Emotion exchange through real-time visual cues in video games and virtual environments

MASTER’S THESIS

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Communication between players in video games is often limited to body language of the player avatar and written or verbal speech. This mimics communication in the real world. However, since video games are virtual, interactive environments, communication can take other forms as well. This thesis inspects the feasibility of the use of real-time visual cues to communicate emotion between players. Several efforts were made to this end. First, an overview of relevant aspects of visual emotion representation were compiled. Next, six artistic video games that utilise subtle visual cues to communicate complex emotions were analysed. Findings from this analysis are that they do this through visual changes to the following: Avatar appearance, World appearance, Avatar movement, Added artifacts and Camera attributes. These were then incorporated into a general model for visual emotion expressions. This model consists of: Visual representation, Duration, Effect on gameplay, Trigger and Metaphor and associations. Lastly, an evaluation was carried out in a 2D test environment where a set of symbolic and subsymbolic cues could be visualised on a 2D character. A survey and user test were conducted to investigate the passive recognition and active expression of the cues in this environment. Results showed expressions made up of real-time visual cues are prone to misinterpretation due to differing associations with individual cues. Out of 41 expressions, 19 were communicated successfully, 10 were interpreted as related emotions, and 12 were interpreted incorrectly. Aligning intention and interpretations of expressions made up of visual cues seems to be the major challenge in utilising real-time visual communication for emotion exchange. Another major challenge concerns the execution of these expressions. Many areas for future work exist within this area.
To begin, I would like to thank everyone involved in collection of the data used in this thesis. This includes everyone who has helped spreading the call for participation in the online survey, the large number of respondents who took the time to complete the survey, those who participated in the user test, and everyone who gave their insights regarding the survey questions and the user test structure and questionnaire. If not for them, this thesis would have had very little data to investigate.

Because a thesis is not written in isolation, I would also like to thank everyone that supported me during this long and sometimes difficult process; your encouragement and support helped me continue in times I most needed it. This includes but isn’t limited to: M.T., L.S., V.P., F.B., M.I. and B.M. for their continuous emotional support, all of the friends and acquaintances who at any point in time offered words of encouragement or a pat on the shoulder, and lastly but not least, my promotor prof. dr. Kris Luyten and supervisor Eva Geurts for their guidance, support, patience and understanding that enabled me to see this project to its end.
CONTENTS

1 INTRODUCTION 1
  1.1 Thesis goal 1

2 BACKGROUND 3
  2.1 Emotion in video games 3
    2.1.1 Diverse emotional content 3
    2.1.2 Emotional interactions 5
    2.1.3 Video games as personal expression 6
  2.2 Emotion in social interactions 8
    2.2.1 Expression in (non-)verbal communication 8
    2.2.2 Emotion exchange in playful experiences 10
    2.2.3 Emotion theories 12
  2.3 Communication standards in online games 14
    2.3.1 Voice and text 14
    2.3.2 Body language actions 16
    2.3.3 Spatial behaviour 16

3 VISUAL EMOTION REPRESENTATION 18
  3.1 Recognition and interpretation 20
  3.2 Symbolic cues 22
    3.2.1 Smileys and emoticons 22
    3.2.2 Comic symbols 23
  3.3 Subsymbolic cues 24
    3.3.1 Colour 24
    3.3.2 Shape 26
    3.3.3 Movement 28
  3.4 Cue clusters 29

