	,000*	3,1407	3,7617
	Sadness	2,93902*	0,10853	,000*	2,6285	3,2495
	Fear	3,24390*	0,10853	,000*	2,9334	3,5544
	Surprise	3,24390*	0,10853	,000*	2,9334	3,5544
	Disgust	2,53659*	0,10853	,000*	2,2261	2,8471
Fear	Happy	0,20732	0,10853	0,397	-0,1032	0,5178
	Sadness	-0,30488	0,10853	0,058	-0,6154	0,0056
	Anger	-3,24390*	0,10853	,000*	-3,5544	-2,9334
	Surprise	0	0,10853	1	-0,3105	0,3105
	Disgust	-,70732*	0,10853	,000*	-1,0178	-0,3968
Surprise	Happy	0,20732	0,10853	0,397	-0,1032	0,5178
	Sadness	-0,30488	0,10853	0,058	-0,6154	0,0056
	Anger	-3,24390*	0,10853	,000*	-3,5544	-2,9334
	Fear	0	0,10853	1	-0,3105	0,3105
	Disgust	-,70732*	0,10853	,000*	-1,0178	-0,3968
Disgust	Happy	,91463*	0,10853	,000*	0,6041	1,2251
	Sadness	,40244*	0,10853	,003*	0,0919	0,7129
	Anger	-2,53659*	0,10853	,000*	-2,8471	-2,2261
	Fear	,70732*	0,10853	,000*	0,3968	1,0178
	Surprise	,70732*	0,10853	,000*	0,3968	1,0178
*. The mean difference is significant at the 0.05 level.						

Table D3.3: Tukey post-hoc results of high intensity anger facial expression

Multiple Comparisons						
Anger High Intensity						
Tukey HSD						
(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Happy	Sadness	-,90244*	0,14788	,000*	-1,3255	-0,4793
	Anger	-3,24390*	0,14788	,000*	-3,667	-2,8208
	Fear	-,47561*	0,14788	,017*	-0,8987	-0,0525
	Surprise	-,42683*	0,14788	,047*	-0,8499	-0,0037
	Disgust	-1,60976*	0,14788	,000*	-2,0329	-1,1867
Sadness	Happy	,90244*	0,14788	,000*	0,4793	1,3255
	Anger	-2,34146*	0,14788	,000*	-2,7646	-1,9184
	Fear	,42683*	0,14788	,047*	0,0037	0,8499
	Surprise	,47561*	0,14788	,017*	0,0525	0,8987
	Disgust	-,70732*	0,14788	,000*	-1,1304	-0,2842
Anger	Happy	3,24390*	0,14788	,000*	2,8208	3,667
	Sadness	2,34146*	0,14788	,000*	1,9184	2,7646
	Fear	2,76829*	0,14788	,000*	2,3452	3,1914
	Surprise	2,81707*	0,14788	,000*	2,394	3,2402
	Disgust	1,63415*	0,14788	,000*	1,211	2,0573
Fear	Happy	,47561*	0,14788	,017*	0,0525	0,8987
	Sadness	-,42683*	0,14788	,047*	-0,8499	-0,0037
	Anger	-2,76829*	0,14788	,000*	-3,1914	-2,3452
	Surprise	0,04878	0,14788	0,999	-0,3743	0,4719
	Disgust	-1,13415*	0,14788	,000*	-1,5573	-0,711
Surprise	Happy	,42683*	0,14788	,047*	0,0037	0,8499
	Sadness	-,47561*	0,14788	,017*	-0,8987	-0,0525
	Anger	-2,81707*	0,14788	,000*	-3,2402	-2,394
	Fear	-0,04878	0,14788	0,999	-0,4719	0,3743
	Disgust	-1,18293*	0,14788	,000*	-1,606	-0,7598
Disgust	Happy	1,60976*	0,14788	,000*	1,1867	2,0329
	Sadness	,70732*	0,14788	,000*	0,2842	1,1304
	Anger	-1,63415*	0,14788	,000*	-2,0573	-1,211
	Fear	1,13415*	0,14788	,000*	0,711	1,5573
	Surprise	1,18293*	0,14788	,000*	0,7598	1,606
*. The mean difference is significant at the 0.05 level.						

D4: Fear Facial Expressions (low, medium and high)

Table D4.1: Tukey post-hoc results of low intensity fear facial expression

Multiple Comparisons						
Fear Low Intensity						
Tukey HSD						
(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Happy	Sadness	-0,36585	0,13381	0,07	-0,7487	0,017
	Anger	-0,15854	0,13381	0,844	-0,5414	0,2243
	Fear	-1,90244*	0,13381	,000*	-2,2853	-1,5196
	Surprise	-2,64634*	0,13381	,000*	-3,0292	-2,2635
	Disgust	-0,15854	0,13381	0,844	-0,5414	0,2243
Sadness	Happy	0,36585	0,13381	0,07	-0,017	0,7487
	Anger	0,20732	0,13381	0,632	-0,1755	0,5902
	Fear	-1,53659*	0,13381	,000*	-1,9194	-1,1537
	Surprise	-2,28049*	0,13381	,000*	-2,6633	-1,8976
	Disgust	0,20732	0,13381	0,632	-0,1755	0,5902
Anger	Happy	0,15854	0,13381	0,844	-0,2243	0,5414
	Sadness	-0,20732	0,13381	0,632	-0,5902	0,1755
	Fear	-1,74390*	0,13381	,000*	-2,1267	-1,3611
	Surprise	-2,48780*	0,13381	,000*	-2,8706	-2,105
	Disgust	0	0,13381	1	-0,3828	0,3828
Fear	Happy	1,90244*	0,13381	,000*	1,5196	2,2853
	Sadness	1,53659*	0,13381	,000*	1,1537	1,9194
	Anger	1,74390*	0,13381	,000*	1,3611	2,1267
	Surprise	-,74390*	0,13381	,000*	-1,1267	-0,3611
	Disgust	1,74390*	0,13381	,000*	1,3611	2,1267
Surprise	Happy	2,64634*	0,13381	,000*	2,2635	3,0292
	Sadness	2,28049*	0,13381	,000*	1,8976	2,6633
	Anger	2,48780*	0,13381	,000*	2,105	2,8706
	Fear	,74390*	0,13381	,000*	0,3611	1,1267
	Disgust	2,48780*	0,13381	,000*	2,105	2,8706
Disgust	Happy	0,15854	0,13381	0,844	-0,2243	0,5414
	Sadness	-0,20732	0,13381	0,632	-0,5902	0,1755
	Anger	0	0,13381	1	-0,3828	0,3828
	Fear	-1,74390*	0,13381	,000*	-2,1267	-1,3611
	Surprise	-2,48780*	0,13381	,000*	-2,8706	-2,105
*. The mean difference is significant at the 0.05 level.						

Table D4.2: Tukey post-hoc results of medium intensity fear facial expression

Multiple Comparisons						
Fear Medium Intensity						
Tukey HSD						
(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Happy	Sadness	-0,34146	0,15753	0,255	-0,7922	0,1092
	Anger	-1,47561*	0,15753	,000*	-1,9263	-1,0249
	Fear	-1,98780*	0,15753	,000*	-2,4385	-1,5371
	Surprise	-2,24390*	0,15753	,000*	-2,6946	-1,7932
	Disgust	-0,39024	0,15753	0,133	-0,841	0,0605
Sadness	Happy	0,34146	0,15753	0,255	-0,1092	0,7922
	Anger	-1,13415*	0,15753	,000*	-1,5849	-0,6834
	Fear	-1,64634*	0,15753	,000*	-2,097	-1,1956
	Surprise	-1,90244*	0,15753	,000*	-2,3531	-1,4517
	Disgust	-0,04878	0,15753	1	-0,4995	0,4019
Anger	Happy	1,47561*	0,15753	,000*	1,0249	1,9263
	Sadness	1,13415*	0,15753	,000*	0,6834	1,5849
	Fear	-,51220*	0,15753	,015*	-0,9629	-0,0615
	Surprise	-,76829*	0,15753	,000*	-1,219	-0,3176
	Disgust	1,08537*	0,15753	,000*	0,6347	1,5361
Fear	Happy	1,98780*	0,15753	,000*	1,5371	2,4385
	Sadness	1,64634*	0,15753	,000*	1,1956	2,097
	Anger	,51220*	0,15753	,015*	0,0615	0,9629
	Surprise	-0,2561	0,15753	0,582	-0,7068	0,1946
	Disgust	1,59756*	0,15753	,000*	1,1469	2,0483
Surprise	Happy	2,24390*	0,15753	,000*	1,7932	2,6946
	Sadness	1,90244*	0,15753	,000*	1,4517	2,3531
	Anger	,76829*	0,15753	,000*	0,3176	1,219
	Fear	0,2561	0,15753	0,582	-0,1946	0,7068
	Disgust	1,85366*	0,15753	,000*	1,403	2,3044
Disgust	Happy	0,39024	0,15753	0,133	-0,0605	0,841
	Sadness	0,04878	0,15753	1	-0,4019	0,4995
	Anger	-1,08537*	0,15753	,000*	-1,5361	-0,6347
	Fear	-1,59756*	0,15753	,000*	-2,0483	-1,1469
	Surprise	-1,85366*	0,15753	,000*	-2,3044	-1,403
*. The mean difference is significant at the 0.05 level.						

