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Emotion recognition: how it is influenced by habituation of socially threatening stimuli in a virtual reality scenario

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Contents

I. Introduction

What effect does a stress inducing situation including socially threatening stimuli have on emotion recognition? Further, what effect does this social stress situation have on emotion recognition when it is repeatedly conducted within a virtual reality scenario? These are some core elements which will be closely looked at in the following thesis.

It would be foolish to analyse facial emotion recognition without looking at work done by Ekman and Friesen (1971), somewhat pioneers in this field of study and among the first to state the universality of certain basic emotions. Moreover, it is believed that females have an advantage when it comes to automatic processing of emotional faces in comparison to men (Hall, Carter, & Horgan, 2000; Hall, & Matsumoto, 2004). Further, to realise the importance of emotion recognition in our everyday lives, its role in a social context has to be analysed. Deficits in emotion recognition and state-anxiety, trait-anxiety and anxiety disorders have been repeatedly linked together. The majority of research conducted in this field found that anxious individuals displayed an attentional bias towards threatening stimuli in their environment (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenbur, & van Ijzendoorn, 2007). A situation that is known to heighten state-anxiety is that of accomplishing a presentation task in front of an audience. Such a task also increases stress-responses, hence is called mental stress task.

Against this background the individuals' response to stressful (or threatening) stimuli and its effect on emotion recognition can be examined. An experimental design was applied in this study, with each subject being confronted with a socially threatening situation at three different times of measurement. Since looking at repeated measurements, mechanisms of stress exposure and habituation in the context of learning theories were also covered.

To add another dimension into the mix, a fairly new research tool was applied in this study:

individuals underwent a stressful situation within a virtual reality (VR) scenario. VR is a digital, three-dimensional space, in which individuals can move around and interact. It is used to take stimuli out of the environment and reproduce them in a digital arena: Thus, to analyse social and psychological phenomena in an easier accessible, more economically and safer environment (Fox, Arena, & Bailenson, 2009; Wiederhold, & Wiederhold, 2000). At this point it is important to say that this work was only part of a greater project at the *Virtual Reality Laboratory* at the University of Vienna. Further, two more theses came out of this project, which were accomplished by my colleagues A. Heinzle (in preparation) and F. Flick (2013). Having said this, it is recommended to read their work for deeper understanding of the whole project.

The current thesis can be divided into two sections. First, the theoretical background is discussed. Of interest were theories and empirical findings on emotion recognition in the context of anxiety and the application of virtual reality technologies as a research tool. Secondly, the empirical section will introduce the research questions, as well as presenting the method that was applied and the results of data analysis. Finally, results, limitations and future outlook will be discussed.

II.Theoretical Background

The aim of this chapter is to give an overview of the theory that forms the base to the design of this study. The main areas of interest include theories on emotion recognition and anxiety, processes connected to stress exposure and the concept of virtual reality.

1. Emotion Recognition

Emotional expression can be seen as part of emotional behaviour, since it is the external action or expression of an inner emotional experience. Of interest are not only expressions themselves but also the accuracy with which they are recognised as a specific emotion (Mesquita, & Frija, 1992; Mesquita, Frijda, & Scherer, 1997). A question that concerns many scientists is, if there are certain “basic emotions” - emotions that can be expressed and correctly recognised by any human being.

1.1 Universality and cultural specificity of emotion recognition

Amongst psychologists there has been an ongoing debate on emotions being universal versus emotions varying by culture. Prominent members are the above mentioned Ekman and Friesen (1971), but also Izard (1994) or Russel (1995). However, the first important piece of work on this topic was published by Charles Darwin, who already in 1872 reported that specific facial expressions could be linked to specific emotional contents. He further concluded that emotion recognition was a universal phenomenon. About a century later, Ekman and Friesen (1971) conducted famous cross-cultural studies, in which they found that members of different cultures adequately recognised certain basic emotions and showed similar expressions in similar situations. After analysing film- and photo material of humans experiencing and depicting emotions, Ekman and Friesen (1975) concluded that facial emotions were characterised by distinct facial muscular patterns. The researchers further compiled their own photo material, using pictures of individuals who were instructed to re-enact these distinct muscular patterns, rather than of individuals truly experiencing the emotions. They further found six basic emotional expressions which were the following: surprise, anger, disgust, fear, grief and happiness. All other facial expressions could be seen as a combination of these six (Ekman, & Friesen, 1971, 1975).

Other studies followed with similar results on the universality of emotion recognition (see Ekman, 1993; Izard, 1994; Mesquita, & Frija, 1992; Mesquita et al., 1997) and up until today cross-cultural studies are pivotal as a source of evidence on the universality of emotions. Russel (1995) on the other hand emphasised the fact that there only exists minimal universality but that specific emotional expressions are culturally dependant. A meta-analysis by Elfenbein and Ambasy (2002) found that emotion recognition could be seen as a universal phenomenon but also reported an in-group advantage, indicating that members of the same ethnic, national or regional group showed higher accuracy in emotional recognition of one another than of members of different groups. All in all, the current study is based on the basic facial expressions found by Ekman and Friesen (1971).

1.1.1 On gender differences in emotion recognition.

A common held believe is that of women being the more emotional gender. For instance, Baron-Cohen and Wheelwright (2004) reported greater levels of empathy in women than in men. Although it stays unclear if this result rather reflects a greater willingness of women to disclose their emotions. Having said this, women are believed to experience and express emotions more intensely than men, which again is thought to accumulate in a superiority of emotional competence. Further, these gender differences are thought to lie within the processing mechanisms of emotional information (Donges, Kertsing, & Suslow, 2012; Gohier et al., 2013; Montagne, Kessels, Frigerio, de Haan, & Perrett, 2005).

One theory on sex differences in emotional processing is that it stems from different social gender roles (Grossmann, & Wood, 1993). Said authors believed that a woman's stereotypical social role is that of a care-taker, whereas men are stereotypically associated to a protective social role. Further, females and males that embraced these stereotypes were found to show advantages in the processing of emotions that were associated to these roles. Such emotions were *happiness, fear* and *sadness* in women and *anger* in men.

However, more recent research did not find any specific emotion recognition skills in men and women: On the contrary, Montagne et al. (2005) reported that women in general showed higher accuracy and sensitivity in recognising facial emotions, including angry faces. Interestingly, men displayed significantly less sensitivity concerning the facial emotions of *anger* and *disgust*. Hoffmann, Kessler, Eppel, Rukavina and Traue (2010) also reported women's advantages in recognising emotions – if emotional faces displayed subtle emotions. When said faces displayed “full” emotions, no gender differences were found. These results also supported findings from Hoheisel and Kryspin-Exner (2005), who did not find any gender related differences in emotion recognition accuracies. Further, Hall and colleagues (Hall, Carter, & Horgan, 2000; Hall, & Matsumoto, 2004) have established in various studies that women showed overall higher accuracies in labelling emotions when emotional stimuli was presented on the edge of conscious awareness. Donges et al. (2012) conducted an affective priming study and reported similar results. Here, the stimuli were presented outside of conscious awareness, but women only showed advantages towards positive, not negative stimuli.

In conclusion, these findings indicate, that women only have an advantage in automatic processing of facial emotions, which could account for gender related differences on other emotional dimensions, such as empathy.

1.2 The importance of emotion recognition

“Emotion recognition is in fact a central skill for social competence and abnormalities in this ability can play an important role in the maintenance or etiology of many interpersonal problems characterizing different disorders such as anxiety and depression” (Surcinelli, Codispoti, Montebarocci, Rossi, & Baldaro, 2006, p.112).

To fully understand the value of emotion recognition and emotional response, some classic emotion theories need to be looked at. These theories describe how inner emotional experience and external emotional expressions are linked together. The James-Lange Theory (1884, as cited in Cannon, 1927) stated that an observable emotional behaviour comes prior to an emotional feeling. The Cannon-Bard Theory (Cannon, 1927) on the other hand assumed no relationship between emotional behaviour and emotional feelings what so ever. Lazarus (1987) believed that an evaluation (appraisal) of a situation caused an emotional response. The Schachter-Singer Theory (1962) went one step further and stated that not only cognitive appraisal but also physiological arousal would result in emotional experience. Finally Zajonc (1980) believed that cognitive appraisal and even recognition of an emotional stimulus as such, set in after an emotional experience itself. The current point of view is that there are three factors that interact: the perception of an emotional stimulus, the physiological arousal and the emotional experience mutually influence each other (Zimbardo, 2004).

As can be seen, there have been many different theories over the decades but they all have in common that emotion recognition is essential to operate effectively and respond accordingly to a social situation. Hence, in a social context it is not only necessary to correctly disclose one's own emotions but also to adequately decode the ones of your counter partner (Engelberg, & Sjöberg, 2004).

1.2.1 Empirical findings on emotion recognition deficits.

In this context it is interesting to analyse certain groups of people that are known to suffer from emotional and cognitive impairments and display poor social functioning. Although healthy subjects participated in this current study, it illustrates the importance of facial emotion recognition.

For instance, patients with schizophrenia typically show deficits in both facial affect recognition and discrimination, which, amongst other dimensions, can be negatively associated with social functioning (Horan et al., 2011; Johnston, Kastikitis, & Carr, 2001; Sachs, Steger-Wuchse, Kryspin-Exner, Gur, & Katschnig, 2004). An interesting study conducted by Sachs et al. (2012) showed that, in patients diagnosed with schizophrenia, a positive training effect of emotion recognition also positively influenced other dimensions of social behaviour, such as social relationships. Other psychiatric disorders which are linked to an impairment of social functioning, in association with deficits in facial affect identification, are anxiety disorders, major depression or bipolar I disorder (Demenescu, Kortekaas, Den Boer, & Alleman, 2010; Derntl, Seidel, Kryspin-Exner, Hasmann, & Dobmeier, 2009; Lawrence et al., 2004).

2. Emotion recognition in the context of anxiety

Coming back to the current study which looked at the relationship between anxiety and emotion recognition, a couple of theories and empirical findings will be presented. Again, a differentiation is required between clinical subjects that suffer from an anxiety disorder and non-clinical subjects with high trait anxiety or non-clinical subjects with high state-anxiety. The difference between clinical and non-clinical populations can be seen in the intensity of anxiety – e.g. the underlying mechanisms and the symptoms themselves (Bar-Haim et al., 2007). Since the participants of this study were healthy, the latter two forms of anxiety were of interest and will be discussed in further detail. Nonetheless empirical findings from clinical populations can be used to get a better understanding of the – more pronounced – underlying mechanisms of anxiety

2.1 Anxiety – a state, a trait, and a disorder

From an evolutionary point of view anxiety can be seen as essential for survival (see Cannon, 1915) and is classified as a common feeling experienced by all humans. The difference between the two above mentioned forms of anxiety is simple: Trait-anxiety can be seen as a stable personality characteristic. For instance, individuals that feel in general more anxious or behave in a more anxious way, are individuals with high trait-anxiety. State-anxiety, on the other hand, is a transitory state, due to some kind of anxiety inducing situation or stimuli (Laux, Glanzmann, Schaffner, & Spielberger, 1981).

A situation that is feared by many people is that of talking in public. Research has shown that, in “presentation situations”, healthy subjects showed signs of heightened physiological arousal and anxiety (see chapter 2.4). When this fear becomes more pronounced and has significant negative effects on people's lives, it can be characterised as a particular type of social phobia: the fear of public talking (Reinecker, 2003). As with a lot of psychiatric disorders, the transition from a subclinical to a clinical individual takes place gradually. Nevertheless, social phobia is amongst the most common disorders within the anxiety disorder spectrum and has a lifetime prevalence of 10% (Kessler et al., 2005). Typical for individuals that are diagnosed with *social phobia* are intense negative emotions when they are facing or interacting in social situations or presentations. This fear is based on the maladaptive believe that one is being judged negatively, hence on the possibility of humiliating and embarrassing oneself in front of strangers. As a result individuals tend to avoid the source of anxiety (Reinecker, 2003). Non-clinical individuals do not get the same intense feelings, nor try to avoid social confrontation. Nevertheless, they have similar believes about being judged negatively and behaving in an embarrassing way (when talking in public) (Dickerson, & Kemeny, 2004).

So how does anxiety manifest itself? According to Lang's three-systems-theory (1993) physical-physiological, emotional-cognitive and behavioural dimensions need to be taken into account. On a physiological level the autonomous nervous system is activated and heart rate and breathing is accelerated. The emotional-cognitive level is associated to (negative) self-evaluation processes and a general demand for perfectionism and a successful performance. Finally, fear-avoidance or withdrawal from a feared situation occurs on a behavioural level.

2.2 Empirical findings concerning facial emotion recognition and anxiety

Deficits in emotion recognition skills and anxiety have previously been linked together

(Demenescu, Kortekaas, Den Boer & Alleman, 2010; Kessler, Roth, von Wietersheim, Deighton & Traue, 2007; Mohlman, Carmin & Price 2007). Interestingly in the context of anxiety, an emotion specific impairment has been suggested (Beck, 1976; Yiend & Mathews, 2001). A study conducted by Joormann and Gotlib (2006) used a classical approach in this field. Participants (in this case people that were diagnosed with either depression or social phobia and a healthy control group) were asked to identify different types and intensities of emotional faces. The first stimuli represented a neutral face and then, step by step, the intensity of a given emotion was increased. Subjects diagnosed with social phobia recognised angry faces at a lesser level of intensity in comparison to the other two groups. In line with this result, Kessler et al. (2007) and Mohlman et al. (2007) found that socially anxious patients, in comparison to healthy subjects, more often mistook neutral facial expressions as angry ones.

Furthermore, Surcinelli and colleagues (2006) were able to replicate these findings in a non-clinical sample. The authors compared individuals with high trait-anxiety to individuals with low-trait anxiety. The former displayed better recognition scores of the facial expression of *fear,* indicating that anxiety influenced recognition performance of threat-related stimuli. Contrary to these results, Cooper, Rowe and Penton-Voak (2008) did not find any significant differences in emotion recognition accuracies between subjects with high or low trait-anxiety. These findings indicated that anxiety might not influence the process of recognising emotions.

The research group around E. Fox again found contradictory results. Their findings indicated that faces associated to threat did not specifically draw the attention of individuals with high state-anxiety. On the contrary, these individuals rather showed difficulties in disengaging from those faces (Fox, Russo, Bowles, & Dutton, K., 2001; Fox, Russo, & Dutton, 2002). Georgiou et al. (2005) could also replicate these findings and found a *delayed disengagement* from fearful stimuli in anxious subjects.

2.3 Theories of cognitive bias in anxiety

"There is a clear evolutionary advantage to a species that can respond rapidly to the presence of potential threat in their environment" (Fox, Lester, Russo, Bowles, & Dutton, 2000, p.62). Therefore it is not surprising, that (anxious) humans seem to detect facial expressions that are related to threat more accurate than other expressions. But what are underlying mechanisms and how are they influenced by anxiety? A possible explanation on how anxiety influences recognition of threatening stimuli could be found within cognitive theories. These theories describe the role cognitive processing has on attention, interpretation, representation or evaluation of stimuli in the context of anxiety (Bar-Haim et al., 2007).

According to schema theories (see Beck, 1976; Bower, 1981, 1987) people develop underlying cognitive schemata which guide the way information is processed. As a consequence, individuals show biases for stimuli that are consistent with certain schemata. When applying this *content-specificity hypothesis* (Beck, 1976) on anxious individuals, they should demonstrate a bias towards stimuli that are in accordance with their cognitive schemata. This was thought to be anger and social threat. As a consequence, threat and anger related stimuli are favoured in both early and later stages of cognitive processing and could lead to biases, for example, in attention but also in interpretation or memory of information (Beck, 1976; Beck, & Clark, 1997; Beck, Emery, & Greenberg, 1985; Bower, 1981, 1987; Bradley, Hogg, White, Groom, & de Bono, 1999; Broadbent, & Broadbent, 1988).

Other theories suggest that biases occur on specific levels during cognitive processing. For instance, Williams, Watts, MacLeod and Matthews (1988) proposed a specific attentional bias in early, automatic stages of cognitive processing. A completely different view was shared by Mogg, Bradley, de Bono and Painter (1997), who thought that cognitive biases did not appear in early stages of attention but throughout later ones, such as interpretation or memory. Furthermore, this group of researchers suggest that, in later stages of cognitive processing, individuals direct their attention away from threatening stimuli, therefore inhibiting a detailed processing and evaluation. This concept could also be a source of explanation for the maintenance of anxiety.

As mentioned above (chapter 2.2), researchers in more recent years have suggested that the difference in attentional biases between anxious and non-anxious individuals lie in the ability to withdraw from threatening stimuli rather than detecting them in the first place (Fox et al., 2001, 2002; Georgiou et al., 2005).

Many different theories and models on cognitive biases in anxiety have been analysed over the past three decades but unfortunately paint a slightly confusing picture. However, Bar-Haim et al. (2007) conducted a meta-analysis aiming to get a better understanding of threat-related information processing in anxiety. This group of researchers comprised 172 studies which varied in experimental methods and in different types of anxious populations (clinically anxious, high & low non-clinically anxious, non-anxious). Results suggested a threat-related attentional bias in all anxious populations with a medium effect size. Interestingly, findings indicated that clinical populations did not differ from high-anxious non-clinical individuals in this regard. Moreover, the researchers did not find the presence of an underlying bias in only one stage of cognitive processing, such as only in attention or only in disengagement. They suggested a “function of several cognitive factors, including preattentive, attentional and postattentive processes” (Bar-Haim et al., 2007, p.17).

2.4 Enhancement of state-anxiety in a laboratory setting

The ambitious reader will have correctly guessed that the design of this study was aiming to enhance state-anxiety in healthy subjects through manipulation. Indeed, core of this project was an experimental confrontation with a standardised psychosocial stress situation in a virtual reality. In general, increased negative emotional reactions like agitation or anger, but also anxiety can be associated to stress-responses (Zimbardo, 2004). Please refer to chapter 3 for a more detailed description of mechanisms associated to stress-confrontation.