4 GAME-TO-PLAYER COMMUNICATION: AN ANALYSIS 32
  4.1 Methodology 33
    4.1.1 Selection procedure 33
    4.1.2 Characteristics of focus 34
  4.2 Observations 35
    4.2.1 What Now? 35
    4.2.2 Gravitation 36
    4.2.3 LIM 37
    4.2.4 Anxiety Attacks 38
    4.2.5 Beyond Eyes 39
<p>| Figure 1 | Game design artifacts for <em>Journey</em> by Thatgamecompany. High focus on emotional experience. Images taken from Jenova Chen’s DICE talk. |
| Figure 2 | <em>Journey</em> by thatgamecompany. |
| Figure 3 | <em>What Now?</em> by Arielle Grimes (in-game screenshot). |
| Figure 4 | Non-verbal communication forms in video games [7]. |
| Figure 5 | Summary of the revised PLEX framework featuring experience categories[13]. Highlighted categories are enhanced through rich emotional communication. |
| Figure 6 | A circumplex model of affect [15]. |
| Figure 7 | A player expressing confusion by executing a predefined action. <em>Source: Tale of Tales.</em> |
| Figure 8 | Several available predefined expressive actions in <em>Aion</em>. |
| Figure 9 | Players seeking closeness in <em>The Endless Forest</em>. <em>Source: Tale of Tales.</em> |
| Figure 10 | Expressionist paintings utilising metaphor and associations. |
| Figure 11 | Some popular emoticons with corresponding text smileys². |
| Figure 12 | Comic symbols are frequently used in comic books and manga to illustrate emotion of characters. |
| Figure 13 | Examples of colour-emotion pairs [22]. |
| Figure 14 | A circumplex model for emotion induction through colour in video games and virtual environments [24]. |
| Figure 15 | Charts of the basic emotions in <em>The Atlas of Emotion</em> [26]. |
| Figure 16 | Detailed view of the <em>Anger</em> chart with different intensities [25]. |
| Figure 17 | The eMoto system [1]. |
| Figure 18 | Laban movement dimensions of <em>time, space, weight</em> and <em>flow</em> associated with different emotion categories [27]. |
| Figure 19 | A frame from the Heider-Simmel animation. |</p>
<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 20</td>
<td>Each point represents the average arousal / valence ratings for one of the 32 character representations. Colour: Blue, Green, Grey, Red. Letters represent shape, pulse size and pulse speed. Shape: jagged (J) / smooth (S), Pulse Size: small (S) / large (L) - Pulse Speed: slow (S) / fast (F). For example: SSS is Smooth, Small, Slow, JLF is Jagged, Large, Fast [29].</td>
</tr>
<tr>
<td>Figure 21</td>
<td>Visual manipulation was searched for in the blue highlighted areas. Adapted from non-verbal communication forms [7]. [31]</td>
</tr>
<tr>
<td>Figure 22</td>
<td>Progressive worsening of mental state in What Now? [35]</td>
</tr>
<tr>
<td>Figure 23</td>
<td>Gravitation (in-game screenshots). [36]</td>
</tr>
<tr>
<td>Figure 24</td>
<td>Dynamic field of vision in LIM. [37]</td>
</tr>
<tr>
<td>Figure 25</td>
<td>Contrasts of mental states in Anxiety Attacks. [38]</td>
</tr>
<tr>
<td>Figure 26</td>
<td>Changing environment in Beyond Eyes [39]</td>
</tr>
<tr>
<td>Figure 27</td>
<td>Mary Woke Up Today (in-game screenshot). [40]</td>
</tr>
<tr>
<td>Figure 28</td>
<td>Changing environment in Mary Woke Up Today (in-game screenshots). [40]</td>
</tr>
<tr>
<td>Figure 29</td>
<td>Summary of the representations found in the examples of the previous section. [41]</td>
</tr>
<tr>
<td>Figure 30</td>
<td>Visual communication channels with examples from the analysed games. [44]</td>
</tr>
<tr>
<td>Figure 31</td>
<td>General characteristics of an expression of emotion. [46]</td>
</tr>
<tr>
<td>Figure 32</td>
<td>Components through which an expression can be visualised. Left: channels based on visual communication as identified in Chapter 4 (player movement excluded). Right: traditional channels based on non-verbal communication in the real world. [47]</td>
</tr>
<tr>
<td>Figure 33</td>
<td>Discrete vs. continuous emotion expression. [50]</td>
</tr>
<tr>
<td>Figure 34</td>
