Nonverbal Communication in Virtual Environments

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Abstract

VRET has been shown to be an effective treatment of phobias compared to drugs and CBT. Research to the treatment of a social phobic with VR is being done and there is a need for knowledge about the use and acceptance of nonverbal communication by avatars. To achieve that knowledge this literature study focuses on the treatment of social phobia and defining nonverbal communication, its sources and its functions. Nonverbal cues can be expressed by many parts of the body, like facial expression and posture, and they can support, conflict with or substitute the verbal component of interaction. Nonverbal cues appear to be a vital part of communication as they are a more reliable source of information compared to the verbally carried message.

1. Introduction

This study focuses on nonverbal communication from avatars in virtual reality environments. Virtual reality has its applications in the entertainment business, gaming, simulation and the treatment of phobias. This work is aimed only at the treatment of phobias, but it results could have uses for entertainment applications as well. Fear of flying (Krijn, et al., 2007), agoraphobia (van der Mast & Hooplot, 2006) and fear of heights (Schuemie, et al., 2000) are examples of phobias that already can be treated with the help of virtual reality. Recently research has started in the area of social phobia in which human-human contact is of main importance. Therapists strive to recreate a virtual treatment as much as it would look like a regular, non-virtual treatment. To treat a patient suffering from social phobia with the help of a virtual environment that patient should be able to interact with virtual human characters, also referred to as avatars. Communication among humans can be verbal as well as nonverbal. Nonverbal communication is a commonly accepted method to depict a credible appearance in human-human interaction (Henley, 1977). It consists of cues in sources such as facial expressions, gesture and posture. To achieve the close recreation of virtual humans, which could be beneficial to the effectiveness of the therapy in the virtual world it would be important to know about the importance and effects of nonverbal communication cues, used by those avatars. This literature study focuses on the nonverbal communication behaviour of those avatars in a virtual world.

This study is part of the VRET project, a joint project at the Delft University of Technology, the University of Amsterdam, VALK Foundation and PsyQ (van der Mast, 2009). This project consists of a group of members from the psychology and Human-Computer-Interaction disciplines. The project's research focuses on the treatment of phobias with virtual reality exposure rather than a treatment in-vivo. Research is being done to see if it is possible to take virtual reality exposure from the experimental lab into the daily practice of psychologists and therapists. The HCI discipline design and test prototypes with the help of expert knowledge provided by the psychologists who in their turn might apply the prototypes to test in a clinical environment.

As an introduction, as well as a better understanding, to the main topic of this study this first chapter will provide a definition and overview of phobias and a short introduction to social phobia, which will be discussed more deeply later on in this work. After that the research questions and the setup of the entire literature study to answer those questions will be discussed.

1.1 Phobias

A phobia is a common form of an anxiety disorder. It is often an irrational, marked, and persistent fear for a specific object, activity, or situation, which is rather avoided or engaged with intense anxiety or distress (American Psychiatric Association, 1994). The main difference between a fear and a phobia is that fears do not necessarily intervene with the daily life. Often the object, activity or situation that is being feared is commonly accepted as not specifically dangerous. Although the sufferers know themselves that their fear might be irrational, they still pursue to avoid the object or situation. It is estimated that between 8.7% and 18.1% of all U.S. residents (Kessler, et al., 1994) suffer from a phobia in their life. It is yet unknown about the true source and reasons of existence of phobias. Some say it is

genetically and heredity (Torgersen, 1979), others say that phobias are created and maintained by self-made irrational mental models or life-experiences. Phobias can arise by both external events and preconceptions. In an experiment (Seligman, 1971) to try to evoke phobias by showing pictures of snakes, spiders and flowers, it was shown that test subjects needed two to four triggers of a malevolent picture to evoke a phobia, while significantly more triggers of pictures of flowers were needed to create an aversion towards flowers. He concluded that fears for spiders and snakes were essential for our survival thousands of years ago and they are still embedded within our mental model and could be triggered at any time. He also concluded that people often are afraid for objects and situations they cannot control.

Phobias can be classified into 3 categories (American Psychiatric Association, 1994):

- Social phobia; A social phobia is a fear involving other people or social interactions, which will be more discussed in chapter 2.
- Agoraphobia; this phobia covers all fears for locations where sufferers do not have a way to escape. They are afraid of the location because they have little control of the situation and feel overwhelmed
- Specific phobia; this is a fear for a specific trigger of any object, activity or situation. Such as a fear for dogs, elevators, flying or even consumables.

Phobias can be treated by means of medication in the form of anti-depressants, cognitive behaviour therapy or virtual reality exposure. Often a therapist can use any combination of these treatments. While classic in-vivo exposure therapy of these fears is effective, a Virtual Reality treatment has its advantages (Schuemie & van der Mast, 2000; Wiersma, Greeven, Berretty, Krijnen, & Emmelkamp, 2008):

- Saving time; the therapist and patient do not have to travel to a specific fear evoking location to start the treatment.
- Increased privacy; the patient is treated in a discrete, closed environment.
- Variation of available scenarios; the therapist can have a wide spectrum of possible situations in a virtual environment. Expensive as well as hard obtainable situations like for example an airplane are within reach.
- Increased control; the therapist is in total control of all stimuli the virtual world could produce to the patient. For example the weather, height, number of spiders and the taxi time of an airplane.
- Increased safety; in case of a panic attack or any other emergency the patient can go back to the real world by a simple press on a button.
- Decreased threshold; patients are less reluctant to start treatment in a virtual world in oppose to a treatment in vivo and will therefore start a virtual reality exposure treatment faster.
- Physiological measurements; since the patient is treated within the office of the therapist, it is possible to do any physiological measurements, like heart rate and skin conductance. These measurements could help the therapist in the treatment.
- Reduced costs; the costs are significantly less due to that the world is bought as a whole package, in contradiction to reproducing a fear evoking scenario.

