# The influence of facial expressions of a virtual coach in a virtual reality skiing application

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# Abstract |

Abstracttt

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# Chapter 1| Introduction

Virtual sport applications are becoming more and more popular. Virtual reality is getting more attention than ever and also sport applications in VR are growing [14] [15]. Skiing requires preparation and one cannot go skiing everyday. People who go on a skiing holiday and are not able to go very often, still would like to be well prepared for when they do go. These skiers can prepare themselves by making use of a virtual reality application, in which the players practise exercises to prepare them.

In such applications a virtual trainer can be present to motivate the player. For a virtual reality setting, the natural choice for a virtual coach is a 3D character. 3D characters are also a step up from 2D or video coaches because 3D characters can be interactively explored and can be viewed from multiple angles [5]. This would be beneficial for a coaching or sports application since the user is then able to see the exercises from every possible angle. It is known that the immersiveness of a VR-application as well as the presence of a coach or trainer can be stimulating factors for the motivation of the user [7] [8].

However there's still little known about how it is best achieved to motivate a player with such a trainer. Virtual agents and coaches are not a new invention [1] [3] but with new technologies, new possibilities arise that we want to explore in this thesis. One question that was raised is if the virtual trainer should be a realistic looking character or a stylized avatar. A stylized character is defined as *"a character that no human would mistake for a real person, but would still be perceived as having human emotions and thought processes"* [13].

Another question raised concerns feedback the coach may give on the user. Feedback and emotions in a teaching environment play an important role when it comes to the motivation of the student. When looking at what feedback is beneficial for the student's motivation it can be seen that both positive and negative emotions can have a positive influence [x][z].

In this research it is tried to determine how users react to a virtual coach using a feedback system with facial expressions. These facial expressions portray both negative and positive feedback. It is researched how this influences the user. The final goal is to determine if the coach is capable of positively influencing the player's motivation. Looking at this goal we come to the following research question for this thesis:

**RQ**: "How can a virtual coach motivate the user in a virtual reality skiing application using facial expressions?"

To answer this overall research question, sub questions are generated

Sub-RQ 1: In what way can the expressions be made understandable for the user?

#### Sub-RQ 2: How are users influenced by the virtual coach?

In order to answer these questions the research goes through various phases. In following chapters it is first discussed what is already out there. We look at existing ski VR applications and at design choices that have been made in earlier research about virtual coaches.

The design process for Creative Technology consists of four main phases: Ideation, Specification, Realization and Evaluation [23]. This design process is used for this research as well. How these four phases are used are shortly described here and in more detail in the following chapters.

We take the newly learned knowledge from the background information to the ideation phase. In this phase design choices are made and a final product concept is generated. This is done by using the background literature from earlier chapters, brain storm sessions and user identification. In this phase we can see why it was chosen to work with virtual instead of augmented reality for example. More design choices are made and used to formulate a final product concept.

This concept is then further specified and finally realized in chapter 5. In this chapter is described how the application was built. Then we enter the evaluation phase in which the installation is tested with potential users. From the results of these tests we formulate answers to the research questions and see if we have achieved our goals. In this concluding chapter it is concluded that the virtual coach is indeed capable of positively influencing the user, however not all users were affected by the coach.

# Chapter 2 State of the Art on virtual coaches and ski applications

# Introduction

In this chapter background information on different topics relevant to the research are discussed. It starts with describing important and universal emotions. These emotions are then looked at more specifically in a teaching environment and in combination with virtual characters. Next, we take a closer look at the design style for the coach. Finally we take a look at similar skiing applications and installations. In the end a conclusion is drawn with which we will continue working in future chapters.

# 2.1 Background on emotions and facial expressions

In order to get a better understanding of what emotions are universally recognized and which ones are suitable in a learning environment, a look is taken at different types of emotions and their use.

# 2.1.1 Universally recognized emotions

First we look at Plutchik's wheel of emotions. The wheel shows eight basic emotions (*Joy, trust, fear, surprise, sadness, disgust, anger, anticipation*) [21]. The idea behind this so-called wheel is that every basic emotions can be shown in different intensities. E.g. the superlative of joy is ecstasy. When emotions are combined, a new emotions can be formed. For example, when one combines surprise with fear, one gets awe. The wheel can be seen below in figure 1.



Figure 1: Plutchik's wheel of emotions

Plutchik states that these eight emotions can be found in all organisms. It is said that these emotions are needed by all organisms in the struggle for individual survival.

Another take on the so-called basic emotions is by Ekman's atlas of emotions. Similar to Plutchik this atlas describes a set of emotions. According to Ekman, these are universal and experienced by everyone. There is overlap in the emotions described by both. Just like Plutchik, Ekman also sees fear, disgust, anger, joy and sadness as the core emotions. The atlas can be seen below in figure 2.



Figure 2: Ekman's atlas of emotions

In addition to his theory on universal emotions, Ekman developed a tool that can measure any facial expression a human can make [22]. He is one of the head-developers of the Facial Action Encoding System (FACS). While developing this system it was concluded that micro expressions say a lot about the emotions a person might be experiencing. Using FACS, every facial movement is called an Action Unit, or AU in short. According to Ekman every facial expression can be broken down into one or more AUs. FACS describes how different AUs can appear in combination, making up a new facial expression.

#### 2.1.2 Emotions in a learning environment

Since the application will be a learning, or coaching, application, it is important to know how emotions and facial expressions expressed by the teacher or coach are seen in this content. Which emotions are seen as important and which ones are motivating for the user. In this part, these things are discussed.

Firstly we look at positive emotions expressed by the teacher or coach and their impact. An emotion is classified as positive if the emotion involves pleasure or progress [23]. Examples of positive emotions are joy, love or satisfaction. These positive emotions often arise from goal congruence. This argument is supported by Reschly's [24] findings, which state that *"Positive emotions appear to be related to greater personal and environmental resources, such as greater student engagement in school activities and more supportive relationships with adults."* 

Secondly negative emotions were looked at. Examples of negative emotions are anger or frustration. Contradictory to where positive emotions often come from, negative emotions arise from goal incongruence [23]. Another characteristic of a negative emotion is that in a teaching environment negative emotions often make the younger students feel ashamed and embarrassed while they often lead to more misbehavior with older students [23]. These aspects of negative emotions mainly lead to negative consequences. However Averill [25] contradicts this by stating that negative emotions expressed by teachers can have a positive influence on a student's motivation. This statement is supported by Emmer [26] who claims that "*Teacher's negative emotions are a central component of management and discipline because they focus attention so powerfully*". Teachers express anger for student failures attributed to lack of effort and express sympathy for failures attributed to lack of ability.

Both negative and positive emotions can have negative and positive influences on the student. However, there are more claims that state that positive emotions are stimulating for students.

#### 2.1.3 Emotions and facial expressions in virtual characters

Facial expressions and nonverbal communication are important when it comes to influencing the user. To see how these can best motivate the user, it needs to be researched what impact nonverbal communication by virtual characters has on humans.

Emotions are essential to build the believability of a character [27] [30]. The term believability in this context means that the character creates an illusion of life and that the user really feels as if the character cares about them. Thomas and Johnston from Disney state that *"From the earliest days, it has been the portrayal of emotions that has given the Disney character the illusion of life."* [28]. In the past couple of years a new term has arisen from research; Believable Embodied Agent [29]. This type of agent has a personality and can express different emotions. Facial expressions and emotions are crucial characteristics for these types of agents.

For this particular installation is it important the coach is believable, since he needs to motivate and influence the player. Therefore it is important that he can show emotions.

#### 2.2 Background on appearance in virtual characters

In this section different design styles of virtual characters are discussed and how they influence the user. Of every design style several pros and cons are given. The first style is realistic characters, then stylized is.

#### 2.2.1 Realistic characters and their influence

There are a four different social aspects that need to be taken into account when working with realistic characters. Friendliness, trustworthiness, seriousness and familiarity are recurring themes [1]-[3]. When designing a virtual coach these aspects need to be taken account and how they influence the user and his motivation.

First the friendliness factor is discussed. Realistic characters are often perceived as less friendly than so-called stylized characters [1]. Ring [1] states that users saw realistic avatars as less caring. On the other hand, McDonnell et al. [2] find contradictory results. In McDonnell's research different render styles were looked at. Ranging from realistic to abstract. McDonnell claims that users rated their most realistic looking character just as appealing and pleasant as the stylized characters. McDonnell's claims are backed up by van Wissen [3]. Similar to McDonnell, Van Wissen claims that realistic looking characters are often rated higher in terms of friendliness and likeability than stylized characters. One can say based on these different statements and claims that a final conclusion cannot be derived yet when it comes to the friendliness factor.

Second, trustworthiness and the degree to which users believe what the avatar is telling them is another important factor [1]-[3]. McDonnell concludes the characters that lay

in the middle of the realism spectrum, were rated as very untrustworthy [2]. Confirming once again that users preferred more realistic looking characters.

Third, the familiarity aspect is taken into account. Using a virtual character that is familiar to the user in a way that the avatar represents a person they know, does not lead to a positive result: "using representations of loved/familiar ones is not (yet) recommended due to the heightened expectations that current state-of-the-art technology has difficulty to address," [3]. In this context familiarity is therefore not a good idea. This is because people get certain expectations of behaviour when the character looks familiar and are then guickly thrown off if the behaviour is not the same as their expectations. Quite similar to this is the Uncanny Valley theory [4]. This theory states that near-photorealistic virtual humans often appear unintentionally eerie or creepy. It is often associated with 3D characters or robots. When using an avatar that looks like someone the user knows, the user might spot characteristics that do not seem natural. On the other hand, when using a design style that is familiar to the user instead of using an avatar as a replica of an existing person, the users tend to prefer these characters [2]. The term familiarity can also be combined (or confused with) the term 'similarity'. When users can relate to the avatar they are more likely to believe and like the character [1],[12]. However this relatability is not solely applicable to realistic characters as people can also recognize themselves in a stylized character.

The fourth and final aspect discussed is seriousness. For a virtual coach it is important that users take him seriously because otherwise users might not follow his instructions. Ring [1] draws the conclusion that a realistic character is most suited in serious application but not necessarily in social context. '*Our results suggest that within a purely medical system a highly realistic agent may be a better design, whereas for a social system a cartoon like agent may work better. [1]*'. One can argue that a virtual ski coach is not as serious as a medical coach and therefore a virtual coach does not necessarily need to have a realistic avatar.

Combining all these different findings into a final statement, one can say that a realistic character can be friendly and trustworthy and is often taken seriously. In addition to that it is stated that a realistic character is often only believable if the user can relate to the avatar. Taking into account all these factors, a realistic character can have a positive influence on the player's motivation. However it needs to be assured that the character is not photorealistic, due to the risk of the Uncanny Valley.

#### 2.2.2 Stylized characters and their pros and cons

Working with stylized characters comes with advantages and disadvantages. A big advantage of using a stylized character is that it is a good way to work around the Uncanny Valley [1]. By making use of characters that do not look like real characters, for example by bringing their bodies out of proportion, the danger of the Uncanny Valley subsides. Since it does not remind the user of a real human and is therefore more forgiving of un-human like behaviour. McDonnell [2] backs this statement by concluding that users are less forgiving of anomalies if the character starts to move its face. Furthermore, in another research McDonnell states that users do not feel eerie or uneasy when the character performs humanlike body movements [9]. From this we see that when it comes to facial expressions, a stylized character is a better choice. However when it comes to full body movement, it does not matter as much. Another big advantage when using stylized character is that they are often perceived as more friendly and trustworthy [1], [2]. In social context stylized characters are often preferred over realistic characters. In addition to this, users tend to find these type of characters more suitable for social context tasks [1]. Consequently, McDonnell says that stylized characters are perceived as highly appealing and friendly and therefore *'might be more appropriate for certain virtual interactions'* [2].

A disadvantage of a stylized character is that the influence of the avatar on the learning abilities of the user is often negative. Baylor [10] concludes that a cartoon-like character is less beneficial for one's learning abilities than a realistic character. This statement is supported by Donners [11] who used a realistic looking character instead of a cartoonish character in his research for a virtual coach because of this.

A stylized character is a good way to work around the Uncanny Valley but has been proven a couple of times that such a character is not per definition suitable in a teaching or coaching role. In addition to this, realistic characters are often preferred as more serious roles. The question how serious a skiing coach is compared to for example a medical coach, rises from this background information.

# 2.3 Similar applications and installations

# 2.3.1 Skiing applications

RideOnVision is an augmented reality ski application [17]. Augmented reality is implemented in a pair of ski goggles. In the glass of the goggles useful information is displayed for the skier. For example: *"the ability to generate virtual slalom runs on the snow, or project directions on the piste as you carve.*" The technology of the application is rather impressive but it is still hard to put it to practise on the actual ski slopes in the outdoors [18]. Because this application is in augmented reality rather than in virtual reality it is not very relevant to this research. However it definitely needs to be taken into account. This because augmented reality might in the future be a good replacement of the virtual reality application in this case because for the player it can be beneficial to see his own body. Which is not possible in VR.