<td>The process of designing expressions for a particular game. [51]</td>
</tr>
<tr>
<td>Figure 35</td>
<td>Visual representation of the process of being less and less gripped by fear in Compass. [57]</td>
</tr>
<tr>
<td>Figure 36</td>
<td>Fear in Compass. [58]</td>
</tr>
<tr>
<td>Figure 37</td>
<td>Test environment with UI. [59]</td>
</tr>
<tr>
<td>Figure 38</td>
<td>Adapted circumplex model of affect, one label per quadrant [30]. [60]</td>
</tr>
<tr>
<td>Figure 39</td>
<td>Visual representations of the four emotional states. [61]</td>
</tr>
<tr>
<td>Figure 40</td>
<td>The UI element used to switch between states, shown only when left mouse button is held down. [62]</td>
</tr>
<tr>
<td>Figure 41</td>
<td>Available symbolic cues: executed. [63]</td>
</tr>
<tr>
<td>Figure 42</td>
<td>Available symbolic cues: UI icons. [63]</td>
</tr>
<tr>
<td>Figure 43</td>
<td>Amount of time respondents spend playing video games (%). [66]</td>
</tr>
<tr>
<td>Figure 44</td>
<td>Game genres played by the respondents (%). [67]</td>
</tr>
<tr>
<td>Figure 45</td>
<td>Snapshots of the four questioned states.</td>
</tr>
<tr>
<td>Figure 46</td>
<td>Example question from <em>Part 1: gauging emotional state</em></td>
</tr>
<tr>
<td>Figure 47</td>
<td>Responses of <em>part 1: emotional state</em> after being mapped onto the circumplex model of affect.</td>
</tr>
<tr>
<td>Figure 48</td>
<td>Example question from <em>Part 2: gauging emotional intensity</em></td>
</tr>
<tr>
<td>Figure 49</td>
<td>Cues present in each clip of the three rankings. ‘Sped up movement’ means that the shift-key was held down to speed up the character.</td>
</tr>
<tr>
<td>Figure 50</td>
<td>Responses of <em>part 2: emotional intensity</em>.</td>
</tr>
<tr>
<td>Figure 51</td>
<td>Breakdown of the 34 deviating responses for Ranking1 (Anger).</td>
</tr>
<tr>
<td>Figure 52</td>
<td>Breakdown of the 17 deviating responses for Ranking2 (Excitement).</td>
</tr>
<tr>
<td>Figure 53</td>
<td>Breakdown of the 12 deviating responses for Ranking3 (Sadness).</td>
</tr>
<tr>
<td>Figure 54</td>
<td>Example question from <em>Part 3: word associations (I)</em></td>
</tr>
<tr>
<td>Figure 55</td>
<td>Laban Movement Analysis (LMA) and shape features that influenced movement execution in the video clips.</td>
</tr>
<tr>
<td>Figure 56</td>
<td>Cues present in the clips. The left-hand column shows the variant group as well as the cue types that differed across each clip in the group. Rows above the clips show intended emotion.</td>
</tr>
<tr>
<td>Figure 57</td>
<td>Snapshots of the clips, shown in same rows (groups) and order as in <em>Figure 56</em>.</td>
</tr>
<tr>
<td>Figure 58</td>
<td>Ratings of the seven clips (X-axis) for specific emotion words (stacked on Y-axis). Exact numbers were left out for clarity. Horizontal slices (such as the Frustrated row) range from 0%-100% top-to-bottom, the bold dashed line in the middle representing the 50% mark, and the less bold dashed lines representing 25% and 75%. Responses marked (-) are the undecided responses.</td>
</tr>
<tr>
<td>Figure 59</td>
<td>States associated with the different clips.</td>
</tr>
<tr>
<td>Figure 60</td>
<td>Association of the clips with their intended emotion. Clip4 is split up to show Cautious/Curious values.</td>
</tr>
<tr>
<td>Figure 61</td>
<td>Snapshots of the clips from word association page II.</td>
</tr>
<tr>
<td>Figure 62</td>
<td>Example question from <em>Part 3: word associations II</em></td>
</tr>
<tr>
<td>Figure 63</td>
<td>Results from <em>Part 3: word associations (page two)</em>.</td>
</tr>
<tr>
<td>Figure 64</td>
<td>The user test environment: exploration phase. A user in the Excited state about to switch to Anger.</td>
</tr>
<tr>
<td>Figure 65</td>
<td>A session in progress. Image used with permission.</td>
</tr>
<tr>
<td>Figure 66</td>
<td>The first 5 target characters in a recording in progress. The character in the center is the user.</td>
</tr>
</tbody>
</table>
List of Figures  ix