Substantial data has already been obtained to support the effectiveness of virtual reality exposure for phobias (Emmelkamp, et al., 2002; Krijn, Emmelkamp, Olafsson, & Biemond, 2004; Powers & Emmelkamp, 2008; Wiersma, et al., 2008).

1.2 Social phobias

Lately research to a more often occurring fear (Magee, Eaton, Wittchen, mcGonagle, & Kessler, 1996) has been conducted: social phobia, of which the fear of public speaking is the most common variant. Social phobia differs itself from other phobias in that it is more likely to interrupt daily activities of the patient. It is much easier to avoid heights, elevators or snakes than to avoid contact with other people. A social phobic is aware that his or her fear is irrational, however the phobic feels extremely uncomfortable when it comes to starting or joining a conversation. People with this anxiety disorder fear to be judged negatively in any public social interaction and in extreme situations the patient chooses to avoid such interaction. This avoiding behaviour could lead to loneliness or unemployment due to the minimal communication skills.

1.3 Agency

Since this study focuses on humanoid representations in a virtual world some terminology has to be introduced. It has to be made clear that there are two types of human representation inside a virtual world: *agents* and *avatars*. Avatars are real-time controlled by humans, for example in Second Life or a forum on the internet, while agents are controlled by an artificial intelligence program, for example Anna, the social agent used by Ikea (Vuorinen, 2007). In terms of communication, and especially building a short relationship with a virtual human it is until now expected that there is more reciprocity with avatars, claiming that it is still doubtful that humans would form increased immediacy towards some AI program (Bailenson, Blascovich, Beall, & Loomis, 2003). The Turing test requires the agent to be perceived as an avatar (Turing, 1950). Despite that the term avatar is consistently used throughout this literature study, but its knowledge would most likely apply to agents as well.

1.4 Motivation and research questions

One of the latest field of interest of the TUDelft VRET project aims at the development of a tool to give the therapist the ability to change and tune the nonverbal communication aspects of the avatars in the virtual environment to the need of his patient. In order to start creating this tool it could be useful to have knowledge about the effectiveness of nonverbal communication by avatars. This literature study will give insight on nonverbal communication and to which extent it is already applied and tested in virtual worlds. The research question of this literature study is:

RQ: *"Whether or not and which non-verbal communication cues by virtual avatars have any influence on the recipient in the virtual world?"*

In order to answer that research question, some meta-questions have to be answered. As explained before nonverbal communication is a vital part of human-human communication and social phobia handles with human-human interaction, so social phobia could be a good source of reading and comprehending nonverbal cues, therefore chapter 2 covers the question:

RQ1: *"What is social phobia and how is VR used in this context?"*

After giving a definition of social phobia and a discussion on its treatment this study focuses in chapter 3 on nonverbal communication to look for answers on the question:

RQ2: *"What is nonverbal communication, what are its functions and its sources?"*

After understanding the scope of nonverbal communication the objective of chapter 4 is to discuss the following question:

RQ3: *"Which aspects of nonverbal communication in a virtual world are already demonstrated to be effective?"*

This literature study is concluded in chapter 5 with a discussion on the material covered. Literature searches have been performed on the Web of Knowledge, the ACM Digital Library with any combination of the keywords: nonverbal communication, nonverbal cues, avatars, gesture, gaze, posture, emotion, dominance, virtual reality, phobias

2. Social Phobia

In order to understand the need for nonverbal behaviour of avatars in a virtual world this chapter will cover social phobia, for social phobia handles with human-human interaction where nonverbal communication has a large role in it (Henley, 1977). First the symptoms of social phobia are to be discussed. After that methods of treatment are presented as well as a discussion on the feeling of social presence in a virtual environment and an overview on experiments on treatment of social phobia in VR.
Social phobia is defined as follows (American Psychiatric Association, 1994):

"Social phobia is an anxiety disorder in which the sufferer has a persistent, intense and chronic fear of being watched and judged negatively by others and of being embarrassed or humiliated by one's actions in public"

About 13.3% of the U.S. population (Kessler, et al., 1994), 6.7% of the European population (Fehm, Pelissolo, Furmark, & Wittchen, 2005) and 4.8% of the Dutch population (Acaturk, de Graaf, van Straten, & ten Have, 2008) suffer from this anxiety disorder. The term was introduced to describe patients who feared being observed while doing any activity (Janet, 1903)as cited by (Angst, 1994) .

2.1 Symptoms

The criteria for the diagnose of social-phobia are defined by DSM-IV (American Psychiatric Association, 1994) as:

A. A marked and persistent fear of one or more social or performance situations in which the person is exposed to unfamiliar people or to possible scrutiny by others. The individual fear that he or she will act in a way (or show anxiety symptoms) that will be humiliating or embarrassing. **Note:** In children, there must be evidence of the capacity for age-appropriate social relationships with familiar people and the anxiety must occur in peer settings, not just in interactions with adults

B. Exposure to the feared social situation almost invariably provokes anxiety, which may take the form of a situationally bound or situationally predisposed Panic Attack. **Note:** In children, the anxiety may be expressed by crying, tantrums, freezing, or shrinking from social situations with unfamiliar people.

C. The person recognizes that the fear is excessive or unreasonable. **Note:** In children, this feature may be absent.

D. The feared social or performance situations are avoided or else endured with intense anxiety or distress.

E. The avoidance, anxious anticipation, or distress in the feared social or performance situation(s) interferes significantly with the person's normal routine, occupational (academic) functioning, or social activities or relationships, or there is marked distress about having the phobia.