SkyTechSport [19] produces ski and snowboard simulators. The simulator is a VR installation that gives the user the illusion he is skiing down the slopes. The installation has different difficulties levels so that both beginners and professional skiers can use the simulator. This application is incredibly relevant to the virtual coach research since it makes use of a fitness machine that helps with training the muscles needed for skiing. SkyTechSport does not have a virtual coach implemented but the hardware used is very similar to what can be used for the coach project. For the virtual coach project a more basic ski fitness machine will probably be used [20]. This machine is especially made to simulate skiing movements so that the user is prepared for the real deal when going on a winter sports holiday.

# 2.4 Conclusion

Emotions that are universally recognized are joy, fear, anger, sadness and disgust. Combining these emotions can result in new emotions, just like different intensities of the basic emotions. Emotions can be seen as either negative or positive. In a teaching environment both these type of emotions can have a positive learning effect on the students. However, it also depends on to which intensity these emotions are expressed. In order for a virtual character to be believable, it is important that it can express emotions. This can be done with nonverbal communication, with for example facial expressions.

When looking at all these separate pieces of information, one can state that the character for this installation should be able to express both negative and positive emotions, since they can both be beneficial for the learning ability and motivation of the user.

Realistic characters are often a better choice as a virtual coach, provided that the Uncanny Valley is taken into consideration. If one decides to make use of a realistic character, the character should be 100% correct in its movements, since users are easier dissatisfied and less forgiving when it comes to interaction with realistic characters. If all these aspects are taken into account, the coach can have a positive influence on the player's motivation.

Stylized characters are often seen as more friendly, likeable and trustworthy. However, these type of characters are not always taken seriously. Within the term 'stylized' are a lot of different forms and definitions. A cartoon-like character is more likely to be taken less seriously. While different forms of stylized characters are taken more seriously. Therefore one can say that for this specific skiing application, the choice of a not realistic but not too cartoony virtual coach may be a good one.

Taking all these sub-conclusions, one final conclusion for this chapter can be conducted. Some design choices and statements about the coach can already be made. The coach should be able to express both negative and positive emotions in order to be a believable agent. In addition to this, the coach should not look too realistic or cartoony. Combining these too requirements, the coach can be a believable coach.

# Introduction

The first description of the project was 'a virtual ski teacher for an indoor skiing slope'. There were no other requirements and specifications yet. In the ideation phase the product concept is developed from the first client proposal. The final product concept generated by the ideation phase is based on personal interest, rationale, background literature, brain storm sessions and user scenarios. Personal interest in the main drive and motivation behind the research. The rationale and background literature look at the practical side of the research and application. Brainstorm sessions and user scenarios are used to add extra dimensions to the research and application.

# 3.1 Personal interest

Character design is a field of interest that would be interesting to further explore. Developing a virtual ski coach comes with a piece of character design. Keeping this in the back of our minds, we look at many different ideas that focus on character design and a virtual skiing coach. These ideas are generated by individual brainstorms. Along the way we make decisions for the final product concept.

# 3.2 Diverging and converging

With the ideas of a virtual ski teacher and character design in the back of our minds, the first ideas were generated in individual brainstorm sessions. We start with a job from the client and end with a final product concept. In this process we diverge and converge a lot. We start with many different ideas, diverging, and converge that into one idea. That idea might be further diverged in other ideas, which will then be again converged. This process keeps on repeating until a final idea is chosen with a final converging phase.

#### 3.2 Virtual reality or augmented reality

A virtual skiing coach can be implemented in many ways. Virtual reality and augmented reality are two technologies that quickly pop into mind. One can wear the glasses while on an indoor ski slope and a virtual coach is present in the application.

The choice to work with virtual or augmented reality is a choice that needs to be made early on, in order to further the develop the product concept. Therefore we list the pros and cons for both technologies. Then a decision between the two is made.

#### Augmented reality

#### Pros

Can see own body

When working with a sports application, or skiing application in this case, it is important that the user knows where his body is. This way it is easier for him to keep balance. If this application were to be implemented on an indoor skiing slope the user can still see himself while wearing these glasses. Cons

#### Underdeveloped technologies and graphics

Augmented reality is still in its early developing phase and the technologies are not very accessible (yet). Graphics are not fully optimized yet. Most AR-glasses show a square projected on the real world instead of creating a virtual world all around. For a coach this is not beneficial since the user might not be able to see the coach very well because the lack of good graphics.

#### Expensive glasses

AR-glasses are more expensive than VR-glasses. This makes them less accessible. One of the most developed AR-glasses is the Microsoft Hololens. However, the Hololens is very expensive and not available all over the world [31].

#### Virtual reality

#### Pros

Developed graphics

Graphics in for virtual reality applications are more developed than in augmented reality applications.

#### More options

There are more VR-glasses available than there are AR-glasses available. This means that there are also relatively cheaper VR-glasses. Such as the Samsung VR gear.

#### Immersive environment

Virtual reality is immersive and the user is in a totally different world. As could be seen from the background literature, this is beneficial for the player's motivation.

#### Multiple angles

In VR the user can view the scene and objects from multiple angles. He can walk through the scene and explore everything. For a sports application this is useful, because the user can see the exercise from every angle and can gain a better understanding of the exercise.

#### Cons

Cannot see own body

The big disadvantage of VR is that the user cannot see his own body. When using a sports/ski application this can be tricky since the user is not aware where he is going in the physical world.

#### The decision

It is decided to work with virtual reality. Since the focus point will be the coach and its character design it is important that the user can see the coach well. Augmented reality would be limiting this. Virtual reality, on the other hand, is very suitable for this. Graphics in VR are further developed than graphics in AR and the user can see the coach from multiple

angles, if he wants to. However, the downside to VR is that the user is not able to see his own body. It is therefore important that this is not necessary for the final product.

# 3.3 Focus point determination

Now that the decision to develop a virtual ski coach in virtual reality has been made it can be determined what the focus point of the research will be. A coach has many different aspects and can influence the player in different ways. Some of the aspects of the coach are listed below. Here these aspects are introduced shortly. Ideas for more specific research regarding these aspects are listed next. After that it is determined which one of these aspects will be the focus point of the research.

• Design style

By looking at background literature on character design it can be seen that the design style of a character has a lot of influence on how the user perceives the character. It can be tested how differently designed characters on users to see what influence the design style has on the user's motivation and performance.

• Feedback

The coach provides feedback on the performance of the user. The coach can give verbal or nonverbal (or both) feedback. It can be tested and researched how the feedback influences the user.

# 3.3.1 Design style research ideas

Using the literature research on design style in virtual coaches it can be seen that stylized figures were often preferred over realistic looking characters by users. However, the term stylized is a very broad one and can have many different meanings. To see what effect a stylized character has on the user, different meanings of abstract need to be researched. Cartoon-like characters versus more vague figures are compared and the influence of them on the user. Animals can also be used as a virtual character and would be seen as a stylized character. A cartoon-like character and an animal character could be compared in a final product to see which one has the most influence on the user.

Another way design style could be the focus point of this research is by looking at the physical appearance of the coach. The background research showed that the physical appearance of a coach can influence the user. However, there were a lot of different findings on this subject. To see if a more stable result on this subject can be found, different coaches with both a fit and an unfit appearance could be tested.

A combination with the first research topic could be made. In total there are then 4 different coaches.

- Cartoon like human fit character
- Cartoon like human unfit character
- Cartoon like animal fit character (e.g. tiger)
- Cartoon like animal unfit character (e.g. bear)

#### 3.3.2 Feedback

A coach is often present to provide feedback on players and tell them what to do. Therefore it might be interesting to research what influence the feedback by the coach has on the users. From the background literature it could be concluded that positive emotions with teachers often have a positive influence on the motivation of the students. It is interesting so see if this also translates to a virtual coach.

The feedback can be given in different ways. The coach can provide feedback verbally or nonverbally. For both these types of communication it can be researched whether positive or negative feedback have a positive influence on the user's motivation.

#### Verbally ideas

- Written feedback
   Texts appears based on the user's performance.
- Spoken feedback
   The coach provides feedback by telling the user if he is doing it right or not.

#### Nonverbally ideas

Facial expressions

The coach displays emotions in the shape of facial expressions based on the performance of the user.

- <u>Bodily positions</u>
   The coach takes on different poses based on the performance of the user.
- \*

# Decision

It is chosen to research a feedback system with facial expressions. Both the design style research and the feedback system are interesting for the personal interest. However, researching design style comes with certain complications. Modelling, rigging and animating more than two characters is incredibly time consuming. Another reason why design style based research is not feasible, is because it needs to be tested on large groups of users. This is due to the many different design styles. Every design style should have its own user test with many users. Since the time frame of the research is rather limited, this was not feasible.

Researching a feedback system with facial expressions was therefore more feasible. Verbal communication is complicated to simulate for virtual characters. Lip syncing is a very specific and time-consuming task. Another reason why nonverbal communication is a better choice than verbal communication, is because people tend to show their emotions with nonverbal communication first [33]. By showing feedback with facial expressions we are simulating real emotions and not going through the hassle of lip syncing. For these reasons it was chosen to research facial expressions on a virtual coach.

# 3.4 User scenarios to understand skiing education environment

User scenarios can provide new insights into the product idea so far. By looking at different aspects of the products through the eyes of potential users, new observations can be done for the product.

#### 3.4.1 User identification

In order to fully understand the target group and shape the application to the needs of this target-group we identify the potential users. In the next segment of this chapter user scenarios are described. Based on these methods design choices are made.

Many people fit a potential target-group. People who fit this target-group probably share the common interest in skiing and virtual reality. Advanced skiers are possibly less interest in the application, since they already know quite well how the ski and need less preparation. However, people who are less advanced might benefit from this application more. There are no restrictions when it comes to age and gender.

Next to people that might directly use the application in the future as consumers, potential retailers are part of the target-group. With retailers we mean people who possibly want to buy the installation and outsource it. This part of the target-groups concerns gyms and indoor ski slopes.

Finally, there might also be people who could be negatively influenced by the application. For example personal trainers or ski teachers. This because their job might be replaced by a technology in the future.

#### 3.4.2 User scenarios

#### Mike 24

Mike is a 24-year old student from Amsterdam. He goes on a skiing holiday every few winters. He likes skiing, but he is not dedicated enough to go each year. Another reason is that winter holidays can be quite expensive. Since he does not go skiing often, his skills aren't developing very fast. However, skiing lessons can be quite expensive and he can already ski a little bit, so he does not want to do skiing lessons again every time. Another problem he has with skiing lessons is that he can't always understand what the teacher is saying, since the lessons are outside and it can be quite windy at times. The face of the teacher is hardly visible because he is wearing goggles and a helmet. The virtual reality application can be a cheap (one-time purchase) and easy solution for Mike to prepare for his skiing trip. In the virtual reality application he can view the coach and instructor from many angles and he can replay exercises if he did not understand it the first time.

#### Claire 37

Claire is 37-year old single mom. She likes to go to the gym two times a week but sometimes struggles to find the time. Being a single mom, her life can be quite hectic combining raising a child, working, going to the gym and maintaining her social life. Therefore, she sometimes skips the gym. She does not want to, but does not feel obliged to go every time. She thinks that hiring a personal trainer can motivate her more to go every time. However, personal trainers are expensive and she cannot afford one. A virtual personal trainer in the gym accessible to everyone could be a cheap solution to her problem.

# 3.4.2 Results user scenarios and user identification

When looking at the potential user-group of this application, it can be said that almost everybody should be able to use this product.

From the user scenarios it can be seen that ski teachers do not always have a clearly visible face. Therefore the combination of a research into facial expressions and a virtual ski teacher might not be sensible. Implementing a skiing coach in a virtual reality application while skiing on an indoor slope, was already not feasible, since the user cannot see his own body in virtual reality. Taking these two constraints to an actual skiing application into account, changing actual skiing to preparatory skiing exercises is a logical consequence. By making a virtual reality application for preparatory skiing exercises a coach whose face is clearly visible can be implemented and the risk of falling on a ski slope due to imbalance with VR-glasses is avoided.

For this research we stick to skiing exercises so that it is still linked to the client. Nonetheless, in the future it might be possible to implement this idea, a virtual coach in VR, in gyms. This makes personal trainers more accessible and cheaper.

#### 3.5 Final product concept

Looking at this chapter and the line of thought we can come to a final product concept. Decisions have been made based on background literature, personal interest, brainstorm sessions, rationale and user scenarios. The specific requirements of the application are determined in the next chapter; *specification*.

In a virtual reality application an abstract figure performs a set of exercises. We choose a stylized character because it is less likely to receive criticism on performance. People follow these exercises and feedback is given by a virtual coach who shows emotions and facial expressions only.