Table D4.3: Tukey post-hoc results of high intensity fear facial expression

Multiple Comparisons						
Fear High Intensity						
Tukey HSD						
(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Happy	Sadness	-1,10976*	0,1554	,000*	-1,5544	-0,6651
	Anger	-,47561*	0,1554	,028*	-0,9202	-0,031
	Fear	-3,09756*	0,1554	,000*	-3,5422	-2,6529
	Surprise	-2,91463*	0,1554	,000*	-3,3593	-2,47
	Disgust	-,81707*	0,1554	,000*	-1,2617	-0,3725
Sadness	Happy	1,10976*	0,1554	,000*	0,6651	1,5544
	Anger	,63415*	0,1554	,001*	0,1895	1,0788
	Fear	-1,98780*	0,1554	,000*	-2,4324	-1,5432
	Surprise	-1,80488*	0,1554	,000*	-2,2495	-1,3603
	Disgust	0,29268	0,1554	0,414	-0,1519	0,7373
Anger	Happy	,47561*	0,1554	,028*	0,031	0,9202
	Sadness	-,63415*	0,1554	,001*	-1,0788	-0,1895
	Fear	-2,62195*	0,1554	,000*	-3,0666	-2,1773
	Surprise	-2,43902*	0,1554	,000*	-2,8836	-1,9944
	Disgust	-0,34146	0,1554	0,241	-0,7861	0,1032
Fear	Happy	3,09756*	0,1554	,000*	2,6529	3,5422
	Sadness	1,98780*	0,1554	,000*	1,5432	2,4324
	Anger	2,62195*	0,1554	,000*	2,1773	3,0666
	Surprise	0,18293	0,1554	0,848	-0,2617	0,6275
	Disgust	2,28049*	0,1554	,000*	1,8359	2,7251
Surprise	Happy	2,91463*	0,1554	,000*	2,47	3,3593
	Sadness	1,80488*	0,1554	,000*	1,3603	2,2495
	Anger	2,43902*	0,1554	,000*	1,9944	2,8836
	Fear	-0,18293	0,1554	0,848	-0,6275	0,2617
	Disgust	2,09756*	0,1554	,000*	1,6529	2,5422
Disgust	Happy	,81707*	0,1554	,000*	0,3725	1,2617
	Sadness	-0,29268	0,1554	0,414	-0,7373	0,1519
	Anger	0,34146	0,1554	0,241	-0,1032	0,7861
	Fear	-2,28049*	0,1554	,000*	-2,7251	-1,8359
	Surprise	-2,09756*	0,1554	,000*	-2,5422	-1,6529
*. The mean difference is significant at the 0.05 level.						

D5: Surprise Facial Expressions (low, medium and high)

Table D5.1: Tukey post-hoc results of low intensity surprise facial expression

Multiple Comparisons						
Surprise Low Intensity						
Tukey HSD						
(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Happy	Sadness	-0,14634	0,12055	0,83	-0,4912	0,1986
	Anger	0,12195	0,12055	0,914	-0,2229	0,4668
	Fear	-1,86585*	0,12055	,000*	-2,2107	-1,521
	Surprise	-3,28049*	0,12055	,000*	-3,6254	-2,9356
	Disgust	0,03659	0,12055	1	-0,3083	0,3815
Sadness	Happy	0,14634	0,12055	0,83	-0,1986	0,4912
	Anger	0,26829	0,12055	0,228	-0,0766	0,6132
	Fear	-1,71951*	0,12055	,000*	-2,0644	-1,3746
	Surprise	-3,13415*	0,12055	,000*	-3,479	-2,7893
	Disgust	0,18293	0,12055	0,653	-0,162	0,5278
Anger	Happy	-0,12195	0,12055	0,914	-0,4668	0,2229
	Sadness	-0,26829	0,12055	0,228	-0,6132	0,0766
	Fear	-1,98780*	0,12055	,000*	-2,3327	-1,6429
	Surprise	-3,40244*	0,12055	,000*	-3,7473	-3,0575
	Disgust	-0,08537	0,12055	0,981	-0,4303	0,2595
Fear	Happy	1,86585*	0,12055	,000*	1,521	2,2107
	Sadness	1,71951*	0,12055	,000*	1,3746	2,0644
	Anger	1,98780*	0,12055	,000*	1,6429	2,3327
	Surprise	-1,41463*	0,12055	,000*	-1,7595	-1,0697
	Disgust	1,90244*	0,12055	,000*	1,5575	2,2473
Surprise	Happy	3,28049*	0,12055	,000*	2,9356	3,6254
	Sadness	3,13415*	0,12055	,000*	2,7893	3,479
	Anger	3,40244*	0,12055	,000*	3,0575	3,7473
	Fear	1,41463*	0,12055	,000*	1,0697	1,7595
	Disgust	3,31707*	0,12055	,000*	2,9722	3,662
Disgust	Happy	-0,03659	0,12055	1	-0,3815	0,3083
	Sadness	-0,18293	0,12055	0,653	-0,5278	0,162
	Anger	0,08537	0,12055	0,981	-0,2595	0,4303
	Fear	-1,90244*	0,12055	,000*	-2,2473	-1,5575
	Surprise	-3,31707*	0,12055	,000*	-3,662	-2,9722
*. The mean difference is significant at the 0.05 level.						

Table D5.2: Tukey post-hoc results of medium intensity surprise facial expression

Multiple Comparisons						
Surprise Medium Intensity						
Tukey HSD						
(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Happy	Sadness	,75610*	0,12086	,000*	0,4103	1,1019
	Anger	,82927*	0,12086	,000*	0,4835	1,1751
	Fear	-0,21951	0,12086	0,456	-0,5653	0,1263
	Surprise	-2,73171*	0,12086	,000*	-3,0775	-2,3859
	Disgust	,75610*	0,12086	,000*	0,4103	1,1019
Sadness	Happy	-,75610*	0,12086	,000*	-1,1019	-0,4103
	Anger	0,07317	0,12086	0,991	-0,2726	0,419
	Fear	-,97561*	0,12086	,000*	-1,3214	-0,6298
	Surprise	-3,48780*	0,12086	,000*	-3,8336	-3,142
	Disgust	0	0,12086	1	-0,3458	0,3458
Anger	Happy	-,82927*	0,12086	,000*	-1,1751	-0,4835
	Sadness	-0,07317	0,12086	0,991	-0,419	0,2726
	Fear	-1,04878*	0,12086	,000*	-1,3946	-0,703
	Surprise	-3,56098*	0,12086	,000*	-3,9068	-3,2152
	Disgust	-0,07317	0,12086	0,991	-0,419	0,2726
Fear	Happy	0,21951	0,12086	0,456	-0,1263	0,5653
	Sadness	,97561*	0,12086	,000*	0,6298	1,3214
	Anger	1,04878*	0,12086	,000*	0,703	1,3946
	Surprise	-2,51220*	0,12086	,000*	-2,858	-2,1664
	Disgust	,97561*	0,12086	,000*	0,6298	1,3214
Surprise	Happy	2,73171*	0,12086	,000*	2,3859	3,0775
	Sadness	3,48780*	0,12086	,000*	3,142	3,8336
	Anger	3,56098*	0,12086	,000*	3,2152	3,9068
	Fear	2,51220*	0,12086	,000*	2,1664	2,858
	Disgust	3,48780*	0,12086	,000*	3,142	3,8336
Disgust	Happy	-,75610*	0,12086	,000*	-1,1019	-0,4103
	Sadness	0	0,12086	1	-0,3458	0,3458
	Anger	0,07317	0,12086	0,991	-0,2726	0,419
	Fear	-,97561*	0,12086	,000*	-1,3214	-0,6298
	Surprise	-3,48780*	0,12086	,000*	-3,8336	-3,142
*. The mean difference is significant at the 0.05 level.						

Table D5.3: Tukey post-hoc results of high intensity surprise facial expression

Multiple Comparisons						
Surprise High Intensity						
Tukey HSD						
(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Hap	Sadness	,43902*	0,12523	,007*	0,0807	0,7973
	Anger	,46341*	0,12523	,003*	0,1051	0,8217
	Fear	-1,35366*	0,12523	,000*	-1,712	-0,9954
	Surprise	-3,19512*	0,12523	,000*	-3,5534	-2,8368
	Disgust	,43902*	0,12523	,007*	0,0807	0,7973
Sadness	Hap	-,43902*	0,12523	,007*	-0,7973	-0,0807
	Anger	0,02439	0,12523	1	-0,3339	0,3827
	Fear	-1,79268*	0,12523	,000*	-2,151	-1,4344
	Surprise	-3,63415*	0,12523	,000*	-3,9925	-3,2758
	Disgust	0	0,12523	1	-0,3583	0,3583
Anger	Hap	-,46341*	0,12523	,003*	-0,8217	-0,1051
	Sadness	-0,02439	0,12523	1	-0,3827	0,3339
	Fear	-1,81707*	0,12523	,000*	-2,1754	-1,4588
	Surprise	-3,65854*	0,12523	,000*	-4,0168	-3,3002
	Disgust	-0,02439	0,12523	1	-0,3827	0,3339
Fear	Hap	1,35366*	0,12523	,000*	0,9954	1,712
	Sadness	1,79268*	0,12523	,000*	1,4344	2,151
	Anger	1,81707*	0,12523	,000*	1,4588	2,1754
	Surprise	-1,84146*	0,12523	,000*	-2,1998	-1,4832
	Disgust	1,79268*	0,12523	,000*	1,4344	2,151
Surprise	Hap	3,19512*	0,12523	,000*	2,8368	3,5534
	Sadness	3,63415*	0,12523	,000*	3,2758	3,9925
	Anger	3,65854*	0,12523	,000*	3,3002	4,0168
	Fear	1,84146*	0,12523	,000*	1,4832	2,1998
	Disgust	3,63415*	0,12523	,000*	3,2758	3,9925
Disgust	Hap	-,43902*	0,12523	,007*	-0,7973	-0,0807
	Sadness	0	0,12523	1	-0,3583	0,3583
	Anger	0,02439	0,12523	1	-0,3339	0,3827
	Fear	-1,79268*	0,12523	,000*	-2,151	-1,4344
	Surprise	-3,63415*	0,12523	,000*	-3,9925	-3,2758
*. The mean difference is significant at the 0.05 level.						