F. In individuals under age 18 years, the duration is at least 6 months.

G. The fear or avoidance is not due to the direct physiological effects of a substance (e.g., a drug of abuse, a medication) or a general medical condition and is not better accounted for by another mental disorder (e.g. Panic Disorder With or Without Agoraphobia, Separation Anxiety Disorder, Body Dysmorphic Disorder, a Pervasive Developmental Disorder, or Schizoid Personality Disorder.

H. If a general medical condition or another mental disorder is present, the fear in Criterion A is unrelated to it, e.g., the fear is not of stuttering, trembling in Parkinson's disease, or exhibiting abnormal eating behavior in Anorexia Nervosa or Bulimia Nervosa.

Symptoms for social phobia exist in 3 levels: the cognitive level, the behavioural level and the physiological level (Furmark, 2000; Lang, 1985).

2.1.1   Symptoms in the cognitive level

Patients suffering from social phobia are concerned with how they are perceived and evaluated by others (Heimberg, Liebowitz, Hope, & Schneier, 1995). This phenomenon is called anticipated anxiety. Patients are motivated to engage a social interaction, but they do not trust their own ability to do so, since they have high standards of self-performance, believe their perception of their personal shortcomings as true and have wrong ideas about how others will evaluate them (Leary & Kowalski, 1995). Before engaging the social situation sufferers anticipate on what they think might happen and how to find escape routes for any problems that could be encountered. Once confronted to the feared situation these anticipations can become reality because they are too nervous. This event leads to an

increase of the anticipated anxiety, creating a vicious circle (Inan, Brinkman, & van der Mast, 2009). A social phobic appears to rate his own performance worse than his listeners would (Rapee, 1995) and values ambiguous and neutral events as negative (Musa & Lépine, 2000).

2.1.2 Symptoms in the behavioural level

Phobias are maintained by escaping and avoiding the feared object, situation or activity, according to the theory of operant conditioning (Skinner, 1974). The main difference with social phobia and any specific phobia is that it is much harder to avoid any social contact than to avoid for example snakes, spiders or large heights. Therefore a social phobia is more likely to interfere with the daily life. Although this escaping behaviour controls the phobia in a short-length perspective, the phobic does not allow himself that way to learn to deal with the feared situation in the wide-length perspective.

2.1.3 Symptoms in the physiological level

Patients often experience physical symptoms of anxiety, like blushing, palpitations, nausea, sweating, gaze aversion and trembling hands (Rapee, 1995). Because these symptoms are visible, the anxiety and self-consciousness of the patient is increased as well.

2.2 Treatment

An early diagnosis of social phobia is very beneficial to the treatment. Treatment for social phobia exists in the form of:

- Drugs
- Cognitive-Behavioural Therapy (CBT)
- Exposure Therapy:
  - ➢ Exposure in-vitro
  - ➢ Exposure in-vivo
  - ➢ Virtual reality exposure

2.2.1 Treatment with drugs

Anti-depressants are the most common type of medications for treating social phobia. The first test with anti-depressants date back to 1995, where the effectiveness of a drug called SSR (Montgomery & Boer, 2001) was significantly confirmed. The drug is a mood-changer; it regulates the intensity of the mood of the imbiber. The taker of the drug experiences a lowered intensity of his emotions and mood and therefore he could worry less about engaging a social interaction. Other drugs used are for example beta-blockers and benzodiazepines. Beta-blockers decrease the heart rate. Because of a lower heart rate the blood pressure is regulated which makes the patient calmer. Benzodiazepines are another type of sedating drugs. By taking drugs the patient decreases the intensity of the social experience by glooming his mood.

2.2.2 Treatment with cognitive-behaviour therapy

Cognitive behaviour therapy, once founded and introduced by Albert Ellis in 1957, has another approach to overcome a phobia. Its aim is to reduce the symptoms of the phobia by having patients to become aware of the situation and change their irrational mental models (Heimberg, 2002). CBT usually is performed by role-playing, group therapy, Socratic questioning, flooding and homework assignments or systematic desensitization.

2.2.3 Treatment with exposure therapy

In exposure therapy the patient is exposed to the feared object or situation and it is seen as the golden standard in the treatment of a phobia (Craske & Rowe, 1997; Krijn, 2006). It is a variant of CBT in such a way that the patient is constantly (gradually) exposed to the feared situation to get habituated with it to reduce the cognitive dissonance. There are several types of exposure:

- Exposure in-vitro; in which the patient is treated by means of hypnotherapy or role-playing.
- Exposure in-vivo; in which the patient is exposed in reality to the feared situation
- Virtual reality exposure; in which the patient in exposed to the feared situation in a virtual environment

2.3 Social Presence in virtual reality exposure

In order to be able to treat patients effectively in a virtual world with avatars the patients should raise the same reactions to avatars as they would to people in real life. Generally the visual system classifies an entity as being humanoid depending on the extent of which behaviour the entity matches the range of behaviour the perceiver could perform (Shiffrar, 2008). Users in a virtual world should feel themselves socially present, meaning that the actors in the virtual environment react on the users (Biocca, 1997). Simulating these reactions, a social relationship, would be a combination of perception and the expected social cognition (Heeter, 1992). When testing the level of responsiveness of virtual actors to generate a co-presence of users in the virtual environment (Garau, Slater, Pertaub, & Razzaque, 2005) it was suggested that simple nonverbal communication, such as looking at the users, already yielded a higher belief of personal contact with the virtual actors. This experiment was performed on users without a social phobia. Extending this finding with people who actually are social phobic resulted in significant levels of anxiety between confident speakers and phobic speakers, as the phobic speakers express a higher level of anxiety when talking to an audience rather than to an empty room whereas confident speakers show no difference between those situations at all (Slater, Pertaub, Barker, & Clark, 2006).