Chapter 4 Specification

#### Introduction

In the specification phase we determine the requirements of the application. Making use of the MoSCoW [32] technique we analyze the requirements. At the end of this chapter a short overview of these requirements are given. These requirements are then taken to the next chapter, in which the system is realized.

# 4.1 MoSCoW

By making use of the MoSCoW analysis [32], the different requirements are grouped in terms of necessity.

#### Must-have

The idea is a virtual reality application in which a virtual coach provides feedback with facial expressions on the user who performs an exercise, or multiple. With this idea and the ideation from the previous chapter, the must-have aspects of the system are described.

• R1 The coach

There needs to be a virtual coach in the application. The coach's appearance needs to meet the following requirements.

- **R1.1** Not photorealistic Because of the risk of the Uncanny Valley
- **R1.2** Not too cartoony-looking Because of the risk that people will not take the coach seriously.
- R1.3 Clear facial features to express emotions
   The emotions need to be clearly visible for the user
- R2 Feedback
  - R2.1 Types of feedback

The coach should be able to give different kinds of feedback. The feedback should be given in the form of facial expressions. This can be done by implementing different emotions. One of each type of feedback is sufficient for now.

- R2.1.1 Positive feedback
- R2.1.2 Negative feedback
- R2.2 Accurate feedback
   The system needs to be able to provide accurate feedback on the user's efforts/performance/motivation.

#### • **R3** Virtual Reality implementation

The system has to be set in virtual reality. The virtual reality gear used has to be of high quality. This is because the user will be performing exercises, if the VR-gear is not of high quality, the chances of the user feeling nauseous or ill are heightened.

#### • <u>R4 Safe</u>

The system has to be safe for the user to use. Since it is set in VR, people are disconnected from the real world and might therefore not be fully aware of their surroundings.

- **R4.1** Enough space to move around
- R4.2 Exercises that are doable without seeing own body
- <u>R5 Exercises</u>
  - **R5.1** The system needs to include exercises that the user needs to perform. There need to be at least two exercises. This is because users might be better at one exercise than at the other.
  - R5.2 The exercises should be easy to understand by the user

#### Should - Have

R6 Facial animations

The animations of the facial expressions can be dynamic. It is more pleasant to watch a face gradually change to an expression instead of that it jumps to the next one. The expressions feel more natural this way. Therefore it is desired to have facial animations.

#### • **<u>R7**</u> Different states of emotions</u>

The expressions chosen need to be able to be shown in different intensities, we call these intensities 'states'. This is desired because it makes the application less one-dimensional. It is desired to have at least two states per emotion.

• **<u>R8** Controllable by researcher</u> It is important that the researcher can control the application with ease.

#### Could - Have

R9 More emotions

It is desired to have more than two emotions, to make the coach more real and relatable. Both negative and positive feedback are not just one emotion and are built out of many emotions. However, this is not necessary to implement in this prototype due to time constraints.

#### Won't - Have

#### • **R10** More states per emotion

It is desired to have more than two states per emotion, to make the emotions more real. Since humans can also show more than one intensity of an emotion. However, this is not necessary to implement in this prototype due to time constraints.

#### R11 Automated system with sensors

By making a fully automated system, that responds to the user's effort measured with the sensors, the application can provide more accurate feedback to the user. This prevents human errors, that can happen more easily now. However, this is not necessary to implement in this prototype due to time constraints.

# 4.2 Final requirements

The previous formulated requirements can be combined together in one final requirement description of the system.

The application is a virtual reality set application. In this application the user has to perform certain exercises. The user is supported by a coach during these exercises. This coach provides both positive and negative accurate feedback on the user. The coach should look not too cartoony, not photorealistic and should be able to express emotions clearly. In addition to these requirements, the system should also try to have facial animations and different states per emotion. It would be nice if the application could show more than two emotions. It also would have been nice if every emotion had more states and if the system was fully automated. However these last two requirements will not be executed for this prototype.

Chapter 5| Realization

# Introduction

In *realization* the application is built. For this application we need to build various 3D models and implement it in Unity. In this chapter it is described in detail how it is built. It starts by explaining how the 3D models were made and animated. The first animations and facial expressions are made based on the background literature. With these first animations it was tested if people understood the animations and how people perceived them. With the results from this short test choices for the final application were made. The final animations are then imported into Unity 3D, in which the whole application is built. In Unity 3D the scripts are written and is the VR gear connected and implemented. The application is now ready for testing and evaluation

# 5.1 Part and software identification

#### 5.1.1 The different parts

Before the application can be realized, it first needs to be determined which different parts the development consists of. The development of the application can be categorized in a couple of main categories:

- Modelling
- Game implementation
- Virtual reality implementation

The modelling category consists of different parts. Such as emotion-choice, modelling, texturing, rigging and animating. The game implementation is the part in which the models are programmed in such a way that they display the right animations (exercises and facial expressions). The final part is the virtual reality implementation. This is the part in which the Oculus VR glasses are combined with the program.

#### 5.1.2 Software identification

For the modeling part it was chosen to work with Autodesk Maya. This software is familiar and works very well together with Unity. Unity 3D is the game engine used to make the application in. The Oculus Rift was used as the virtual reality glasses. The Oculus works really well together with the Unity Engine. The HTC Vive glasses were also taken into consideration, but are heavier and are complicated to set up. The HTC Vive glasses have the advantage that the user is able to walk around in the application, however this feature is not needed for our application.

#### 5.2 The models

The 3D models are an important part of the application. In this part of the chapter it is explained how these models were made, textured, rigged and animated and why.

#### 5.2.1 Modelling

#### The different models

In the product there are four objects: three abstract instructors and one floating head. The three instructors perform the exercises, while the floating head provides the feedback with facial expressions. It is chosen to work with two separate figures to meet requirement **R.1.3** *Clear facial expressions*. By having a separate model for the feedback, the face that provides the feedback is always visible. It is possible that the face of the instructor is hardly visible when he is performing the exercises, therefore it was chosen with a separate head for the feedback. Modelling a well topologized mesh for the instructor and another one for the floating head, was not feasible within the timeframe of the research. Since the focus point of this product is not the models of the application it was chosen to work from existing 3D models. These models were then modified to suit our needs.

#### The instructors

The models of the instructors need to be abstract and expressionless. This is needed in order to meet requirement **R5.2** *Easy to understand*. If the instructors are too expressive or have any distracting features they might distract from the exercise and the user might become confused. Due to these reasons it was chosen to work with an abstract model.

#### The coach

Subsequently the floating head should not be photorealistic to meet requirement **R.1.1.1**. For the floating head, a very generic model is chosen. From the background literature it was concluded that a too realistic, or too cartoony looking character was not suitable for the application [x]-[z]. To meet these requirements (**R1.1 and R1.2**), choosing a generic model is a good solution. With a model like this, texturing is important. The texture applied can make it look very realistic, or maybe very abstract. Texturing is described in 5.2.2.

#### 5.2.2 Texturing

The textures of the instructor models have been kept fairly simple.

Each instructor receives its own colour. These colours are blue, green and yellow. They only have one colour. This is to not distract from the exercise and keep them as expressionless as possible. The only task they have is to perform the exercise. Any unneeded extras might distract from that purpose. The floating head is very simply textured. Since the model is quite generic, it can easily look too realistic by using realistic textures. The textures used are simple but still recognizable. The final textures of both the instructors and the floating head can be seen in figure 4 on the next page.



Figure 4; Floating head and first instructor textured

# 5.2.3 Rigging

The instructors needed to be rigged but the floating head did not have to be rigged, since its animation is based on using blendshapes. The instructors need a basic rig. Facial rigging is not necessary. The Autodesk Maya plug-in 'Advanced Skeleton' was used for this task. This plug-in provides a built-in rig, which can be modified to the geometry used.

#### 5.2.4 Animating

For the instructors, three different animations were created. All these animations are related to skiing. The exercises can be done as preparation for a skiing holiday. The three animations are animated by hand. These animations are discussed in 5.2.4.2. The floating head makes use of blendshapes. The head is modelled in three different ways. For every emotion one;

- Happy
- Disapproving
- Admiration

#### 5.2.4.1 Emotions

In the background literature in chapter two, emotions in teaching/coaching environments and classification systems for emotions were described. Based on this information the emotions and facial expressions were chosen. It was stated that positive emotions often have a positive influence on the student's motivation and learnability, more than negative emotions expressed by the teacher. However it was also stated that negative emotions could work motivational. Therefore we implement both positive and negative emotions in the application. Using Plutchik's wheel [21] and the background literature we determine which emotions will be used. These were the reasons to conduct requirement **R2.1** *Different types of feedback*. Next it will be described how these different types of feedback were chosen.

For the first emotion we look at positive emotions and feedback, to meet requirement **R2.1.1** *Positive feedback.* When talking about positive emotions, we mean *love, joy, satisfaction* or *pleasure* [23][24]. Teachers and coaches that express these emotions are more likely to motivate students. Therefore we strive for a facial expression that expresses these emotions. Looking at Plutchik's wheel, given below again in figure 5, it can be seen that love is a combination of joy and trust. The superlative of joy is ecstasy and the superlative of trust is admiration. What can also be seen is that satisfaction and pleasure are not shown in this scheme. Therefore we stick to joy and love. Joy is used as the base emotion for the positive feedback facial expressions. From there on we build multiple states. In short, states simply mean that different emotions are shown in different intensities. These states are further explained in segment 5.3. Thus, the first emotion is joy, or happiness.



Figure 5; Plutchik's wheel of emotions

The second emotion will be derived from negative feedback and the negative emotions in Plutchik's wheel, to meet requirement **R2.1.2** *Negative feedback*. With negative emotions we mean *anger, frustration, disapproval* and *sadness*. It has been said that negative emotions can work beneficial on the student's motivation and learnability [26][25]. However, sometimes students feel ashamed, embarrassed and sometimes negative emotions lead to misbehavior. This means that the negative feedback has to be chosen with care, since there is a thin line between a positive influence and a negative influence on the user. It was stated that a teacher can not lose control over his emotions in order to maintain discipline and authority [23]. Anger is also often associated with stress and tiredness, indicating lack of control. Therefore we dismiss the emotion anger.

Looking again at Plutchik's wheel in figure 5 above, we can see that frustration is not shown in the scheme. However, we do see anger and that annoyance is a milder version of anger. Frustration and annoyance are very similar, and since we dismissed anger we also dismiss annoyance and thus frustration.

We are left with sadness and disapproval. We believe that sadness is not the most suitable emotion for a coaching environment, so disapproval is preferred. Sadness can, just like anger, indicate lack of control and this is not desired. Therefore disapproval is preferred.

We see that disapproval is a combination of sadness and surprise. This means that both sadness and surprise will be implemented in the final disapproval facial expression. We take disapproval as our second emotion.

The third and last emotion is again a positive emotion, to meet requirement **R2.1.1** *Positive feedback.* Since positive emotions and feedback are proven to be more beneficial for the user's motivation, it was chosen to work with one extra positive emotion. This emotion is an exaggeration of the happy emotion determined before. Looking at the paragraph about the dissection of the joy/happy emotion, it can be seen that love is a very important emotion. With the positive emotions the general feeling of love is tried to be achieved. Love is a combination of joy and trust. The superlative of trust is admiration, and since we strive to the most positive emotion it was chosen to work with a facial expression that shows admiration. Together with the previous joy/happy emotions described before, this should result in the feeling of love.

With these three emotions (happy, disapproval and admiration) we start modelling the facial expressions.

#### Blendshapes and expressions

The blendshapes made are a very exaggerated version of the happy emotion. With a slider different intensities of the blendshape can be chosen. If the slider is set to 100%, it shows the full blendshape. If the slider is set to 50%, the blendshape is twice as less intense. The blendshapes are modelled in Maya but later animated in Unity 3D. This is because animations in Unity are easier to adjust once the models are imported into Unity.

The neutral state of the face and the 100% state of the happy emotion are depicted below in figure 6. The facial expression shows a mouth in a broad smile, but still with a closed mouth. The eyebrows lift. This makes the *happy* facial expression.



Figure 6; Neutral and 100% happy

The second facial expression is for the negative feedback, so for the *disapproval* expression. In this expression the face lifts one eyebrow, his eyes narrow and one corner of his mouth goes down. The neutral face and the 100% state of the disapproval expression are given below in figure 7;



Figure 7; Neutral and 100% disapproval

The next facial expression is the *admiration* expression. In this expression the face has an open mouth, wide eyes and raised eyebrows. If this expression is then blended with the happy expression, the expression that is meant to show love forms. The neutral face, the admiration expression and the blended expression are shown below in figure 8.