Figure 67  Cues used by group A (above) and B (below) to form their expressions. Each expression includes State, Symbol and Movement cue usage.  96

Figure 68  Breakdown of state and symbol usage during the execution phase.  97

Figure 69  Cue usage per type across all 42 expressions. ‘combination’ indicates a combination of symbol and state usage.  104

Figure 70  Cue usage per type for each instruction. ‘combination’ indicates a combination of symbol and state usage.  104

Figure 71  One-word descriptions for the different states. Note that some participants wrote down multiple words. These have been included.  109

Figure 72  One-word descriptions for the different states mapped onto the 4 quadrants of the circumplex model of affect. Some words were omitted because they did not seem to map neatly onto one of the quadrants. These were: love, friendship, unsure, neutral, jealous. Words that were counted are as follows. Anger: anger, scared, cautious, alarmed. Excited: excitement, happy, bright. Calm: zen/calm/content, positive, relieved, safe. Sad: sad, depression, blue, cold.  109

Figure 73  Group A: one-word descriptions of each state. Instructions: Excited, Sad, Affectionate.  110

Figure 74  Group B: one-word descriptions for each state. Instructions: Angry, Curious, Cautious.  110

Figure 75  One-word descriptions for the different discrete expressions. Note that some participants wrote down multiple words.  113

Figure 76  Group A: one-word descriptions for each symbol. Instructions: Excited, Sad, Affectionate.  114

Figure 77  Group B: one-word descriptions for each symbol. Instructions: Angry, Curious, Cautious.  114

Figure 78  Was it easy to execute your expressions?  117

Figure 79  Responses regarding usage of the state switcher.  118

Figure 80  Did this icon set a correct expectation of what state would follow when pressed?  119

Figure 81  Responses regarding usage of the symbols.  119

Figure 82  Did this icon set a correct expectation of what expression would follow when pressed?  120

Figure 83  Interpretations by group A. Top row shows the intended emotion. Description of the expression by the group A participant is seen in the grey boxed label above the cues that made up the expression.  123
Figure 84  Interpretations by group B. Top row shows the intended emotion. Description of the expression by the group B participant is seen in the grey boxed label above the cues that made up the expression. 124

Figure 85  Relation between intended expression (right-hand) and interpretation of the observer (Y-axis). 125

Figure 86  Number of expressions correctly described by the interpreting participants. "Related" indicates the description was some form of the intended emotion. Cases counted as related are as follows: Curious as "confused" (4), Cautious as "scared" (2) and "doubt" (1), Excited as "happy" (1), "attention-seeking" (1) and "friendly" (1). Omitted was the (likely accidental) case of Red+Hearts for Sad, described earlier. 125

Figure 87  Total number of times a cue was mentioned to play a role in the participant’s interpretation of the expression. 129

Figure 88  Total number of expressions interpreted correctly, as a related emotion, and incorrectly. 131

Figure 89  Number of expressions correctly described by the interpreting participants. "Related" indicates the description was some form of the intended emotion. Cases counted as related are as follows: Curious as "confused" (4), Cautious as "scared" (2) and "doubt" (1), Excited as "happy" (1), "attention-seeking" (1) and "friendly" (1). Omitted was the (likely accidental) case of Red+Hearts for Sad, described earlier. 131

Figure 90  Causes of miscommunication per instruction. 132

Figure 91  Specific cues that caused the miscommunications. Shown are the number of times it caused a miscommunication, its intended meaning by the executing participant, the interpretation of the observing participant, and whether instructions are believed to have been the cause the difference in interpretation. 132

Figure 92  Overzicht van geïdentificeerde visuele kanalen met voorbeelden. 150

Figure 93  Algemene kenmerken van een emotie expressie. 151

Figure 94  Visuele representatie van het overwinnen van angsten in Compass. 152

Figure 95  Angst in Compass. 152

Figure 96  Geïmplementeerde emotionele staten. 153

Figure 97  Geïmplementeerde discrete symbolen. 154

Figure 98  Samenvatting van de antwoorden uit deel 1: emotionele staat. 155

Figure 99  Antwoorden voor deel 2: emotionele intensiteit. 155
Figure 100  Associaties van de clips ten opzichte van de bedoelde emotie. 156