2.4 Related work on treatment with virtual reality exposure therapy

Although most patients do not seek directly treatment for their symptoms (Kessler, 2003), VRET is a solution since one of its advantages is that it is a treatment discrete, realistic and safe environment and it offers a medium for exposure to feared situations in a virtual world when an in vivo exposure is too difficult to control, inconvenient to reproduce or initially overwhelming to the patient (Anderson, Rothbaum, & Hodges, 2003).
In one of the first researches applying VRET against fear of public speaking by means of progressive exposure during several sessions of treatment a significant reduction of fear was suggested (North, North, & Coble, 1998). Based on two case studies (Anderson, et al., 2003) it is suggested that VRET could be a useful solution to the treatment of social phobia by showing that patients after a treatment reported a decrease of self-report anxiety comparable to typical public speaking fears in the general population (Hoffmann & DiBartolo, 2000; Klorman, Weerts, Hastings, Melamed, & Lang, 1974) as well as the fact that patients were more willing to engage in a behavioural avoidance test. Also by comparing the application of a VRET to CBT and absence of treatment the effectiveness of VRET was suggested which resulted into a clinical based protocol (Roy, et al., 2003) to treat social phobia based on four recognized cases of social phobia: assertiveness, performance, intimacy and scrutiny. Although patients participating in the VRET experiment missed less sessions than patients in the CBT experiment, due to the 'playful' aspect of the therapy, they reacted to the virtual confronted situations in a similar way to the CBT in vivo sessions by feeling discomfort, anxiety and experiencing physical feelings like blushing.
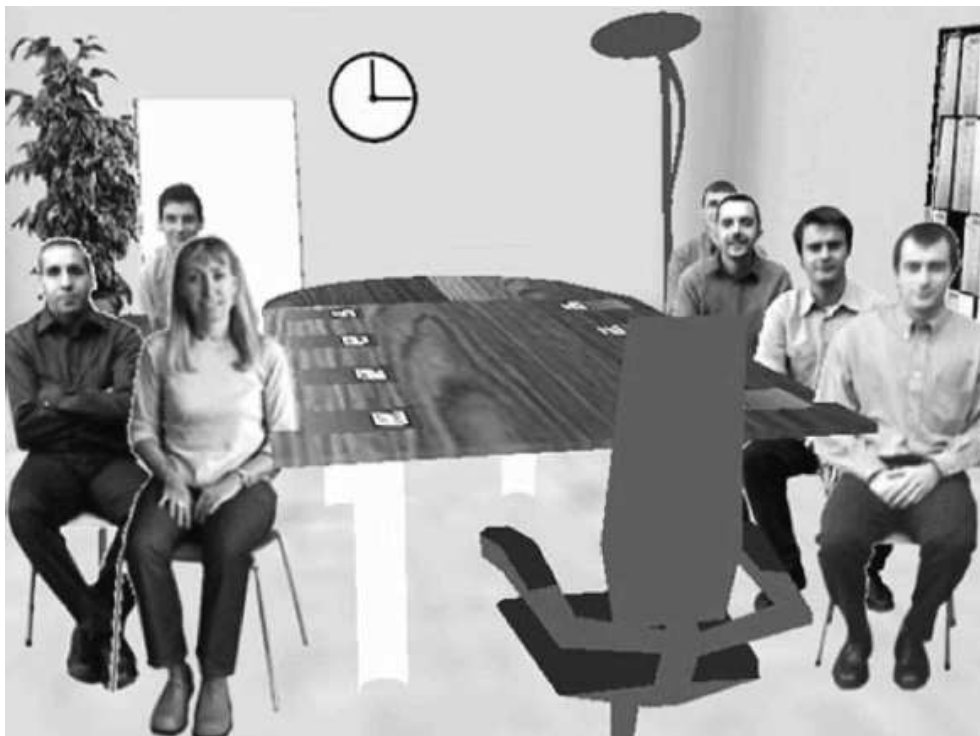
Figure 1: meeting room scenario in the work of Roy et al. (2003)

In a recreation of a classical social situation (Inan, et al., 2009), having the participants choose a seat among an audience with respect to distance between them and the avatars and the distance to the speaker in front of the virtual room, the reaction of the participants was in accordance with the expected real life behavioural responses.

Figure 2: Avatar seating positions in the work of Inan (2008)

3.   Nonverbal communication

Communication amongst humans hardly occurs with just speech only. Communication can be seen as being multimodal as the sender uses gestures, speech, touch, smell and taste, while the receiver perceives by means of vision, hearing, feeling, smell and taste (Allwood, 2008). Utterances consist of coordinated ensembles of coherent verbal and nonverbal actions (McNeill, 1992). The importance of nonverbal behaviour while communicating is recognized in social psychology. Since the amount of nonverbal cues is overwhelming, it is a challenge to do any research in this field of psychology. This chapter covers an overview of nonverbal communication. At first a definition of nonverbal communication is given by looking at psychological scholar's definitions. After giving the scope of nonverbal communication, this chapter focuses on the sources of those nonverbal cues or codes. After that, when understanding how humans can express themselves nonverbally, the reasons or the function of those nonverbal codes will be presented. Finally the interactions between verbal and nonverbal communication is discussed.