Figure 8; Neutral, admiration, blended

#### 5.2.4.2 Exercises

The instructors perform three exercises. This is in line with requirement **R5.1** *Amount* of *exercises*. Two of which are specific skiing preparation exercises [34]-[36]. The other exercise is a so-called 'lunge'. This is a general fitness exercise, used to train the upper legs. Since it trains the upper legs, it is also suitable for skiing preparation. In figure 9 below the instructors can be seen in the starting position of the exercise they will perform.



Figure 9; the instructors in the starting position

Exercise 1

Exercise 1 is a lunge. Lunges is a common leg exercise in which in the leg muscles are trained. These are muscles that are very important for skiing. In figure 10 below the exercise is demonstrated.



Figure 10; Lunges

#### Exercise 2

In this exercise a ski jump is practiced. It is a deep jump from side to side in which the participant bends through the knees. With this exercise the lower abdominal muscles are trained. This type of jump also goes by the name 'lateral jumps'. This jump can be seen in figure 11 below.



Figure 11; the ski jump

#### Exercise 3

In the third and final exercise a quick small jump is practiced. In this jump the participant stands up straight and performs a quick jump from side to side. This exercise is to practice the participant's agility. It is a variation on the lateral jump from the second exercise.

# 5.3 Emotional States

To make the range of emotions more varied, it was chosen to work with different intensities of those emotions, this correlates with requirement **R7** *Different states of emotions.* The combination of a certain emotion together with a certain intensity is called a state. As can be seen in the background literature, it has been concluded many times that positive feedback

and emotions have a positive influence on motivation and learnability]. Therefore, the decision was made to work with one extra happy ('Admiration') emotion. This emotion will only be shown in one intensity.

To determine how many states per emotion were needed and feasible a small evaluation test was conducted. This is described in segment 5.3.1 below.

# 5.3.1 Evaluation test

Happy and disapproving both have three states. At first we thought it was desirable to have a wide range of intensities. In order to see if people could tell the different states apart a short evaluation test was done. In this test different states were shown following each other and people were asked to describe the difference between the two. Pictures of all the different states can be seen below in figure 12. Bigger images of the different states can be seen in appendix B. For each emotion, except for admiration, there are four states. The highest intensity state is 100% of the blendshape. The second-highest 80%, the third-highest 60% and the lowest 40%.



*Figure 12; First four: The four happy states, Second four: The four disapproval states, Bottom two: Admiration and neutral* 

Another aspect that was researched with this test, was to see if people perceive the emotions as we intended them to be perceived. For example, do people recognize the

admiration expression as a very positive emotion? This was done by asking people to say which emotion they found most positive and how they perceived different expressions. The complete test can be seen in appendix C.

The responses on the test were mixed, to see the full responses see appendix D. However there are similarities in the replies. It can be seen that people often do notice the differences between the states. However, in this test people could view the expressions as often as they wanted to. In the real product this is not the case and the expressions will quickly follow each other. A small pre-test was done if people could also see differences if they only saw the expressions briefly, it was concluded that people then often thought the expressions were the same.

To see how people perceived the expressions a table is made to see which words they associate with the expressions. The most frequent used words are bold and red.

	Disapproving	Нарру	Admiration
Words used to describe the expressions	Disgust, arrogance, Annoyed, Angry, irritated, rigid, doubtful, dissatisfied,	Happy, Surprised, friendly, content, entertained, satisfied	Shocked, <b>Surprised,</b> Happy, Excited, Curious, In love
Positive or Every participant perceived these expressions as not positive		Every participant perceived these expressions as <b>positive</b>	Almost every participant perceived these expressions as <b>positive</b>

Table 1; the expressions as viewed by the participants

It can be seen that most people saw the disapproving expressions as annoyed and/or angry. They perceived the happy expressions as happy and/or friendly. The final emotion, admiration, they perceived as happy and/or surprised. All the emotions are shown once again in figure 13 below.



Figure 13; happy emotion, disapproval emotion, admiration emotion, neutral emotion

In addition to these observations another thing that came forward in the test, was that some people could not take the expressions seriously or it made them feel uncomfortable because they were so over the top. It can be concluded that most people perceived the expressions as we wanted them to be perceived, however we need to keep in mind that the expressions of the highest intensities are sometimes a bit too much.

#### 5.3.2 Decisions for the states

The conclusion from the test made that only three states for happy and disapproving were used for the product. This leads to seven states in total. They can be seen below.

State H1 = Happy's lowest intensity (25 % of the blendshape)
State H2 = Happy's middle intensity (55% of the blendshape)
State H3 = Happy's highest intensity (70% of the blendshape)
State D1 = Disapproving's lowest intensity (30% of the blendshape)
State D2 = Disapproving's middle intensity (45% of the blendshape)
State D3 = Disapproving's highest intensity (65% of the blendshape)
A = Admiration's only intensity (40% of the blendshape)

In the pictures below the states can be seen.



Figure 14; state D1 - D3



Figure 15; state H1 - H3



Figure 16; Admiration state

Each state has its own animation, transitioning from a neutral facial expression to one of the seven facial expressions introduced above. These animations were created in Unity, using the blendshapes modelled in Maya.

# 5.4 Game implementation

# 5.4.1 Animating in Unity

The blendshapes made in Maya still needed to be animated using the states determined before. They need to be animated to meet requirement **R6** *Facial Animations.* Each state has its own animation. The animation follows a curve. We call this the intensity curve. It first shows the expression with quite a high intensity, and then the expression will gradually go to a lower intensity, the intensity determined before for each state. This is done so that the floating head is dynamic instead of a static model that provides feedback.

#### 5.4.2 Scripting

Scripting (or programming) in Unity for this product is done in C#. Several things need to be scripted in Unity;

- The facial expressions feedback
- Controls for the researcher

#### Facial expressions feedback

Using the states earlier, a script was written for the facial expressions of the floating head. By making use of the arrow keys on the keyboard, the researcher can determine if she wants to give negative (left arrow) or positive feedback (right arrow). By making the researcher able to control the application requirement **R8** *Controllable for the researcher* is met. After using one of the arrows, the floating head moves to the next state. The way it is chosen which state the floating head is in, is depicted below in the image. This algorithm is designed so that the feedback is as accurate and justifiable as possible. With this algorithm and feedback scheme, we meet requirement **R2.2** *Accurate feedback* A red arrow resembles negative feedback and a green arrow resembles positive feedback. The full script for this feedback system can be found in appendix E.



Figure 17; State algorithm scheme

#### Controls for the researcher

The application is controllable by the researcher. Unfortunately this means that requirement **R11** *Automated System* is not reached. However, this was a 'won't-requirement' and therefore it is not of great significance. Since the system is not automated, it is necessary for the user testing phase in the next chapter *Evaluation* that the researcher is able to fully control the application. She needs to be able to control the instructors and the feedback.

Each instructor has one exercise that he performs continuously. These exercises are animations made in Maya. The model, including its animations, was then imported into Unity. The animation in the import file is now also a part of the gameobject in Unity. When one instructor performs his exercise the others should stay still. By pressing different number keys on a keyboard the three different exercises are triggered.

The researcher is the one that controls the floating head and the emotions it shows. The researcher can determine if the user is performing well, resulting in positive feedback, or not performing well, resulting in negative feedback.

The full overview of the controls for the researcher and what they do is shown in table x below.

Key	Action	
1	Exercise 1, The Lunge	

2	Exercise 2, The Ski Jump / The Deep Lateral Jump
3	Exercise 3, The Side-jump / The Quick Lateral Jump
Spacebar	Pause
$\rightarrow$	Positive Feedback
$\leftarrow$	Negative Feedback

Table 2; overview of controls for the researcher

These controls and their actions have been implemented by means of a script. This script can be found in appendix F.

# 5.4.2 Virtual reality implementation

To meet requirement **R3** *Virtual reality implementation* it was chosen to work with the Oculus Rift. Another option would have been the HTC Vive. The Oculus and the HTC weigh around the same but are different in setup. The HTC requires two sensors and quite a lot of space, whereas the Oculus only requires one sensor and less space. Since the exercises in this application do not require a lot of space, the Oculus is a more logical option.

Another, and final, reason why the Oculus was used, is because it works very well together with Unity. Not a lot of effort is required to get a Unity-made application working with the Oculus.

In addition to the Oculus and the HTC Vive there are budget options available. For example the Samsung VR gear or even Google Cardboard. It was chosen not to work with these headsets because the application at this stage is not an automated system, and running it on a pc is therefore easier. This way it is easier for the researcher to control the application. Another reason one of the budget options was not chosen is because the frame rate in these devices is low compared to the higher end models [36]. A lower frame rate can result in motion sickness. In this application people have to move around a lot and motion sickness is therefore anything but desired. However, a big advantage of cheaper headsets is their weight. Budget VR headsets often weigh less than their more expensive competitors [37]. For application in which you have to move around a lot, this is more practical, however this benefit does not weigh up to the benefits of the more expensive headsets. Therefore, we stick with the Oculus Rift.

# 5.5 The final application

In the final application there are four objects; three instructors and one floating head. The instructors are abstract and expressionless figures who perform three exercises in total. The user is supposed to follow the instructor's lead. The floating head is a generic face who provides feedback with facial expressions on the performance of the user. The floating head is able to provide three different emotions

- Нарру
- Disapproval

Admiration

Each emotion comes in three states, except for admiration. The researcher is able to determine which feedback is given (either negative or feedback) by pressing the left and right arrow key on the keyboard. The application runs in Unity and can be viewed on an Oculus Rift. The user wears the VR glasses and performs the exercise.

#### Introduction

In the first section of this chapter we check to what extent our original requirements were met in the final realization. Thereafter (6.2) we discuss the setup of a user test, and we discuss the results of this user test in section 6.3. By making use of user testing different aspects of the application are tested. These results are taken to the next chapter in which an answer to the research question is formulated. Also iterations and potential follow-up research are defined there.

# 6.1 Functionality and requirements evaluation

In chapter 5, specification, the requirements for the system were defined. Before the final application is user-tested it is evaluated if the system meets the requirements set up in chapter 5. The requirements that are *yet to be determined* or have only been *partially* met, are explained further in 6.1.1 and 6.1.2. The functionality evaluation can be seen below in table 3.

Nr.	Sub	Sub	Description	M/S/C/ W	Met?	How
R1	R1.1		Not photorealistic	М	Yes	The instructors are abstract and expressionless. The floating head is not hyper realistic
	R.1. 2		Not too cartoony-looking	Μ	Yes - partially	The instructors are not cartoony. The floating head was not meant to be too cartoony, however some users did not take it seriously
	R.1. 3		Clear facial features to express emotions	М	Yes	According to the results of the test in <i>realization</i> , the expressions were clear
R2	R2.1	R2.1.1	Positive feedback	М	Yes	Concluded from the test in <i>realization</i>
		R.2.1. 2	Negative feedback	М	Yes	Concluded from the test in <i>realization</i>
	R2.2		Accurate feedback	М	Yes - Partially	Accurate feedback is generated by means of an algorithm. However, if the user also finds it accurate is not yet determined.
R3			Virtual reality implementation	М	Yes	Chosen was for the Oculus rift
R4	R4.1		Enough space to move around	М	Yes - see test setup	See test setup for the user-test
	R4.2		Exercises that are doable without seeing own body	М	Yet to be determined	This will show after the user test
R5	R5.1		Set of exercises	М	Yes	Three ski-related exercises were chosen

	R5.2	The exercises should be easy to understand by the user	Μ	Yes - partially	The exercises were animated as clearly as possible
R6		Facial animations	S	Yes	Each state has its own animation
R7		Different states of emotions	S	Yes - partially	Each emotion has three states, except for <i>admiration.</i> States for this one was thought not to be necessary
R8		Controllable by researcher	S	Yes - partially	The researcher can control the emotions with a keyboard. But it is still hard to determine how to give feedback. See further explanation below
R9		More emotions	С	No	Maybe in future iterations
R10		More states per emotion	W	No	Maybe in future iterations
R1 1		Automated system	W	No	Maybe in future iterations

Table 3; Functionality evaluation

# 6.1.1 The partially met requirements

#### R1.2 Not too cartoony-looking

When looking at the instructors this requirement is met. When looking at the floating head the requirement is only partially met. In the neutral state, the floating head does not look too cartoony. However, some of the emotions are a bit over the top, as realized with the short evaluation test in *realization*. Therefore the final emotions are not the most expressive ones, since we found those were perceived as a bit weird or funny. Hopefully by choosing the somewhat less expressive emotions of the head, the participants take him more seriously.

#### R2.2 Accurate feedback

This requirement is only partially met because it is not yet proven that the users find the feedback accurate or justified. However, by implementing the algorithm constructed in 5.4.2. the feedback has been made as accurate as possible. The algorithm makes sure that the right emotion follows the previous emotion.

#### R7 Different states of emotions

Both *happy* and *disapproving* come in three different states. *Admiration* does not come in different states. This is because *admiration* is an exaggeration of *happy*. The reason for this choice was already explained in the previous chapter.