Figure 101  Totaal aantal expressies omschreven als de bedoelde emotie, als een gerelateerde emotie, en als een compleet ongere- lateerde emotie. 157

Figure 102  Detailfiguur. Omschrijvingen geteld als “gerelateerd” zijn: Curious als “confused” (4), Cautious as “scared” (2) en “doubt” (1), Excited als “happy” (1), “attention-seeking” (1) en “friendly” (1). 1 expressie van Sad werd niet in acht genomen. 157

Figure 103  Oorzaken van miscommunicatie per instructie. 158

Figure 104  Specifieke signalen die miscommunicatie veroorzaakten. Getoond zijn het aantal keer dat het signaal een miscom- municatie veroorzaakte, de bedoelde emotie van de uitvoerende gebruiker, de interpretatie van de observerende gebruiker, en of het waarschijnlijk is dat de instructies een rol hebben gespeeld in het verschil in interpretatie. 158
# List of Tables

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 1</td>
<td>Separate elements of each representation categorised across general visual channels.</td>
<td>42</td>
</tr>
<tr>
<td>Table 2</td>
<td>Further distinctions between the categories.</td>
<td>43</td>
</tr>
<tr>
<td>Table 3</td>
<td>Expressions the participants were asked to form.</td>
<td>94</td>
</tr>
</tbody>
</table>
INTRODUCTION

1.1 THESIS GOAL

During interactions in the real world, a substantial amount of information about our internal emotional state seeps through into our body language, our words, and our characteristics of speech. But in the medium of video games and in virtual environments in general, the act of emotion expression is more restricted. Players don’t have the same amount of fine-grained control over their virtual avatar as they do over their physical bodies.

In such virtual environments, written and voiced speech are the dominant channels through which emotions are communicated. To enrich this communication, a feature often present in online games is to give the player the possibility to perform body language cues on command. This makes their avatar show certain gestures or take on specific postures that we are familiar with from social interactions in the real world. However, keeping in mind that “emotional communication between people depends on what media is used and the specific qualities that characterize that media channel” [1], communication in virtual worlds can go beyond simulating speech and body language alone.

Being an interactive, highly visual medium, video games lend themselves well to the manipulation of the visual characteristics of the virtual world and its content. This allows for expressive communication that is not possible in the real world: subtle visual cues can be used to communicate emotion, much like an artist adds emotional content to a painting by selecting certain colours, using expressive strokes or shapes. Giving the player control over the visual appearance of their virtual surroundings could give them an additional layer through which to express themselves.

Usage of this is demonstrated by a variety of artistic (and often personal) games that utilise visual changes in the game world to convey complex emotions. These games are an interesting case study to examine the feasibility of channeling communication through such subtle visual cues, which could perhaps be called real-time visual communication.
The goal of this thesis is to explore how visual communication can be used in real-time and under the player’s control to enrich players’ expression of emotion in video games and virtual environments.

There are three components to the thesis that work toward this goal:

- A discussion of important aspects of visual emotion representation inside and outside of video games (Chapter 3),

- An analysis of a selection of artistic games that convey complex emotion through visual cues (Chapter 4, Chapter 5),

- An evaluation involving a survey and a user test that investigate the passive recognition and active expression of emotion using a set of visual cues, respectively (Chapter 7, Chapter 8). A test environment was built for this evaluation (Chapter 6).

As a final note, this work will not focus on sound cues, speech or non-verbal communication cues such as gestures, postures and facial expressions as a means to express emotion. The focus is on the manipulation of colours and shapes and movement, and/or the addition of symbolic content in order to allow the player to communicate their feelings.

Before moving on to three parts just mentioned, Chapter 2 situates the work further by discussing some relevant aspects of emotion in video games, emotion in social interactions in the real world, and typical communication features in online video games that allow for emotion exchange.
BACKGROUND

2.1 EMOTION IN VIDEO GAMES

Emotion in video games is a broad topic. An extensive or complete overview is not purposed here. The aim of this chapter is rather to highlight several cultural forces within video games in which the topic of this work can be situated.