So what exactly is a psychosocial stress situation in our modern society? Psychosocial stressors are stressors that are individually classified as such, through perception, interpretation, experience, or (non-existent) coping strategies. In this sense Lazarus and Folkman (1984) stated that stress can be seen as “a particular relationship between the person and the environment that is appraised by the personas taxing or exceeding his or her resources and endangering his or her well-being” (p.19). A meta-analysis conducted by Dickerson and Kemeny (2004) was aiming to find psychosocial stressors that significantly increased cortisol levels (as a marker of stress-arousal, see chapter 3) in a laboratory setting. Their results showed that situations that seemed uncontrollable and posed a social threat significantly enhanced stress-arousal, thus were associated to the greatest change in hormonal levels (also see von Dawans, Kirschbaum, & Heinrichs, 2011; Kemeny, 2009; Kirschbaum et al., 1993; Kothgassner et al., 2012). These researchers further stated that social threat was associated to the fear of negative evaluation by others and uncontrollability was the inability to influence an outcome of a situation. Such a situation could be any performance tasks (which are also called mental stress tasks) in front of an audience. These tasks come with a certain likelihood that an embarrassment or humiliation could occur (see Felnhofer, Kothgassner, Beutl, Hlavacs, & Kryspin-Exner, 2012; Kothgassner et al., 2012; Lehenbauer, Kothgassner, Kryspin-Exner, & Stetina, 2013; Pertaub, Slater, & Barker, 2002).

In summary, to successfully induce stress and thus increase (state-) anxiety in a laboratory setting, individuals should be exposed to an uncontrollable and social threatening situation.

Dickerson and Kemeny (2004) stated that the Trier Social Stress Test (TSST, Kirschbaum et al., 1993) was a highly reliable tool of inducing stress-responses. Hence, it was used in this project for stress-confrontation (see chapter 4 and 7.2.8). But what exactly are stress-responses, besides from increasing anxiety, and what does confrontation and exposure mean? These questions will be answered in the next chapter.

3. Exposure and habituation in the context of psycho-physiological stress responses

Aim of this chapter is to allow a better understanding of mechanisms that are connected to confrontation with stressful stimuli. Key words in this context are not only stimuli but also exposure and habituation, which means that an individual familiarises oneself with a stimulus when he or she is repeatedly exposed to it.

3.1 Psycho-physiological stress response

A threatening, or better stressful, stimulus marks the beginning of a so-called physiological stress response. In order to successfully master the situation and as a result of the perceived threat, a variety of automatic or adaptive reactions are triggered. These responses apply to physiological, behavioural and emotional-cognitive dimensions with varying intensity (see Lang's *three-systems model* described in chapter 2.1). The hypothalamus plays an essential role in this process due to the fact that it controls the autonomic nervous system. One of the first to describe responses of the autonomic nervous system to threat was Cannon (1915) and he further developed the famous *fight- or flight syndrome*. Due to circumstances that are perceived as stressful, nerves and glands are stimulated and prepare the body to either fight the threat or basically run away. As mentioned in chapter 2.1, physiological responses to negative stimuli include the following: heart rate and breathing accelerate, sweating increases and certain hormones are released. Hormones that have been connected to a physiological stress response are *adrenalin*, *thyrotrophic hormone* (TTH), *adrenocorticotrophic hormone* (ACTH) and *cortisol* (Glenk, 2011; Zimbardo, 2004).

Concerning this current study, emotional responses to psychosocial stress were of interest and how they influenced emotion recognition skills. See chapter 2 for a detailed description of anxiety in the context of social threat and emotion recognition.

3.2 Exposure to socially threatening stimuli

The term exposure needs to be seen in the context of learning and cognitive theories. A so-called *stimulus-response principle* can be applied. As mentioned above, if an individual is exposed to a negative stimulus, like a socially threatening situation, certain changes – or responses – in behaviour, cognition, emotion or physiology can be noticed. Pawlow (1927), Watson (1913), Thorndike (1898) and Skinner (1930) are some of the most prominent and most important individuals in the context of learning theories. Not surprisingly, since they introduced *classical conditioning* (Pavlov, 1927; Watson, 1913) and *operant conditioning* (Skinner, 1930; Thorndike, 1898). Essentially, these researchers tried to explain individual aversive responses to a once neutral stimuli, through learning processes that underlay these stimulus-response patterns (Bodenmann, Perrez, Schär, & Trepp,2004).

Mowrer's *Two-Factor Theory* (1960) is a well known theory that combined principles of classical and operant conditioning to explain the source and maintenance of phobias. In short: a once neutral stimulus is associated with an aversive reaction (classical conditioning) which leads to avoidance of this stimulus in the future. Unfortunately this leads to a negative reinforcement (operant conditioning) which inhibits the individual to deal with the feared stimulus in the first place. Criticism towards this point of view was the disregard of cognitive factors that lie within an individual and between stimulus and response. Just think of the above mentioned schema theories (see Beck, 1976), that focus on maladaptive cognitive processing in the context of fear (see chapter 2.2).

Today's point of view not only regards learning and cognitive principles as important variables in psycho-physiological stress-responses, but also takes biological and social variables into account (Zimbardo, 2004). In line with this stand the previously mentioned results on significant psychosocial stressors, which consequently were classified as aversive stimuli: social threat and uncontrollability. Clearly there were maladaptive cognitive factors like information processing, interpretation or evaluation involved in the fear of being judged by others and the feeling of not being able to interfere (Kothgassner et al., 2012; Lehhenbauer et al., 2013; Pertaub et al., 2002).

Answering the entrance question – what is exposure – it can be said, that it is the confrontation of an individual with an aversive stimuli that provokes a maladaptive response in physiological, emotional-cognitive or behavioural dimensions.

3.2.1 Influence of social stress on selective attention processes.

Concerning this current study, research done by Roelofs, Bakvis, Hermans, van Pelt and van Honk (2007) is of special interest. Herein subjects were confronted with a stress-inducing situation via a TSST (Kirschbaum et al., 1993) and accomplished a masked emotional Stroop task before and after stress induction. The aim was to analyse preconscious selective attention to threat (angry faces). Individuals with high stress-responses showed an avoidant attentional bias to threat prior to stress-induction. Interestingly, the same individuals showed an attentional bias towards the facial emotion of *anger* after stress-induction. On the contrary, individuals with low stress-responses displayed the opposite reaction pattern and became avoidant after stress induction. These results confirmed previous findings by Roelofs and her colleagues (see Roelofs, Elzinga, & Rotteveel, 2005). Measures of self-reported anxiety scores increased significantly after stress-arousal but did not differ between the two groups of individuals. However, these findings gave a better insight into avoidance behaviour in the context of social stress, which can also be related to anxiety dimensions in a greater sense. Please refer to chapter 2.3 for theories of attentional bias in anxiety.

3.3 Habituation

The aim of confronting individuals with a fearful situation is for the individual to overcome the fear itself and experience the possibility to successfully face the situation. For this to happen the aversive stimulus needs to be repeatedly presented and a positive experience will reduce the level of stress-response. This process of familiarising oneself with a certain stimulus is called habituation (Bodermann et al., 2004).

In the context of learning theories this process can be seen as a modification of the stimulus-response pattern. In the context of cognitive theories a modification of maladaptive cognitive schemata (see chapter 2.2) takes place. For instance, an individual who fears public talking is convinced that other people will judge him or her negatively and that he or she will embarrass himself or herself. When being confronted with this feared situation the person gets the chance to evaluate these cognitive assumptions and might experience that they are not true and that the feared situation can be mastered quite successfully. Through this positive experience the feared stimulus loses its threat. In order for this modification to happen the individual needs to be repeatedly exposed to the threat-related stimulus and the once severe anxiety-response will gradually decrease (see Bodenmann et al., 2004; Rothbaum, & Hodges, 1999).

Exposure and the process of habituation have been and still are being successfully used in the treatment of anxiety disorders. Already in 1958 Wolpe developed the well-known *Systematic Desensitization*, the aim of which was to gradually expose patients to their feared stimuli (combined with a state of relaxation). Up until today these principles – as part of a greater treatment plan – are applied, both as a training tool and a research tool (see

Kothgassner et al., 2012; Rothbaum, & Hodges, 1999; Wiederhold, & Wiederhold, 2000).

In the classical forms, confrontation with threat-related stimuli took place in thought only (in-sensu exposure) or in the physical environment (in-vivo exposure). In recent years the concept of *virtual reality* became more popular in this context because it allows participants to experience certain stimuli in a digital world (Wiederhold, & Wiederhold, 2000). As mentioned various times before, the subjects of this study were confronted with a social stress situation within a digital environment. In order to make any assumptions on the severity of stress-arousal, results were compared to subjects that experienced the same situation in the physical world. The concept of *virtual reality* with its advantages and disadvantages in the context of stimulus-exposure will be discussed in the next chapter.

4. Virtual Reality

"Virtual Reality is a technology, a communication interface, and an artificial experience (Riva, 2003, p.1)". As such, virtual reality (VR) is used to simulate artificial environments in a digital, three-dimensional space. Within this environment individuals can actively move around and interact with objects, people or other environments, thus can experience social situations or accomplish specific tasks. Therefore VR is used to take stimuli out of the physical environment and reproduce them in a digital arena (Bente, Krämer, & Petersen, 2002; Fox et al., 2009).

The term *Virtual Reality* was introduced by Jaron Larnier towards the end of the 1980s when information technology and in particular technologies associated to human-computer interfaces were further developing and becoming of greater interest in the scientific world (Bente et al., 2002; Larnier, & Biocca, 1991). However, due to a demand to sufficiently train a large number of pilots during World War II flight simulators were already used by the military. It was recognised as an effective tool to enable pilots in training to experience flying without leaving the ground and endangering people that were involved. Since then, technology has immensely evolved and today's VR equipment is a far cry from the first simulators that were applied (see Tart, 1990; Bente et al., 2002; Fox et al., 2009).

To make an artificial experience as "real" as possible, *head mounted displays* (HMD) are most commonly used nowadays. These HMDs are placed on one's head, so that two displays (almost) cover the whole field of vision. Further, specific sensors track head movement and continually adapt the digital perspective to the person's motion. Apart from vision, there are another four senses that make an experience seem "real": the senses of hearing, of touching, of smelling and of tasting. The more senses are included when creating an artificial environment, the more a person can block out the physical environment and can immerse in the synthetic one – which are crucial elements to the whole experience (Fox et al., 2009; Riva, 2003; Wiederhold, & Wiederhold, 2000). This process of engrossing the digital world while shutting out the physical one is called i*mmersion* (Witmer, & Singer, 1998). Immersion is further enhanced through a process called *rendering*, which means that the digital environment changes in accordance to a movement. For example, if a person moves his head to the right, this movement is *tracked* and the surroundings *rendered* in a way that the new perspective of the environment can be seen (Fox et al., 2009).

The term (tele)presence (see Minsky, 1980; Steuer, 1992) is often used simultaneously with the term immersion. To a certain degree these two terms do overlap in their meanings but then again can also be differentiated. "Telepresence is defined as the experience of presence in an environment by means of a communication medium" (Steuer, 1992, p.76) and as such can be seen as a "sense of being there" (Steuer, 1992, p.76). Immersion on the other hand, describes the processes of focusing on and engaging with an artificial environment (see Bente et al., 2002; McMahan, 2003). In summary, the main difference of a virtual reality experience to other technical mediums is the sensation of being within that artificial environment and having the possibility to interact with it and not merely observe the happening on screen (Bossard, Kermarrec, & Buche, 2008). The next section will discuss the application of VR in social sciences.

4.1 Virtual reality as a research tool

In the context of social sciences VR can be applied in three different ways: first, the virtual environment itself can be seen as the object of research. For example, questions concerning the enhancement of i*mmersion* are of interest. Secondly, VR can be taken out of a laboratory setting and can be applied as a training tool. For instance, medical students can familiarise themselves with surgical procedures (Fox et al., 2009). Further, there is a whole body of literature on the application of virtual reality exposure (or in-virtuo exposure) in the treatment of anxiety disorders. Particularly, specific phobias such as fear of flying, of driving or of heights as well as social phobias have been well studied in this context. Results indicate that virtual environments can be successfully used to confront individuals with aversive stimuli in order to reduce anxiety-responses (Emmelkamp, Bruynzeel, Drost, & van der Mast, 2002; Fox et al., 2009; Kotlyar et al., 2008; Parsons, & Rizzo, 2008; Wiederhold, & Wiederhold, 2000; 2005).

But when it comes to this study, a third way of applying VR in the field of social sciences was of interest: VR as a method of researching psychosocial phenomena. Already in 1987 Hut and Sussmann claimed that “Computational experiments are enriching scientific investigation. They are now becoming as important as theory, observation and laboratory experiments” (p.145). Today this statement is as true as ever and a lot of basic experimental research is done within VR environments (Bente, & Krämer, 2002; Bossard, Kermarrec, Buche, & Tisseau, 2008; Fox et al., 2009; Kothgassner et al., 2012; McCall & Blascovich, 2009). Some advantages and disadvantages of this approach are discussed in chapter 4.1.1.

A key element to help enable the appliance of VR as a research tool, and a training tool for that matter is that it needs to trigger stimuli responses that are comparable to those experienced in a physical environment (Gregg, & Tarrier, 2007). Chapter 3 talked about processes connected to stimuli exposure and habituation and mentioned in-sensu and in-vivo exposure as the classical approaches in this field. However, the application of VR in this context (in-virtuo exposure) opened up new possibilities of confronting individuals with aversive stimuli. But how come computer generated stimuli cause the same reactions as real stimuli? In order for this to happen the above mentioned concepts of immersion and presence are vital. For effective in-virtuo exposure, individuals need to fully immerse into the artificial world and experience the stimuli as real as possible (Bente, & Krämer, 2002; Gregg, & Tarrier, 2007; McCall, & Blascovich, 2009). Once a virtual environment is created that meets these requirements, it can be used as a method for experimental research. Its advantages and disadvantages will be discussed in the following chapter.

4.1.1 Advantages and disadvantages of implementation of virtual reality.

The main advantage of VR as a research method lies in high experimental control combined with high ecological validity. In conventional research there often is a trade-off between these two variables, with experimenters either focusing on high stimuli control and neglecting ecological validity or vice versa (Loomis, Blascovics, & Beal, 1999; McCall, & Blascovich, 2009). With VR technology stimuli can still be highly controlled by the experimenter but can be taken out of a sterile, laboratory setting and can be presented in an environment very similar to the real world. As such, the generalisability of given results can be enhanced (Bente et al., 2002; Bente, & Krämer, 2002; Loomis et al., 1999).

Said high experimental control also creates a safer and more accessible environment to be confronted with than the physical world itself. The experimenter can control for the intensity and frequency of a given aversive stimuli and can individually adjust the programme. This is especially important if an individual's fear or embarrassment of a situation is too great to be confronted within the real world but agrees to face the stimuli in a safer digital environment. Needless to say, that it is also less time- and cost-consuming than in-vivo exposure (see Kothgassner et al., 2012; Loomis et al., 1999; McCall, & Blascovich, 2009; Riva, 2003; Rothbaum, & Hodges, 1999; Tart, 1990).

When it comes to the use of VR technology in the context of assessing stress-responses (see chapter 3.1) there are some great advantages to more conventional research methods. As mentioned above, an effective stress-task consists of a performance task in front of an audience. One advantage of applying VR technology is, that the scenario is presented consistently across all subjects. Secondly, the greater the audience in front of whom subjects present stress tasks, the more severe stress-responses are to be expected (Kotlyar et al., 2008). Although, it has been shown that an audience as little as two people created sufficient stress-arousal (Kirschbaum et al., 1993; Kotlyar et al., 2006). The point is that there is no size limit when creating the audience in a virtual world. Thus, it is solely the researcher's choice to have subjects interact with only two avatars or 100 of them. Another advantage of being able to programme the audience is that facial expressions, behaviour and verbal responses can be standardised across all subjects (Kotlyar et al., 2008, Kothgassner et al., 2012).

Disadvantages associated to the use of VR are reported after-effects such as symptoms of motion (simulator) sickness, disturbance of eye-hand coordination or drowsiness (Loomis et al., 1999; Schuemie, van der Straaten, Krijn, & van der Mast, 2001). Occurrences of after-effects depend highly on individual characteristics but also on features of the technology itself. Basically, all senses involved in the VR experience need to perfectly fit together. For example, if vision and motion are ill-fitted, dizziness and nausea are more likely to occur (Schuemie at al., 2001). It is also important to keep external artefacts to a minimum.

However, the most significant challenge in VR research is the question of transfer. Can experiences and training effects that were gathered in a VR scenario be transferred into reality? As mentioned above ecological validity is higher than in conventional research but it still has its limits. Although VR technology, both programming of simulations and VR equipment itself, has improved significantly over the years, it comes with imperfections and problems that can unintentionally influence people's experience (Loomis et al., 1999; Schuemie et al., 2011). Research indicates that higher levels of *presence* are related to a better transfer of knowledge and skills accumulated within a VR scenario (see Bossard et al., 2008; Kothgassner et al., 2012). Kothgassner et al. (2012) concluded that “It therefore seems crucial to develop virtual scenarios with the best possible stimulation and rich content in order to enhance presence and therein increase the efficacy of the training tool” (p.64). So how is VR technology being used in the context of mental stress tasks?

4.1.2 Confrontation with social threat within a virtual reality.

VR technologies have become popular in research assessing physiological as well as psychological stress responses. Indeed, results indicate that VR technology seems to be a useful tool for applying mental stress tasks, thus confronting individuals with socially threatening stimuli (see Kothgassner et al., 2012; Kotlyar et al., 2008; Pertaub et al., 2002; Slater, Pertaub, Barker, & Clark, 2006).