#### R8 Controllable by researcher

The feedback is controllable by the researcher in a way that there are buttons for the researcher to press in order to display a certain expression. However, a small practical test showed that it can be quite difficult to estimate when to give which feedback. This was tested by letting someone perform one of the exercises. The researcher observed the participant
and said 'negative' if she thought the participant was performing badly and the other way around. This turned out to be quite difficult. Since an automated system is not feasible and the aim of the research is not to give extremely accurate feedback, this problem can be dismissed. However, it is something that might influence test results.

#### 6.1.2 The yet to be determined requirements

#### R4.2 Exercises that are doable without seeing own body

This requirement will be tested in this evaluation phase. In the user test it will show if people feel comfortable with performing such exercises in an environment in which they cannot see their own body clearly

#### 6.2 Goal of the test

In the test the user has to perform three exercises, all of which are related to skiing. Each exercise will receive a different kind of feedback. The user is told beforehand that the floating head will give feedback on his/her efforts and performance. However, this is only partially true. In reality, the user will only receive feedback based on their efforts in the first exercise. The user's learnability or skills in regards to the exercise are not looked at. Since the timespan for this evaluation phase does not allow for an extensive research on one's learnability. Therefore the test only looks at the effort the user puts into the exercise. In the second exercise the user only receives positive feedback. In the third and final exercise, the user will only receive negative feedback.

By giving different types of feedback, it can be tested if people look at the feedback at all and if they do something with it. So by sometimes providing unjustified feedback it can be seen if people look at the coach in the first place. A second thing that can be tested is to see which kind of feedback has the most influence on the user. By giving only negative feedback with one exercise and with another exercise only positive, it can be tested if people are more influenced by positive or by negative feedback. In the questionnaire afterwards general questions about people's preference in coaching type is asked. A possible correlation between those answers could occur.

In short; there are two things that are researched in this test.

- 1. Do people notice the feedback and what is its influence on them?
- 2. Are people more motivated by negative or positive feedback?

## 6.3 Test set-up

#### 6.3.1 materials

- Oculus Rift
- Laptop
- Unity program
- Consent form
- Questionnaire
- Videocamera

#### 6.3.2 Participants

The potential user group of this application is very broad. This user group was already described in chapter 4, ideation. The group is very broad because many people might have interest in a virtual coach or trainer. However, this does not mean that the application can be tested with anyone. The application is not fully optimized yet and since it is an application which involves physical exercise, this can be a problem to some users. People who the application can be tested with, are people that are healthy, can move around freely and preferably have tried out virtual reality before. This last requirement is because if a user has never done VR before, he is not be familiar with the sensations and disorientation that sometimes comes with virtual reality.

The test is conducted at the University of Twente. Where the average person is young and has a technological background. Since the test is conducted to find out whether or not people feel motivated and affected by the virtual coach, it is sensible to have participants who are able to perform the exercises and understand virtual reality.

#### 6.3.3 Set-up

Before the user begins the test he is asked to sign a consent form, see appendix G for the form. On the consent form it is explained what will happen in the test and if the user feels uncomfortable, he may stop at any given moment. The user is also asked if he minds if he is recorded. If the user agrees with this the researcher turns on the videocamera to record the test. Then the user puts on the VR headset and the unity application described in chapter 6 runs. The user sees three abstract figures (AF) and a floating head. The AF perform three exercises that are related to skiing, consecutive of each other. The user has to perform the same exercises. The floating head gives feedback in the form of facial expressions on the way the user performs the exercises. There are both negative/critical and positive/motivating facial expressions. The specific expressions are described in chapter 6, *Realization*. The floating head is controlled with the wizard of Oz method [38][39]. The researcher controls which facial expressions are displayed with controls on the keyboard. The test situation can be seen in figure 18 below.



Figure 18; Schematic scene of test situation

The user performs three exercises, all for 30 seconds. With a short break in between to catch his/her breath. After making sure the user is ready to perform the next exercise, the researcher starts the next exercise. After the user has performed the three exercises he is asked to fill out a questionnaire asking about his experiences while performing the test.

#### What the user sees

The Wizard of Oz method is used, that means that the user thinks the application is an automated system, while it actually is not. The researcher controls the application. The only thing the user sees is an application that seems to respond to his actions. This creates the illusion of a fully automated system and gives the user the feeling as if he coach is responding. While in fact the researcher is responding. For all the different scenes the user sees in the application see appendix H.

#### What the researcher sees

The researcher controls the exercises shown and the feedback system. In figure 19 below the setup and materials for the researcher are shown.



Figure x; setup from researcher's perspective

Figure 19; setup from researcher's perspective

At the beginning of the test the researcher asks the user if he is ready for the exercise. If the participant is ready the researcher starts the first exercises and sets a timer for 30 seconds. This

The user performs exercise 1:

• The researcher gives feedback according to the user's performance

The user performs exercise 2:

• The researcher only gives positive feedback

The user performs exercise 3:

• The researcher only gives negative feedback

After exercise 3, the test is over. The researcher then asks the user if he wants to fill in the questionnaire.

For exercise 1, the researcher needs to know when to give someone positive or negative feedback. It can be quite difficult for the researcher to estimate what feedback to give. Therefore a small set of guidelines was established to help with this. These guidelines can be seen in table x. These guidelines are possible actions the user might perform during the exercises. If one of these actions is noticed by the researcher, she can provide either positive or negative feedback according to this table.

← Negative	Positive $\rightarrow$
Remarks such as 'This is stupid' 'I don't want to do this anymore'	Remarks such as 'This is hard' 'I am struggling' 'I don't know if I can do this'
Barely moving	Sweating
No need to catch breath	Breathing heavily

Table 4; guidelines for feedback indication

#### 6.3.4 Questionnaire

The questionnaire that the user is asked to fill in afterwards consists of different parts. Each of these parts are linked to a different topic that is desired to be researched. The first part are the general questions, to determine someone's age and gender.

The second set of questions is related to sports and preference in coaching methods. We ask the user what he prefers in a coach and if he normally pays attention to the teacher's or coach's emotions. With these questions we want to find out the following things;

- Correlation between the opinion the user has of the coach and what type of coach the user prefers
- Correlation between if people would normally pay attention to a coach and if they would now

Some of the questions are given below.

When you're in class, do you pay attention to the teacher's emotions/feelings?
0 Yes 0 No
0 Other
Are you, in general, more motivated by happy teachers or strict teachers?
0 Strict
0 Happy
0 I don't know
When you're playing sports, do you pay attention to the coach's emotions/feelings?
0 Yes
0 No
0 I don't know
0 Other
Are you, in general, more motivated by happy or strict coaches?
0 Strict
0 Нарру
0 I don't know
U Other

The third part of the questionnaire are questions about the actual test. This part is the most extensive. The full questionnaire can be seen in appendix A. With these questions we try to find answers to the following;

- How much can the coach influence the user?
- What type of feedback has the most influence on the user?
- How do the users perceive the feedback?
- How motivated were the users by the feedback?
- Do the users change their behavior based on the feedback?

Some of the questions of this part are given below.

In exercise 2, I perceiv (More answers can app [] Supportive [] Motivating [] Encouraging [] Positive [] Happy [] Critical [] Angry [] Frustrated [] Negative [] Strict Did you feel as if the f If yes, in what way did 0 Yes 0 No	ved the floating head as	d the way you perfo	ormed the exercises?
When you perceived t 0 0 Unmotivated	he head as critical/neg 0	ative, how did you 0 Mo	feel 0 tivated
When you perceived t 0 0 Unmotivated	he head as motivating/ 0	positive, how did y 0 Mo	ou feel 0 tivated

#### 6.4 Results

In this part we try to answer the questions formulated in 6.2. Each question is tried to be answered as detailed as possible. The exact answers to the questionnaire can be found in appendix I.

#### How much does the coach influence the user?

The group of participants gave many different types of results. Some people did not notice the floating head until relatively late, while others tried to please the head from the beginning. Nonetheless in general people are happier when receiving positive feedback. Receiving positive feedback means that the face showed the happy or admiration expression. On the other hand negative feedback resulted in mixed responses. Some people were more motivated by negative emotions from the head, while others became demotivated.

About 50% of the participants says that the head did not influence them at all or only influenced them shortly. The other 50% says that they did feel influenced by the floating head and said they adjusted their behavior according to the feedback.

In the questionnaire an explicit question to the influence of the coach on the user was asked. The results to this are mixed. Eleven out of ten people claimed that the coach influenced them while performing the exercises.

#### What type of feedback has the most influence on the user?

It is hard to say which type of feedback influenced the user the most. Both types of feedback had an impact on the user, whether this was positive or negative. Positive feedback mostly had a positive influence on the user. With a positive influence we mean that the user felt

motivated and as if they had succeeded when the head showed positive feedback and emotions. In graph 1 it can be seen how people rated how the head made them feel.



Graph 1; How the feedback made the users feel

#### Do the users change their behavior based on the feedback?

Twelve out of twenty users said that the floating head and its feedback changed their behavior. Of those twelve, seven people said that they started to perform better in order to make the floating head happy. They stated the following things about the way they changed their behavior.

#### -----

- At first I tried to please it, but halfway through the second exercise, I wasn't bothered by it anymore
- Yes I tried to do better when the head was not positive
- I felt better when the face looked happy
- I tried to make it happy
- Yes, halfway through the second exercise the face did not look happy and I tried to do better in the exercise
- Yes, I wanted to please him

#### How do the users perceive the feedback?

There is more overlap in opinions when it comes to describing the emotions. In table 5 below the frequency of words to describe the feedback in the different exercises can be seen.

Legend Frequency < 2

```
2 < Frequency <
6
Frequency > 6
```

	Supportive	Motivating	Encouraging	Positive	Нарру	Critical	Angry	Frustrated	Negativ e	Strict
1										
2										
3										
		-								



From this table it can be seen that people perceived the feedback given in exercise two as critical/negative/strict, this is how that feedback was intended. It can also be seen that users perceived the feedback given in exercise three as it was intended; positive/supportive/happy. This is in line with what was expected.

The admiration emotion received some mixed responses. People classified it often as a positive emotion and as positive feedback. However, the emotion sometimes invoked reactions stating that it looked funny or unnatural. As soon as this emotion appeared some people started laughing or they were surprised.

#### How motivated were the users by the feedback?

Striking is that not many users described the feedback as motivating. Neither the positive nor the negative feedback. (In table x above the row for motivating has been highlighted). This is interesting since it was expected, based on the background literature, that the positive feedback would have a motivating effect on the user. This result is contradictory with other observations in the test. Namely because seven out of the twenty participants said something along the lines of that they wanted to correct themselves when the head looked critical or strict as described previously.

#### Do the users change their behavior based on the feedback?

A question in the questionnaire explicitly asked if the user felt as if the coach changed their behavior (*Do you feel that the floating head changed your behavior at any given moment?*). To answer to this question, again, was mixed. Twelve out of twenty people stated that they felt as if the coach changed their behavior, while the other eight claimed that it did not.

#### Correlation findings

In addition to these questions in 7.3 another factor desired to find out was formulated. Those were the following statements;

- Correlation between the opinion the user has of the coach and what type of coach the user prefers
- Correlation between if people would normally pay attention to a coach and if they would now

Unfortunately the results of the questionnaire showed too little to determine these correlations. Almost everybody, with the exception of two or three participants, stated that they paid attention to a coach/teacher and their emotions. However, the results from the other questions of the questionnaire indicated that people's perception of the coach was too different to determine a possible correlation.

#### 6.5 Additional observations

In addition to the questions formulated in 6.3 and desired to be answered with the questionnaire, several other things are worth mentioning.

The first additional observation is that one user said that after a while he did not bother for the coach anymore. This can indicate that the user got bored with the coach or thought he had explored all the options with the coach and that it could not bring him anything new.

The next additional observation concerns the videos of the users. Many users made verbal remarks while executing the test. By filming the test we were able to obtain additional feedback on the application by users we otherwise would not have obtained. Unfortunately, not every participant was filmed. This is because it was only realized later in the testing-phase that filming the participants has additional value. The transcripts of the videos can be found in appendix J. A couple of things stood out when analyzing the material. Most remarks concerned the discomfort of the VR glasses and about jumping around without knowing where they were. Many participants needed to be guided to a different place after they had jumped too far to one side. Many of them were concerned that they would jump into a wall, hit something or lose balance. Another remark that was often made, is that the glasses would not stay on well when performing the exercises. Also, with the glasses on, it was very hot to perform the exercises. A couple of these remarks are given;

Remarks about balance and space concerns ٠ Where is the backwall? ÷ I am afraid to use my arms a lot, because of the space I'm afraid I'll jump into something ٠ ٠ It's hard to keep balance Am I still in the right spot ٠ ٠ I'm scared to jump here ٠ Oh, I'm falling over ٠ Am I still in the same spot? Remarks about discomfort of the glasses ٠ The glasses do not stay on well ٠ The glasses are really hot It is really hot with this thing on ٠ The glasses become blurry when you start jumping ٠ ٠ My glasses are getting loose The glasses go up and down when I jump \* ٠ That cable is annoving ٠ I am super hot with these glasses on my head ٠ The cable is in the way

I'm getting hot

## Chapter 7 | Conclusion

#### Introduction

In chapter 1, the introduction the final goal of the thesis was formulated:

*"The final goal is to determine if the coach is capable of positively influencing the player's motivation."* 

In this final chapter we see if these goals are met and the answers to the research questions are formulated. This results in the final conclusion of this research. After this conclusion has been drawn, we reflect and discuss the process of the thesis and the results. The thesis ends by describing potential follow-up research and iterations on the product.