D6: Disgust Facial Expressions (low, medium and high)

Table D6.1: Tukey post-hoc results of low intensity disgust facial expression

Multiple Comparisons						
Disgust Low Intensity						
Tukey HSD						
(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Happy	Sadness	-1,09756*	0,13444	,000*	-1,4822	-0,7129
	Anger	-,51220*	0,13444	,002*	-0,8969	-0,1275
	Fear	-0,12195	0,13444	0,945	-0,5066	0,2627
	Surprise	-0,09756	0,13444	0,979	-0,4822	0,2871
	Disgust	-1,41463*	0,13444	,000*	-1,7993	-1,03
Sadness	Happy	1,09756*	0,13444	,000*	0,7129	1,4822
	Anger	,58537*	0,13444	,000*	0,2007	0,97
	Fear	,97561*	0,13444	,000*	0,5909	1,3603
	Surprise	1,00000*	0,13444	,000*	0,6153	1,3847
	Disgust	-0,31707	0,13444	0,173	-0,7017	0,0676
Anger	Happy	,51220*	0,13444	,002*	0,1275	0,8969
	Sadness	-,58537*	0,13444	,000*	-0,97	-0,2007
	Fear	,39024*	0,13444	,045*	0,0056	0,7749
	Surprise	,41463*	0,13444	,026*	0,03	0,7993
	Disgust	-,90244*	0,13444	,000*	-1,2871	-0,5178
Fear	Happy	0,12195	0,13444	0,945	-0,2627	0,5066
	Sadness	-,97561*	0,13444	,000*	-1,3603	-0,5909
	Anger	-,39024*	0,13444	0,045	-0,7749	-0,0056
	Surprise	0,02439	0,13444	1	-0,3603	0,4091
	Disgust	-1,29268*	0,13444	,000*	-1,6773	-0,908
Surprise	Happy	0,09756	0,13444	0,979	-0,2871	0,4822
	Sadness	-1,00000*	0,13444	,000*	-1,3847	-0,6153
	Anger	-,41463*	0,13444	,026*	-0,7993	-0,03
	Fear	-0,02439	0,13444	1	-0,4091	0,3603
	Disgust	-1,31707*	0,13444	,000*	-1,7017	-0,9324
Disgust	Happy	1,41463*	0,13444	,000*	1,03	1,7993
	Sadness	0,31707	0,13444	0,173	-0,0676	0,7017
	Anger	,90244*	0,13444	,000*	0,5178	1,2871
	Fear	1,29268*	0,13444	,000*	0,908	1,6773
	Surprise	1,31707*	0,13444	,000*	0,9324	1,7017
*. The mean difference is significant at the 0.05 level.						

Table D6.2: Tukey post-hoc results of medium intensity disgust facial expression

Multiple Comparisons						
Disgust Medium Intensity						
Tukey HSD						
(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Happy	Sadness	-1,40244*	0,14913	,000*	-1,8291	-0,9758
	Anger	-1,13415*	0,14913	,000*	-1,5608	-0,7075
	Fear	-,42683*	0,14913	0,05	-0,8535	-0,0002
	Surprise	-,51220*	0,14913	,008*	-0,9389	-0,0855
	Disgust	-3,18293*	0,14913	,000*	-3,6096	-2,7563
Sadness	Happy	1,40244*	0,14913	,000*	0,9758	1,8291
	Anger	0,26829	0,14913	0,467	-0,1584	0,695
	Fear	,97561*	0,14913	,000*	0,5489	1,4023
	Surprise	,89024*	0,14913	,000*	0,4636	1,3169
	Disgust	-1,78049*	0,14913	,000*	-2,2072	-1,3538
Anger	Happy	1,13415*	0,14913	,000*	0,7075	1,5608
	Sadness	-0,26829	0,14913	0,467	-0,695	0,1584
	Fear	,70732*	0,14913	,000*	0,2807	1,134
	Surprise	,62195*	0,14913	,001*	0,1953	1,0486
	Disgust	-2,04878*	0,14913	,000*	-2,4754	-1,6221
Fear	Happy	,42683*	0,14913	0,05	0,0002	0,8535
	Sadness	-,97561*	0,14913	,000*	-1,4023	-0,5489
	Anger	-,70732*	0,14913	,000*	-1,134	-0,2807
	Surprise	-0,08537	0,14913	0,993	-0,512	0,3413
	Disgust	-2,75610*	0,14913	,000*	-3,1828	-2,3294
Surprise	Happy	,51220*	0,14913	,008*	0,0855	0,9389
	Sadness	-,89024*	0,14913	,000*	-1,3169	-0,4636
	Anger	-,62195*	0,14913	,001*	-1,0486	-0,1953
	Fear	0,08537	0,14913	0,993	-0,3413	0,512
	Disgust	-2,67073*	0,14913	,000*	-3,0974	-2,2441
Disgust	Happy	3,18293*	0,14913	,000*	2,7563	3,6096
	Sadness	1,78049*	0,14913	,000*	1,3538	2,2072
	Anger	2,04878*	0,14913	,000*	1,6221	2,4754
	Fear	2,75610*	0,14913	,000*	2,3294	3,1828
	Surprise	2,67073*	0,14913	,000*	2,2441	3,0974
*. The mean difference is significant at the 0.05 level.						

Table D6.3: Tukey post-hoc results of high intensity disgust facial expression

Multiple Comparisons						
Disgust High Intensity						
Tukey HSD						
(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Happy	Sadness	-2,10976*	0,15261	,000*	-2,5464	-1,6731
	Anger	-,80488*	0,15261	,000*	-1,2415	-0,3683
	Fear	-,48780*	0,15261	0,018	-0,9244	-0,0512
	Surprise	-0,40244	0,15261	0,09	-0,8391	0,0342
	Disgust	-3,24390*	0,15261	,000*	-3,6805	-2,8073
Sadness	Happy	2,10976*	0,15261	,000*	1,6731	2,5464
	Anger	1,30488*	0,15261	,000*	0,8683	1,7415
	Fear	1,62195*	0,15261	,000*	1,1853	2,0586
	Surprise	1,70732*	0,15261	,000*	1,2707	2,1439
	Disgust	-1,13415*	0,15261	,000*	-1,5708	-0,6975
Anger	Happy	,80488*	0,15261	,000*	0,3683	1,2415
	Sadness	-1,30488*	0,15261	,000*	-1,7415	-0,8683
	Fear	0,31707	0,15261	0,301	-0,1196	0,7537
	Surprise	0,40244	0,15261	0,09	-0,0342	0,8391
	Disgust	-2,43902*	0,15261	,000*	-2,8756	-2,0024
Fear	Happy	,48780*	0,15261	0,018	0,0512	0,9244
	Sadness	-1,62195*	0,15261	,000*	-2,0586	-1,1853
	Anger	-0,31707	0,15261	0,301	-0,7537	0,1196
	Surprise	0,08537	0,15261	0,994	-0,3513	0,522
	Disgust	-2,75610*	0,15261	,000*	-3,1927	-2,3195
Surprise	Happy	0,40244	0,15261	0,09	-0,0342	0,8391
	Sadness	-1,70732*	0,15261	,000*	-2,1439	-1,2707
	Anger	-0,40244	0,15261	0,09	-0,8391	0,0342
	Fear	-0,08537	0,15261	0,994	-0,522	0,3513
	Disgust	-2,84146*	0,15261	,000*	-3,2781	-2,4048
Disgust	Happy	3,24390*	0,15261	,000*	2,8073	3,6805
	Sadness	1,13415*	0,15261	,000*	0,6975	1,5708
	Anger	2,43902*	0,15261	,000*	2,0024	2,8756
	Fear	2,75610*	0,15261	,000*	2,3195	3,1927
	Surprise	2,84146*	0,15261	,000*	2,4048	3,2781
*. The mean difference is significant at the 0.05 level.						