A key element to mental stress tasks is that those tasks are presented in front of an audience and therein enhance stress-arousal (see chapter 2.3). For instance, Slater et al. (2006) conducted a VR study wherein individuals with tendencies towards “fear of public speaking” had to either give a talk in front of a virtual audience or within an empty room. Subjects showed greater levels of anxiety and physiological stress-responses when talking in front of an audience. These results indicated that the presence of an audience was related to greater arousal, not merely the use of VR technology itself. In addition, other research showed that

VR technology could also be successfully applied to induce stress in healthy subjects (see Kotlyar et al., 2008). Kothgassner et al. (2012) found similar results on the importance of an audience being present during a speech task. The research group compared healthy subjects that had to accomplish a speech task in front of a virtual audience (experimental group) to subjects that accomplished the same task but were instructed to only imagine an audience (control group). Results showed that the experimental group displayed higher physiological stress levels and self-reported anxiety. Further, in comparison to the control group, subjects of the experimental group perceived the VR scenario at a greater level as "real".

Concerning the present study two things have to be noted. One, it was chosen to apply the Trier Social Stress Test (TSST) because it was found to be a highly effective and reliable tool for evoking stress-responses (see chapter 3.1 and 7.2.8). The research group around Wallegård and Jönsson (2010; 2011) were among the first to develop a virtual version of the TSST (VR-TSST). Results indicated that levels of stress-arousal were comparable to those in studies that applied traditional versions of the TSST. Secondly, each subject completed a VR-TSST repeatedly on three different days of testing. Again, a study conducted by Jönsson et al. (2010) is the only one known of that analysed habituation of stress-arousal with the application of a VR-TSST. Results indicated a significant reduction of stress-arousal (reduced heart rate and self-reported anxiety) on the second day of testing.

Generally speaking, the aim of repeated stimulus-exposure within a VR is the same as within the physical environment. As a result of confrontation, maladaptive responses are triggered, allowing subjects to modify their stimulus-response pattern and cognitive schemata (see chapter 3.3) (Rothbaum, & Hodges, 1999; Wiederhold, & Wiederhold, 2000).

III. Empirical section

5. Objective of the study

The aim of this study was to analyse the influence of a stress-inducing situation within a virtual reality setting on the recognition of facial emotions – specifically facial emotions that were related to threat, such as anger and fear (see chapter 2). It was of further interest, if any gender differences in recognition accuracies occurred (see chapter 1.1.1).

However, the most important but underlying purpose of this study was to gather information on the application of virtual reality in an experimental context. Since the use of virtual reality technology is fairly new in the field of psychological research, phenomena associated to it are of great interest (Bente at al., 2002). Subsequently, individuals were confronted with a stress-inducing situation within a virtual environment. Levels of state-anxiety were used as indicators of stress and arousal. A reliable way of inducing stress and thus, enhancing anxiety, is to confront individuals with some kind of presentation task in front of an audience. Such tasks are characterised as socially threatening (Dickerson, & Kemeny, 2004).

Of further interest was the process of habituation to these socially threatening stimuli in a virtual environment. Hence, confrontation was repeatedly conducted over a period of three days. To date, there is no virtual reality study known of that analysed the habituation of stress-arousal over a three day period and how emotion recognition is influenced by it.

6. Research questions and hypotheses

This study stands in line with previous research conducted by Jönsson et al. (2010), who confronted participants with a virtual version of the TSST (Kirschbaum et al., 1993) on two consecutive days. Results indicated that subjects showed signs of habituation of stress-arousal. For instance, HRV and state-anxiety scores declined on day two of testing. However, there are a couple of limitations to this study, such as a very small number of only

10 participants and the non-existence of a control group. Consequently, Jöhnsson and colleagues (2010) compared their own results only with results attained from other publications. Thus, it was of interest if the current study could replicate these findings of habituation of stress-arousal in a virtual environment. In addition, a three-day testing period was chosen and a second experimental group was created, that experienced the exact same experimental manipulation – a social stress situation (TSST, Kirschbaum et al., 1993) – but in the physical world. Throughout this thesis the first experimental condition will be labelled as “virtual” and the second experimental condition as “real”. There is a whole body of literature on successful habituation-processes in the context of virtual reality exposure and anxiety (Fox et al., 2009; Rothbaum, & Hodges, 1999; Wiederhold, & Wiederhold, 2000). Therefore it was believed that state-anxiety would habituate.

Having said this, the influence of anxiety on emotion recognition was of interest and if the two experimental groups differed in this regard. Empirical findings very much support theories of cognitive biases in the context of anxiety. Further, the majority of studies reported attentional biases in anxiety provoking situations, indicating that threatening or threat related stimuli draw one's attention in such situations (Bar-Haim et al., 2007; Roelofs et al., 2005; 2007).

The literature suggests that there are gender differences in facial emotion recognition accuracies, with females showing an advantage in automatic processing of facial emotions (Hall et al., 2000; Hall, & Matsumoto, 2004; Montagne et al., 2005). Hoffman and colleagues (2010) however, suggested that these differences only occurred regarding the recognition of subtle emotions, not of “full” emotions. It therefore was of interest if participants showed any gender differences in recognition accuracies. Figure 1 presents variables that were analysed in this study and how they were thought to influence each other.

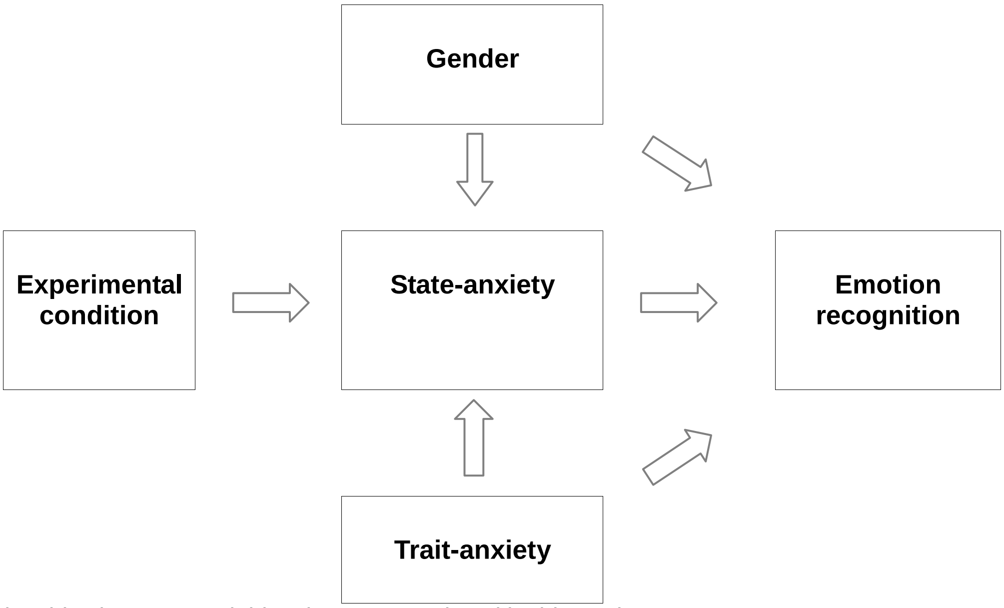

Fig. 1 Relationships between variables that were analysed in this study

In sum, research questions and accompanying hypotheses were the following:

Research question one: Do emotion recognition accuracies differ over a three-day testing period, when regarding each experimental condition (virtual and real) and levels of state-anxiety?

$H_1 0$: Emotion recognition accuracies do not differ over a three-day testing period ($\mu_1 = \mu_2$)

$H_1 1$: Emotion recognition accuracies differ over a three-day testing period ($\mu_1 \neq \mu_2$)

Research question two: Is there a relationship between state-anxiety, trait-anxiety and emotion recognition accuracies in the two experimental conditions (virtual and real) over a three-day testing period?

$H_2 0$: There is no relationship between state-anxiety, trait-anxiety and emotion recognition accuracies ($p = 0$)

$H_2 1$: There is a relationship between state-anxiety, trait-anxiety and emotion recognition accuracies ($p = 1$)

Research question three: Do female and male subjects differ in emotion recognition accuracies over a three-day testing period, when regarding each experimental condition (virtual and real) and levels of state-anxiety?

$H_3 0$: Females and males do not differ in emotion recognition accuracies ($\mu_1 = \mu_2$)

$H_3 1$: Females and males differ in emotion recognition accuracies ($\mu_1 \neq \mu_2$)

7. Method

The aim of this chapter is to present specific characteristics of this study, such as the design itself, the testing procedure and the sample, as well as research instruments and statistical analysis that were applied.

7.1 Research design

This thesis is part of a greater project which focused on the habituation of psychophysiological and endocrinological factors via repeated social-stress exposure in a virtual environment. In short, it is called “Reizhabituation” and was conducted at the *Virtual Reality Laboratory* at the Department of Applied Psychology: Health, Development, Enhancement and Intervention of the University of Vienna in association with Univ.-Prof. Helmut Hlavacs (Faculty of Computer Science), Dr. Lisa M. Glenk (Molecular Biology), o. Univ.-Prof. Dr. Ilse Kryspin-Exner (Department of Applied Psychology: Health, Development, Enhancement and Intervention), Mag. Anna Felnhofer (Working Group Clinical Psychology) and Mag. Oswald D. Kothgassner (Working Group Clinical Psychology).

Consequently, that project lead to the initiation of this current study, as well as the accomplishment of two parallel theses (Flick, 2013; Heinzle, in preparation). The main purpose of this greater project was a better insight into phenomena associated to virtual reality and stress-arousal. It has to be seen in the context of basic psychological research. Further, an experimental design with repeated measurement was applied and there were two conditions to which participants were randomly assigned: “virtual” and “real”. Within the sample no clinical symptoms were documented, meaning that it could be classified as a non-clinical population.

To assemble this population a preliminary assessment was carried out (see chapter 7.2.3 for selection criteria) and only after accomplishing this, the actual testing began. Each participant had to come in for approximately 150 minutes on three separate occasions. In sum, each subject had a testing period of approximately 450 minutes, which add up to about seven and a half hours. The first and the second day of testing had to be on consecutive days and, if possible, beginning at the same time every day. The third day of testing was a follow-up exactly seven days after the second day of testing, again beginning at the same time as on the previous two days. There is no difference in the design of the three days – apart from a few questionnaires that were only presented on one of the three days (see chapter 7.2.7, table 3). Basically the design of each day can be divided into three parts: pre-experimental measurements, experimental manipulation “virtual” versus “real” and post-experimental measurements (figure 2).

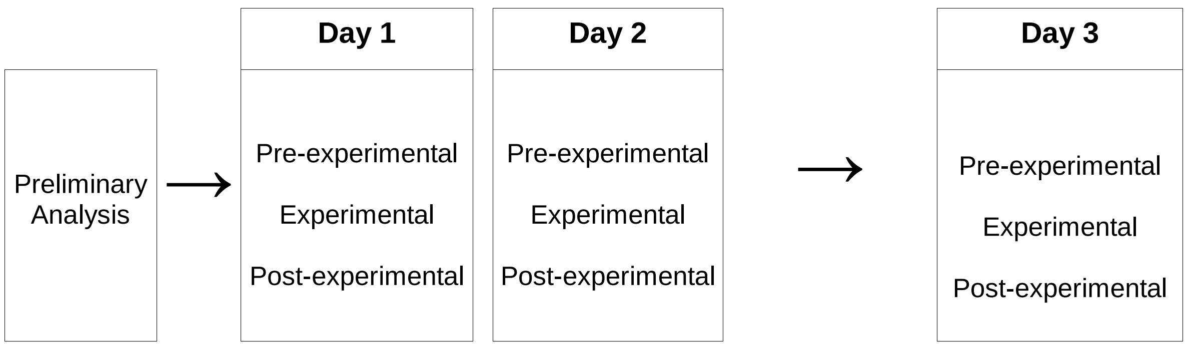

Fig. 2 Research design

The experimental manipulation can be further divided into five sections. These five sections are based on the Trier Social Stress Test (TSST), a tool developed by Kirschbaum, Pirke and

Hellhammer (1993) for investigating psychophysiological stress responses in a laboratory setting. For exact definition of the five periods see figure 3 and for more detailed information chapter 7.2.6. Participants assigned to the “virtual” condition, accomplished speech and arithmetic tasks in a virtual reality environment. Participants assigned to the “real” condition, experienced the whole TSST within the natural environment.

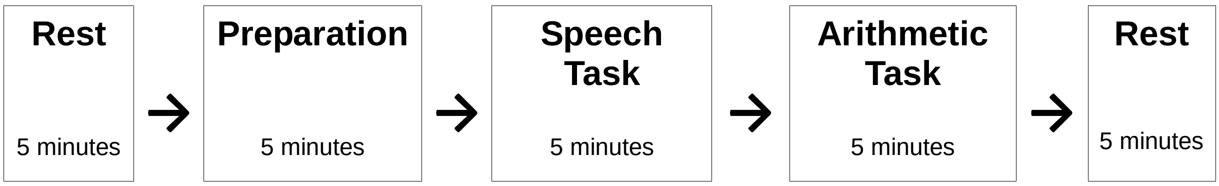

Fig. 3 Five periods of the TSST (Kirschbaum et al., 1993)

Three types of measurement were used: For the analysing of psychological mechanisms questionnaires were deployed. For a more objective measurement of individual stress-arousal physiological and endocrinological dimensions were used. Heart rate variability (HRV) and respiratory rate were assessed, and, since Cortisol is one of the most important hormones related to stress, samples of such were collected (Glenk, 2011). Concerning the research questions of this study, only psychological measurements were used. For a more detailed explanation of physiological measurements please refer to the work done by Heinzle (in preparation). However, for the sake of completeness, these measures are mentioned throughout this piece of work.

7.2 Characteristics of the study

Object of this section is to explain initial considerations that had to be taken into account before starting the actual testing process. These include thoughts on ethical questions and how to ensure aspects like anonymity and freedom of voluntariness (Felnhofer, Kothgassner, & Kryspin-Exner, 2011). Other crucial aspects include recruitment of participants, hence, inclusion/ exclusion criteria and drop outs, as well as potential confounding variables.

7.2.1 Ethical questions and informed consent.

To induce psychosocial stress, which is accompanied by negative affects, could be ethical questionable. However, stress levels experienced because of the TSST do not greatly differ from stress levels that are experienced in every day life. Students especially, should be used to similar situations and stimuli confrontations and should not show any negative consequences or aftermath (Kirschbaum et al., 1993). Another strain on participants was the extremely time consuming design. On the one hand, benefits for basic psychological research could not have been pronounced enough. On the other hand, and more popular with the subjects, they received course credit or real credit in exchange.

Prior to testing, participants were provided with as little information as possible on the core content of the study. Design and purpose of the study was only roughly explained because the experimental manipulation via TSST was ought to have a surprising effect on each subject (Birkett, 2011). Thus, participants were only fully informed about the purpose of the project at the end of the whole testing process. Nonetheless, prior to testing, individuals were advised about general issues (via written informed consent). This included anonymity of data and their right to quit the experiment at any point in time (Felnhofer et al., 2011). Anonymity was ensured because each participant got allocated a code, made up out of a consecutive subject number and the number of the day of testing and, if a specific measurement was repeatedly conducted in one day, then the serial number of that as well (e.g. 01.T1.1; 01.T2.1; 01.T3.1; 01.T1.2; 01.T2.2). The same code was used on all measurements – questionnaires, cortisol samples and physiological measures. Further, cortisol samples will be destroyed after they are analysed by Dr. Glenk of the department of molecular biology. With participants signing the informed consent, they confirmed that they would participate at all three days of testing.

7.2.2 Recruitment.

Most subjects were undergraduate students of the Faculty of Psychology at the *University of Vienna*. In exchange for course credit (regarding lectures of Clinical Psychology I and II), individuals participated in the project. The project was actively promoted in the lectures themselves and in seminars associated to new technologies in the area of clinical psychology. If subjects had no use for course credit, they got paid a small amount of money.

7.2.3 Inclusion and exclusion criteria.

Both males and females, aged between 20 and 30 years were invited to participate in the project. Results and conclusions from this study were based on data that was accumulated from a non-clinical population. To ensure that individuals did not have any clinical manifestations the *Brief Symptom Inventory* (BSI; Derogatis, & Melisaratos, 1983; Franke, 1995) was applied (for a more detailed explanation see chapter 7.2.6). Franke (1995) suggests a cut-off value of T greater than or equal 63 on at least two scales. Any value exceeding this given number indicated a certain amount of psychological distress and the person was excluded.

Since the greater project was designed to also measure heart rate variability and cortisol dimensions, it was important to ensure potential confounders could not do any harm to those variables. Thus, other exclusion criteria had to be introduced: On the days of the actual testings participants were not allowed to consume caffeine or nicotine, take blood thinning medications, nor perform any form of extreme physical activity prior to testing. Also, subjects suffering from heart disease and individuals that took psychotropic drugs or drugs that influenced the endocrinological system had to be excluded from the study (von Dawans, Kirschbaum, & Heinrichs, 2011; Kirschbaum, Kudielka, Gaab, Schommer, & Hellhammer, 1999). One last, but definitely not least, exclusion criteria needs to be explained: only females that did not use any form of contraception could participate. This is due to the influence various forms of contraception have on the natural menstrual cycle and the hormone cortisol (Kirschbaum et al., 1999).

7.2.4 Drop-out.

Unfortunately, there always seems to be a certain drop out rate in empirical studies, thus there was no exceptions in this project. All in all, six of 50 individuals (12%) abandoned, due to various reasons, the testing process. Interestingly, only one person immediately quit on finding out that the task would involve presenting oneself in front of a jury ("real" condition). Apart from that person, all drop-outs were participants that were assigned to the "virtual" condition. Two individuals completed the first day of testing fully but cancelled the follow-up appointments (see chapter 7.2.8 for a more detailed description).

7.2.5 Potential confounding variables.

Extraneous variables that correlate with independent variables and outcome variables, might lead to misinterpretation of the relationship between the two latter. Hence, the observed results might not reflect the real results. Having this in mind, testers made sure that noise, light or other hazards were kept to a minimum – especially throughout the crucial experimental manipulation phase.

7.3 Research instruments

Since this thesis is part of a greater project, a variety of research instruments were applied that were not used in answering the current research questions. However, for sake of completeness they will be listed in the following tables. As mentioned above, participants had to meet the inclusion and exclusion criteria. Therefore a preliminary assessment was conducted. Table 1 lists questionnaires that were applied. They were accessed online (via www.socisurvey.de) and were completed in the participants' own time.