#### 7.1 Conclusion

The research question for this thesis was

# <u>RQ</u>: "How can a virtual coach motivate the user in a virtual reality skiing application using facial expressions?"

To answer this overall research question, sub questions were generated

Sub-RQ 1: In what way can the expressions be made understandable for the user?

Sub-RQ 2: How are users influenced by the virtual coach?

Using the answers found for these sub questions and with the results from user testing, a final answer to the overall research question can be formulated.

First the sub questions are answered using the results from the evaluation phase.

#### In what way can the expressions be made understandable for the user?

To see if the users perceived the expressions as they were intended to be perceived, the users were asked to describe the feedback they had received from the coach. The emotions were almost always recognized as positive when intended to be positive and negative when intended to be negative. However, when looking at the admiration emotion, it was not always taken seriously. The admiration emotion was meant as an extra positive emotion to motivate people the most. While people often classified it as a positive emotion, their remarks sometimes stated that they did not really understand what the emotion was and that they found it funny or unnatural.

How are users influenced by the expressions of the virtual coach?

What could be seen in the results of the evaluation phase of this research is that users respond differently to the virtual coach. Not all of them are motivated by the same type of feedback the coach gave them. Some of the users did not even notice the head or barely paid attention to it. This makes it hard to give one final concluding answer to the question.

# How can a virtual coach motivate the user in a virtual reality skiing application using facial expressions?"

The final question to answer is the main research question. As we have seen in the results of the user-testing phase people are affected differently by the coach and therefore motivated in different ways. The majority of the users did change their behavior based upon the feedback they received from the coach. About half of the users tried to please the coach by executing the exercises better. Therefore we can say that the coach can indeed motivate users by showing facial expressions as feedback. It is also important the coach shows both positive and negative feedback, so that the user can have a goal: please the coach. From the people that were influenced by the coach, most of them said that they wanted to make the coach happy or please him.

However some results contradict this conclusion. Sometimes people barely paid attention, or no attention at all, to the floating head. Since they did not pay attention to the head, the coach did not influence them and therefore did not motivate them. It was not said explicitly at the beginning of the test that the floating head would function as a coach, it could be possible people thought that the head was out of place and therefore they did not pay attention to it. Another result that does not support the conclusion is that people almost never described the facial expressions as motivating.

Since these results are contradicting it is hard to formulate an answer to this research question. When you ask people explicitly if they think the feedback was motivating, almost nobody says yes. However, it can be seen that a lot of people change their behavior based on the feedback. Therefore it cannot be said with certainty that solely facial expressions cause the user to be more motivated. Since not everybody paid attention to the coach, it can be said that maybe the coach should be able to do more than only facial expressions to grab the full attention of the user. A definite answer to this research question can therefore not be given, yet.

#### 7.2 Discussion

A couple of things need to take into consideration before we can assume the results and the answer to the research question. First of all, we are trying to test whether or not people were more motivated. This is a hard aspect to test, especially in a short term research. Motivation is subjective and is therefore hard to measure. It would have been interesting to see if people actually become better at the exercises with feedback from the coach in the long run. However, it is not feasible to test this on such a short term basis.

Another thing is that many users seemed to be cautious about their surroundings and/or were annoyed by the VR-glasses. This can cause distraction from the task and might influence the results. People might have been paying too much attention to being safe in the exercise, that they neglected the coach and missed feedback. In addition to these discussion point, a point about the user group can be added. In the test, only early-twenty year-old university students took part in the test. This can result in a very biased result. It might be possible, that a group of users who has less experience with the technology might give other results. This is something that needs to be kept in mind when evaluating the conclusion of the research.

#### 7.3 Potential follow up research

#### Different design styles

In the ideation phase another potential focus point for the research was discussed. This concerned the design style of the coach. The idea was to design different coaches and test how these different styles affected the user. This plan was not executed due to time constraints and the amount of test-participants needed. In a follow up research this may be doable.

#### More emotions

For this research we only made use of three emotions and the third emotion was also based on one of the other two. For a potential follow up research more emotions could be animated and used. In the background literature we could see that different emotions invoke different behaviors with the students. It would be interesting to see how user would respond to a coach with a more varied set of emotions.

Simultaneously this can help with the observation of the one participant that he became bored with the coach. By having more emotions the user has 'more to explore'. This might keep the user more focused.

#### 7.4 Possible iterations of the product

#### Implement on fitness machines

Virtual reality could be implemented on fitness machines. The user is then completely immersed in another world and it might make the experience of working out on a fitness machine a bit more interesting. Virtual reality glasses are not restricting body movement in this setting, since often on fitness machines, people have to stay in a fixed position. There is little opportunity to make a wrong move on for example a home trainer.

#### Implement in gyms

Similar products to this application, once fully optimized, could function as personal trainers in gyms. It might be cheaper than hiring an actual person as a personal trainer.

#### Augmented reality implementation

For this application one of the major concerns is, is that people cannot see their surroundings and own body. They become a bit anxious of bumping into stuff or losing balance. A solution to this problem is augmented reality. In an AR-application people are able to see themselves and their surroundings. However, for now, augmented reality is not optimized enough to show the desired graphics for such an application.

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## Appendices | Appendix A

#### Questionnaire user test – Chapter 6 Evaluation Questionnaire

<u>General</u>

What is your age

What is your gender

0 Male 0 Female

Sport related questions

#### Do you play sports?

0 Yes 0 No

If you do play sports, do you have a coach?

0 Yes	
0 No	
0 Other	

#### When you're in class, do you pay attention to the teacher's emotions/feelings?

0 Yes 0 No 0 Other\_\_\_\_\_

#### Are you, in general, more motivated by happy teachers or strict teachers?

0 Strict 0 Happy 0 I don't know 0 Other

# Are you, in general, more hard-working when taught by happy teachers or strict teachers?

0 Strict 0 Happy 0 I don't know 0 Other\_\_\_\_

#### When you're playing sports, do you pay attention to the coach's emotions/feelings?

0 Yes 0 No 0 I don't know 0 Other\_\_\_\_\_

#### Are you, in general, more motivated by happy or strict coaches?

0 Strict 0 Happy 0 I don't know 0 Other\_\_\_\_\_

#### Are you, in general, more hard-working when taught by happy or strict coaches?

0 Strict 0 Happy 0 I don't know 0 Other\_\_\_\_\_

Performance under stress

How well do you perform under stress, on a scale from 1 to 5000000Not well at allVery well

#### Do you like working when the pressure is high?

0 Yes 0 No 0 I don't know 0 Other\_\_\_\_\_

#### Questions about the test

#### In exercise 1, I perceived the floating head as

(More answers can apply)

- [] Supportive
- [] Motivating
- [] Encouraging
- [] Positive
- [] Happy
- [] Critical
- [] Angry
- [] Frustrated

[] Negative

[] Strict

#### In exercise 2, I perceived the floating head as

(More answers can apply)

- [] Supportive
- [] Motivating
- [] Encouraging
- [] Positive
- [] Happy
- [] Critical
- [] Angry
- [] Frustrated
- [] Negative
- [] Strict

#### In exercise 3, I perceived the floating head as

(More answers can apply)

- [] Supportive
- [] Motivating
- [] Encouraging
- [] Positive
- [] Happy
- [] Critical
- [] Angry
- [] Frustrated
- [] Negative
- [] Strict

# Did you feel as if the floating head gave valid feedback on your performance in the first exercise?

- 0 Yes
- 0 No

0 Other \_\_\_\_\_

# Did you feel as if the floating head gave valid feedback on your performance in the second exercise?

0 Yes 0 No 0 Other \_\_\_\_\_

# Did you feel as if the floating head gave valid feedback on your performance in the third exercise?

0 Yes

0 No

0 Other \_\_\_\_\_

#### I thought the exercises were

0	0	0	0	0
Easy				Difficult

I thought all the exercises were equally difficult/easy000000DisagreeAgree

I think my performance at the exercises was000000BadExcellent

I tried my best at the exercises 0 0 0 0 0 0

Disagree Agree

How much attention did you pay to the floating head?0000No attention at alAttention all the time

Did you feel as if the floating head influenced the way you performed the exercises? *If yes, in what way did it influence you?* 

0 Yes 0 No

Did the floating head, at any given moment, give you the feeling that you were NOT doing it right? *Please, explain* 

0 Yes 0 No

Did the floating head, at any given moment, give you the feeling that you were doing it right? *Please explain* 

0 Yes 0 No

# Do you feel that the floating head changed your behaviour at any given moment? *If yes, in what way did it change?*

0 Yes 0 No

When	you perce	eived the	head	d as critical/negative, how did you feel
0	0	0	0	0
Unmoti	vated			Motivated
When	you perce	eived the	e head	d as critical/negative, how did you feel
0	0	0	0	0
Sad				Нарру
When	you perce	eived the	head	as critical/negative, how did you feel
0	0	0	0	0
That I f	ailed			That I succeeded
When	you perce	eived the	e head	d as motivating/positive, how did you feel
0	0	0	0	0
Unmoti	vated			Motivated
When	you perce	eived the	e head	d as motivating/positive,, how did you feel
0	0	0	0	0
Sad				Нарру
When	you perce	eived the	head	d as motivating/positive, how did you feel
0	0	0	0	0
That I f	ailed			That I succeeded

## Appendix B

Every state for evaluation test – Chapter 5 realization – big images







#### Test for state evaluation - chapter 5 realization

# Facial expressions on a virtual character

You will be shown a virtual character. This character will display different facial expressions. Different facial expressions are compared to each other. You are asked a couple of questions concerning these expressions.

The questionnaire will take approximately 5 to 10 minutes.

Thanks for you cooperation!

NEXT

Page 1 of 12

# Facial expressions on a virtual character

Difference	s		
You will see a c to scroll back. \ has its own pag	couple of different exp You can watch the ani ge. The first one will b	pressions. Every questi imations as often as y e shown on the next p	ions has its own video. So no need ou want to. Each pair of expressions age. There are 7 pairs in total.
BACK	NEXT	_	Page 2 of 12

Never submit passwords through Google Forms.

First pair: 1 and 2

1 and 2



What difference do you see between expression 1 and expression 2?



### Second pair: 1 and 4

1 and 4



# What difference do you see between expression 1 and expression 4?



### Third pair: 5 and 6

5 and 6



# What difference do you see between expression 5 and expression 6?



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### Fourth pair: 5 and 8

5 and 8



# What difference do you see between expression 5 and expression 8?



Fifth pair: 5 and 9

5 and 9



What difference do you see between expression 5 and expression 9?

 Your answer

 BACK
 NEXT

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### Sixth pair: 2 and 9

2 and 9



# What difference do you see between expression 2 and expression 9 ?



### Seventh (and last!) pair: 4 and 9?

4 and 9



# What difference do you see between expression 4 and expression 9 ?



### Description

Could you describe the following facial expressions?

#### How would you describe emotion 7?

Your answer



### How would you describe emotion 3?

Your answer





### How would you describe emotion 9?

Your answer



### Postive or negative

Do you perceive the expressions as negative or positive? A couple of questions will follow.