D7: Readjusted Fear Facial Expressions (low, medium and high)

Table D7.1: Tukey post-hoc results of low intensity readjusted fear facial expression

Multiple Comparisons						
Readjusted Fear Low Intensity						
Tukey HSD						
(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Happy	Sadness	-0,21951	0,20206	0,886	-0,8	0,361
	Anger	-,78049*	0,20206	,002*	-1,361	-0,2
	Fear	-1,85366*	0,20206	,000*	-2,4342	-1,2732
	Surprise	-2,41463*	0,20206	,000*	-2,9951	-1,8341
	Disgust	-0,09756	0,20206	0,997	-0,6781	0,4829
Sadness	Happy	0,21951	0,20206	0,886	-0,361	0,8
	Anger	-0,56098	0,20206	0,065	-1,1415	0,0195
	Fear	-1,63415*	0,20206	,000*	-2,2146	-1,0536
	Surprise	-2,19512*	0,20206	,000*	-2,7756	-1,6146
	Disgust	0,12195	0,20206	0,991	-0,4585	0,7025
Anger	Happy	,78049*	0,20206	,002*	0,2	1,361
	Sadness	0,56098	0,20206	0,065	-0,0195	1,1415
	Fear	-1,07317*	0,20206	,000*	-1,6537	-0,4927
	Surprise	-1,63415*	0,20206	,000*	-2,2146	-1,0536
	Disgust	,68293*	0,20206	0,011	0,1024	1,2634
Fear	Happy	1,85366*	0,20206	,000*	1,2732	2,4342
	Sadness	1,63415*	0,20206	,000*	1,0536	2,2146
	Anger	1,07317*	0,20206	,000*	0,4927	1,6537
	Surprise	-0,56098	0,20206	0,065	-1,1415	0,0195
	Disgust	1,75610*	0,20206	,000*	1,1756	2,3366
Surprise	Happy	2,41463*	0,20206	,000*	1,8341	2,9951
	Sadness	2,19512*	0,20206	,000*	1,6146	2,7756
	Anger	1,63415*	0,20206	,000*	1,0536	2,2146
	Fear	0,56098	0,20206	0,065	-0,0195	1,1415
	Disgust	2,31707*	0,20206	,000*	1,7366	2,8976
Disgust	Happy	0,09756	0,20206	0,997	-0,4829	0,6781
	Sadness	-0,12195	0,20206	0,991	-0,7025	0,4585
	Anger	-,68293*	0,20206	,011*	-1,2634	-0,1024
	Fear	-1,75610*	0,20206	,000*	-2,3366	-1,1756
	Surprise	-2,31707*	0,20206	,000*	-2,8976	-1,7366
*. The mean difference is significant at the 0.05 level.						

Table D7.2: Tukey post-hoc results of medium intensity readjusted fear facial expression

Multiple Comparisons						
Readjusted Fear Medium Intensity						
Tukey HSD						
(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Happy	Sadness	-,97561*	0,19697	,000*	-1,5415	-0,4097
	Anger	-1,43902*	0,19697	,000*	-2,0049	-0,8732
	Fear	-2,82927*	0,19697	,000*	-3,3951	-2,2634
	Surprise	-2,85366*	0,19697	,000*	-3,4195	-2,2878
	Disgust	-0,43902	0,19697	0,228	-1,0049	0,1268
Sadness	Happy	,97561*	0,19697	,000*	0,4097	1,5415
	Anger	-0,46341	0,19697	0,177	-1,0293	0,1025
	Fear	-1,85366*	0,19697	,000*	-2,4195	-1,2878
	Surprise	-1,87805*	0,19697	,000*	-2,4439	-1,3122
	Disgust	0,53659	0,19697	0,074	-0,0293	1,1025
Anger	Happy	1,43902*	0,19697	,000*	0,8732	2,0049
	Sadness	0,46341	0,19697	0,177	-0,1025	1,0293
	Fear	-1,39024*	0,19697	,000*	-1,9561	-0,8244
	Surprise	-1,41463*	0,19697	,000*	-1,9805	-0,8488
	Disgust	1,00000*	0,19697	,000*	0,4341	1,5659
Fear	Happy	2,82927*	0,19697	,000*	2,2634	3,3951
	Sadness	1,85366*	0,19697	,000*	1,2878	2,4195
	Anger	1,39024*	0,19697	,000*	0,8244	1,9561
	Surprise	-0,02439	0,19697	1	-0,5903	0,5415
	Disgust	2,39024*	0,19697	,000*	1,8244	2,9561
Surprise	Happy	2,85366*	0,19697	,000*	2,2878	3,4195
	Sadness	1,87805*	0,19697	,000*	1,3122	2,4439
	Anger	1,41463*	0,19697	,000*	0,8488	1,9805
	Fear	0,02439	0,19697	1	-0,5415	0,5903
	Disgust	2,41463*	0,19697	,000*	1,8488	2,9805
Disgust	Happy	0,43902	0,19697	0,228	-0,1268	1,0049
	Sadness	-0,53659	0,19697	0,074	-1,1025	0,0293
	Anger	-1,00000*	0,19697	,000*	-1,5659	-0,4341
	Fear	-2,39024*	0,19697	,000*	-2,9561	-1,8244
	Surprise	-2,41463*	0,19697	,000*	-2,9805	-1,8488
*. The mean difference is significant at the 0.05 level.						

Table D7.3: Tukey post-hoc results of high intensity readjusted fear facial expression

Multiple Comparisons						
Readjusted Fear High Intensity						
Tukey HSD						
(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Happy	Sadness	-1,29268*	0,23904	,000*	-1,9794	-0,606
	Anger	-1,19512*	0,23904	,000*	-1,8818	-0,5084
	Fear	-3,00000*	0,23904	,000*	-3,6867	-2,3133
	Surprise	-2,46341*	0,23904	,000*	-3,1501	-1,7767
	Disgust	-1,00000*	0,23904	,001*	-1,6867	-0,3133
Sadness	Happy	1,29268*	0,23904	,000*	0,606	1,9794
	Anger	0,09756	0,23904	0,999	-0,5892	0,7843
	Fear	-1,70732*	0,23904	,000*	-2,394	-1,0206
	Surprise	-1,17073*	0,23904	,000*	-1,8575	-0,484
	Disgust	0,29268	0,23904	0,825	-0,394	0,9794
Anger	Happy	1,19512*	0,23904	,000*	0,5084	1,8818
	Sadness	-0,09756	0,23904	0,999	-0,7843	0,5892
	Fear	-1,80488*	0,23904	,000*	-2,4916	-1,1182
	Surprise	-1,26829*	0,23904	,000*	-1,955	-0,5816
	Disgust	0,19512	0,23904	0,964	-0,4916	0,8818
Fear	Happy	3,00000*	0,23904	,000*	2,3133	3,6867
	Sadness	1,70732*	0,23904	,000*	1,0206	2,394
	Anger	1,80488*	0,23904	,000*	1,1182	2,4916
	Surprise	0,53659	0,23904	0,221	-0,1501	1,2233
	Disgust	2,00000*	0,23904	,000*	1,3133	2,6867
Surprise	Happy	2,46341*	0,23904	,000*	1,7767	3,1501
	Sadness	1,17073*	0,23904	,000*	0,484	1,8575
	Anger	1,26829*	0,23904	,000*	0,5816	1,955
	Fear	-0,53659	0,23904	0,221	-1,2233	0,1501
	Disgust	1,46341*	0,23904	,000*	0,7767	2,1501
Disgust	Happy	1,00000*	0,23904	,001*	0,3133	1,6867
	Sadness	-0,29268	0,23904	0,825	-0,9794	0,394
	Anger	-0,19512	0,23904	0,964	-0,8818	0,4916
	Fear	-2,00000*	0,23904	,000*	-2,6867	-1,3133
	Surprise	-1,46341*	0,23904	,000*	-2,1501	-0,7767
*. The mean difference is significant at the 0.05 level.						

APPENDIX E

TUKEY POST-HOC RESULTS OF THE DIFFERENT INTENSITIES FOR EMOTIONAL FACIAL EXPRESSION FOR THE FIRST STUDY

E1: Happy Facial Expressions

Table E1.1: Tukey post-hoc results of the different intensities for happy facial expressions

Multiple Comparisons							
Tukey HSD							
	(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Happy	Low	Medium	-0,0723	0,15736	0,89	-0,4433	0,2988
		High	-,45783*	0,15736	0,011*	-0,8289	-0,0868
	Medium	Low	0,07229	0,15736	0,89	-0,2988	0,4433
		High	-,38554*	0,15736	0,04*	-0,7566	-0,0145
	High	Low	,45783*	0,15736	0,011*	0,0868	0,8289
		Medium	,38554*	0,15736	0,04*	0,0145	0,7566
*. The mean difference is significant at the 0.05 level.							

E2: Sadness Facial Expressions

Table E2.1: Tukey post-hoc results of the different intensities for sadness facial expressions

Multiple Comparisons							
Tukey HSD							
			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Sadness	Low	Medium	0,02439	0,08714	0,958	-0,1811	0,2299
		High	-,24390*	0,08714	0,015*	-0,4494	-0,0384
	Medium	Low	-0,0244	0,08714	0,958	-0,2299	0,1811
		High	-,26829*	0,08714	0,007*	-0,4738	-0,0628
	High	Low	,24390*	0,08714	0,015*	0,0384	0,4494
		Medium	,26829*	0,08714	0,007*	0,0628	0,4738
*. The mean difference is significant at the 0.05 level.							

E3 : Anger Facial Expressions

Table E3.1: Tukey post-hoc results of the different intensities for anger facial expressions

Multiple Comparisons							
Tukey HSD							
			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Anger	Low	Medium	-1,0243	0,16257	0,000*	-1,4078	-0,641
		High	-,82927*	0,16257	0,000*	-1,2126	-0,4459
	Medium	Low	1,02439*	0,16257	0,000*	0,641	1,4078
		High	0,19512	0,16257	0,454	-0,1882	0,5785
	High	Low	,82927*	0,16257	0,000*	0,4459	1,2126
		Medium	-0,1951	0,16257	0,454	-0,5785	0,1882
*. The mean difference is significant at the 0.05 level.							