Tab. 1

Questionnaires applied in a preliminary assessment

Questionnaires	Authors	Measured construct
Informed Consent		
Socio-Demographic Data		
Brief Symptom Inventory (BSI)	Franke , 1995	Self-assessment of psychological distress
Expectations		Expectation and experience in the context of VR
Social Support questionnaire (F-SozU)	Frydrich, Sommer, Brähler, 2007	Social support
Big Five Inventory BFI-10	Rammstedt, Kemper, Klein, Beierlein, & Kovaleva, 2012	Personality dimensions
Fear of Negative Evaluation Scale (FNE)	Leany, 1983	Fear of negative evaluation
Emotion Regulation Questionnaire Trait (ERQ TRAIT)	Abler, & Kessler, 2009	Emotion regulation
Rosenberg Self-Esteem Scale (RSES)	Rosenberg, 1965	Self-Esteem
Personal Report of Confidence as a Speaker (PRCS-12)	Paul, 1966	Fear of public speaking

Further, table 2 lists all instruments that were conducted in the main analysis but only the ones that were used in this thesis will be explained in greater detail. In order to control for fatigue, questionnaires were alternated between paper-pencil versions and online versions. Instruments marked with * in table 2 were applied as paper-pencil.

7.3.1 Informed consent.

Aim of the informed consent, which was based on results from Felnhofer (2011), was to provide participants with information on the project, on their rights and on data privacy (see chapter 7.2.1). It also provided the experimenters with a written confirmation of a subject's participation. With participants signing the informed consent, they agreed to all terms. In case of any urgent questions after the testing-process, contact details were given.

Tab. 2

Overview of all research instruments applied in the main testing procedure

Instrument	Authors	Measured construct
Informed Consent*		
Positive and Negative Affect Schedule (PANAS)*	Watson & Clark, 1994	Current affects
State-Trait Anxiety Inventory (STAI)*	Laux, Glanzmann, Schaffner, &Spielberger, 1981	Trait-Anxiety (STAI T) and State-Anxiety (STAI S)
Subjective- Stress-Scale (VAS)		Subjective stress-arousal
Vienna Emotion Recognition Task-Short (VERT-K)	Pawelak, 2004	Emotion recognition
Interpersonal Reactivity Index (IRI)	Davis, 1980	Empathy
Primary Appraisal Secondary Appraisal (PASA)*	Gaab, 2009	Subjective stress-arousal
Focus of Attention Questionnaire (FAQ)	Woody, Chambless & Glass, 1997	(Self-) focus of attention
Networked Mind Questionnaire (NMQ)	Biocca, Harms & Gregg, 2001	Social presence
Five Facet Mindfulness Questionnaire (FFMQ)	Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006	Mindfulness
Reading Mind in the Eyes-Test*	Baron-Cohen, 2001	Cognitive and emotional empathy
Rumination Response Scale (RRS)*	Nolen-Hoeksema, & Morrow, 1991	Rumination
PASA-2, consisting of VAS (PASA), ERQ and social support*	Gaab, 2009; Abler & Kessler, 2009	Subjective stress-arousal, social support, emotion regulation
IPQ*	Schubert, Friedmann, & Regenbrecht, 2001	Presence
SPQ*	Bailenson, Blascovich, Beall & Loomis, 2001	Social presence
Immersion Questionnaire (IQ)*	Jennett, Cox, Cairns, Dhoparee, Epps, Tijs & Walton, 2008	Immersion
Presence-questionnaire (SUS)*	Slater, Usoh & Steed, 1998	Presence
Trier Social Stress Test (TSST)	Kirschbaum, Pirke & Hellhammer, 1993	Stress-responses

*paper-pencil questionnaires

7.3.2 Socio-demographic Data.

Socio-demographic data was determined through the preliminary assessment.

Questions were specifically constructed for this project and engrossed following variables: a) gender, b) age, c) highest completed level of education, d) nationality, e) marital status, f) occupation, g) first language, h) field of study, i) handedness, j) height and weight, k) existence of physical or psychological disorder, l) regular taking of medication, m) existence of any skin disease or irritations n) existence of claustrophobia, o) type of contraception, p) number of children, q) cycle duration and the first day of the last menstrual cycle, r) lactation period, s) mean grade of the high-school subject mathematics t) self-assessment of mathematical knowledge), u) routine use of computers, v) weekly hours working with a computer, w) experience with computer and video games/ which type of games. Further, positive and negative expectations towards *virtual reality* were assessed. Apart from a general rating, it was specifically asked to note one's exact expectation. Previous experiences with VR technology were also assessed, as was the level of joy over the possible experience of VR technology.

7.3.3 Brief Symptom Inventory (BSI).

The *Brief Symptom Inventory* (BSI; Derogatis, & Melisaratos, 1983; Franke, 1995) is a self-report inventory designed to assess physical and mental symptoms of psychological distress. With its 53 items it is a short form of the *Symptom Check List 90- revised* (SCL-90-R; Derogatis, 1977). In order to evaluate individual distress subjects rate, on a five point likert scale (0= *not at all* to 4= *extremely*), the extent to which they disagree or agree with each of the 53 items. The symptoms assessed in the *BSI* can be divided into nine subscales: 1. Somatisation, 2. Obsessive-compulsive, 3. Interpersonal sensitivity, 4. Depression, 5. Anxiety, 6. Hostility, 7. Phobic anxiety, 8. Paranoid ideation and 9. Psychoticism. In addition three global scales of psychological distress can be gained: 1. Global Severity Index (GSI), 2. Positive Symptoms Total (PST) and 3. Positive Symptoms Distress (PSD). GSI can be seen as a general estimate of psychological distress, PST assesses the number of “critical” symptoms and PSD the intensity of these.

So what are “critical” symptoms? The raw scores can be transformed into standardised T-values with the help of norm charts. The norms of non-patient adults were used. Franke (1995) suggests that values between 40 and 60 were in the range of healthy individuals and indicated a cut-off T-value greater than or equal 63 on at least two scales or on the GSI score. Any value exceeding this given number indicated a certain amount of psychological distress and the symptom could be seen as clinical significant. Internal consistencies of the *BSI* scales lie between r=.63 and r=.85 and show a retest reliability over a period of one week of r=.73 and r=.92. The average time required to accomplish the inventory is about 10 minutes (Franke, 1995).

7.3.4 Trier Social Stress Test (TSST).

Throughout this thesis it has been mentioned various times that the TSST, developed by Kirschbaum, Pirke and Hellhammer in 1993, was conducted to induce standardised psychosocial stress (measured in psychological, physiological and endocrinological dimensions) in a laboratory setting. The authors also stated that the TSST was a reliable tool for repeated stress-exposure. Kirschbaum (2010) himself reported that enhanced levels of stress-arousal could be measured in 80–85% of healthy subjects that were exposed to the TSST. Further, stress-arousal was highest 1–30 minutes after stress-exposure (see Dickerson, & Kemedy, 2004; von Dawans et al., 2011; Kirschbaum, 2010).

Kirschbaum et al. (1993) developed a test protocol with exact instructions that led to standardised stress induction. In figure 2 (chapter 7.1) the five crucial periods have already been presented: 1) Rest Period, 2) Preparation Period, 3) Speech-Task, 4) Arithmetic Task and 5) Rest Period. Time that was given for each of these sections varied in all studies on hand (see von Dawans et al., 2004; Jönsson et al., 2010; Kirschbaum et al. 1999) and it was decided to set each period to five minutes. Hence, the time required to complete the TSST was 25 minutes. To elevate stress responses it also was recommended to complete the

TSST in a separate room to pre- and post-measurements (Birkett, 2011; Kirschbaum et al. 2010).

To make sure that instructions were standardised across all subjects, they were handed over in written form. First, participants only found out that they were going to accomplish a job interview including a task and what condition they were assigned to (prior to the first rest period). Then, prior to the preparation period, subjects were told to choose their ideal job and that they would have five minutes to prepare a speech on why they were the “perfect applicant for the vacant job” (Kirschbaum et al., 1993, p.77). Further, it was pronounced that the committee was going to evaluate the performance.

Individuals were allowed to outline their speech but were notified that they were not to use notes in the actual interview. After five minutes of preparation the job interview began. The committee, consisting of a female and a male, entered, welcomed the applicant and asked him or her to give their speech. If the participant stopped talking he or she was asked to continue. After the five minutes speech-task participants were asked to “serially subtract the number 13 from 1.022” (Kirschbaum et al., 1993, p.77). If a mistake was made they were asked to start again from 1.022. After completing five minutes of this arithmetic task the committee thanked for the participation, left the room and a rest period followed.

It was mentioned in chapter 2, that the key components of a social threatening situation are the fear of being negatively judged as well as uncontrollability of a performance task (see Dickerson, & Kemedy, 2004; von Dawans et al., 2011). Both of these criteria have been met in the construction of the TSST. Hence, on top of the performance tasks, there was an evaluative audience present which wore neutral facial expressions and showed no emotional responses (Kirschbaum et al., 1993). In recent years various research groups applied the TSST within a VR scenario and reported promising results. No significant differences in stress levels were found between a TSST applied in-vivo and a TSST applied in-virtuo (Jönsson et al., 2010; Kelly et al., 2007; Kotlyar et al., 2008). Please refer to chapter 4.2 for advantages and disadvantages of the use of VR as a research tool.

7.3.5 Vienna Emotion Recognition Task (VERT-K).

This instrument was applied to measure performance of emotion recognition of unfamiliar faces. The theoretical framework is based on the importance of emotion recognition for nonverbal communication. The VERT-K (Pawelak, 2004) is a shortened version of the VERT-160 (Kryspin-Exner, Gur, Hoheisel, Klein and Six, 2003), which again is based on neuropsychological diagnostic procedures called *Computerized Neurobehavioral Probes* (CNP) which were developed by Gur, Erwin and Gur (1992).

The VERT-K consists of 36 coloured photographs of facial expressions based on Ekman's (1993) basic emotions. Thus, an equal number of five basic facial expressions (anger, fear, disgust, happiness and sadness) and neutral expressions were depicted by middle-aged Caucasians. The computerised material was balanced for gender (18 female and 18 male pictures) and valence, meaning that the same number of stimuli per emotion and neutral expression could be found: six. The emotion surprise, which is according to Ekman (1993) one of the six basic emotions, was not included in the stimuli because there is doubt to whether it can be categorised as such (Kryspin-Exner et al., 2003). The material was originally taken from a whole set of stimuli that were developed, standardised and repeatedly used by Gur et al. (1992; 2002). During the process of adapting the stimuli to German speaking populations, they were validated for the Austrian population (Hoheisel & Kryspin-Exner, 2005). Only evoked emotions were used in the VERT-K and each person depicting an expression was seen only once. The stimuli were presented in randomised order.

The task itself was to classify the facial expression on screen as one of the five emotions (anger, fear, disgust, happiness and sadness) or the neutral expression. All six answering options were given next to the facial expression and a forced-choice format was selected. Prior to the actual task participants had the chance to practice on one separate stimulus, then the 36 photographs followed. The average time for completing the task varied between 5 – 10 minutes. The VERT-160 (Kryspin-Exner et al., 2003) and VERT-K (Pawelak, 2004) have both been repeatedly used in research. For instance, results can be used for generating hypothesis on the correlation of impairment of performance and neurological activity (see Derntl et al., 2008).

Due to the computerised procedure and according to Pawelak (2004) objectivity of application, analysis and interpretation can be expected. Internal consistencies (cronbach's α) of the emotional expressions lie between α=.46 and α=.55 and of the neutral one α=.48. It was found in numerous studies that the expression of happiness was correctly recognised the best (Derntl, Kryspin-Exner, Fernbach, Moser, & Habel, 2008; Derntl, Windischberger et al., 2008; Kryspin-Exner at al., 2003). Further, Hoheisel, & Kryspin-Exner (2005) did not find any significant gender differences when applying the VERT-160 to a healthy population.

7.3.6 State-Trait Anxiety Inventory (STAI).

In order to measure anxiety at various points of the testing process the state-trait-anxiety-inventory was applied. The original version had already been developed in 1970 by Spielberger, Gorusch and Lushene but the German adaption by Laux, Glanzmann, Schaffner and Spielberger from 1981 was used in this project. The inventory is based on the differentiation between anxiety as a temporary state and anxiety as a set trait in the sense of a personality trait (see chapter 2.1). According to Spielberger and Sydemann (1994) the theoretical framework was based on Freud's danger signal theory (1936) and Cattell's constructs of state and trait anxiety (1966). Up until today it is widely used in anxiety and stress research, as well as in clinical practice (Bar-Haim et al., 2007; Kothgassner et al., 2012).

The state anxiety scale is consists of 20 statements and subjects are basically asked to characterise, on a four point scale (1=”not at all” to 4=”extremely”), their momentary state (of anxiety). Ratings can be seen as information on the intensity of anxiety, which again depends on variables such as the situation itself, the individual level of trait-anxiety or the availability of coping-strategies. Since individual changes in between pre-experimental and post-experimental state-anxiety were of interest, these statistical values were compared with one another. The trait anxiety scale is also made up of 20 statements and subjects were asked to rate, on a four point scale (1=”hardly ever” to 4=”almost always”), their general feeling (of anxiety). Ratings can be seen as information on the frequency of anxiety. A high statistical value is associated with a stable tendency of evaluating a situation as threatening and consequently responding with an increase of state-anxiety. This scale was only completed once on the first day of testing.

Internal consistencies of both scales are high (r=.90). The trait scale exhibits a retest reliability over a period of 63 days of r=.77 to r=.99. Not surprisingly, the state scale exhibits a lower retest reliability of r=.22 to r=.53. The average time required to accomplish the inventory is said to be 15 minutes, but participants of this project never exceeded a five minutes limit.

7.4 Testing process

The design of this study was already briefly introduced in chapter 7.1 but this section describes the testing process in more detail. Once individuals were selected through preliminary analysis, the actual testing process started. Generally speaking, each day could be divided into three parts: pre-experimental phase, experimental phase and post-experimental phase (see table 3). Please refer to table 2, p.41 for a more detailed description of all instruments listed in table 3.

Testings were conducted between 2 pm and 8 pm each day in order to control for fluctuation of cortisol levels (Pruessner et al., 1997). Upon arrival, individuals were asked, if nicotine or caffeine had been consumed that day or if any form of extreme physical activity had been performed – if that were the case, these subjects would have to be excluded (see section 7.2.1). Also noted was the time the person awoke that morning. Again, these variables could affect physiological and hormonal activity (von Dawans et al. 2011; Kirschbaum et al., 1999). After completing pre-experimental measures (table 3), the experimental phase began, which was conducted in the *Virtual Reality Laboratory.*

Tab. 3

Research instruments by experimental phase

Pre-Experimental Phase	**Experimental Phase**	**Post-Experimental Phase**
Pre-screening	PANAS [a]	IPQ [b]
Informed consent [a]	STAI S [a]	PASA-2
PANAS	Subjective Stress 1	Slater-PQ
STAI S	Debriefing	SPQ [b]
STAI T [a]	PASA	IQ [b]
IRI	**TSST- “virtual” vs. “real”**	FAQ
VERT-K[a]	PANAS	NMQ
	STAI S	IRI
	Subjective Stress 2	FFMQ
		VERT-K
		RME [c]
		Rumination Scale
		PANAS
		STAI S

Note. Instruments in bold letters were pivotal for this study. Refer to table 2, p.41 for a more detailed description of all instruments.
[a] These questionnaires were only applied on the first day of testing, not the second or third day
[b] These questionnaires were only applied in the “virtual” condition
[c] This questionnaire was only applied on the third day of testing

What happened next? To put it simple: participants experienced a standardised job interview and an arithmetic task in front of a committee (TSST, Kirschbaum et al., 1993). This happened either within a VR environment (“virtual” condition) or in the natural environment (“real” condition). After participants accomplished the TSST, the effects of stressful stimuli, on various psychological constructs, were operationalised in the post-experimental phase.

Aim of the greater project was not only to examine psychological dimensions but to also collect physiological and hormonal data (see Glenk, 2011). Hence, during the experimental phase, heart rate variability and respiratory rate of each participant were recorded via biofeedback technology (Schuhfried BFB 2000 x-pert, Modelling, Austria). After completing the TSST, four cortisol samples were taken once every 10 minutes. A fifth and sixth sample was taken once every 20 minutes after the fourth sample. I will not go into more detail about these variables, since this current work is only focusing on psychological dimensions. Please refer to Heinzle (in preparation) for more information on these types of measurement.

7.4.1 “Real” condition.

Overall, 22 participants completed parts of the TSST in front of a *real* committee. After the preparation period the committee, consisting of a male and a female, entered the room and sat down opposite the subject. Since the interview was standardised, a specific script was followed. The same applied to the arithmetic task. On accomplishing both tasks, the committee got up and left the room.

Further, eleven subjects communicated only with the male and eleven subjects communicated only with the female committee-member. Again, this was randomised prior to testing. In order to further elevate stress-arousal, the committee was also instructed to wear a neutral facial expression and not to show any form of social interaction or emotional reaction, e.g. approval or disapproval (Kirschbaum et al., 1993).

7.4.2 “Virtual” condition.

Data collected from the ”real” condition, would later be compared to data gathered from the “virtual” condition. To ensure comparable statistical information the same script applied to both conditions. The only difference was that after five minutes of preparation, individuals experienced the actual interview and the arithmetic task within a virtual reality. The virtual environment was simulated via a *Head Mounted Display* (HMD), meaning that individuals wore glasses with two integrated micro-displays. This device creates an accurate impression of depth and perspective in a three-dimensional space. The glasses used in this project were *Sony HMZ-T1 3D Visor (1x)*, including an additional Head-Tracking System (TrackIR). The simulation itself was created with the help of following programmes: Visual Studio C++ Express, Ogre3d graphics engine in combination with QuickGUI, Blednder3D and Gimp (c.f. Kothgassner et al., 2012).