3.1 Defining nonverbal communication

Defining nonverbal communication is not an easy task (Leathers, 1997). Instead of defining explicitly it could be described in terms of existing nonverbal cues or codes and conceptualized nonverbal communication in terms of three interacting communication systems (Leathers, 1997):
The **visual** communication system produces the most shared meaning within face-to-face interaction. This system contains:
- Kinesics, being body movement, gestures, eye behaviour and visual expression
- Proxemics, being space, distance and territory
- Artefacts, like physical appearance, clothing and accessories

The **auditory** communication system covers the area of vocalics and paralanguistics.
The **invisible** communication system contains olfactory, chronemic and tactile communication. Smells or odours may influence the perception of people and the communication, even though it cannot be seen. Although tactile communication is obviously visible, Leathers stated that "tactile messages can, and often do, communicate powerful meanings in the absence of any illumination and the decoder of tactile messages relies on cutaneous receptors rather than eyesight to decode them" (Leathers, 1997, p. 13).
In the narrow sense, nonverbal communication refers to all actions dealing with communication, distinct from speech, like facial expression, gesture, posture, position and leg movement. Although, the Oxford dictionary defines nonverbal as "not involving words or speech" (Pearsall, 1999), in a wider perspective nonverbal communication is called a misnomer, for subtle aspects of speech are indeed part of the field of nonverbal communication and therefore the term is extended with paralinguistic and vocal phenomena (Mehrabian, 1972). Others talk of "the exchange of messages primarily through non-linguistic means" (Tortoriello, Blatt, & DeWine, 1978) or as "transfer of meaningful information from one person to another by means other than written or spoken language (e.g. gaze, facial expression, posture, touch)". More specific it can be described as "those behaviours other than words themselves that form a socially shared coding system" (Burgoon, 1994). This definition encompasses all behaviour besides just body language and above all it assumes that people recognize the meaning of these behaviours within their social and cultural setting (Afifi, 2007).

3.2 Sources of nonverbal communication

Another approach to defining nonverbal communication is by De Meuse (1987). Stating that there is "a lack of a cogent taxonomy of nonverbal cues" (De Meuse, 1987, p. 207), De Meuse suggested a taxonomy based upon how nonverbal codes are received. According to De Meuse's taxonomy, nonverbal codes can be broken up into two dimensions: the origin, which ranges from non-behavioural to behavioural, and the amount of individual control, ranging from low to high.
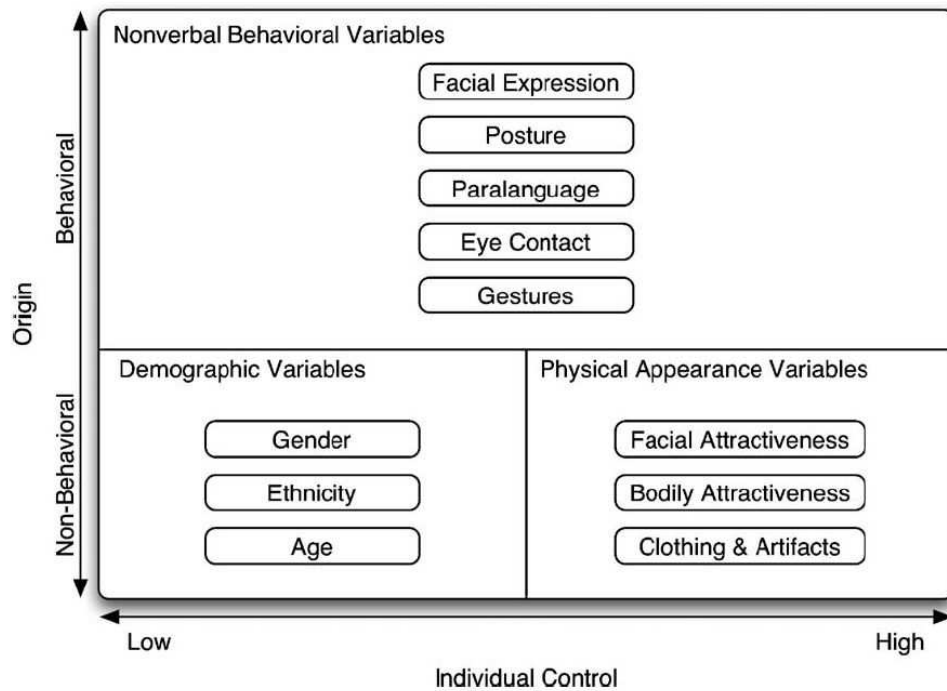

Figure 3: taxonomy of behaviour as suggested by DeMeuse (1987)

The taxonomy is split up into three variables: demographics, personal appearance and nonverbal behaviour. In a previous study (Cowell & Stanney, 2005) this taxonomy by DeMeuse was coupled with the functions of nonverbal communication with the objective to present guidelines that should lead to a credible agent in a virtual world. This section will cover these variables as described in Cowell and Stanney, including the study of proxemics which is not included in De Meuse's taxonomy.

3.2.1   Facial expression

The face is an important source of non-verbal cues and often regarded to as the most expressive part of the body (Argyle, 1969), especially in conversations when people are close to each other and focused on each other's faces. It is seen as the primary source for the communication of emotions and moods(Knapp & Hall, 2007) . Based on some experiments on isolated tribes in Papua New Guinea Paul Ekman showed that some facial expressions are universal, and not cultural dependant (Ekman, 1971). He classified emotions into the following basic emotions:

- Happiness
- Sadness
- Anger
- Fear
- Disgust
- Surprise

3.2.2   Gestures

Gestures are another form of nonverbal communication made with any part of the body. They can be defined by categorizing them into five major functions in terms of kinesics (Babad, 2007; Ekman & Friessen, 1969):

- **Emblems** are movements that have a direct, clear and shared verbal equivalent meaning; therefore an emblem can be used when verbal communication is not possible. The use of an emblem is intentional. A goodbye wave or "thumbs up" are examples of an emblem.
- **Illustrators** are movements that are tied to speech, serving to illustrate and reinforce what is verbally said. For example holding the arms wide apart to indicate something large. An illustrator is always used intended.
- **Affect Displays** are movements than display information on the sender's emotional and psychological state. Most of the affect displays are facial expressions and are demonstrated to have a universal meaning. An affect display is used with less intention and less awareness than an emblem or illustrator.
- **Regulators** are movements, like nodding and gaze, intended to regulate the back-and-forth interaction and flow of a conversation. An regulator is not necessarily deliberate or intentional
- **Adaptors** are movements, like nail biting and head scratching, which provide information about the sender's attitude, anxiety level and self-confidence. An adaptor is used unconsciously and is therefore a potentially rich source of involuntary information about the psychological state of the sender.