E4: Fear Facial Expressions

Table E4.1: Tukey post-hoc results of the different intensities for fear facial expressions

Multiple Comparisons							
Tukey HSD							
			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Fear	Low	Medium	0,03659	0,18373	0,978	-0,3967	0,4699
		High	-1,08537*	0,18373	0,000*	-1,5186	-0,6521
	Medium	Low	-0,0366	0,18373	0,978	-0,4699	0,3967
		High	-1,12195*	0,18373	0,000*	-1,5552	-0,6887
	High	Low	1,08537*	0,18373	0,000*	0,6521	1,5186
		Medium	1,12195*	0,18373	0,000*	0,6887	1,5552
*. The mean difference is significant at the 0.05 level.							

E5 : Surprise Facial Expressions

Table E5.1: Tukey post-hoc results of the different intensities for surprise facial expressions

Multiple Comparisons							
Tukey HSD							
			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Surprise	Low	Medium	-0,0244	0,10703	0,972	-0,2768	0,228
		High	-0,1585	0,10703	0,302	-0,4109	0,0938
	Medium	Low	0,02439	0,10703	0,972	-0,228	0,2768
		High	-0,1342	0,10703	0,423	-0,3865	0,1182
	High	Low	0,15854	0,10703	0,302	-0,0938	0,4109
		Medium	0,13415	0,10703	0,423	-0,1182	0,3865
*. The mean difference is significant at the 0.05 level.							

E6: Disgust Facial Expressions

Table E6.1: Tukey post-hoc results of the different intensities for disgust facial expressions

Multiple Comparisons							
Tukey HSD							
			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Disgust	Low	Medium	-1,58537*	0,18099	0	-2,0122	-1,1586
		High	-1,63415*	0,18099	0	-2,061	-1,2073
	Medium	Low	1,58537*	0,18099	0	1,1586	2,0122
		High	-0,0488	0,18099	0,961	-0,4756	0,378
	High	Low	1,63415*	0,18099	0	1,2073	2,061
		Medium	0,04878	0,18099	0,961	-0,378	0,4756
*. The mean difference is significant at the 0.05 level.							

E7: Readjusted Fear Facial Expressions

Table E7.1: Tukey post-hoc results of the different intensities for readjusted fear facial expressions

Multiple Comparisons							
Tukey HSD							
			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Fear	Low	Medium	-,70732*	0,23186	0,008	-1,2575	-0,1571
		High	-,85366*	0,23186	0,001	-1,4039	-0,3034
	Medium	Low	,70732*	0,23186	0,008	0,1571	1,2575
		High	-0,1463	0,23186	0,803	-0,6966	0,4039
	High	Low	,85366*	0,23186	0,001	0,3034	1,4039
		Medium	0,14634	0,23186	0,803	-0,4039	0,6966
*. The mean difference is significant at the 0.05 level.							

APPENDIX F (a)

THE PAPER VERSION OF THE ONLINE QUESTIONNAIRE OF THE RECOGNITION OF THE READJUSTED FEAR FACIAL EXPRESSION (In Turkish)

GİRİŞ

Bu çalışma Orta Doğu Teknik Üniversitesi, Mimarlık Fakültesi, Endüstri Ürünleri Tasarımı bölümünde yürütülen 'ETKİLEŞİMLİ DİJİTAL GÖREVLERDE KULLANILAN SANAL KARAKTERLERİN DUYGUSAL YÜZ İFADELERİNİN İNSANLARIN PERFORMANSI ÜZERİNDEKİ ETKİSİ' konulu yüksek lisans tezi çalışması için kullanılacaktır. Bu çalışmada insanların belirli duygusal yüz ifadelerini hangi yoğunlukta algıladığını araştırıyorum.

Bu araştırmam için sizden aşağıdaki çalışmayı doldurmanızı istiyorum.

Bu çalışma yaklaşık olarak **2 dakikanızı** alacaktır.

Çalışmama yardımcı olduğunuz için çok teşekkür ederim.

Alper Karadoğaner

Bu çalışmada size 3 adet duygusal yüz ifadeleri verilecektir. Sizden bu 3 duygusal yüz ifadelerinin her biri için karakterin hangi duygusal ifadeyi ne kadar iyi yansıttığına göre 1'den 5'e kadar değerlendirmenizi istiyoruz. Eğer karakterin bir duygusal yüz ifadesini çok iyi yansıttığını düşünüyorsanız 5 puan; eğer hiç yansıtmadığını düşünüyorsanız 1 puan verebilirsiniz. Örnek olarak, eğer karakterin duygusal yüz ifadesinin çok iyi derecede mutluluk, az derecede üzgünlük ve orta derecede kızgınlık ifadesini yansıttığını düşünüyorsanız, mutluluk için 5 puan, üzgün için 2 puan, kızgınlık için 3 puan ve diğer ifadeler için 1 puan vererek değerlendirebilirsiniz.

Çalışmaya başlamadan önce, bu çalışmada doğru veya yanlış cevap olmadığını ve çalışmanın amacının karakterin duygusal ifadeleri ne kadar iyi yansıtıp yansıtmadığını öğrenmek olduğunu belirtmek isteriz.

Anket

Sağdaki kutuyu 'X' ile işaretleyiniz.

Yaş: ....
Cinsiyet: ☐ **Erkek** ☐ **Kadın**

Table F1.1: The facial expressions used in the online questionnaire

	Hiç 1	2	orta 3	çok iyi 4	5
MUTLU	[ ]	[ ]	[ ]	[ ]	[ ]
ÜZGÜN	[ ]	[ ]	[ ]	[ ]	[ ]
KIZGIN	[ ]	[ ]	[ ]	[ ]	[ ]
KORKU	[ ]	[ ]	[ ]	[ ]	[ ]
ŞAŞIRMA	[ ]	[ ]	[ ]	[ ]	[ ]
İĞRENME	[ ]	[ ]	[ ]	[ ]	[ ]

	Hiç 1	2	orta 3	çok iyi 4	5
MUTLU	[ ]	[ ]	[ ]	[ ]	[ ]
ÜZGÜN	[ ]	[ ]	[ ]	[ ]	[ ]
KIZGIN	[ ]	[ ]	[ ]	[ ]	[ ]
KORKU	[ ]	[ ]	[ ]	[ ]	[ ]
ŞAŞIRMA	[ ]	[ ]	[ ]	[ ]	[ ]
İĞRENME	[ ]	[ ]	[ ]	[ ]	[ ]

	Hiç 1	2	orta 3	çok iyi 4	5
MUTLU	[ ]	[ ]	[ ]	[ ]	[ ]
ÜZGÜN	[ ]	[ ]	[ ]	[ ]	[ ]
KIZGIN	[ ]	[ ]	[ ]	[ ]	[ ]
KORKU	[ ]	[ ]	[ ]	[ ]	[ ]
ŞAŞIRMA	[ ]	[ ]	[ ]	[ ]	[ ]
İĞRENME	[ ]	[ ]	[ ]	[ ]	[ ]

APPENDIX F (b)

THE PAPER VERSION OF THE ONLINE QUESTIONNAIRE OF THE RECOGNITION OF THE READJUSTED FEAR FACIAL EXPRESSION (In English)

Introduction

For the master thesis, the effect of emotional facial expressions on people's performance, I am conducting a study to find out the perceived intensity of people in response to the emotion specific facial expression in the Department of Industrial Design at the faculty of Architecture at the Middle East Technical University.

In order to investigate the perceived intensity of facial expressions, I would like to ask you to fill in this study.

It will take you about **2 minutes**.

Thank you very much for helping me!

Alper Karadoğaner

We want you to rate each 3 facial expressions according to how well the character expresses specific emotions. You have to rate the expressions on a scale of 1 to 5 for each of the six emotions. 1 means no expression of this emotion, 5 means a very good expression of this emotion. So, if you find the stimulus face express happiness very well, sadness poorly, anger moderate, etc.; rate 5 for happiness, 2 for sadness, 3 for anger.

Before starting the survey, we would like to remember you that there is no right or wrong answer in this survey. Our aim is to investigate how well you recognize emotional facial expressions.

Questionnaire

Put an X in the right box.