### Would you perceive expression 7 as positive?

- O Yes
- O No
- Other:





### Would you perceive expression 2 as positive?

- O Yes
- O No
- O Other:





### Would you perceive expression 9 as positive?

- O Yes
- O No
- O Other:




# Which expression do you find most positive?

- 0 2
- 06
- 09

# 2, 6 and 9



# Appendix D

# Responses state test – Chapter 5 Realization

Timestamp	What difference do you see between expression 1 and expression 2?	What difference do you see between expression 1 and expression 4?	What difference do you see between expression 5 and expression 6?
07/06/2017 10:08:23			
09/06/2017 12:22:49	The second expression goes a little happier, but then bounces back to the same face as the first expression.	The fourth expression is unnaturally happy.	The second expression is an exaggerated version of expression 5.
09/06/2017 12:28:32	Expression 2 seems more exuberant	1 seems way more subtle	6 is more extreme
09/06/2017 12:39:31	The second expression is more elaborate and pronounced.	Expression 1 is more realistic, whereas expression 4 is over the top adding a comical effect. Both are definitely happy emotions.	Expression 5 is a subtle indication of irritation and frustration, whereas expression 6 leans more to angry.
09/06/2017 12:46:18	The first expression had a less broad smile on its face	The first did not show any enthausiasm (just neutral expression), the 4th one was really happy and had a broad smile and also widend its eyes	5 showed a minor disgrace and 6 had its eyebrows and lip far more up than 5. Also the expression was more exaggerated than 5
09/06/2017 13:04:05	expression 2: mouth is wider, eyes are wider open than in expression 1, eyebrows lift up in expression two - the whole process in expression 2 looks faster	again, eyebrows lift up in 4, mouth looks (slightly) retardedly crooked, eyes are opened wider than in 1	in 6 the mouth and eyebrows are more crooked than in 5
09/06/2017 13:30:48	None	4 is happier than one	5 is emotionless, 6 is irritated
10/06/2017 08:29:26	Number 2 looks happier because the eyes look somehow brighter and the corners of the mouth are way more up	this time the corners of the mouth are also way more up, but in a weird way, I feel uncomfortable looking at it	number 6 looks angrier
10/06/2017 16:20:12	2 looks more happy than 1, because eyes are bigger and mouth is smiling more	4 is a bit scary. 1 seems happier and friendlier than 4	both look annoyed, although 6 looks a bit more annoyed than 5

What difference do you see between expression 5 and expression 8?	What difference do you see between expression 5 and expression 9?	What difference do you see between expression 2 and expression 9 ?
Expression 8 is not so much a expression, more a deformation.	Expression 5 is dissatisfied and expression 9 is happy with a too large chin.	Expression 9 is an exaggeration from expression 2.

8 seems angry while the other seems arrogant	5 seems angry while 9 is more surprised	2 seems more realistic while 9 seems cartoonish
Expression 5 is again subtle and realistic. Expression 6 is an expression that I would associate with animated characters than real people, due to being over the top.	Both expressions could express the emotion of being surprised, but expression 9 has a happy element mixed with it.	Both expression denote some form of being happy, however expression 2 is much more subtle. Expression 9 looks overdone in comparison.
Basically the same as the difference between 5 and 6, but 8 is even more exaggerated than 6	Firstly, person 9 shouldn't use that much botox in its lips. Besides from that, person 5 looks a bit irritated by someone or disagreeing and person 9 looks like it has heard some exciting news and widens its eyes and mouth	Person 2 hears something and thinks its reasonably funny, so it smiles. Person 9 hears something exciting and gets excited too so the mouth widens and eyes are wide open as well
in 8 the eyebrows strongly lift up, the mouth is a lot more crooked than in 5 . The character looks weirdly angry in 8	As 5 supposedly represents an angry person or someone in a bad mood, 9 basically represents the exact opposite. The facial expressions display curiosity and delight. The eyes are wide open and the jaw moves forward, creating a smiling mouth.	expression 2 looks more like a friendly smile in context of a reaction to someone/something else happening in the surroundings while expression 9 looks more curious/ surprised about sth in the surroundings than friendly.
8 is very irritated	9 has more chin	/
number 8 looks angrier and more like he is losing it, because of his eyes and mouth	number 9 looks somewhat surprised but in a weird way	number 9 has bigger eyes and his mouth became somehow bigger
8 is really annoyed and angry. 5 just has a bit of a skeptical face and is only a bit annoyed	5 again looks skeptical and a little annoyed. 9 seems surprised. 9 is not scared, since his mouth is happy. 9 is also a bit scary	2 seems very friendly and sympathetic, where 9 is a bit scary and seems surprised.

What difference do you see between expression 4 and expression 9 ?	How would you describe emotion 7?	How would you describe emotion 3?
Expression 9 is more surprised and expression 4 is happy.	Option 1	Option 1
4 seems more realistic	Disgust and arrogance	Happily surprised
Expression is 4 denotes happiness with more emotion (like seeing someone again after a long time being separated), expression 9 denotes happiness with a surprised element in it (when someone suddenly shows up for a lecture in a weird costume).	annoyed, angry.	happy, content.
Person 4 just heard that it could get an icecream, but it is too old to be superexcited for that, but still, it likes icecream so it smiles widely. Person 9 just heard it can go to disneyland	Irritated or rigid	(You showed emotion 2 in the movie) fairly happy, entertained

and gets superexcited because that's where it always wanted to go to		
Expression 4 looks more naive, sort of stupid (almost animal like) than expression 9.	doubtful, dissatisfied	friendly, content, pleased, happy
4 looks better	Angry, irritated	-> 2?!
both look surprised but number 4 is weirder, it doesn't look very normal	angry	satisfied
4 looks very happy, where 9 looks more surprised. 4 is more pleasant to watch than 9, mainly because of the eyes.	annoyed	happy, friendly

How would you describe emotion 9?	Would you perceive expression 7 as positive?	Would you perceive expression 2 as positive?	Would you perceive expression 9 as positive?	Which expression do you find most positive?
	No	Yes	surprise	2
Option 1	No	Yes	No	2
Shocked but happy	No	Yes	Yes	2
happily surprised.	No	Yes	Yes	9
Overly excited and craving for something it sees and wants to have	No	Yes	Yes	9
curious, surprised, happy	No	Yes	Yes	9
Idiot who's smiling	No	-> 2	Yes	2
in love	No	Yes	Yes	2
surprised	No	Yes	surprised in a slightly positive way	2

### Appendix E

#### Script for feedback system - Chapter 5 realization

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
public class FeedBackScriptForAnimation : MonoBehaviour {
    int state;
    int newState;
    Animation anim;
      // Use this for initialization
      void Start () {
        anim = GetComponent<Animation>();
        state = 0;
        newState = 0;
      }
    int UpdateState(int fb)
    {
        switch (state)
        {
            case 0: return (fb > 0 ? 1 : 2);
            case 1: return (fb > 0 ? 3 : 4);
            case 2: return (fb > 0 ? 5 : 6);
            case 3: return (fb > 0 ? 7 : 8);
            case 4: return (fb > 0 ? 9 : 10);
            case 5: return (fb > 0 ? 11 : 12);
            case 6: return (fb > 0 ? 13 : 14);
            case 7: return (fb > 0 ? 7 : 8);
            case 8: return (fb > 0 ? 9 : 10);
            case 9: return (fb > 0 ? 11 : 12);
            case 10: return (fb > 0 ? 13 : 14);
            case 11: return (fb > 0 ? 7 : 8);
            case 12: return (fb > 0 ? 9 : 10);
            case 13: return (fb > 0 ? 11 : 12);
            case 14: return (fb > 0 ? 13 : 14);
            default: return 0;
        }
    }
    int GetFeedback ()
    {
        if (Input.GetKeyDown(KeyCode.LeftArrow)) return -1;
        if (Input.GetKeyDown(KeyCode.RightArrow)) return 1;
        return 0;
    }
    void MoveState (int state, int newState)
    {
        Debug.Log("The New State =" + newState);
```

```
PlayNewState(newState);
}
void ClipReset (string name)
{
    anim[name].time = 0.0f;
    anim[name].enabled = true;
    anim[name].weight = 1;
   anim.Sample();
   anim[name].enabled = false;
}
void AnimReset ()
{
   ClipReset("Happy1");
    ClipReset("Happy2");
   ClipReset("Happy3");
   ClipReset("Disapproving1");
   ClipReset("Disapproving2");
   ClipReset("Disapproving3");
   ClipReset("Amazement");
}
void PlayNewState (int newState)
{
    AnimReset();
    switch (newState)
    {
        case 0: AnimReset(); break;
        case 1: anim.Play("Happy1"); break;
        case 2: anim.Play("Disapproving1"); break;
        case 3: anim.Play("Happy3");break;
        case 4: anim.Play("Happy1"); break;
        case 5: anim.Play("Happy1"); break;
        case 6: anim.Play("Disapproving3"); break;
        case 7: anim.Play("Amazement"); break;
        case 8: anim.Play("Happy1"); break;
        case 9: anim.Play("Happy2"); break;
        case 10: anim.Play("Disapproving2"); break;
        case 11: anim.Play("Happy3"); break;
        case 12: anim.Play("Disapproving1"); break;
        case 13: anim.Play("Happy1"); break;
        case 14: anim.Play("Disapproving3"); break;
        default: break;
    }
}
  // Update is called once per frame
  void Update () {
    int fb = GetFeedback();
    if (fb == 0) return;
    newState = UpdateState(fb);
    Debug.Log("State =" + newState);
    MoveState(state, newState);
```

```
state = newState;
```

}

### Appendix F

```
Script for exercises – Chapter 5 realization
```

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.UI;
public class Movements : MonoBehaviour {
    Animation anim1;
    Animation anim2;
    Animation anim3;
    Animation anim4;
    int step;
    GameObject Man1;
    GameObject Man2;
    GameObject Man3;
    GameObject Face;
    Text instruction;
    // Use this for initialization
    void Start() {
        step = 0;
        Man1 = GameObject.Find("Proper_FBX_export_first");
        Man2 = GameObject.Find("Proper FBX export second");
        Man3 = GameObject.Find("Proper FBX export third");
        Face = GameObject.Find("kut");
        anim1 = Man1.GetComponent<Animation>();
        anim2 = Man2.GetComponent<Animation>();
        anim3 = Man3.GetComponent<Animation>();
        anim4 = Face.GetComponent<Animation>();
        instruction =
GameObject.Find("Canvas/Panel/Text").GetComponent<Text>();
        instruction.text = "Welcome";
    }
    int GetKeyValue()
    {
        if (Input.GetKeyDown(KeyCode.Alpha1)) return 1;
        if (Input.GetKeyDown(KeyCode.Alpha2)) return 2;
        if (Input.GetKeyDown(KeyCode.Alpha3)) return 3;
        if (Input.GetKeyDown(KeyCode.Alpha4)) return 4;
        if (Input.GetKeyDown(KeyCode.Alpha5)) return 5;
        if (Input.GetKeyDown(KeyCode.Alpha6)) return 6;
```

```
return 0;
}
void ExecuteAnimations()
{
    step = GetKeyValue();
    if (step == 0) return;
    if (step == 1)
    {
        TextIs("");
        Man1.transform.position = new Vector3(202, 204, 151);
        anim1.Play("Take 001");
    }
    else if (step != 1)
    {
        Man1.transform.position = new Vector3(284, 204, 59);
        anim1.Stop("Take 001");
    }
    if (step == 2)
    {
        TextIs("");
        Man2.transform.position = new Vector3(184, 204, 160);
        anim2.Play("Take 001");
    }
    else if (step != 2)
    {
        Man2.transform.position = new Vector3(197, 204, 61);
        anim2.Stop("Take 001");
    }
    if (step == 3)
    {
        TextIs("");
        Man3.transform.position = new Vector3(155, 204, 165);
        anim3.Play("Take 001");
    }
    else if (step != 3)
    {
        Man3.transform.position = new Vector3(104, 204, 48);
        anim3.Stop("Take 001");
    }
    if (step == 4)
    {
        TextIs("");
        anim4.Play("appearance");
    }
    if (step == 5)
    {
        TextIs("The next exercise will follow now");
    }
    else if (step == 6)
    {
```

Appendix G

Consent form - Chapter 6 evaluation

### Informed Consent Form Virtual reality ski coach

Subject number: \_\_\_\_\_

In this user test it is researched what influence a virtual coach has on the user. In the test you will have to perform a set of exercises. All of these exercises are fairly simple and will have to be performed for approximately 30 seconds.

By signing this consent form you give permission the collected data about you is used for this research. All the data is anonymous and will be safely stored. Information about you personally will not be shared with third parties or used for any other purposes than this research. If you do not feel comfortable or want to stop the test at any given time, let me know and I will stop the test. You do not have to perform any actions if you are not comfortable with them.