Having this technology made it possible to simulate the interview and take participants into a virtual room resembling the *Virtual Reality Laboratory*. Hence, when subjects first put on the glasses, they were sitting opposite a table and two empty chairs in a room and they had a chance to get familiar with the scene. Once the committee, a male and a female avatar, entered, the interview began and the arithmetic task followed. Again, each subject either heard the male or the female speak.

Facial expressions of the avatars were adjusted to a neutral level, meaning they did not show an emotional reaction. Sound was heard through speakers connected to the computer and individuals were asked to speak into a microphone, implying that the avatars actually heard and reacted to whatever was said. However, this was not the case as such because the virtual environment, including exact wording of the avatars, had been programmed prior to testing (with credit to Univ.-Prof. Helmut Hlavacs) and was executed via pressing a button by the experimenters. On a separate screen the whole simulation could be watched and controlled via hitting certain buttons on the keyboard. At this point I want to stress that no recordings were made and that the microphone itself was only a dummy to make participants believe that they could be heard by the avatars. In order for the participants to fully focus on the virtual environment, the laboratory got darkened and the only other person in the room was the experimenter herself.

7.4.3 Role of the experimenter.

Apart from obvious tasks such as handing out and explaining questionnaires and debriefing participants, there were three important duties of the experimenter. One was that of controlling the virtual environment. The other tasks concerned the measurement of physiological arousal and hormonal deviations, hence monitoring heart rate variability and breathing as well as taking samples of saliva. At the beginning of the experimental phase, individuals were hooked up to biofeedback equipment. Electrodes were placed on the torso to measure heart beat and interbeat intervals. To measure respiratory rate, two flexible sensor bands were placed around chest and waist (Birkett, 2011). Further, Cortisol samples were taken at seven different points in time: One before the experimental phase, four of the remaining six once every 10 minutes after completing the arithmetic task of the TSST, followed by the final two once every 20 minutes. As mentioned above, this data was gathered in the context of the larger project and was not used for answering the current research questions.

The experimenter was not involved with confronting individuals with the actual mental stress tasks of the TSST (Kirschbaum et al., 1993). However, it was instructed to wear white lab coats throughout the whole testing process in order to increase stress-responses (Birkett, 2011).

7.5 Participants

Due to the process of recruitment (see 7.2.2) the majority of subjects were students of the Faculty of Psychology at the *University of Vienna*. In total 85 persons completed the preliminary assessment. Due to selection criteria (see 2.3) only 50 individuals (58.8%) could be included in this project. A further six people (12%) quit during the testing process, thus there was a total of 44 participants that accomplished all three days of testing.

7.5.1 Demographic Variables concerning the preliminary assessment.

Of the 85 people that completed the screening 62.4% were female and 37.6% were male. The average age was 23.7 years with a standard deviation (SD) of 2.51 and ranging from 20 to 30 years. About 53% were Austrian, 41% German and 6% various other nationalities. Due to the *BSI* selection criteria (Franke, 1995), 17.6% were excluded. These individuals showed a T-value greater than or equal 63 in two or more scales. Any value exceeding this given number indicated a certain amount of psychological distress. See table A1 in the Appendix for a more detailed description of the BSI scales of this group.

Of the females, 7.5% were using hormonal contraception and were excluded from further investigation. Other exclusion criteria were the use of certain medications, heart-disease, irregular cycle or very heavy smokers. In sum, 41.2% of the original 85 individuals were excluded.

7.5.2 Demographic Variables of the sample.

In the end, 50 (58.8%) individuals met selection criteria and were selected to participate in this project. Mean age was 23.7 years (SD = 2.60), ranging from 20 to 30 years and with half of the sample being female and the other half male. The 12% drop-out rate was made up of three females and three males, who discontinued the testing process due to various reasons. This led to a sample size of 44 individuals, again with 50% being female and 50% being male. 48% of these were Austrian, 50% German and 2% from other nationalities, with 96% stating German as their mother tongue. Further, 84% declared *Matura* as highest completed level of education and 91% were students of psychology.

Of the 22 females, eleven experienced the “virtual” TSST and eleven experienced the “real” TSST. The same applied to the 22 male participants and was randomised prior to testing. The following data only applies to individuals from the “virtual” condition. It was asked how familiar individuals were with operating computers and how many hours weekly were spent directly at the PC. Both females (82%) and males (91%) seemed to be very familiar with PCs. The greatest proportion of females (45%) stated that 10 – 15 hours were spent in front of a PC; the greatest proportion of males (54%) spent 15 – 30 hours, and 18% even spent over 30 hours. Further, 64% of males played computer or video games, whereas 91% of females did not play computer or video games. Not surprising, this difference was significant, $t(40.59) = -3.79$, $p < .001$. Concerning *virtual reality technology* 45% of the females and 55% of the males had not experienced it before. All men and all women stated that they were excited to experience the technology and had medium to high expectations.

Taking a look at the data of the drop-outs nothing striking in particular appears. 50% were female, 50% male. Five of the six people were Austrian, the other one German. None of them had a *BSI* T-value equal or above 63 on any of the scales nor did they take any medications or have any physical or psychological impairments. The only interesting information was that five of the six were assigned to the “virtual” condition and only one person immediately quit after debriefing and finding out that the task would involve presenting oneself in front of a jury (“real” condition). Participants stated they had medium to high expectations to *VR* technology.

7.6 Statistical Analysis

For statistical analysis *SPSS 15.0 for Windows* was used and a significance level of 5% ($p = .05$) was chosen. First, a preliminary analysis was conducted to analyse the baseline data of the VERT-K and the data set of state-anxiety scores. Therefore, repeated measurement analyses of variance (ANOVAs) were applied (see chapter 8.1). For analysing the three research questions a repeated measurement multivariate analysis of covariance (MANCOVA) was run (see chapter 8.2). Cohen's *d* was used as a measure of effect size. According to Cohen (1988) an effect size of $d = .2$ presents a small effect, $d = .5$ a medium effect and $d = .8$ a large effect. When comparing more than two means, η^2 will be reported instead.

8. Results

Aim of this following chapter is to first report results of the preliminary analysis of the VERT-K and STAI and secondly to look at how they interacted over the three day testing period. As mentioned above the sample consisted of 44 subjects. However, due to missing data of the VERT-K on the second and third day of testing, only 39 participants could be included in the analysis of those days.

8.1 Preliminary Analysis

First, in order to check for differences between the two conditions or other confounding variables, baseline data of the VERT-K was analysed. Further, it was hypothesised that state-anxiety would habituate. Hence, scores of state-anxiety were studied.

8.1.1 Baseline data of the VERT-K.

In order to analyse the baseline data of the VERT-K on the first day of testing a repeated measurement ANOVA was conducted with emotions as within-subject factor and gender and condition as between-subject factors.

8.1.1.1 Testing assumptions.

Mauchly's tests indicated that the assumption of sphericity was not met, $\chi^2(14) = 74.92$, $p < .001$. Therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon = .56$). To test whether the data-set was normally distributed, Shapiro-Wilk tests were conducted. There were six levels to the variable *emotion* (anger, fear, disgust, happiness, sadness and neutral). All emotions but one showed significant values indicating that the assumption of normality was violated (all p's < .05). Only data concerning *sadness* within the male population was not significant and indicated normality, $W (22) = .925$, $p > .05$.

Further, Levene's test was conducted to test the assumption of *homogeneity of variances* and showed no significant results, indicating that variances were not significantly different (all p's > .05). Box's test was applied to test the assumption of *homogeneity of covariance matrices*. The test was non-significant, indicating that the matrices were roughly the same.

8.1.1.2 Main results.

In general the facial emotion of *happiness* was recognised best and *sadness* worst. Results from the ANOVA indicated that emotion recognition scores were significantly affected by type of emotion being depicted, $F (2.682, 112.65) = 25.99$, $p < .001$, $\eta^2 = 382$. Post-hoc tests revealed that facial emotions of *sadness* and *disgust* were recognised significantly less often than the facial expressions of *anger, fear, happiness* and *neutral* (all p's < .001). Further, the emotion of *happiness* was recognised significantly better than the emotions of *fear*, *sadness* and *disgust* (all p's < .05). However, recognition scores of *happiness, anger* and *neutral* did not differ significantly (all p's > .10). Please refer to table 4 for means and standard deviations of all scores.

Tab. 4

Means (SD) of correctly recognised emotions by group and gender (baseline data)

Group (N)	**M (SD) of correctly recognised emotions**					
	Anger	**Fear**	**Happiness**	**Sadness**	**Disgust**	**Neutral**
virtual (22)	5.55 (0.858)	5.73 (0.550)	5.82 (0.395)	4.09 (1.950)	4.59 (0.959)	5.55 (0.739)
real (22)	5.64 (0.790)	5.23 (0.685)	5.82 (0.395)	3.73 (1.316)	4.36 (1.177)	5.32 (0.995)

Regarding recognition scores of the facial expression of *fear,* significant differences between the two conditions ("virtual" vs. "real") became apparent, $F (1, 40) = 7.035$, $p = .011$, $d = .82$. According to Cohen (1988) this is a high effect size. This means that the two experimental groups differed prior to experimental manipulation, making any further comparison impossible. Any significant effect could not be associated to the independent variable per se. No significant differences between recognition scores of female and male individuals were found (all p's > .10).

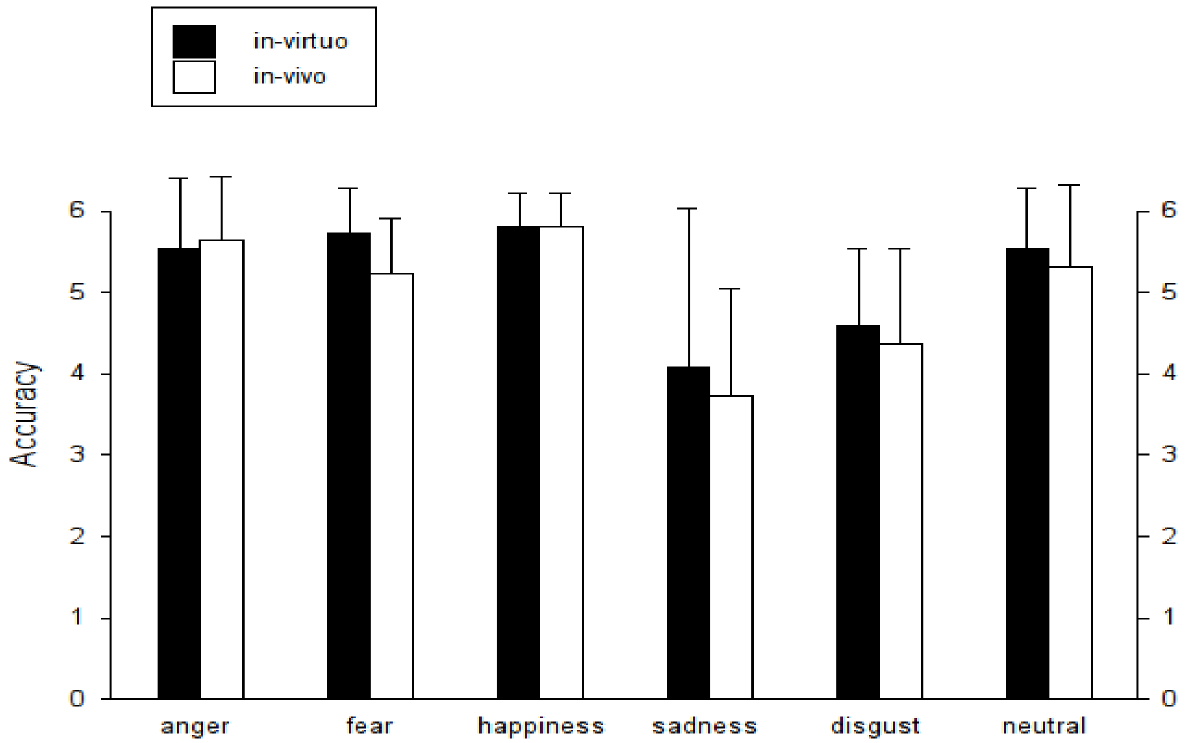

Fig. 4 Baseline emotion recognition accuracies by emotion and group. Highest possible recognition score was 6.

8.1.1.3 Type I error inflation due to ceiling effects.

As figure 4 indicates, most subjects recognised anger-, fear-, happiness-, and neutral-items close to the highest possible score. This is not surprising, since the VERT-160 was mainly developed to analyse emotion recognition deficits in clinical populations (Kryspin-Exner et al., 2003). Further, previous research applying the VERT-K reported similar results in healthy populations (Derntl, Kryspin-Exner et al., 2008; Derntl, Windischberger et al., 2008). However, these results can either mean that most participants showed close to perfect recognition skills or the measure was unable to discriminate between high levels of accuracy, which is characterised as ceiling effects. These ceiling effects present a statistical artifact in further analysis because the probability of obtaining false positive results can inflate. False positive (or type I error) is a statistical term that is used when a null hypothesis is wrongly being rejected, thus is actually true (Austin, & Brunner, 2003; Austin, Escobar, & Kopec, 2000). Having this in mind, some of the data had to be excluded from further analysis: anger-items of the “real” group, fear-items of the “virtual” group and all happiness-items showed very high scores (see table 5) and the risk of making type I errors was too high to interpret further results. Regarding fear-items, further group comparisons were impossible to attain anyway, since baseline-scores significantly differed between the two experimental groups.

Tab. 5

Percentage of correctly recognised emotions by group.

	% correctly recognised emotion					
Group (N)	**Anger**	**Fear**	**Happiness**	**Sadness**	**Disgust**	**Neutral**
virtual (22)	92	**96**	**97**	68	77	92
real (22)	**95**	87	**97**	63	73	89

Note. Bold percentages were excluded from further analysis due to ceiling effects.

8.1.2 Habituation of state-anxiety.

In order to analyse for habituation of state-anxiety over the three days of testing, a repeated measurement ANOVA was conducted, with state-anxiety as within-subject factors and gender and condition as between-subject factors.

8.1.2.1 Testing assumptions.

Mauchly's tests indicated that the assumption of sphericity was not met, $\square^2$ (5) = 27.5,p < .001. Therefore degrees of freedom were corrected using Huynh-Feldt estimates of sphericity ($\square$= .882). To test whether the data-set was normally distributed, Shapiro-Wilk tests were conducted and results are reported for each condition separately. All anxiety scores but one showed non-significant values (all p's > .10), indicating that data was normally distributed. Only anxiety scores of the in-virtuo group on the first day of testing (pre-experimental) were significant, W (22) = .868, p < .05, indicating deviation from normality. However, the ANOVA is thought to be a robust method and deviations from normality can be ignored in this case (Field, 2009). Further, Levene's test was conducted to test the assumption of *homogeneity of variances* and showed non-significant results, indicating that variances were not significantly different (all p's > .05). Since sample sizes were equal, Box's test could be disregarded.

8.1.2.2 Main results.

The results showed that scores of state-anxiety were significantly different across all points of testing, F (2.65, 105.82) = 25.81, p < .001, η^2= .392. Post-hoc tests revealed that post-experimental state-anxiety on the first day of testing was significantly higher in comparison to state-anxiety scores at the other points of testing (all p's < .001). These scores did not differ significantly from one another (all p's > .10). Please refer to table 6 for means and standard deviations of state-anxiety, as well as trait-anxiety, for each condition separately and at all points of testing.

Looking at between-subject factors it was noted that scores did not differ between gender ($p > .10$) but were close to significance for condition, $F(1,40) = 3.25$, $p = .079$, $\eta^2 = .075$. Univariate analysis further revealed that the two conditions did not differ significantly in their anxiety scores on day one of the testing-process, but did differ significantly on day two, $F(1,40) = 5.92$, $p < .05$, $d = .74$ and day three, $F(1,40) = 6.54$, $p < .05$, $d = .76$. According to Cohen (1988) these are medium effect sizes.

Tab. 6

Means (SD) of trait-anxiety and state-anxiety separately for each condition and at four points of testing

		State-Anxiety M (SD**)**			
Group (N)	**Trait-Anxiety** M (SD**)**	**Pre-experimental Day 1**	**Post-experimental Day 1**[a]	**Post-experimental Day 2**[b]	**Post-experimental Day 3**[c]
virtual (22)	36.77 (6.45)	36.41 (7.84)	**44.32** (10.57)	34.27 (6.83)	33.00 (6.32)
real (22)	35.41 (5.95)	37.73 (6.17)	**46.09** (9.50)	38.77 (5.52)	37.77 (6.47)

[a] Scores differed from all other scores at a significance level of $p < .05$
[b] Group-scores differed from one another at a significance level of $p < .05$
[c] Group-scores differed from one another at a significance level of $p < .05$

8.2 Main analysis of emotion recognition scores

A repeated measurement MANCOVA was run to test if state-anxiety, group, gender or point in time influenced the outcome of emotion recognition. Emotions (correct emotion recognition) were repeated within-subject factors, gender and condition between-subject factors and state-anxiety served as covariate. Facial emotions associated to social threat (anger and fear) were of greatest interest, but for sake of completeness other facial emotions were also analysed. However, some of the baseline data of the VERT-K showed ceiling effects (see chapter 8.1.1) and in order to avoid type I errors – finding a significant result when there really is no significant result – following data was excluded: data concerning *anger*-items of the “real” group, data concerning *fear*-items of the “virtual” group and all *happiness*-items. Finally, day one was of greatest interest because state-anxiety scores were highest (see chapter 8.1.2) and most likely to influence the outcome.

8.2.1 Testing assumptions.

Mauchly's tests indicated that the assumption of sphericity was not met for most of the emotion recognition scores. When appropriate, degrees of freedom were corrected using Huynh-Feldt estimates of sphericity. Again, data was not normally distributed (all p's < .05) but the overall high scores lie in the nature of the VERT-K itself. Since MANCOVA is characterised as a robust measure to deviations from normality (Field, 2009) it was applied. Further, levels of the covariate did not differ significantly across the independent variables (p > .10). Since sample sizes were equal, Box's test could be disregarded.