Age: ....
Gender: ☐ **Male** ☐ **Female**

Table F2.1: The facial expressions used in the online questionnaire

	slightly 1	2	3	extremely 4	5
HAPPY	[ ]	[ ]	[ ]	[ ]	[ ]
SADNESS	[ ]	[ ]	[ ]	[ ]	[ ]
ANGER	[ ]	[ ]	[ ]	[ ]	[ ]
FEAR	[ ]	[ ]	[ ]	[ ]	[ ]
SURPRISE	[ ]	[ ]	[ ]	[ ]	[ ]
DISGUST	[ ]	[ ]	[ ]	[ ]	[ ]

	slightly 1	2	3	extremely 4	5
HAPPY	[ ]	[ ]	[ ]	[ ]	[ ]
SADNESS	[ ]	[ ]	[ ]	[ ]	[ ]
ANGER	[ ]	[ ]	[ ]	[ ]	[ ]
FEAR	[ ]	[ ]	[ ]	[ ]	[ ]
SURPRISE	[ ]	[ ]	[ ]	[ ]	[ ]
DISGUST	[ ]	[ ]	[ ]	[ ]	[ ]

	slightly 1	2	3	extremely 4	5
HAPPY	[ ]	[ ]	[ ]	[ ]	[ ]
SADNESS	[ ]	[ ]	[ ]	[ ]	[ ]
ANGER	[ ]	[ ]	[ ]	[ ]	[ ]
FEAR	[ ]	[ ]	[ ]	[ ]	[ ]
SURPRISE	[ ]	[ ]	[ ]	[ ]	[ ]
DISGUST	[ ]	[ ]	[ ]	[ ]	[ ]

APPENDIX G (a)

POST EXPERIMENT QUESTIONNAIRE FOR THE SECOND STUDY (In Turkish)

Anket

Yaş: **.....**

Cinsiyet:
☐ **Kadın**
☐ **Erkek**

Eğitim:
☐ **Lise**
☐ **Üniversite**
☐ **Yüksek Lisans**
☐ **Doktora**

1. Sanal odada gezinmeyi ne kadar zor buldunuz?

Çok kolay	**kolay**	**normal**	**zor**	**çok zor**
☐ **1**	☐ **2**	☐ **3**	☐ **4**	☐ **5**

2. Ne kadar sıklıkla bilgisayar oyunları oynarsınız?

☐ **hiç**
☐ **nadiren**
☐ **sık sık**
☐ **genelde**
☐ **her zaman**

3. Ne tür oyunlar oynarsınız?

_____

4. Kendinizi nasıl bir oyuncu olarak tanımlarsınız?

Çok kötü	**kötü**	**normal**	**iyi**	**çok iyi**
☐ **1**	☐ **2**	☐ **3**	☐ **4**	☐ **5**

‘Duygusal Yüz İfadelerinin Algısı’ Anketi

Sizden bu 3 duygusal yüz ifadelerinin her biri için karakterin hangi duygusal ifadeyi ne kadar iyi yansıttığına göre 1’den 5’e kadar değerlendirmenizi istiyoruz. Eğer karakterin bir duygusal yüz ifadesini çok iyi yansıttığını düşünüyorsanız 5 puan; eğer hiç yansıtmadığını düşünüyorsanız 1 puan verebilirsiniz. Örnek olarak, eğer karakterin duygusal yüz ifadesinin çok iyi derecede mutluluk, az derecede üzgünlük ve orta derecede kızgınlık ifadesini yansıttığını düşünüyorsanız, mutluluk için 5 puan, üzgün için 2 puan, kızgınlık için 3 puan ve diğer ifadeler için 1 puan vererek değerlendirebilirsiniz.

Çalışmaya başlamadan önce, bu çalışmada doğru veya yanlış cevap olmadığını ve çalışmanın amacının karakterin duygusal ifadeleri ne kadar iyi yansıtıp yansıtmadığını öğrenmek olduğunu belirtmek isteriz.

Table G1.1: The facial expressions used in the online questionnaire

	Hiç 1	2	orta 3	4	çok iyi 5
MUTLU	[ ]	[ ]	[ ]	[ ]	[ ]
ÜZGÜN	[ ]	[ ]	[ ]	[ ]	[ ]
KIZGIN	[ ]	[ ]	[ ]	[ ]	[ ]
KORKU	[ ]	[ ]	[ ]	[ ]	[ ]
ŞAŞIRMA	[ ]	[ ]	[ ]	[ ]	[ ]
İĞRENME	[ ]	[ ]	[ ]	[ ]	[ ]

	Hiç 1	2	orta 3	4	çok iyi 5
MUTLU	[ ]	[ ]	[ ]	[ ]	[ ]
ÜZGÜN	[ ]	[ ]	[ ]	[ ]	[ ]
KIZGIN	[ ]	[ ]	[ ]	[ ]	[ ]
KORKU	[ ]	[ ]	[ ]	[ ]	[ ]
ŞAŞIRMA	[ ]	[ ]	[ ]	[ ]	[ ]
İĞRENME	[ ]	[ ]	[ ]	[ ]	[ ]

Table G1.1 (continued): The facial expressions used in the online questionnaire

	Hiç 1	2	orta 3	4	çok iyi 5
MUTLU	[ ]	[ ]	[ ]	[ ]	[ ]
ÜZGÜN	[ ]	[ ]	[ ]	[ ]	[ ]
KIZGIN	[ ]	[ ]	[ ]	[ ]	[ ]
KORKU	[ ]	[ ]	[ ]	[ ]	[ ]
ŞAŞIRMA	[ ]	[ ]	[ ]	[ ]	[ ]
İĞRENME	[ ]	[ ]	[ ]	[ ]	[ ]

	Hiç 1	2	orta 3	4	çok iyi 5
MUTLU	[ ]	[ ]	[ ]	[ ]	[ ]
ÜZGÜN	[ ]	[ ]	[ ]	[ ]	[ ]
KIZGIN	[ ]	[ ]	[ ]	[ ]	[ ]
KORKU	[ ]	[ ]	[ ]	[ ]	[ ]
ŞAŞIRMA	[ ]	[ ]	[ ]	[ ]	[ ]
İĞRENME	[ ]	[ ]	[ ]	[ ]	[ ]

	Hiç 1	2	orta 3	4	çok iyi 5
MUTLU	[ ]	[ ]	[ ]	[ ]	[ ]
ÜZGÜN	[ ]	[ ]	[ ]	[ ]	[ ]
KIZGIN	[ ]	[ ]	[ ]	[ ]	[ ]
KORKU	[ ]	[ ]	[ ]	[ ]	[ ]
ŞAŞIRMA	[ ]	[ ]	[ ]	[ ]	[ ]
İĞRENME	[ ]	[ ]	[ ]	[ ]	[ ]

	Hiç 1	2	orta 3	4	çok iyi 5
MUTLU	[ ]	[ ]	[ ]	[ ]	[ ]
ÜZGÜN	[ ]	[ ]	[ ]	[ ]	[ ]
KIZGIN	[ ]	[ ]	[ ]	[ ]	[ ]
KORKU	[ ]	[ ]	[ ]	[ ]	[ ]
ŞAŞIRMA	[ ]	[ ]	[ ]	[ ]	[ ]
İĞRENME	[ ]	[ ]	[ ]	[ ]	[ ]

Table G1.1 (continued): The facial expressions used in the online questionnaire

	Hiç 1	2	orta 3	4	çok iyi 5
MUTLU	[ ]	[ ]	[ ]	[ ]	[ ]
ÜZGÜN	[ ]	[ ]	[ ]	[ ]	[ ]
KIZGIN	[ ]	[ ]	[ ]	[ ]	[ ]
KORKU	[ ]	[ ]	[ ]	[ ]	[ ]
ŞAŞIRMA	[ ]	[ ]	[ ]	[ ]	[ ]
İĞRENME	[ ]	[ ]	[ ]	[ ]	[ ]

APPENDIX G (b)

POST EXPERIMENT QUESTIONNAIRE FOR THE SECOND STUDY
(In English)

Post Experiment Questionnaire

Age: **.....**

Gender: ☐ **Female**
☐ **Male**

Education: ☐ **High school**
☐ **Undergraduate**
☐ **Graduate**
☐ **PHD**

1. How much difficult did you find to navigate in the virtual room?

Very easy	**easy**	**normal**	**difficult**	**very difficult**
☐ **1**	☐ **2**	☐ **3**	☐ **4**	☐ **5**

2. How often do you play computer games?

☐ **never**
☐ **rarely**
☐ **often**
☐ **usually**
☐ **always**

3. What kind of games do you play?

_____

4. How do you define yourself as a game player?

Very bad	**bad**	**normal**	**good**	**very good**
☐ **1**	☐ **2**	☐ **3**	☐ **4**	☐ **5**

‘The Recognition of Emotional Facial Expressions’ Questionnaire

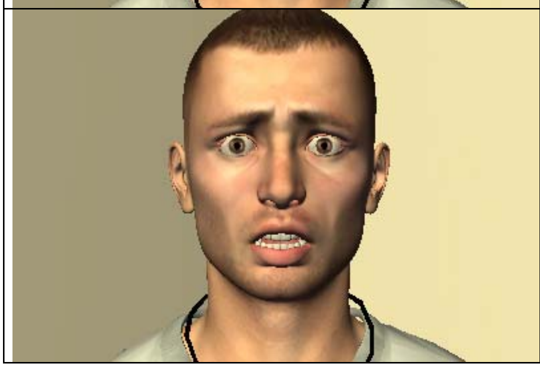
We want you to rate each facial expression according to how well the character expresses specific emotions. You have to rate the expressions on a scale of 1 to 5 for each of the six emotions. 1 means no expression of this emotion, 5 means a very good expression of this emotion. So, if you find the stimulus face express happiness very well, sadness poorly, anger moderate, etc.; rate 5 for happiness, 2 for sadness, 3 for anger.

We would like to remember you that there is no right or wrong answer in this survey. Our aim is to investigate how well you recognize emotional facial expressions.