Rather than dividing up gestures into categories, it is suggested that they should be classified into dimensions (McNeill, 2005), stating that most gestures are multifaceted. Gestures are classified by into the meaning they carry (McNeill, 1992):

- **Deictic** gestures are pointing movements with any extensible object or body part, although it is prototypically performed with the index finger of the dominant hand. These gestures could point to entities or individuals that are being referred to in the narrative part of communication, but often select a part of the gesture space and the

meaning of the gesture depends on the referential value attached to that region instead. (McNeill, 1992)

- **Iconic** gestures present images of concrete entities or actions (McNeill, 2005). The form of these gestures as well as the way they are executed in terms of trajectory and direction embody semantic aspects that are present in the speech. It is also referred to as a representational gesture. They are in concept closely related to the illustrators
- **Metaphoric** gestures present images of the abstract (McNeill, 2005). Although the speaker acts like he is holding or manipulating an object, the true meaning is that he is presenting a thought, a memory or some other abstract object. Another type of metaphoric gestures involves the metaphoric use of space. A speaker can use the space in front of him to classify all aspects of the message he is carrying out, for example by uttering negative parts to the left of him, and positive parts to the right of him.
- **Beat** gestures are defined as movements that do not present a discernable meaning They are mere small, low energy, rapid flicks of the hands and fingers (McNeill, 1992) that seem to beat along with the rhythm of the speech. They can be used to signal the temporal loci in speech of something the speaker feels that is important with respect to the larger discourse (McNeill, 2005) . These gestures lack a gesture space and are performed wherever the hands happen to be, including rest positions.

3.2.3   Posture

Posture is an intentionally or habitually attained position of the body. It can be a very important clue to the emotional state a person is in (Mehrabian, 1972). If someone is standing in front of an audience he will have a total different body position when he is nervous compared to his posture when he is confident. In the former he will make his body a bit smaller by pressing his arms to his side and stomach and will hardly look to the audience, while in the latter he stands relaxed trying to engage the audience into the subject.
Also the motor skill is different among emotions (van Meer, van Neijenhof, & Bouwens, 2001). A motor skill is a learned body movement and it can be both automatic movements, like walking or balancing, and movements that require attention. In terms of motor skills one can for example walk faster or slower depending on the emotional state or make mistakes like dropping objects.

3.2.4   Gaze

Gaze covers all the communication and actions within a conversation that are performed by the eyes and has several functions (Kendon, 1967). Gaze can be regulatory, which means that eye contact can be used to start a conversation, and to indicate turn taking within a conversation. Another function of gaze is to monitor another person's behaviour by showing concern. The eyes and eyebrows are also a source of expressing emotions. When the gaze shifts or averts it means that the person is thinking or reflecting on a question. People tend to look at their conversational partner more while listening than while speaking (Argyle & Cook, 1976; Vertegaal, Slagter, van der Veer, & Nijholt, 2001).

3.2.5   Proxemics

Previously mentioned sources of nonverbal communication focused on parts of a human body as a mean to transfer information. This section deals with the distance between bodies as a way to communicate. The study of this area is referred to as proxemics. This interpersonal distance can be used to control intimacy and privacy. There are 4 different interpersonal, or social, distances as defined by classic works (Hall, 1966):

- Intimate distance: 0 – 0.5m range
  This zone is meant for direct affective and tactile contact. Applications of this zone are whispering, touching and accepting trust. Standing next to each other in a crowded place, like an elevator, is not accepted as an intimate distance. Instead of that people ignore each other if they do not know them.

- Personal distance: 0.5m – 1.5m range
  This zone is meant for contact among good friends. In this zone someone can talk on a normal volume and is able to have a private conversation. This is also the zone for shaking hands. When people are not in the personal distance, while the other parties assume they should be, they are thought of being not interested.

- Social distance: 1.5m – 3m range
  This zone is meant for contact among acquaintances. It is not possible to touch one another, like in the personal distance. Subjects of conversations within this distance are rarely personal.

- Public distance: 3m or more
  This zone is meant for public speaking. Applications of this zone are for example discussions among a teacher and pupils in a classroom, or theatres and concerts.

Hall also states that social distances are cultural dependant. It is critical in a conversation that all parties involved agree on the social distance being used. If the interpersonal distance is either too small or too large people may start feeling uncomfortable.