8.2.2 Post-experimental differences in recognition scores.

Results of the “virtual” group related to the facial expression of *anger* were first looked at. They showed that the number of correctly identified anger-expressions was significantly affected by the time of testing, F (1, 39) = 4.57, p = .039, *d* = .56. According to Cohen (1988) this is a medium effect size. Individuals correctly identified more *anger*-expressions post-experimental, in comparison to pre-experimental on the first day of testing. No such effects were found on any other day. Recognition scores declined on day two and three of testing. Due to ceiling effects in the baseline data of the “real” group, post-experimental data was not further analysed and the two groups could not be compared.

Of interest were also recognition scores of the facial expression of *fear.* Due to ceiling effects in the baseline data of the “virtual” group, it was decided not to analyse any post-experimental data of this group. However, data of the “real” group showed that individuals correctly identified more *fear*-expressions post-experimental, in comparison to pre-experimental on the first day of testing. But this result was not significant and only described a trend (p < .10). Further, recognition scores peaked on the second day of testing with individuals recognising significantly more *fear*-expressions in comparison to pre-experimental scores on the first day of testing, F (3, 32) = 4.95, p < .05, *d* = .75. According to Cohen (1988) this is a medium effect size. Table 7 lists means and standard deviations of recognition scores of the emotions *anger* and *fear*.

Regarding recognition scores of the facial expressions of *sadness, disgust* and *neutral*, no significant differences between the testing points were found (all p's > .10). Please refer to table A2 in the Appendix for means and standard deviations of recognition scores of all facial emotions by group, gender and day.

Tab. 7

Means (SD) of recognition scores of the facial emotions *anger* and *fear* by day and condition

Facial Emotion	**Group**	**Pre-experimental Day 1**	**Post-experimental Day 1**	**Post-experimental Day 2**	**Post-experimental Day 3**
Anger M (SD**)**	virtual	**5.55** (0.858)	**5.92** (0.426)	5.88 (0.332)	5.88 (0.332)
Fear M (SD**)**	real	5.23 (0.685)	5.45 (0.671)	5.70 (0.123)	5.45 (0.596)

Note. Highest possible recognition score was 6.

8.2.3 The relationship between emotion recognition and state-trait-anxiety.

The covariate, state-anxiety, was not significantly related to the participant's recognition of any facial emotions, including *anger*, F (1, 39) = 1.81, p > .10 and *fear*, F (1, 39) = .85, p > .10. In order to analyse the relationship between emotion recognition and trait-anxiety, a correlation matrix was created (table 8). Correlations between state-anxiety and emotion recognition were also included. As was explained above (chapter 8.1.1.3) not all data could be used for analysis, thus *anger*-items of the “real” group, *fear*-items of the “virtual” group and all *happiness*-items were excluded. None of the correlations were significant (all p's > .10).

Tab. 8

Pearson correlations between emotion recognition and trait-anxiety (STAI-T) and post-experimental state-anxiety (STAI-S) by group and day

		Day 1		Day 2		Day 3	
Facial Emotion	**Group**	**STAI-T**	**STAI-S**	**STAI-T**	**STAI-S**	**STAI-T**	**STAI-S**
Anger	virtual	.200	.239	-.106	-.039	-.161	.136
Fear	real	.082	.016	.209	-.146	.200	.213
Sadness	virtual	.252	.119	.057	.116	.198	.155
	real	-.392	.004	.060	.033	.169	-.318
Disgust	virtual	.109	-.133	.158	.258	.115	.158
	real	-.089	-.231	.095	.174	.592	-.159
Neutral	virtual	-.252	.097	-.411	.139	-.284	.168
	real	.271	.066	.293	.166	.186	.104

Note. None of the correlations were significant at a significance level of p< .10.

8.2.4 Gender and emotion recognition.

Data concerning the facial expression of *anger* was looked at first. Results showed that on day one, only women recognised *anger*-stimuli better post-experimental (M = 5.82, SD = 0.60) than pre-experimental (M = 5.36, SD = 1.03). However, this effect was only significant at a significance level of p < .10, F (1, 39) = 3.51, p = .069, *d* = .56. According to Cohen (1988) this is a medium effect size. When looking at means and standard deviations of male subjects it became clear on why their recognition scores could not significantly improve. Male individuals already showed extremely high recognition scores pre-experimental, hence there was no room to improve (i.e. ceiling effect). However, males did show a slight improvement post-experimental and recognised all *anger*-items correctly. Table 9 lists means and standard deviations of recognition scores of the facial emotions *anger* for female and male individuals separately. Regarding recognition scores of the facial expression of *fear* in the in-vivo group, no gender differences were found (p > .10) on any of the days. Neither were there gender differences in recognition scores of the facial expressions of s*adness, disgust* and *neutral* (all p's > .05). Please refer to table A2 in the Appendix for means and standard deviations of recognition scores of all facial emotions by group, gender and day.

Tab. 9

Means (SD) of recognition scores of the facial emotion *anger* by day and gender ("virtual" group)

Gender	Pre-experimental Day 1	Post-experimental Day 1	Post-experimental Day 2	Post-experimental Day 3
Female M (SD)	5.36 (1.027)	5.82 (0.603)	6.00 (0.000)	5.88 (0.354)
Male M (SD)	5.73 (0.647)	6.00 (0.000)	5.78 (0.441)	5.89 (0.333)

Note. Highest possible recognition score was 6.

9. Interpretation and Discussion

Subjects were confronted with a stress-inducing situation in a virtual environment or in the physical environment. Aim of the exposure was to increase state-anxiety and analyse the influence it had on recognition accuracies of emotional faces. Of particular interest were facial expressions that were associated to threat and the occurrence of gender differences. A repeated measurement design was chosen to analyse if habituation of arousal occurred. Further, the application of virtual reality technology was of interest and it's efficacy as a research tool was analysed.

9.1 Enhancement of recognition scores of threatening stimuli

Research question one inquired if emotion recognition accuracies differed over a three-day testing period, when regarding each experimental condition ("virtual" vs. "real") and levels of state-anxiety. Although there was no relationship between anxiety scores and emotion recognition scores, individuals of the “virtual” group showed significant changes in accuracy of the facial emotion of *anger* post-experimental on day one. This finding indicated that after being confronted with a stress-inducing situation, individuals recognised a threatening stimulus significantly better than prior to the experiment.

This finding underpins previous results that reported attentional biases in anxiety provoking situations (Bar-Haim et al., 2007; Roelofs et al., 2005; 2007). According to Beck's *content-specificity hypothesis* (1976) stimuli in the environment draw one's attention when they are in accordance with the person's cognitive schemata. In the context of anxiety, such stimuli are thought to be of threatening or of threat related nature, such as angry and fearful faces. Regarding anger-expressions, this hypothesis can be supported with the data of the virtual group.

Concerning fear-expressions, it cannot be supported, even though participants showed significantly higher recognition accuracies on the second day of testing than to the baseline-data. This result however is believed to stem from a training effect, rather than an experimental effect. State-anxiety scores indicated that the first day of testing was the most eliciting and one would expect a more pronounced effect on cognitive processing (Bar-Haim et al., 2007). Since no significantly enhanced accuracy was observed on the first day, it was less likely that stress-induction would influence the recognition of fear-expressions on the second day. However, an analysis of cortisol changes in this context might shed more light on this result.

Unfortunately data concerning fear-stimuli of the “virtual” group and anger-stimuli of the “real” group could not be included into analysis due to ceiling effects in the baseline-data. Subjects displayed very high scores, making further investigation impossible since any outcome could not be attributed to experimental manipulation. Data concerning the other facial expressions (sadness, disgust, neutral and happiness) did not show any recognition differences across the three-day testing period.

9.2 The influence of anxiety on emotion recognition

Research question two was posed to investigate recognition accuracies (of angry and fearful faces) in the context of fear. It was asked if there was a relationship between state-anxiety, trait-anxiety and emotion recognition accuracies in the two experimental conditions over a three-day testing period. Neither state-anxiety scores nor trait-anxiety scores showed any relationship with emotion recognition accuracies.

Concerning trait-anxiety scores, it is important to note that the sample was selected from a general population. However, due to *BSI* criteria (see chapter 7.) highly anxious individuals were excluded. Thus, the remaining sample should be characterised as rather non-anxious. Keeping this in mind, results stand in line with research conducted by Bar-Haim et al. (2007), Cooper et al. (2008) and Surcinelli et al. (2006). None of these studies found any relationship between low trait-anxiety and emotion recognition processes.

Results concerning state-anxiety and emotion recognition however were in stark contrast to previous research (Bar-Haim et al., 2007; Roelofs, Bakvis et al., 2007; Roelofs, Elzinga et al., 2005). No influence of state-anxiety on recognition accuracies of threatening stimuli could be reported in this sample. Whereas, results of a meta-analysis (Bar-Haim et al., 2007) strongly suggested threat-related attentional biases in anxious populations, including those with high state-anxiety.

However, self-reported levels of anxiety might not be the best measure of arousal in this context. Results from a study conducted by Roelofs et al. (2007) stand in line with this thought. Individuals were confronted with a TSST (Kirschbaum et al., 1993) and self-reported anxiety, HRV and cortisol changes were used as measures of arousal. The only measure that could significantly differ between high stress-responders and low stress-responders, were hormonal responses. Moreover, cortisol samples were acquired in the course of this current project. Unfortunately these samples have not been analysed yet. It would be of interest to analyse the relationship of hormonal responses and recognition accuracies of threatening stimuli of this sample. This might give a better insight to the role of cognitive biases in the context of fear. Research indicates that there is a relationship between high stress-responses and anxiety, as well as between high stress-responses and attentional bias to threat related stimuli (Roelofs et al., 2005; 2007).

9.3 Gender differences

The third research question considered whether female and male subjects differed in emotion recognition accuracies over a three-day testing period, when regarding each experimental condition and levels of state-anxiety. Previous research indicated that there are gender differences in emotion recognition, in the way that females showed higher accuracy and sensitivity towards facial expressions (Donges et al., 2012; Hall & Matsumoto, 2004; Montagne et al., 2005). These findings could not be supported with this data.

Yet at first glance, only women showed higher *anger* recognition accuracies after stress-induction. However, men displayed extremely high baseline recognition scores and could basically not much improve their scores. This ceiling effect enhanced the probability of making type I errors and finding significant results, where there are actually none. Hence, it would be ill-advised to compare *anger* scores of females and males. Having said this, women did show a significant enhancement, but no assumptions on gender differences can be made.

However, two things have to be noted when it comes to studies that reported gender differences in affective recognition. First, Hall et al. (2000) and Hall and Matsumoto (2004) found greater differences when emotional stimuli were presented on the edge of conscious awareness and Donges et al. (2012) reported some differences when stimuli were presented outside of conscious awareness. On the contrary, the VERT-K is constructed in a way that emotional faces are labelled with full conscious awareness (see chapter 7.2.8.5). This difference in test-construction could account for the divergent results. Moreover, Hall et al. (2000) only found rather small effect-sizes, when it comes to gender differences in labelling of emotional faces and Hoheisel and Kryspin-Exner (2005) also did not find gender differences when applying the VERT-160 to a healthy population.

Secondly, men and women seem to differ in their sensitivity to recognising emotions (Hoffmann et al., 2010; Montagne et al., 2005). For instance, Hoffman and colleagues (2010) did not find any gender differences, when subjects were labelling faces that showed “full” emotions. However, when faces only subtly displayed emotions, women were more accurate at labelling them. These results confirmed a previous study by Montagne et al. (2005), who also found that women correctly recognised emotional faces at a lesser level of intensity than men. Instruments that are typically used in these kinds of studies present a series of a face, slowly increasing the intensity in the emotion being depicted (see Hoffmann et al., 2010; Joormann, & Gotlib, 2006; Montagne et al., 2005). Again, stimuli of the VERT-K consists of only “full” emotional expressions, thus sensitivity cannot be operationalised through it. In hindsight, to analyse possible gender differences it would have been wiser to choose a measure where this is possible.

9.4 The use of virtual reality technology as a research tool

The underlying purpose of this study – and the whole project – was to gain more information about the application of virtual reality technologies in the context of stress-induction and anxiety-responses. The virtual reality version of the TSST (Kirschbaum et al., 1993) was simulated and programmed in association with Univ.-Prof. Helmut Hlavacs of the

Faculty of Computer Science. It is only fair to say, that he did a very good job because individuals of the “virtual” condition reported the same increased state-anxiety scores as did subjects of the “real” condition (see table 5). Having said this, these are only self-reported measurements of anxiety and it will be of interest to analyse the objective measurements (HRV and cortisol changes) in the near future (Heinzle, in preparation). Nonetheless, these results indicated that this newly simulated version of the TSST (Kirschbaum et al., 1993) can successfully be used to induce stress and increase anxiety in both female and male individuals. These results stand in line with previous studies, wherein subjects were confronted with virtual versions of the TSST and showed increased arousal (Jönsson et al., 2010; Kelly et al., 2007; Kotlyar et al., 2008; Wallegård et al., 2011).

Of further interest was the habituation of subjectively reported stress-levels in a virtual environment. Research has shown that virtual environments can be used effectively for training purposes in the context of anxiety. Hence, VR previously has been used to repeatedly expose individuals to aversive stimuli in order to reduce anxiety-responses (Emmelkamp et al., 2002; Fox et al., 2009; Wiederhold, & Wiederhold, 2005). However, there is only one study known of by Jönsson et al. (2010) that presented participants with a virtual version of the TSST (Kirschbaum et al., 1993) on two consecutive days. Results indicated that arousal did habituate on the second day of testing. There were some limitations to this study, such as a very small number of subjects and the non-existence of a control group. Hence, it was of interest if these findings could be replicated in this project.

Analysis of state-anxiety showed that said scores significantly decreased on day two and three of testing. These results indicated that subjects familiarised themselves with the aversive situation. This did not come as a huge surprise since Kirschbaum (1993) himself stated that in order to inhibit habituation processes, certain variables of the TSST should be varied. And this did not happen. On the contrary, all experimental variables stayed the same throughout the whole testing process. When comparing the two experimental groups, it became clear that subjects of the “real” group showed higher anxiety scores on day two and three of testing in comparison to scores of the “virtual” group. These results confirmed findings reported by Jönsson et al. (2010). The research group actually almost did not find any stress-responses on day two of testing and concluded a strong habituation process.

But how come the two experimental groups differed? Virtual environments are perceived as safer than the real world (Fox et al., 2009; McCall, & Blascovich, 2009; Riva, 2003). This feeling of being “safe” could be an explanation for more decreased anxiety scores in the “virtual” group than the “real” group on the second and third day of testing. Having said this, these results lie within the nature of virtual reality itself and can still be interpreted as signs of habituation.

9.4.1 Advantages and disadvantages.

Chapter 4.1.1 discussed advantages and disadvantages of the use of virtual reality in research. In sum, listed advantages, such as experimental control and improved accessibility, could be confirmed (see Bente et al., 2002; McCall, & Blascovics, 2009). In particular high experimental control was experienced as extremely sufficient. Since avatars were programmed prior to testing, facial expressions and verbal responses were presented consistently to all subjects, ensuring standardised experimental manipulation.

Previous research has shown that the use of virtual reality can have some disadvantages, such as simulator sickness or drowsiness (Loomis et al., 1999; Schuemie, van der Straaten, Krijn, & van der Mast, 2001). No such negative effects could be reported concerning this study. Of course, the simulation itself did not require subjects to actively move around but head-movement, vision and sound complemented each other very well.

9.5 Limitations

As mentioned above, self-reported levels of anxiety might not be sufficient enough to analyse the role of fear in emotional recognition. Results of this study do indicate that an attentional bias towards angry faces occurred after stress induction, hence heightened arousal influenced recognition accuracy of anger-expressions. According to Roelofs et al. (2007) hormonal measures are more accurate markers of arousal than state-anxiety and they found that high stress-responses significantly influenced cognitive processing of threatening stimuli. In conclusion, an analysis of cortisol samples that were attained during this project is recommended.

Another limitation of this study is the state the VERT-K baseline data was in. Some ceiling effects and between-group differences appeared which inhibited post-experimental analysis. However, the only solution to circumvent this problem would have been to gather new data. Regarding the extremely time (and cost)-consuming design, this would have been quite impossible to attain. Further, the VERT-K (Pawelak, 2004) was developed as a shortened version of the VERT-160 (Kryspin-Exner et al., 2003), which again was developed to analyse emotion recognition deficits in clinical populations. Results of this study indicated that it might not be suitable to apply in healthy populations because it could not sufficiently differentiate between high levels of emotion recognition abilities.

9.6 Outlook

It can be said that the virtual version of the TSST (Kirschbaum et al., 1993) that was developed for this project can be used in future studies concerning the assessment of psychological stress responses. Although only having analysed self-reported measures, results indicated that this tool was useful for applying mental stress tasks.

Further, it would be interesting to analyse the influence of stress-induction in a virtual environment on emotional stimuli that were presented on the edge of or below conscious awareness. Applying such measure might shed more light on gender differences in the context of emotional processing and anxiety.

10. Summary

Ever since Ekman’s and Friesen's (1971) studies on the universality of facial emotion recognition, there has been an ongoing debate on said universality versus culture specificity. Results from a meta-analysis by Elfenbein and Ambassy (2002) indicated the existence of universality but also reported some in-group advantages. Further, previous studies reported mixed results on gender differences in affective recognition (Hall, Carter, & Horgan, 2000; Hoheisel, & Kryspin-Exner, 2005; Montagne et al., 2005). The ability to correctly identify facial emotions is a central social competence, since it enables one to respond accordingly to a counter partner (Engelberg, & Sjörberg, 2004). Furthermore, deficits in this ability have previously been linked to some disorders such as anxiety but also to high levels of trait- and state-anxiety (Bar-Haim et al., 2007).

Many different theories on cognitive biases have been proposed in this context. According to Beck's schema-theory (1976), individuals show an attentional bias towards stimuli that are consistent with a certain intrapersonal schemata. Hence, anxious individuals are thought to be drawn towards threatening or threat related stimuli.