Table G2.1: The facial expressions used in the online questionnaire

	slightly			extremely	
	1	2	3	4	5
HAPPY	[ ]	[ ]	[ ]	[ ]	[ ]
SADNESS	[ ]	[ ]	[ ]	[ ]	[ ]
ANGER	[ ]	[ ]	[ ]	[ ]	[ ]
FEAR	[ ]	[ ]	[ ]	[ ]	[ ]
SURPRISE	[ ]	[ ]	[ ]	[ ]	[ ]
DISGUST	[ ]	[ ]	[ ]	[ ]	[ ]

	slightly			extremely	
	1	2	3	4	5
HAPPY	[ ]	[ ]	[ ]	[ ]	[ ]
SADNESS	[ ]	[ ]	[ ]	[ ]	[ ]
ANGER	[ ]	[ ]	[ ]	[ ]	[ ]
FEAR	[ ]	[ ]	[ ]	[ ]	[ ]
SURPRISE	[ ]	[ ]	[ ]	[ ]	[ ]
DISGUST	[ ]	[ ]	[ ]	[ ]	[ ]



	slightly			extremely	
	1	2	3	4	5
HAPPY	[ ]	[ ]	[ ]	[ ]	[ ]
SADNESS	[ ]	[ ]	[ ]	[ ]	[ ]
ANGER	[ ]	[ ]	[ ]	[ ]	[ ]
FEAR	[ ]	[ ]	[ ]	[ ]	[ ]
SURPRISE	[ ]	[ ]	[ ]	[ ]	[ ]
DISGUST	[ ]	[ ]	[ ]	[ ]	[ ]

Table G2.1 (continued): The facial expressions used in the online questionnaire

	slightly			extremely	
	1	**2**	**3**	**4**	**5**
HAPPY	[ ]	[ ]	[ ]	[ ]	[ ]
SADNESS	[ ]	[ ]	[ ]	[ ]	[ ]
ANGER	[ ]	[ ]	[ ]	[ ]	[ ]
FEAR	[ ]	[ ]	[ ]	[ ]	[ ]
SURPRISE	[ ]	[ ]	[ ]	[ ]	[ ]
DISGUST	[ ]	[ ]	[ ]	[ ]	[ ]

	slightly			extremely	
	1	**2**	**3**	**4**	**5**
HAPPY	[ ]	[ ]	[ ]	[ ]	[ ]
SADNESS	[ ]	[ ]	[ ]	[ ]	[ ]
ANGER	[ ]	[ ]	[ ]	[ ]	[ ]
FEAR	[ ]	[ ]	[ ]	[ ]	[ ]
SURPRISE	[ ]	[ ]	[ ]	[ ]	[ ]
DISGUST	[ ]	[ ]	[ ]	[ ]	[ ]

	slightly			extremely	
	1	**2**	**3**	**4**	**5**
HAPPY	[ ]	[ ]	[ ]	[ ]	[ ]
SADNESS	[ ]	[ ]	[ ]	[ ]	[ ]
ANGER	[ ]	[ ]	[ ]	[ ]	[ ]
FEAR	[ ]	[ ]	[ ]	[ ]	[ ]
SURPRISE	[ ]	[ ]	[ ]	[ ]	[ ]
DISGUST	[ ]	[ ]	[ ]	[ ]	[ ]

	slightly			extremely	
	1	**2**	**3**	**4**	**5**
HAPPY	[ ]	[ ]	[ ]	[ ]	[ ]
SADNESS	[ ]	[ ]	[ ]	[ ]	[ ]
ANGER	[ ]	[ ]	[ ]	[ ]	[ ]
FEAR	[ ]	[ ]	[ ]	[ ]	[ ]
SURPRISE	[ ]	[ ]	[ ]	[ ]	[ ]
DISGUST	[ ]	[ ]	[ ]	[ ]	[ ]

APPENDIX H

TUKEY POST-HOC RESULTS OF EMOTIONAL FACIAL EXPRESSION FOR THE SECOND STUDY

H1: Happy Facial Expression

Table H1.1: Tukey post-hoc results of happy facial expression

Multiple Comparisons						
Happy						
Tukey HSD						
(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Happy	Sadness	3,06667*	0,18445	,000*	2,5351	3,5982
	Anger	3,00000*	0,18445	,000*	2,4685	3,5315
	Fear	3,30000*	0,18445	,000*	2,7685	3,8315
	Surprise	3,10000*	0,18445	,000*	2,5685	3,6315
	Disgust	3,06667*	0,18445	,000*	2,5351	3,5982
Sadness	Happy	-3,06667*	0,18445	,000*	-3,5982	-2,5351
	Anger	-0,06667	0,18445	0,999	-0,5982	0,4649
	Fear	0,23333	0,18445	0,804	-0,2982	0,7649
	Surprise	0,03333	0,18445	1	-0,4982	0,5649
	Disgust	0	0,18445	1	-0,5315	0,5315
Anger	Happy	-3,00000*	0,18445	,000*	-3,5315	-2,4685
	Sadness	0,06667	0,18445	0,999	-0,4649	0,5982
	Fear	0,3	0,18445	0,582	-0,2315	0,8315
	Surprise	0,1	0,18445	0,994	-0,4315	0,6315
	Disgust	0,06667	0,18445	0,999	-0,4649	0,5982
Fear	Happy	-3,30000*	0,18445	,000*	-3,8315	-2,7685
	Sadness	-0,23333	0,18445	0,804	-0,7649	0,2982
	Anger	-0,3	0,18445	0,582	-0,8315	0,2315
	Surprise	-0,2	0,18445	0,887	-0,7315	0,3315
	Disgust	-0,23333	0,18445	0,804	-0,7649	0,2982
Surprise	Happy	-3,10000*	0,18445	,000*	-3,6315	-2,5685
	Sadness	-0,03333	0,18445	1	-0,5649	0,4982
	Anger	-0,1	0,18445	0,994	-0,6315	0,4315
	Fear	0,2	0,18445	0,887	-0,3315	0,7315
	Disgust	-0,03333	0,18445	1	-0,5649	0,4982
Disgust	Happy	-3,06667*	0,18445	,000*	-3,5982	-2,5351
	Sadness	0	0,18445	1	-0,5315	0,5315
	Anger	-0,06667	0,18445	0,999	-0,5982	0,4649
	Fear	0,23333	0,18445	0,804	-0,2982	0,7649
	Surprise	0,03333	0,18445	1	-0,4982	0,5649
*. The mean difference is significant at the 0.05 level.						

H2: Sadness Facial Expression

Table H2.1: Tukey post-hoc results of sadness facial expression

Multiple Comparisons						
Sadness						
Tukey HSD						
(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Happy	Sadness	-3,43333*	0,15288	,000*	-3,8739	-2,9928
	Anger	-0,1	0,15288	0,987	-0,5406	0,3406
	Fear	-,73333*	0,15288	,000*	-1,1739	-0,2928
	Surprise	-0,26667	0,15288	0,505	-0,7072	0,1739
	Disgust	0,06667	0,15288	0,998	-0,3739	0,5072
Sadness	Happy	3,43333*	0,15288	,000*	2,9928	3,8739
	Anger	3,33333*	0,15288	,000*	2,8928	3,7739
	Fear	2,70000*	0,15288	,000*	2,2594	3,1406
	Surprise	3,16667*	0,15288	,000*	2,7261	3,6072
	Disgust	3,50000*	0,15288	,000*	3,0594	3,9406
Anger	Happy	0,1	0,15288	0,987	-0,3406	0,5406
	Sadness	-3,33333*	0,15288	,000*	-3,7739	-2,8928
	Fear	-,63333*	0,15288	,001*	-1,0739	-0,1928
	Surprise	-0,16667	0,15288	0,885	-0,6072	0,2739
	Disgust	0,16667	0,15288	0,885	-0,2739	0,6072
Fear	Happy	,73333*	0,15288	,000*	0,2928	1,1739
	Sadness	-2,70000*	0,15288	,000*	-3,1406	-2,2594
	Anger	,63333*	0,15288	,001*	0,1928	1,0739
	Surprise	,46667*	0,15288	,031*	0,0261	0,9072
	Disgust	,80000*	0,15288	,000*	0,3594	1,2406
Surprise	Happy	0,26667	0,15288	0,505	-0,1739	0,7072
	Sadness	-3,16667*	0,15288	,000*	-3,6072	-2,7261
	Anger	0,16667	0,15288	0,885	-0,2739	0,6072
	Fear	-,46667*	0,15288	0,031	-0,9072	-0,0261
	Disgust	0,33333	0,15288	0,252	-0,1072	0,7739
Disgust	Happy	-0,06667	0,15288	0,998	-0,5072	0,3739
	Sadness	-3,50000*	0,15288	,000*	-3,9406	-3,0594
	Anger	-0,16667	0,15288	0,885	-0,6072	0,2739
	Fear	-,80000*	0,15288	,000*	-1,2406	-0,3594
	Surprise	-0,33333	0,15288	0,252	-0,7739	0,1072
*. The mean difference is significant at the 0.05 level.						