Signature subject

Signature Researcher

### Appendix H

The scenes the user will see during the test - Chapter 6 evaluation



Start Scene



First exercise scenes



Break scene



Second exercise scene



Third exercise scene

# Thank you for participating. This is the end of the test

End scene

# Appendix I

# Exact results to questionnaire – Chapter 6 evaluation

What is your age?	What is your gender?	Do you play sports?	If you do play sports, do you have a choach?
21	Female	Rarerly	No
21	Male	No	No
22	Male	No	No
21	Female	l do fitness 3 times a week	only during group lessons
20	Female	Yes	No
19	Female	Yes	Yes
20	Female	Yes	Yes
22	Female	No	No
21	Male	Yes	No
22	Male	No	No
19	Female	Yes	Yes
22	Female	Yes	Yes
23	Male	Yes	Yes
21	Male	Yes	Yes
25	Male	Yes	No
21	Female	Yes	Yes
21	Female	Yes	Yes
23	Male	No	Yes
21	Female	Yes	No
25	Female	Yes	Yes

When you're playing sports, do you pay attention to the coach's emotions/feelings?	Are you, in general, more motivated by happy or strict (sports) coaches?	Are you, in general, more hard-working when coached by happy or strict (sport) coaches?	When you're in class, do you pay attention to the teacher's emotions/feelings?
Yes	Нарру	Strict	Yes
Yes	Нарру	Нарру	Yes
No	Нарру	Strict	Yes
Yes	Нарру	Нарру	Yes
No	Нарру	Strict	No
Yes	Нарру	Нарру	Yes
Yes	Strict	Both! So strict and happy. One does not exclude the other :)	Yes
Yes	Нарру	Нарру	Yes
Yes	Нарру	Нарру	Yes
			Yes
Yes	Strict	Strict	Yes
Yes	Нарру	Нарру	Yes

Yes	Strict	l don't know	Yes
Yes	Нарру	l don't know	Yes
	Нарру	Нарру	Yes
Yes	Нарру	Нарру	yes
Yes	Нарру	l don't know	Yes
Yes	Нарру	Нарру	Yes
No coach	I dont know	l don't know	No
Yes	Нарру	Нарру	Yes

Are you, in gene or strict teachers	ral more motivated by happy ?	Are you, in general, more hard-working when taught by happy teachers or strict teachers?			
Нарру		Нарру			
Нарру		l don't know			
Нарру		Нарру			
Нарру		Нарру			
Нарру		Нарру			
Нарру		Нарру			
Нарру		Again, both			
Strict		Strict			
Нарру		Нарру			
Нарру		Нарру			
Нарру		Нарру			
Нарру		Нарру			
Нарру		Strict			
I don't know		l don't know			
Нарру		Нарру			
Both		Strict			
I don't know		I don't know			
Нарру		Нарру			
Нарру		l don't know			
Нарру		Нарру			
In exercise 1, I perceived the floating head as	In exercise 2, I perceived the floating head as	In exercise 3, I perceived the floating head as	Did you feel as if the floating head gave valid feedback on your performance in the first exercise?		
	Frustrated, Strict	Angry, Negative, Strict	No		
Motivating, Positive, happy	Motivating, Critical, Frustrated	Positive, Frustrated	Yes		
Supportive, Encouraging, Strict	Critical, Strict	Supportive, Motivating, Encouraging, happy, Strict	Yes		
Positive	Critical, Angry, Negative	Positive, happy	Yes		
Positive	Positive	Positive	Yes		
Motivating, Positive, happy	Encouraging	Critical, Angry, Frustrated	Yes		

happy	Positive,	Strict	Positive, happ	у	To be honest, I did not pay that much attention to the floating head at that point.		
Critical	Critical, / Negative	Angry, Frustrated, , Strict	Supportive, M Encouraging,	otivating, Positive, happy	I didn't pay attentio	n to the head	
Motivating, Positive	Frustrate	ed, Negative	Positive		most of the time		
Critical, Angry, Frustrated	Positive		Encouraging,	Positive, happy	No		
Positive, happy	Encoura	ging	Strict		No		
	Critical, I	Negative	Supportive, Er happy	ncouraging,	No		
	Supporti	ve	Supportive		i didn't notice the h	ead yet	
Negative	Critical, / Negative	Angry, Frustrated, , Strict	Supportive, Po	ositive, happy	Yes		
Supportive	Supporti	ve	Supportive		yes, it felt like i had an effect on his reacgtion, however only based on my head movement as opposed to every small movement in my body, for		
Positive	Supporti	ve	Critical		Invalid		
Supportive, positive, strict	Motivatir	ng, critical, strict	Supportive, Mo positive, happ	otivating, y	Yes		
Motivating, Happy	Critical, r	negative, strict	Encouraging, Positive, happy		Yes		
Positive, happy	critical, a	ingry, frustrated	Positive, happy		Yes		
Encouraging, happy, surprised	critical, fi strict	rustrated, negative,	Supportive, motivating, encouraging, positive, happy		Yes		
Did you feel as if the floating head gave valid feedback on your performance in the second exercise?		Did you feel as if the gave valid feedback performance in the t	e floating head on your hird exercise?	I thought the exercises were	I thought all the exercises were equally difficult/easy	I think my performance at the exercises was	
No		No		3	1	2	
No		Yes		3	2	3	
No		Yes		3	2	3	
No		Yes		2	4	3	
Yes		No		3	1	3	
Yes		No		1	1	4	
Yes Y		Yes		1	4	3	
Yes		Yes		1	2	2	
No Yes		Yes		2	2	3	
Yes		Yes		3	4	4	
No		No		2	2	4	
No		No		1	2	3	
No		No		2	2	3	
Yes		No		5	1	1	

yes, it felt like i hi effect on his read however only bas my head movem opposed to every movement in my for ovious technic reasons	ad an cgtion, sed on ent as / small body, cal	yes, it felt lik his reacgtio on my head opposed to in my body, reasons	ke n, l m ev foi	i had an effect on however only based ovement as ery small movement r ovious technical		2	2	3
Invalid		Invalid				2	5	3
No		Yes				2	5	3
Yes		Yes				2	3	4
No		Yes				2	1	3
No		Yes				3	2	5
I tried my best at the exercises	How muo did you p floating h	ch attention bay to the head?		Did you feel as if the floating head influence the way you perform the exercises?	ced ed	Did the floa give you the doing it righ	ting head, at any giv e feeling that you we ht?	ven moment, ere NOT
4			2	It made me think a lit bit if I were doing something wrong: wanting to correct myself	ttle	Јар		
3			2	At first yes, but after while my attention towards the head decreased.	а	Yes, during	the second exercise	e
4			5	Yes, the immediate feedback stimulated to do better.	me	Yes, the an indicitive of	gty look on it's face that.	is very
4			3	Yes, when the head a more negative expression I tried to figure out what I was doing wrong in order perform better.	had to	Yes during	the second exercise	
3			2	no		no		
5			2	A bit, only with the la exercise	st	Yes		
4			2	No.		No.		
4			3	I only looked at the floating head from exercise 2 onward		at exercise	2	
4			4	a bit		yes		
4			3	slightly, when i saw t head was angry, i trie to correct myself	he ed	during the f	irst excersise	
4			1	no		yes		
3			2	No, not really. I did n have the feeling that had the proper exper to judge me	ot he rtise	Yes, when	it looked negative/ju	dging

4	1	no		no		
4	4	No, I felt his justice was a bit random		Yes, when he had a negative attitude		
4	3	yes! I tried to make it happy		ves		
		Yes, it made me	e laugh			
4	3	more		Yes, he looked a bit weird to me		
5	3	Yes, if I saw that the floating head did not look happy I knew I had to be more precise in the exercise		Yes, during the 2nd exercise it was angry for a pretty long time, that made me feel like i was performaing bad		
5	4	Yes, during the second exercise i as not performing that well, than the floaty head was frowning and i tried to perform better		Yes, halway during the second exercise		
5	4	Νο		Yes, it seemed to me it did not like the way i was doing exercise 2		
4	5	Yes, i was interested in how he would react and at one point his eyes were so big, i thought his head would explode		Yes, in exercise 2 i thought i did it right but he kept frowning. One exercise I provoked him by doing something else and he responded		
Did the floating head, at any given moment, give you the feeling that you were doing it right?				Do you feel that the floating head changed your behaviour at any given moment?		
Nop				Yes		
Yes, during the first exercise				At first I tried to 'please' it, but halfway through the second exercise I wasn't bothered by it anymore.		
Yes, the happy face is very rewarding.				Yes, I tried to do better when the face was not positive.		
Yes during the first exercise				yes during the second exercise		
Yes				no		
The first exercise				No		
Not sure?				No.		
at exercise 3				I felt better when the head looked happy		
sort of, i saw the smile				a bit, it was weird when the floating head had a negative emotion		
during the last excersise				during the first excsersise		
yes				no		
Yes, when it was smiling				No, because as said above, I did not feel like he could judge me so I didn't take its opinion as the truth		
yes				no		
Not really, he smiled a lot at the last exercise, but I felt I did not perform the exercise correctly, so it did not believe the floating head				When critical it demotivated me		
yes				yes i tried to make it happy		
No				No		

Yes, when it look	ked happy		Yes, halfway during the second exercise i noticed the head did not look happy and i tried to do better in the exercise				
Yes, he was happy durig the first and last exercise				yes, started to perform better			
Yes, in the other did the erxercise it right	eexercise it looke s, which made me	ed more hapy whe e feel like i was de	No				
Yes, when he was smiling				IYes, I wanted to please him			
When you perceived the head as critical/negative, how did you feel?	When you perceived the head as critical/negative , how did you feel?	When you perceived the head as critical/negative, how did you feel?	When you perceived the head as motivating/positive , how did you feel?		When you perceived the head as motivating/positive, how did you feel?	When you perceived the head as motivating/positive, how did you feel?	
2	2	2	4		4	4	
4	2	2		4	4	4	
4	3	2		4	5	4	
2	2	2		3	4	4	
3	2	3		4	4	4	
3	2	3		5	3	3	
1	1	1	1		5	5	
3	2	2		4	3	4	
4	3	2		4	4	5	
2	2	2		4	4	4	
2	2	3		4	4	3	
3	2	3		4	5	3	
2	2	1		3	3	2	
3	1	1		5	5	5	
3	5	2		4	5	3	
4	2	2		4	4	4	
4	3	1		5	5	5	
3	2	2		4	4	4	
1	2	2		5	5	5	

### Appendix J

### Transcripts from user-test videos - Chapter 6 evaluation

#### Transcript 1

'Hij is wel een beetje intens hoor'
'Misschien ook omdat zijn hoofd zo groot is als de anderen'
'oh god'
'De bril blijft niet goed zitten'
'lk vind dit een moeilijke beweging'
'De bril is heel warm' *Almost bumps into the table* 'its also dangerous!'
'Het is warm zo'n ding man'

#### **Transcript 2**

'Ik ga brede lunges maken'
'Waar is de achterkant?'
'Oh god' *Laughing*'This is hilarious'
'I want this in the gym/ik w il dit in de sportschool'
'Zijn ogen zijn wel een beetje eng
'Oh god'
'Wat voor beweging is dit?'
'De bril wordt onscherp als je gaat springen' *Laughing*

#### Transcript 3

'30 seconden ga ik elk poppetje na doen'
Uh oh, uh oh
'lk heb de verkeerde schoenen aan'
'Ja ik heb vroeger op de sportschool gezeten'
'Bij de bodypump viel ik vaak om
'Die man is helemaal niet tevreden'
'Oh nu wel!'
'Oh jeej'
'Dit vind ik een leuke'
'Mijn bril gaat los'
'Mijn armen durf ik niet veel te gebruiken, vanwege de ruimte'

#### Transcript 4

'Ik ben bang dat ik ergens tegen aan spring'
'Ik voel me helemaal fit'
'Volgens mij ga ik sneller dan het poppetje'
'Het is lastig om je balans te houden'
'Misschien komt het door de bril'
'Uh oh'
'De bril gaat heen en weer als ik spring'
'Poeh, intense work out'
'Volgens mij zie ik er echt uit als een mongool'
'Oh!'
'Een paar hopjes en dan stopt ie'
'Ooh je doet het gewoon zo'
'Dit is leuk!'
Laughing

#### Transcript 5

'Moet ik op de middellijn staan?'
'Moet ik 'm meteen na doen?'
'Kan ik nergens op stappen ofzo?'
'Het lijkt wel tai chi'
'Waarom beweegt dat hoofd?' *Laughing*'Waarom kijkt dat hoofd boos'
'Sta ik nog op de goede plek?' *Laughing*'Sportief dagje zo'
'Ging het erom dat ik het goed nadeed, dan heb ik gefaald namelijk'

#### Transcript 6

'Moet ik het tegelijkertijd met hem doen?'
'Hij wordt blij!'
'Kan jij dat ook zien?'
'Waar baseert ie op, hoe ik het doe?'
'Kijkt ie naar mijn hoofd'
'Hoe meet het hoofd hoe je het doet'
'Mn broek zakt af!'
'Die kabel is lastig'
'Wacht dat poppetje nou ook op wat ik doe?'
'Zijn de 30 sec al om?'
'Ik heb het heel warm met die bril op mijn hoofd'
'Wat doet ie nou? Heen en weer springen?'
'Is het belangrijk dat ik de armen ook zo hou?'

#### Transcript 7

'Zo lang ik maar niet op youtube kom'
'De kabel zit in de weg'
'Moet ik m gewoon nadoen?'
'Oh wat kijkt ie blij' *Laughing*Dikke work-out
'Wat doet ie nou?'
'Het beeld versprong'
'Ik krijg het warm'
'Het grote hoofd vindt dat ik het niet zo goed doe'
'Au mn benen'
'Oeh, ik val om'
'Sta ik nog op dezelfde plek?'