The aim of this study was to analyse the influence of heightened levels of state-anxiety on emotion recognition accuracies (specifically anger- and fear- expressions). Underlying purpose of this study was the application of a virtual reality as a research tool. Having said this, virtual reality technology has become popular in the assessment of psychological and physiological stress-responses. This is not surprising, since high experimental control combined with high ecological validity is one main advantage (Bente et al., 2002).

Furthermore, results from previous research indicated that it is a useful tool for applying mental stress tasks (Kothgassner et al., 2012; Kotlyar et al., 2008). Consequently, individuals were confronted with a socially threatening situation – to increase state-anxiety – within a virtual environment. A second experimental group experienced the same threatening situation but in the physical world. Moreover, confrontation was repeatedly conducted over a period of three days to analyse processes of habituation. As such, three research questions were developed: 1) Do emotion recognition accuracies differ over a three-day testing period, when regarding each experimental condition and levels of state-anxiety? 2) Is there a relationship between state-anxiety, trait-anxiety and emotion recognition accuracies in the two experimental conditions over a three-day testing period? 3) Do female and male subjects differ in emotion recognition accuracies over a three-day testing period, when regarding each experimental condition and levels of state-anxiety?

Following measures were applied for stress-induction, state-trait-anxiety scores and emotion recognition accuracies: Trier Social Stress Test (Kirschbaum et al., 1993), State-Trait-Anxiety-Inventory (Laux et al., 1981) and Vienna Emotion Recognition Task-K (Pawelak, 2004). 22 individuals were assigned to the "virtual" condition and 22 to the "real" condition. An experimental design with repeated measurement was applied and each day could be divided into pre-experimental measures, experimental manipulation "virtual" versus "real" and post-experimental measures. Statistical analysis revealed 1) individuals of the "virtual" group showed significant changes in accuracy of *anger* items post-experimental on day one. Data of the "real" group could not be analysed due to ceiling effects. No differences in accuracy scores of any other emotion; there were no group differences 2) neither state-anxiety scores nor trait-anxiety scores showed any relationship with emotion recognition accuracies. 3) No gender differences were found.

In conclusion, although influence of anxiety was not found, participants of the "virtual" condition showed signs of attentional bias in line with Beck's schema theories (1976). For future studies with a non-clinical sample however, it is recommended to apply a different emotion recognition measure, due to the fact that the VERT-K (Pawelak, 2004) was constructed to apply in clinical populations. Further, the virtual version of the TSST (Kirschbaum et al., 1993) that was developed for this project can be used in future studies concerning the assessment of psychological stress responses.

Abstract

This study was conducted to analyse the influence of a stress-inducing situation, within a virtual reality, on accuracies of facial emotion recognition. Many different theories on cognitive biases have been proposed in this context but a meta-analytic study by Bar-Haim et al. (2007) suggested an attentional bias towards threatening or threat related stimuli. Following research questions were proposed: 1) Do emotion recognition accuracies differ over a three-day testing period, when regarding each experimental condition and levels of state-anxiety? 2) Is there a relationship between state-anxiety, trait-anxiety and emotion recognition accuracies in the two experimental conditions over a three-day testing period? 3) Do female and male subjects differ in emotion recognition accuracies over a three-day testing period, when regarding each experimental condition and levels of state-anxiety? A repeated measurement experimental design was chosen and two (“virtual” versus “real”) experimental groups were created. For stress-induction 22 individuals completed a virtual version and 22 individuals a classical version of the TSST (Kirschbaum et al., 1993). STAI (Laux et al., 1981) and VERT-K (Pawelak, 2004) were applied for measures of state-trait-anxiety and emotion recognition accuracies. Results indicated that individuals in the “virtual” group displayed an attentional bias towards angry faces, but self-reported anxiety scores showed no influence on facial recognition accuracies. Gender differences were not apparent. Further, the newly simulated version of the TSST can successfully be used to induce stress and increase anxiety in future studies.

Kurzzusammenfassung

Diese Studie wurde durchgeführt, um den Einfluss einer Stress auslösenden Situation – innerhalb einer Virtuellen Realität – auf die Emotionserkennung zu untersuchen. Es gibt viele Theorien im Bezug auf kognitive Fehlattributionen innerhalb dieses Kontextes, aber eine Metaanalyse von Bar-Haim et al. (2007) weist darauf hin, dass eine Aufmerksamkeitsverschiebung hin zu bedrohlichen, oder mit Bedrohung assoziierten Stimuli vorliegt. Folgende Forschungsfragen wurden untersucht: 1) Unterscheidet sich die Genauigkeit der Emotionserkennung über den dreitätigen Testzeitraum, wenn Testbedingung und Level der State-Angst berücksichtigt werden? 2) Gibt es einen Zusammenhang zwischen State-Angst, Trait-Angst und Genauigkeit der Emotionserkennung in beiden Testbedingungen innerhalb des dreitägigen Testzeitraums? 3) Unterscheiden sich männliche und weibliche Testpersonen bezüglich der Genauigkeit der Emotionserkennung, über den dreitätigen Testzeitraum, wenn Testbedingung und Level der State-Angst berücksichtigt werden? Ein Messwiederholungs-Design wurde gewählt und die TeilnehmerInnen einer von zwei („virtuell“ versus „real“) Experimentalgruppen zugewiesen. Zur Stressinduzierung führten je 22 TeilnehmerInnen eine virtuelle, beziehungsweise eine klassische Version des TSST (Kirschbaum et al., 1993) durch. Zudem wurden STAI (Laux et al., 1981) und VERT-K (Pawelak, 2004) vorgegeben, um State-Trait-Angst und Genauigkeit der Emotionserkennung zu erfassen. Die Ergebnisse deuten darauf hin, dass Testpersonen der „virtuellen“ Gruppe, eine Aufmerksamkeitsverschiebung hin zu wütenden Gesichtern zeigten, aber die subjektive Einschätzung der Ängstlichkeit zeigte keinen Einfluss auf die Genauigkeit der Emotionserkennung. Es konnten keine Geschlechtsunterschiede festgestellt werden. Außerdem zeigte sich, dass die, zum Zwecke dieser Studie programmierte virtuelle Version des TSST, gut geeignet ist, um in zukünftigen Studien Stress zu induzieren und Ängstlichkeit zu erhöhen.

Literature

Austin, P. C., & Brunner, L. J. (2003). Type I error inflation in the presence of a ceiling effect. *The American Statistician, 57* (2), 97–104.

Austin, P. C., Escobar, M., & Kopec, J. A. (2000). The use of the Tobit Model for analysing measures of health status. *Quality of Life Research, 9* (8), 901–910.

Bar-Haim, Y., Lamy, D., Pergamin L., Bakermans-Kranenburg, M. J., & van Ijzendoorn, M. H. (2007). Threat-related attentional bias in anxious and nonanxious individuals: a meta-analytic study. *Psychological Bulletin, 133* (1), 1–24.

Baron-Cohen, S., & Wheelwright, S. (2004). The empathy quotient: an investigation of adults with Asperger Syndrome or High Functioning Autism, and normal sex differences. *Journal of Autism and Developmental Disorders, 34* (2), 163–175. doi: 0162-3257/04/0400-0163/0

Beck, A. T. (1976). *Cognitive therapy and the emotional disorders.* NewYork: International Universities Press.

Beck, A. T., & Clark, D. A. (1997). An information processing model of anxiety: Automatic and strategic processes. *Behaviour Research and Therapy, 35,* 49–58.

Beck, A. T., Emery, G., & Greenberg, R. L. (1985). *Anxiety disorders and phobias: A cognitive perspective.* New York: Basic Books.

Bente, G., & Krämer, N. C. (2002). VR-Einsatz in der nonverbalen Kommunikations-forschung. In G. Bente, N. C. Krämer & A. Petersen (Hrsg.), *Virtuelle Realitäten* (S.81-107). Göttingen: Hogrefe.

Bente, G., Krämer, N. C., & Petersen, A. (2002). Virtuelle Realität als Gegenstand und Methode in der Psychologie. In G. Bente, N. C. Krämer & A. Petersen (Hrsg.), *Virtuelle Realitäten* (S.1-31). Göttingen: Hogrefe.

Birkett, M. A. (2011). The Trier Social Stress Test protocol for inducing psychological stress. *Journal of Visualized Experiments, 56*, e3238. doi: 10.3791/3238

Bodenmann, G., Perrez, M., Schär, M., & Trepp, A. (2004). *Klassische Lerntheorien. Grundlagen und Anwendungen in Erziehung und Psychotherapie.* Bern: Hans Huber.

Bossard, C., Kermarrec, G., Buche, C., & Tisseau, J. (2008). Transfer of learning in virtual environments: a new challenge? *Virtual Reality, 12*, 151–161. doi: 10.1007/s10055-008-0093-y

Bower, G. H. (1981). Mood and memory. *American Psychologist, 36,* 129–148.

Bower, G. H. (1987). Commentary on mood and memory. *Behaviour Research and Therapy, 25,* 443–455.

Bradley, B. P., Hogg, K.,White, J., Groom, C., & de Bono, J. (1999). Attentional bias for emotional faces in generalized anxiety disorder. *British Journal of clinical psychology, 38,* 267–278. doi: 10.1348/014466599162845.

Broadbent, D., & Broadbent, M. (1988). Anxiety and attentional bias: State and trait. *Cognition & Emotion, 2,* 165–183.

Cannon, W. B. (1915). *Bodily changes in pain, hunger, fear and rage: an account of recent researches into the function of emotional excitement.* New York: D. Appelton & Company.

Cannon, W. B. (1927). The James-Lange Theory of emotions: a critical examination and an alternative theory. *The American Journal of Psychology*, *39* (1/ 4), 106–124.

Cattel, R. B. (1966). Patterns of change: Measurement in relation to state-dimension, trait change, lability, and process concepts. In R. B. Cattell (Ed.). *Handbook of multivariate experimental psychology* (pp. 355-408). Chicago: Rand McNally.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Earlbaum Associates.

Cooper, R. M., Rowe, A. C., & Penton-Voak, I. S. (2008). The role of trait anxiety in the recognition of emotional facial expressions. *Journal of Anxiety Disorder, 22*, 1120–1127.

Darwin, C. (1872). *The expression of the emotions in man and animals.* London: Murray.

Demenescu, L. R., Kortekaas, R., den Boer, J. A., & Aleman, A. (2010). Impaired attribution of emotion to facial expressions in anxiety and major depression. *PLoS ONE, 5* (12), e15058.

Derntl, B., Kryspin-Exner, I., Fernbach, E., Moser, E., & Habel, U. (2008). Emotion recognition accuracy in healthy young females is associated with cycle phase. *Hormones and Behavior, 53*, 90–95.

Derntl, B., Seidel, E., Kryspin-Exner, I., Hasmann, A., & Dobmeier M. (2009). Facial emotion recognition in patients with bipolar I and bipolar II disorder. *British Journal of Clinical Psychology, 48*, 363–375.

Derntl, B., Windischberger, C., Robinson, S., Lamplmayr, E., Kryspin-Exner, I., Gur, C., Moser, E., & Habel, U. (2008). Facial emotion recognition and amygdala activation are associated to menstrual cycle phase. *Psychoneuroendocrinology, 33,* 1031–1040.

Derogatis, L. R. (1977). *SCL-90: Administration, scoring & procedures manual for the Revised version and other instruments of the psychopathology rating scale series.* Baltimore, MD: Johns Hopkins.

Derogatis, L., & Melisaratos, N. (1983). The Brief Symptom Inventory: An introductory report. *Psychological Medicine, 13*, 595–605.

Dickerson, S. S., & Kemeny, M. E. (2004). Acute stressors and cortisol responses: a theoretical integration and synthesis of laboratory research. *Psychological Bulletin,* *130 (3)*, 355–391.

Donges, U. S., Kersting, A., & Suslow, T. (2012). Women's greater ability to perceive happy facial emotion automatically: gender differences in affective priming. *PLoS ONE, 7* (7), e41745. doi:10.1371/journal.pone.0041745

Ekman, P. (1993). Facial expression and emotion. *American Psychologist*, *48* (4), 384–392.

Ekman, P., & Friesen, W. V. (1971). Constants across cultures in the face and emotion. *Journal of Personality and Social Psychology*, *17*, 124–129.

Ekman, P., & Friesen, W. V. (1975). *Unmasking the face: a guide to recognizing emotions from facial clues.* Englewod Cliffs, NJ: Prentice-Hall.

Elfenbein, H. A., & Ambasy, N. (2002). On the universality and cultural specificity of emotion recognition: a meta- analysis. *Psychological Bulletin*, *128* (2), 203–235.

Emmelkamp, P. M. G., Bruynzeel, M., Drost, L., & van der Mast, C. A. P. G. (2002). Virtual reality treatment in Acrophobia: a comparison with exposure in vivo. *Cyber Psychology & Behavior, 4* (3), 335–339.

Engelberg, E., & Sjöberg, L. (2004). Internet use, social skills, and adjustment. *Cyber Psychology & Behaviour, 7* (1), 41–50.

Felnhofer, A. (2011). *Informed Consent bei Demenz? Kognitive Prädiktoren für die Fähigkeit von Patienten mit Demenz in eine Forschungsstudie einzuwilligen.* Unveröffentlichte Diplomarbeit, Universität Wien.

Felnhofer, A., Kothgassner, O. D., Beutl, L., Hlavacs, H., & Kryspin-Exner, I. (2012). Is virtual reality made for men only? Exploring gender differences in the sense of presence. *Proceedings of the International Society for Presence Research Annual Conference*.

Felnhofer, A., Kothgassner, O. D , & Kryspin-Exner, I. (2011). Ethik in der Psychologie. Wien: UTB facultas.wuv.

Field, A. (2009). *Discovering statistics using SPSS* (3rd edition). London: SAGE.

Flick, F. (2013). *Der Einfluss von Angst und Achtsamkeit auf das Präsenzerleben im virtuellen und realen Stressszenario im Rahmen einer Habituationsstudie.* Unveröffentlichte Diplomarbeit, Universität Wien.

Fox, E., Lester, V., Russo, R., Bowles, R. J., & Dutton, K. (2000). Facial expressions of emotion: Are angry faces detected more efficiently? *Cognition & Emotion, 14*, 61–92.

Fox, E., Russo, R., Bowles, R., & Dutton, K. (2001). Do threatening stimuli draw or hold visual attention in subclinical anxiety? *Journal of Experimental Psychology: General, 130,* 681–700. doi:10.1037/0096-3445.130.4.681

Fox, E., Russo, R., & Dutton, K. (2002). Attentional bias for threat: Evidence for delayed disengagement from emotional faces. *Cognition &* Emotion, 16, 355–379.

Fox, J., Arena, D., & Bailenson, J. N. (2009). Virtual Reality. A survival guide for the social scientist. *Journal of Media Psychology*, 21(3), 95–113.

Franke, G. H. (1995). *SCL-90-R. Die Symptomcheckliste von Derogatis – Deutsche Version – Manual*. Göttingen: Beltz.

Freud, S. (1936). *The problem of anxiety.* New York: W. W. Norton.

Georgiou, G., Bleakley, C., Hayward, J., Russo, R., Dutton, K., Eltiti, S., & Fox, E. (2005). Focusing on fear: attentional disengagement from emotional faces. *Visual Cognition, 12* (1), 145–158.

Glenk, L. M. (2011). Psychophysiologische Methoden der Stressmessung. In B. U. Stetina, O. D. Kothgassner & I. Kryspin-Exner (Hrsg.), *Wissenschaftliches Arbeiten und Forschen in der Klinischen Psychologie* (S. 204-213). Wien: UTB facultas.wuv.

Gohier, B., Senior, C., Brittain, P. J., Lounes, N., & El-Hage, W. (2013). Gender differences in the sensitivity to negative stimuli: Cross-modal affective priming study. *European*

Psychiatry, 28, 74–80*.* doi: 10.1016/j.eurpsy.2011.06.007

Gregg, L., & Tarrier, N. (2007). Virtual reality in mental health. S*ocial Psychiatry and Psychiatric Epidemiology, 42* (5), 343–354.

Grossman, M., & Wood, W. (1993). Sex differences in intensity of emotional experience: a social role interpretation. *Journal of Personality and Social Psychology, 65*, 1010–1022.

Gur, R. C., Erwin, R. J., & Gur, R. E. (1992). Neurobehavioral probes for physiologic neuroimaging studies. *Archives of General Psychiatry, 49* (5), 409–414.

Gur, R. C., Sara, R., Hagendoorn, M., Marom, O., Hughett, P., Macy, L., Turner, T., Bajcsy, R., Posner, A., & Gur, R. E. (2002). A method for obtaining 3-dimensional facial expressions and its standardization for use in neurocognitive studies. *Journal of Neuroscience Methods, 115*, 137–143.

Hall, J. A., Carter, J. D., & Horgan, T. G. (2000). Gender differences in the nonverbal communication of emotion. In A. H. Fischer (Ed.), *Gender and emotion: Social psychological perspectives* (pp. 97-117). Paris: Cambridge University Press

Hall, J. A., & Matsumoto, D. (2004). Gender differences in judgement of multiple emotions from facial expressions. *Emotion, 4* (2), 201–206.

Hoffmann, H., Kessler, H., Eppel, T., Rukavina, S., & Traue, H. C. (2010). Expression intensity, gender and facial emotion recognition: Women recognize only subtle facial emotions better than men. *Acta Psychologica, 135* (3), 278–283. doi: 10.1016/j.actpsy.2010.07.012

Hoheisel, B., & Kryspin-Exner, I. (2005). Emotionserkennung in Gesichtern und emotionales Gesichtergedächtnis – Neuropsychologische Erkenntnisse und Darstellung von Einflussfaktoren. *Zeitschrift für Neuropsychologie, 16*, 77–87 [Emotion recognition and memory for emotional faces – neuropsychological findings and influencing factors].

Horan, W. P., Green, M. F., Degroot, M., Fiske, A., Hellemann, G., Kee, K., Kern, R. S., Lee, J., Sergi, M. J., Subotnik, K. L., Sugar, C. A., Ventura, J., & Nuechterlein, K. H. (2011). Social cognition in schizophrenia, part 2: 12-month stability and prediction of functional outcome in first-episode patients. *Schizophrenia Bulletin, 38* (4), 865–872.