H3: Anger Facial Expression

Table H3.1: Tukey post-hoc results of anger facial expression

Multiple Comparisons						
Anger						
Tukey HSD						
(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Happy	Sadness	-,63333*	0,17023	0,004	-1,1239	-0,1428
	Anger	-3,60000*	0,17023	,000*	-4,0906	-3,1094
	Fear	-0,4	0,17023	0,18	-0,8906	0,0906
	Surprise	-0,13333	0,17023	0,97	-0,6239	0,3572
	Disgust	-,80000*	0,17023	,000*	-1,2906	-0,3094
Sadness	Happy	,63333*	0,17023	0,004	0,1428	1,1239
	Anger	-2,96667*	0,17023	,000*	-3,4572	-2,4761
	Fear	0,23333	0,17023	0,744	-0,2572	0,7239
	Surprise	,50000*	0,17023	0,043	0,0094	0,9906
	Disgust	-0,16667	0,17023	0,924	-0,6572	0,3239
Anger	Happy	3,60000*	0,17023	,000*	3,1094	4,0906
	Sadness	2,96667*	0,17023	,000*	2,4761	3,4572
	Fear	3,20000*	0,17023	,000*	2,7094	3,6906
	Surprise	3,46667*	0,17023	,000*	2,9761	3,9572
	Disgust	2,80000*	0,17023	,000*	2,3094	3,2906
Fear	Happy	0,4	0,17023	0,18	-0,0906	0,8906
	Sadness	-0,23333	0,17023	0,744	-0,7239	0,2572
	Anger	-3,20000*	0,17023	,000*	-3,6906	-2,7094
	Surprise	0,26667	0,17023	0,622	-0,2239	0,7572
	Disgust	-0,4	0,17023	0,18	-0,8906	0,0906
Surprise	Happy	0,13333	0,17023	0,97	-0,3572	0,6239
	Sadness	-,50000*	0,17023	0,043	-0,9906	-0,0094
	Anger	-3,46667*	0,17023	,000*	-3,9572	-2,9761
	Fear	-0,26667	0,17023	0,622	-0,7572	0,2239
	Disgust	-,66667*	0,17023	0,002	-1,1572	-0,1761
Disgust	Happy	,80000*	0,17023	,000*	0,3094	1,2906
	Sadness	0,16667	0,17023	0,924	-0,3239	0,6572
	Anger	-2,80000*	0,17023	,000*	-3,2906	-2,3094
	Fear	0,4	0,17023	0,18	-0,0906	0,8906
	Surprise	,66667*	0,17023	0,002	0,1761	1,1572
*. The mean difference is significant at the 0.05 level.						

H4: Fear Facial Expression

Table H4.1: Tukey post-hoc results of fear facial expression

Multiple Comparisons						
Fear						
Tukey HSD						
(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Happy	Sadness	-1,26667*	0,22384	,000*	-1,9117	-0,6216
	Anger	-0,33333	0,22384	0,672	-0,9784	0,3117
	Fear	-3,36667*	0,22384	,000*	-4,0117	-2,7216
	Surprise	-2,30000*	0,22384	,000*	-2,945	-1,655
	Disgust	-0,36667	0,22384	0,575	-1,0117	0,2784
Sadness	Happy	1,26667*	0,22384	,000*	0,6216	1,9117
	Anger	,93333*	0,22384	,001*	0,2883	1,5784
	Fear	-2,10000*	0,22384	,000*	-2,745	-1,455
	Surprise	-1,03333*	0,22384	,000*	-1,6784	-0,3883
	Disgust	,90000*	0,22384	,001*	0,255	1,545
Anger	Happy	0,33333	0,22384	0,672	-0,3117	0,9784
	Sadness	-,93333*	0,22384	,001*	-1,5784	-0,2883
	Fear	-3,03333*	0,22384	,000*	-3,6784	-2,3883
	Surprise	-1,96667*	0,22384	,000*	-2,6117	-1,3216
	Disgust	-0,03333	0,22384	1	-0,6784	0,6117
Fear	Happy	3,36667*	0,22384	,000*	2,7216	4,0117
	Sadness	2,10000*	0,22384	,000*	1,455	2,745
	Anger	3,03333*	0,22384	,000*	2,3883	3,6784
	Surprise	1,06667*	0,22384	,000*	0,4216	1,7117
	Disgust	3,00000*	0,22384	,000*	2,355	3,645
Surprise	Happy	2,30000*	0,22384	,000*	1,655	2,945
	Sadness	1,03333*	0,22384	,000*	0,3883	1,6784
	Anger	1,96667*	0,22384	,000*	1,3216	2,6117
	Fear	-1,06667*	0,22384	,000*	-1,7117	-0,4216
	Disgust	1,93333*	0,22384	,000*	1,2883	2,5784
Disgust	Happy	0,36667	0,22384	0,575	-0,2784	1,0117
	Sadness	-,90000*	0,22384	,001*	-1,545	-0,255
	Anger	0,03333	0,22384	1	-0,6117	0,6784
	Fear	-3,00000*	0,22384	,000*	-3,645	-2,355
	Surprise	-1,93333*	0,22384	,000*	-2,5784	-1,2883
*. The mean difference is significant at the 0.05 level.						

H5: Surprise Facial Expression

Table H5.1: Tukey post-hoc results of surprise facial expression

Multiple Comparisons						
Surprise						
Tukey HSD						
(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Happy	Sadness	,96667*	0,19338	,000*	0,4094	1,5239
	Anger	,96667*	0,19338	,000*	0,4094	1,5239
	Fear	-0,03333	0,19338	1	-0,5906	0,5239
	Surprise	-2,60000*	0,19338	,000*	-3,1573	-2,0427
	Disgust	1,03333*	0,19338	,000*	0,4761	1,5906
Sadness	Happy	-,96667*	0,19338	,000*	-1,5239	-0,4094
	Anger	0	0,19338	1	-0,5573	0,5573
	Fear	-1,00000*	0,19338	,000*	-1,5573	-0,4427
	Surprise	-3,56667*	0,19338	,000*	-4,1239	-3,0094
	Disgust	0,06667	0,19338	0,999	-0,4906	0,6239
Anger	Happy	-,96667*	0,19338	,000*	-1,5239	-0,4094
	Sadness	0	0,19338	1	-0,5573	0,5573
	Fear	-1,00000*	0,19338	,000*	-1,5573	-0,4427
	Surprise	-3,56667*	0,19338	,000*	-4,1239	-3,0094
	Disgust	0,06667	0,19338	0,999	-0,4906	0,6239
Fear	Happy	0,03333	0,19338	1	-0,5239	0,5906
	Sadness	1,00000*	0,19338	,000*	0,4427	1,5573
	Anger	1,00000*	0,19338	,000*	0,4427	1,5573
	Surprise	-2,56667*	0,19338	,000*	-3,1239	-2,0094
	Disgust	1,06667*	0,19338	,000*	0,5094	1,6239
Surprise	Happy	2,60000*	0,19338	,000*	2,0427	3,1573
	Sadness	3,56667*	0,19338	,000*	3,0094	4,1239
	Anger	3,56667*	0,19338	,000*	3,0094	4,1239
	Fear	2,56667*	0,19338	,000*	2,0094	3,1239
	Disgust	3,63333*	0,19338	,000*	3,0761	4,1906
Disgust	Happy	-1,03333*	0,19338	,000*	-1,5906	-0,4761
	Sadness	-0,06667	0,19338	0,999	-0,6239	0,4906
	Anger	-0,06667	0,19338	0,999	-0,6239	0,4906
	Fear	-1,06667*	0,19338	,000*	-1,6239	-0,5094
	Surprise	-3,63333*	0,19338	,000*	-4,1906	-3,0761
*. The mean difference is significant at the 0.05 level.						

H6: Disgust Facial Expression

Table H6.1: Tukey post-hoc results of disgust facial expression

Multiple Comparisons						
Disgust						
Tukey HSD						
(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Happy	Sadness	-1,30000*	0,21673	,000*	-1,9246	-0,6754
	Anger	-,80000*	0,21673	0,004	-1,4246	-0,1754
	Fear	-0,5	0,21673	0,197	-1,1246	0,1246
	Surprise	-0,3	0,21673	0,736	-0,9246	0,3246
	Disgust	-3,30000*	0,21673	,000*	-3,9246	-2,6754
Sadness	Happy	1,30000*	0,21673	,000*	0,6754	1,9246
	Anger	0,5	0,21673	0,197	-0,1246	1,1246
	Fear	,80000*	0,21673	,004*	0,1754	1,4246
	Surprise	1,00000*	0,21673	,000*	0,3754	1,6246
	Disgust	-2,00000*	0,21673	,000*	-2,6246	-1,3754
Anger	Happy	,80000*	0,21673	,004*	0,1754	1,4246
	Sadness	-0,5	0,21673	0,197	-1,1246	0,1246
	Fear	0,3	0,21673	0,736	-0,3246	0,9246
	Surprise	0,5	0,21673	0,197	-0,1246	1,1246
	Disgust	-2,50000*	0,21673	,000*	-3,1246	-1,8754
Fear	Happy	0,5	0,21673	0,197	-0,1246	1,1246
	Sadness	-,80000*	0,21673	,004*	-1,4246	-0,1754
	Anger	-0,3	0,21673	0,736	-0,9246	0,3246
	Surprise	0,2	0,21673	0,94	-0,4246	0,8246
	Disgust	-2,80000*	0,21673	,000*	-3,4246	-2,1754
Surprise	Happy	0,3	0,21673	0,736	-0,3246	0,9246
	Sadness	-1,00000*	0,21673	,000*	-1,6246	-0,3754
	Anger	-0,5	0,21673	0,197	-1,1246	0,1246
	Fear	-0,2	0,21673	0,94	-0,8246	0,4246
	Disgust	-3,00000*	0,21673	,000*	-3,6246	-2,3754
Disgust	Happy	3,30000*	0,21673	,000*	2,6754	3,9246
	Sadness	2,00000*	0,21673	,000*	1,3754	2,6246
	Anger	2,50000*	0,21673	,000*	1,8754	3,1246
	Fear	2,80000*	0,21673	,000*	2,1754	3,4246
	Surprise	3,00000*	0,21673	,000*	2,3754	3,6246
*. The mean difference is significant at the 0.05 level.						