3.2.6   Paralanguage

Paralanguage, or vocalics, is the study of nonverbal codes in the voice. It deals with how something is said, rather than what is said. The three major functions of vocalics (Leathers, 1997) are expressing emotions, projecting positive impressions and regulating or managing communication. With the use of vocalics the meaning of words may be changed. These characteristics add crucial information to the message that is being communicated, like emotional state and personality characteristics, as well as information on gender, age and race (Cowell & Stanney, 2005). In order to interpret vocalics correctly, the voice set is a contextual parameter, including gender, mood, age, cultural background and situation (Trager, 1958). Based on this voice set Trager suggested that paralanguage could be classified in terms of *voice qualities* and *vocalizations*. The voice set and voice qualities are permanent qualities of a voice that allow identification and remembering of that voice. These qualities include loudness, pitch range, rate, rhythm, duration, quality, regularity, articulation and pronunciation. Vocalizations are more specific and detailed that make a human's voice unique and consist of characterisers, qualifiers and segregates. Vocal characterisers relate to elements such as laughing, crying, sneezing in the terms that it says something about how

someone performs that action. Vocal qualifiers include the intensity and the height of pitch whereas segregates are sounds that do not fit in phonological or word frames in sequences in a language

3.2.7   Physical Appearance

By observing characteristics like height, hair, skin colour, gender and clothing people make themselves a first impression of someone else. With that impression people can engage into a conversation using a specific mental model on how to interact with that person. For example people who are taller than average have an advantage in getting jobs and being promoted (Argyle, 1975). Stereotyping allows concluding about someone's behaviour by applying knowledge about behaviour of people with the same personal characteristics.

3.3 Functions of nonverbal communication

Having discussed the definition as well as the sources of nonverbal communication, this section covers the functions (Argyle, 1988) of nonverbal communication.
In a conversation all involved parties take turns to talk. Each turn in a conversation is requested, given, continued or ended in a clear, subtle nonverbal code. A turn to talk is requested by creating eye contact with the current speaker or by a notable breath (Wiemann & Knapp, 1975) as if someone would interrupt by saying something. On the other hand it is made clear that a speaker is ending his turn by changing the rhythm or pitch of the voice (Boomer, 1978) and nods and blinks are used by the recipient to engage the speaker to tell more (Argyle, 1988).
Nonverbal communication gives and shows the identity of an individual. It is mainly achieved by appearance and kinesics. Identities are created by people in a way they want how others to see them confirming to the way they see themselves, mainly as having positive and socially desirable qualities (Leary, MacDonald, & Tangney, 2002).
Emotions are expressed mostly by facial expressions, body posture and vocalics. As shown in the work of Ekman (1971), where he demonstrated the existence of 6 universal basic facial expressions, humans are able to decode and comprehend facial cues without training. Although these emotions are universal, there are arousal differences across cultures because of cultural or contextual rules of expressing the emotions and cultural differences in associating events and emotions.
Since nonverbal communication uses codes that all involved parties of the communication agree on it is a good way to communicate with people from a group. Relationships are defined and maintained in terms of proxemics, tone of voice, touch, gaze and facial expression (Argyle, 1988). With respect to proxemics, the degree of relationship is defined by the interpersonal distance between two people (Hall, 1966).
Nonverbal communication can also be used to influence the behaviour and attitudes of one another. It appears that humans are influenced the most by people they like or find attractive (O'Keefe, 1990). Eye contact or gaze increase the chance of influencing others
Another way of using nonverbal communication is to deceive one another by aware sending false information. Being successful as a liar is dependent on the ability to control nonverbal cues, the behaviour of the receiver and the relationship between the sender and receiver. Generally maintaining eye contact, suggesting a friendly and open attitude increases the chance of deceiving others (Burgoon, 1994).
Nonverbal cues play a very important part in rituals, like greeting. In greetings the social status difference between the parties is defined by for example the way hands are shaken, as well as the relationship by means of interpersonal distance and openness to one another (Argyle, 1988).

3.4 The interaction of verbal and nonverbal communication

As stated earlier in this chapter communication hardly occurs with just speech. With respect to speech nonverbal communication has 6 interactions (Knapp & Hall, 2007).

First a nonverbal cue is redundant when it expresses the same information as the verbal message contains. It consists of using gestures to strengthen the verbal message like pointing to the object of discussion or counting with the fingers (Knapp & Hall, 2007).

It appears that verbal messages are remembered better when combined with nonverbal cues that clarify or reinforce the meaning of the verbal message by adding some information to it (Knapp & Hall, 2007). The nonverbal cue has no specific meaning when used on its own and only has value combined with a verbal message. An example of complementary interaction is when someone is verbally explaining aspects on a particular subject and having his hands in the front left when talking about negative aspects and in the front right when talking about positive aspects.

Besides being redundant and reinforcing the nonverbal cues can also counter the verbal message. For example when someone is expressing a true statement while avoiding eye contact with the listeners he might send a mixed message. In this scenario people tend to value the nonverbal cues more than the speech (Knapp & Hall, 2007).

Nonverbal cues sometimes have to be used when verbal communication is not possible or allowed. There are scenarios where speech is not possible, because of for example distance or noise (Knapp & Hall, 2007). Besides that words not always necessary to express one's opinion, like shaking one's head in disapproval or drawing a smile in approval of what is being said (van Meer, et al., 2001).

As explained in 3.3 there is a regulatory interaction between nonverbal behaviour and verbal communication, by nodding to approve what is being said, touching one another's arm to interrupt or changing the vocalics to indicate the end of turn of speech (Knapp & Hall, 2007; van Meer, et al., 2001).

Finally the meaning of a verbal message can also be adapted or enhanced by the nonverbal cues used. An individual that is verbally expressing himself happy can accent that happiness by smiling, raising the eyebrows, changing pitch and have an open posture towards the receiver (Knapp & Hall, 2007).

4. Nonverbal communication in virtual reality

Avatars are claimed to be engaged more easily into interaction with human users of a virtual world if those avatars are to be perceived as having human-like behavioral characteristics (Bailenson, Beall, Blascovich, Raimundo, & Weisbush, 2000). It is argued that the more realistic an avatar is in visual appearance the higher the expectations for behavioural realism may be for the recipient (Garau, et al., 2003). Although this could mean that behavioural realism is more important than form realism (Bente, Krämer, Rüggenberg, Tietz, & Wortberg, 2004; Strippgen, 1998), the computer experience of the recipient can diminish the dependency of those two kinds of realism (Garau, et al., 2005), claiming that the more proficient users are with virtual environments, the less effort has to be made to convince them into immersion. In another study (Vinayagamoorthy, Garau, Steed, & Slater, 2004) the results were that a realistic model of eye-gaze behaviour improved the fidelity of the realistic avatar, although that same model did not influence the communication with a cartoonish avatar, which confirms that there would be a correlation between the virtual realism of the avatar and the degree of realism of the behaviour it exhibits.