Hut, P., & Sussmann, G. J. (1987). Advanced computing for science. *Scientific American, 225* (19), 145–153.

Izard, C. E. (1994). *Die Emotionen des Menschen- eine Einführung in die Grundlagen der Emotionspsychologie*. Weinheim: Beltz.

Johnston, P. J., Katsikitis, M., & Carr, V. J. (2001). A generalised deficit can account for problems in facial emotion recognition in schizophrenia. *Biological Psychology, 58*, 203–227.

Jönsson, P., Wallegård, M., Österberg, K., Hansen, A. M., Johansson, G., & Karlson, B. (2010). Cardiovascular and cortisol reactivity and habituation to a virtual reality version of the Trier Social Stress Test: A pilot study. *Psychoneuroendocrinology, 35*, 1397–1403.

Joormann, J., & Gotlib, I. H. (2006). Is this happiness I see? Biases in the identification of emotional facial expressions in depression and social phobia. *Journal of Abnormal Psychology,*115, 705–714.

Kelly, O., Matheson, K., Martinez, A., Merali, Z., & Anisman, H. (2007). Psychosocial stress evoked by a virtual audience: Relation to neuroendocrine activity. *CyberPsychology & Behavior, 10* (5), pp. 655-662.

Kemeny, M. E. (2009). Psychobiological responses to social threat: evolution of psychological model in psychoneuroimmunology. *Brain, Behavior, and Immunity, 23,* 1–9.

Kessler, R. C., Berglund, P., Demler, O., Jin, R., Merikangas, K. R., & Walters, E. E. (2005). Lifetime prevalence and age-of-onset distributions of DSM-IV disorders in the National Comorbidity Survey Replication. *Archives of General Psychiatry, 62* (6), 593–602.

Kessler, H., Roth, J., von Wietersheim, J., Deighton, R. M., & Traue, H. C. (2007). Emotion recognition patterns in patients with panic disorder. *Depression and Anxiety, 24,* 223–226.

Kirschbaum, C. (2010). Trier Social Stress Test. In I.P. Stolerman (ed.), *Encyclopedia of Psychopharmacology* (pp.1-3). Berlin, Heidelberg: Springer.

Kirschbaum, C., Kudielka, B.M., Gaab, J., Schommer, N.C., & Hellhammer, D.H. (1999). Impact of gender, menstrual cycle phase, and oral contraceptives on the activity of the hypothalamus-pituitaryadrenal axis. *Psychosomatic Medicine 61*, 154–162.

Kirschbaum, C., Pirke, K. M., & Hellhammer, D. H. (1993). The 'Trier social stress test'- a tool for investigating psychobiological stress responses in a laboratory setting. *Neuropsychobiology*, *28*, 76–81.

Kothgassner, O. D., Felnhofer, A., Beutl, L., Hlavacs, H., Lehenbauer, M., & Stetina, B. (2012). A virtual training tool for giving talks. In M. Herrlich, R. Malaka, & M. Masuch (Eds.), Lecture Notes in Computer Science, 7522, 53–66.

Kotlyar, M., Brauer, L. H., al'absi, M., Adson, D. E., Robiner, W., & Thuras, P. (2006). Effect of bupropion on physiological measures of stress in smokers during nicotine withdrawal. *Pharmacology, Biochemistry, and Behavior, 83*, 370–379. doi:10.1016/j.pbb.2006.02.017

Kotlyar, M., Donahue, C., Thuras, P., Kushner, M. G., O'Gorman, N., Smith, E. A., & David, E. A. (2008). Physiological response to a speech stressor presented in a virtual reality environment. *Psychophysiology, 45* (6), 1034–1037.

Kryspin-Exner, I., Gur, R. C., Hoheisel, B., Klein, M. & Six, N. (2003). “Neurobehavioral probes”: Adaptierung und Erweiterung von Verfahren zur Computergestützten neuropsychologischen Diagnostik. *Verhaltestherapie und Verhaltensmedizin, 24* (1), 27–51.

Lang, P. J. (1993). The three-system approach to emotion. In N. Birbaumer & A. Öhman (Hrsg.), *The structure of emotion* (18-30). Seattle: Hogrefe & Huber.

Larnier, J., & Biocca, F. (1992). An inside view of the future of virtual reality. *Journal of communication, 42* (2), 150–172.

Lehenbauer, M., Kothgassner, O. D., Kryspin-Exner, I., & Stetina, B. (2013). An online self-administered social skills training for young adults: Results from a pilot study. *Computer & Education, 61,* 217–224.

Lawrence, N. S., Williams, A. M., Surguladze, S., Giampietro, V., Brammer, M. J., Andrew, C., Frangou, S., Ecker, C., & Phillips, M. L. (2004). Subcortical and ventral prefrontal cortical neural responses to facial expressions distinguish patients with bipolar disorder and major depression. *Biological Psychiatry*, *55* (6), 578–587.

Lazarus, R. S., & Folkman, S. (1984). *Stress, Appraisal, and Coping*. New York: Springer.

Lazarus, R. S., & Folkman, S. (1987). Transactional theory and research on emotions and coping. European Journal of Personality, *1* (3), 141–169.

Laux, L., Glanzmann, P., Schaffner, P., & Spielberger, C.D. (1981). *Das State-Trait-Angstinventar. Theoretische Grundlagen und Handanweisung.* Weinheim: Beltz Test.

Loomis, J. M., Blascovich, J. J. & Beall, A. C. (1999). Immersive virtual environment technology as a basic research tool in psychology. *Behaviour Research Methods, Instruments, & Computers, 31* (4), 557–564.

McCall, C., & Blascovich, J. (2009). How, when, and why to use digital experimental virtual environments to study social behavior. *Social and Personality Psychology Compass, 3*, 744–758. doi:10.1111/j.1751-9004.2009.00195.x

McMahan, A. (2003). Immersion, engagement, and presence. A method for analyzing 3-D video games. In M. J. Wolf & B. Perron (eds.), *The video game, theory reader* (pp.67-86). New York: Routledge.

Mesquita, B., & Frijda, N. H. (1992). Cultural variations in emotions: A review. *Psychological Bulletin, 112,* 197–204.

Mesquita, B., Frijda, N. H., & Scherer, K. R. (1997). Culture and emotion. In J. W. Berry, P. R. Dasen, & T. S. Saraswathi (Eds.), *Handbook of cross-cultural psychology: Vol. 2. Basic processes and human development* (pp. 255-297). Boston: Allyn & Bacon.

Minsky, M. (1980). Telepresence. *Omni*, 45–51.

Mogg, K., Bradley, B. P., De Bono, J., & Painter, M. (1997). Time course of attentional bias for threat information in non-clinical anxiety. *Behaviour Research and Therapy, 35,* 297–303.

Mohlman J., Carmin C. N., & Price R. B. (2007). Jumping to interpretations: social anxiety disorder and the identification of emotional facial expressions. *Behaviour Research and Therapy, 45*, 591–599.

Montagne, B., Kessels, R. P., Frigerio, E., de Haan, E. H., & Perret, D. I. (2005). Sex differneces in th eperception of affective facial expressions: do men really lack emotional sensitivity? *Cognitive Processing, 6*, 136–141. doi: 10.1007/s10339-005-0050-6.

Mowrer, O. H. (1960). Learning theory and behavior. New York: Wiley.

Parsons, T. D., & Rizzo, A. A. (2008). Affective outcomes of virtual reality exposure therapy for anxiety and specific phobias: A meta-analysis. *Journal of Behavior Therapy* and

Experimental Psychiatry, 39, 250–261.

Pavlov, I. P. (1927). *Conditioned reflexes.* Oxford: Oxford University Press.

Pawelka, U. (2004). *Kurzform der “Vienna Emotion Recognition Task” (VERT-K) und der “Vienna Memory of Emotion Recognition Task” (VIEMER-K).* Konstruktion und Erstanwendung. Unveröffentlichte Diplomarbeit, Universität Wien.

Pertaub, D. P., Slater, M., & Barker, C. (2002). An experiment on public speaking anxiety in response to three different types of virtual audience. *Presence Teleoperators & Virtual Environments, 11* (11), 68–78. doi:10.1162/105474602317343668

Pruessner, J. C., Wolf, O. T., Hellhammer, D. H., Buske-Kirschbaum, A., von Auer, K., Jobst, S., Kaspers, F., & Kirschbaum, C. (1997). Free cortisol levels after awakening: a reliable biological marker for the assessment of adrenocortical activity. *Life Science, 61*, 2539b–2549.

Reinecker, H. (2003). *Lehrbuch der Klinischen Psychologie und Psychotherapie: Modelle psychischer Störungen.* Göttingen: Hogrefe.

Riva, G. (2003). Virtual Environments in Clinical Psychology. *Psychotherapy: Theory/Research/Practice/Training, 4* (1, 2), 1–9.

Roelofs, K., Bakvis, P., Hermans, E. J., van Pelt, J., & van Honk, J. (2007). The effects of social stress and cortisol responses on the preconscious selective attention to social threat. *Biological Psychology, 75* (1), 1–7.

Roelofs, K., Elzinga, B. M., & Rotteveel, M. (2005). The effects of stress-induced cortisol responses on approach-avoidance behavior. *Psychoneuroendocrinology, 30*, 665–677.

Rothbaum, B. O., & Hodges, L. F. (1999). The use of virtual reality exposure in the treatment of anxiety disorders. *Behavior Modification, 23* (4), 507-25.

Russel, J. A. (1995). Facial expression of emotion: what lies beyond minimal universality? *Psychological Bulletin*, *118* (3), 379–391.

Sachs, G., Steger-Wuchse, D., Kryspin-Exner, I., Gur, R.C., & Katschnig, H. (2004). Facial recognition deficits and cognition in schizophrenia. *Schizophrenia Research, 68*, 27–35.

Sachs, G., Winklbaur, B. Jagsch, R., Lasser, I, Kryspin-Exner, I., Frommann N., & Wölwer W. (2012). Training of affect recognition (TAR) in schizophrenia—Impact on functional outcome. *Schizophrenia Research, 138*, 262–267.

Schachter, S., & Singer, J. (1962). Cognitive, social, and physiological determinants of emotional state. *Psychological Review*, *69* (5), 379–399.

Schuemie, M., van der Straaten, P., Krijn, M., & van der Mast, C. (2001). Research on presence in virtual reality: A Survey. *Cyberpsychology & Behavior, 4* (2), 183-201.

Skinner, B. F. (1930). On the Conditions of Elicitation of Certain Eating Reflexes. *Proceedings of the National Academy of Sciences, 16* (6), 433–438.

Slater, M., Pertaub, D. P., Barker, C., & Clark, D. M. (2006). An experimental study on fear of public speaking using a virtual environment. *Cyberpsychology & Behavior, 9* (5), 627–634.

Spielberger, C. D., Gorsuch, R. L., & Lushene, R. E. (1970). State-Trait Anxiety Inventory: Manual for the State-Trait Anxiety Inventory. Palo Alto: Consulting Psychologist Press.

Spielberger, C. D., & Sydeman, S. J. (1994). State-Trait Anxiety Inventory and State-Trait-Anger Expression Inventory. In M. E. Maruish (Ed.), *The use of psychological testing for treatment planning and outcome assessment* (pp.292-321). Hillsdale, N.J.: L. Erlbaum Associates.

Surcinelli, P., Codispoti, M., Montebarocci, O., Rossi, N., & Baldaro, B. (2006). Facial emotion recognition in trait-anxiety. *Anxiety Disorders, 20*, 110–117.

Steuer, J. (1992). Defining virtual reality: Dimensions determining telepresence. *Journal of communication, 42* (4), 73–93.

Tart, C.T. (1990). Multiple personality, altered states and virtual reality: The world simulation process approach. *Dissociation Progress in the Dissociative Disorders, 3*(4), 222–233.

Thorndike, E. L. (1898). Animal intelligence: an experimental study of the associate processes in animals, *Psychological Review Monograph Supplement, 2*(4), 1–8.

von Dawans, B., Kirschbaum, H., & Heinrichs, M. (2011). The Trier Social Stress Test for Groups (TSST-G): A new research tool for controlled simultaneous social stress exposure in a group format. *Psychoneuroendocrinology, 36* (4), 514–522. doi: 10.1016/j.psyneuen.2010.08.004

Wallegård, M., Jönsson P., Österberg, K., Johansson, G., & Karlson, B. (2011). A virtual reality version of the Trier Social Stress Test: a pilot study. *Presence: Teleoperators and Virtual Environments, 20* (4), 325–336.

Watson, J. B. (1913). Psychology as the behaviorist views it. *Psychological Review, 20,* 157–177.

Wiederhold, B. K., & Wiederhold, M. D. (2000). Lessons learned from 600 virtual reality sessions. *Cyberpsychology and Behavior, 3* (3), 393–400.

Wiederhold, B. K., & Wiederhold, M. D. (2005). *Virtual Reality Therapy for Anxiety Disorders.* Washington: American Psychological Association.

Williams, J. M. G., Watts, F. N., MacLeod, C., & Matthews, A. (1988). *Cognitive psychology and emotional disorders.* Chichester: Wiley.

Witmer, B. G., & Singer, M. J. (1998). Measuring presence in virtual environments: A presence questionnaire. *Presence: Teleoperators and Virtual Environments, 7,* 225–240.

Wolpe, J. (1958). *Psychotherapy by reciprocal inhibition.* Stanford: Stanford University Press.

Yiend, J., & Mathews, A. (2001). Anxiety and attention to threatening pictures. *Quarterly Journal of Experimental Psychology: Human Experimental* Psychology, 3, 665–681.

Zajonc, R. B. (1980). Feeling and thinking: preferences need no inferences. *American Psychologist*, *35* (2), 151–175.

Zimbardo, P. G. (2004). *Psychologie.* Berlin Heidelberg: Springer.

Tables

Figures

Appendix

Tab. A1

Means, standard deviations, minimum and maximum for *BSI*-scales.

Scales of the BSI	N	M	SD	Minimum	Maximum
Somatisation	15	55.73	11.23	39	74
Obsessive-Compulsive	15	65.27	6.09	51	72
Interpersonal Sensitivity	15	66.47	9.79	50	80
Depression	15	66.40	9.31	49	80
Anxiety	15	67.20	10.37	48	76
Hostility	15	65.13	10.91	40	80
Phobic Anxiety	15	59.07	8.93	44	76
Paranoid Ideation	15	64.80	6.7	55	79
Psychoticism	15	66.93	9.47	54	80

Note. N= individuals that did not meet the *BSI* inclusion criteria.

Tab. A2

Means (standard deviations) of emotion recognition scores by group, gender and day.

Facial Emotion	Group	Gender	Pre-experimental Day 1 (N=44)	Post-experimental Day 1 (N=44)	Post-experimental Day 2 (N=39)	Post-experimental Day 3 (N=39)
Anger M (SD)	**virtual**	**Female**	**5.36 (1.03)**[a]	**5.82 (0.603)**[a]	6.00 (0.000)	5.88 (0.354)
		Male	5.73 (0.647)	6.00 (0.000)	5.78 (0.441)	5.89 (0.333)
	real	**Female**	5.64 (0.674)	5.82 (0.405)	5.73 (0.647)	5.73 (0.467)
		Male	5.64 (0.924)	5.55 (0.934)	5.73 (0.647)	5.64 (0.674)
Fear M (SD)	**virtual**	**Female**	5.64 (0.674)	5.36 (0.674)	5.25 (0.707)	5.38 (1.06)
		Male	5.82 (0.405)	5.82 (0.603)	5.89 (0.333)	5.78 (0.441)
	real	**Female**	5.36 (0.674)	5.55 (0.688)	5.82 (0.603)	5.55 (0.688)
		Male	5.09 (0.701)	5.36 (0.674)	5.55 (0.522)	5.36 (0.505)
Happiness M (SD)	**virtual**	**Female**	5.82 (0.405)	5.82 (0.405)	5.75 (0.707)	5.88 (0.354)
		Male	5.82 (0.405)	5.91 (0.302)	5.89 (0.333)	5.89 (0.333)
	real	**Female**	5.82 (0.405)	5.82 (0.405)	5.73 (0.905)	5.82 (0.405)
		Male	5.82 (0.405)	5.91 (0.302)	5.91 (0.302)	5.73 (0.467)
Sadness M (SD)	**virtual**	**Female**	4.54 (1.21)	4.45 (1.29)	4.75 (1.28)	5.13 (1.36)
		Male	3.64 (2.46)	3.36 (1.86)	4.33 (1.73)	4.33 (1.73)
	real	**Female**	4.00 (1.48)	4.00 (1.41)	3.91 (1.14)	3.55 (1.29)
		Male	3.45 (1.13)	3.82 (1.47)	4.00 (1.41)	4.36 (1.12)
Disgust M (SD)	**virtual**	**Female**	4.45 (0.934)	4.73 (0.905)	4.13 (0.835)	4.25 (1.16)
		Male	4.73 (1.01)	4.64 (0.809)	4.48 (1.09)	4.67 (1.00)
	real	**Female**	4.45 (1.51)	4.45 (1.04)	4.36 (0.809)	4.18 (0.874)
		Male	4.27 (0.786)	4.09 (1.04)	4.09 (0.701)	4.09 (1.04)
Neutral M (SD)	**virtual**	**Female**	5.45 (0.522)	5.55 (0.688)	**5.75 (0.463)**[b]	**5.50 (0.535)**[b]
		Male	5.64 (0.924)	5.73 (0.467)	5.89 (0.333)	5.89 (0.333)
	real	**Female**	5.18 (1.33)	5.45 (0.820)	5.55 (0.688)	5.55 (0.688)
		Male	5.45 (0.522)	5.82 (0.405)	5.73 (0.467)	5.73 (0.467)

Note. Highest possible recognition score was 6.
[a] Scores differed significantly at a significance level of $p < .10$
[b] Scores differed significantly at a significance level of $p < .05$

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