In another work the focus was aimed at the valence of the reactions of a virtual audience (Pertaub, Slater, & Barker, 2001). Participants seemed to respond to a virtual audience in a same way as they would to a real audience by feeling more at ease with a positive and enthusiastic group and experiencing discomfort with a group with negative attitudes.

Figure 4: Facial expressions and gaze directions used in the experiment by Slater, Pertaub, Barker, Clark (2001)

Although the participants felt more at ease with talking to a positive audience, the positive audience had less influence on the subjects. Some subjects reported the positive responses to be exaggerated and distracting and it lacked the challenge to speak and convince. The negative audience seemed more realistic to talk to. A determining factor in this is the timing of a positive response. Appropriate timing of avatar response is critical to maintain co-presence in the virtual world.

Apparently avatars that express trustworthy facial expressions are found as being more credible compared to avatars without any facial animation at all, suggesting an importance of the existence of facial nonverbal behaviour of an avatar (Cowell & Stanney, 2005). Although in that same study facial expressions were combined with gestural behaviour, yielding no significantly increased credibility over using only facial expressions, the authors negate this finding by claiming the tasks performed in the experiment to have none to little relation with gestural behaviour. The influence of the existence of an eye gaze model has been shown by comparing the effects of avatars with and avatars without such a model, resulting the fact that users pay more attention to avatars with implemented eye gaze behaviour (Colburn, Drucker, & Cohen, 2000). The direction of eye gaze (Garau, Slater, Bee, & Sasse, 2001) appears to have influence as well as an inferred-gaze avatar outperforms an avatar with random gaze behaviour, concluding that avatars should exhibit behaviour that relate to the conversation or activity. Evidence has showed that the blinking rate of the eyes of an avatar has a "dramatic impact" on the impression of the user, just as real human being blinking would have (Takashima, et al., 2008). A moderate blinking rate of 18 blinks per minute appears to suggest a friendly impression, while a higher reduces the potency and fidelity of the avatar and a lower blinking rate gives a more intelligent impression.

Even the smallest increase of an avatar's responsiveness can have a impact on certain aspects of people's social responses to humanoid agents suggesting that on some level people can respond to virtual humans as social actors even in the absence of complex interaction (Garau, et al., 2005). Nonverbal behaviour appears to be a key factor in human-avatar communication, just like it is in human-human communication (Prendinger, Ma, Mori, & Ishikuza, 2005). It helps in expressing the avatar's affect to the user and the use of deixis combined with speech could direct the attention and provide navigational aid.

5. Discussion

The goal of this literature study was to provide knowledge on the use and acceptance of nonverbal communication by avatars by seeking answers to several meta-questions. As part of the VRET project of TUDelft the interest of those nonverbal behaviour by avatars was only laid upon the application of the treatment of phobias.

The first question to be answered was what social phobia is and how it can be treated, especially by means of VRET. People suffering from social phobia are afraid to engage any form of social interaction, because they assume to be judged negatively on any action or expression they express. By means of comparative clinical studies VRET appears to be a solution as effective as the classic treatments as medication and CBT, yet it has its advantages since it offers a medium for exposure to feared situations in a virtual world when an in vivo exposure is too difficult to control, inconvenient to reproduce or initially overwhelming to the patient.

After discussing social phobia and treatment by virtual reality the study switched to a discussion about nonverbal communication to answer the question what nonverbal communication is. Definitions by scholars were presented and it appeared that there is not an exact scope of nonverbal codes that is generally agreed upon. The work of (de Meuse, 1987) and (Burgoon, 1994) appeared the most complete and were used as a guideline throughout the chapter. A conversation among humans hardly consists of just verbal messages; instead it is a coordinated multimodal ensemble of verbal, nonverbal and interpersonal codes. Besides presenting the sources of nonverbal cues it was explained that nonverbal communication helps in regulating a conversation, showing the identity of someone, sharing emotions, defining relationships, influencing one another's behaviour and attitude and even deceiving, as well as playing a big role in rituals like for example greeting. Also the way of interaction and dependency between nonverbal and verbal communication was presented in this chapter

The final and main question to be answered was to find out in which extent nonverbal communication already had been applied on avatars and what the effects were on the users in the virtual worlds. With respect to nonverbal communication by avatars in virtual environments an important find is that the more realistic an avatar is in visual appearance the higher the expectations for behavioural realism may be for the recipient (Garau, et al., 2003), meaning that behavioural realism is more important than form realism (Bente, et al., 2004; Strippgen, 1998). No matter how good the avatar is in visual appearance, when the nonverbal communication models do not match with the behaviour the recipient would expect the avatars would lose their credibility and therefore their utility. Humans are very apt to classify what human behaviour actually is and have high standards for that. It is claimed that nonverbal behaviour appears to be a primary factor in human-avatar interaction as much as it is for human-human interaction.

The knowledge on social phobia and nonverbal communication presented in this study can be used to research the use and effect of nonverbal cues in virtual reality. Virtual worlds could be created more realistic and lively when the inhabiting avatars exhibit humanlike nonverbal behaviour. Possible field of interest could be to do research to the possibility to have the therapist adapt the nonverbal aspects of avatars to the need of his patient to the benefit of the treatment.

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