2.1.1 Diverse emotional content

The video game medium is one that has been evolving at a rapid pace since its birth several decades ago. Its history however is saturated with violent and competitive games. Frequently about power fantasies and epic adventures, many games feature battling and killing as its core gameplay mechanics. Although there have always been games about more peaceful topics that utilise more peaceful verbs, there has been an explosion of these in the last decade or so. Many developers as well as players have started to notice a lack of variety of emotional content in video games [2], and it is starting to be remedied. Next are some examples of developers speaking about this topic. Jenova Chen’s DICE keynote talk in 2013, the title alone already calling for more diverse emotional experiences in games: ‘Emotion Oriented Interactive Entertainment - Inspirations And Theories Behind Journey’ [1]. While this dates back to 2013, in 2016 Florian Veltman called for games to feature more mundane, relatable stories as opposed to epic fantasy adventures [2], and Brie Code wrote a popular piece on why many “non-gamers” don’t like video games [3]. Until games start delivering more diverse emotional content that speaks to a broader audience than the traditional

3 Video Games Are Boring, Brie Code: http://www.gamesindustry.biz/articles/2016-11-07-video-games-are-boring
“gamer” audience, it will not be considered as mature a medium as for instance film and literature[3].

One way this bleeds into game development is a focus on designing for emotion during the design process. Artifacts such as emotional requirements are an example of this. This was notably utilised in the highly successful PS3 game *Journey* ⁴, a multiplayer game that offers no text-communication between players, but is generally considered as offering deeply emotional connections between players. During development of *Journey*, an emotional arc (Figure 1a) was used to show which emotions the designer intended to induce in the player over the course of the game.

![Emotional arc of Journey.](image)

![Mood picture of the arc in (a).](image)

**Figure 1.** Game design artifacts for *Journey* by *Thatgamecompany*. High focus on emotional experience. Images taken from Jenova Chen’s DICE talk.

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This is used as guidance in creating and designing each area and the overall game experience. Shown on the X-axis is the game’s overall progression, divided into specific areas within the game (approximately reflected in Figure 1b). Shown on the Y-axis is the emotional intensity associated with each of these areas. Positive emotional intensities are pleasant, while negative emotional intensities are unpleasant, both ranging from neutral to strong. In Figure 1b one can see a similar progression or emotional intensities just by observing the moods portrayed. The utilisation of emotional requirements has also appeared in academic research [4].

2.1.2 Emotional interactions

As an extension to the above, certain developers are also looking to create more meaningful interactions between players. One of the ‘four keys of fun’ by Lazzaro, N. is The People Factor: using games as mechanisms for social experiences [5]. This involves competition, teamwork, social bonding and personal recognition, which are all big reasons why people play games. However, games in general have a dominant history in violent or combat-oriented gameplay, and this is true as well for multiplayer games. World of Warcraft, Counter Strike, League of Legends, Overwatch, just to name a few, all deal with killing, battling and competing, be it player vs player or player vs environment. In comparison to single player video games, there are relatively few online games that focus on other types of gameplay. Online games that do offer a different focus are mostly casual, social and free-to-play games such as Little Big Planet, Dance Dance Revolution, FarmVille or Second Life. Even though it can be said that players can have meaningful interactions in such games, a clear difference can be perceived in the depth of emotional communication in games such as Journey (previously mentioned) and Tale of Tale’s The Endless Forest §. Both offer highly unique and deeply emotional interactions in an online setting without any forms of speech.

One specific phenomenon observed on the official Journey forum demonstrates the capacity the game has for deep emotional connection. The forum contains a 155-page thread titled “Thank You’s”—this is a thread where players post their gratitude to the players they’ve played with during one of their playthroughs (which they cannot do extensively in-game because there is no text communication). It was started in 2012 when the game first launched, but it is still highly active7. These accounts of gratitude demonstrate the possibility for emotional

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7 Observed at the time of writing, January 2017.
connections with other players that leave a deep impact without the usage of speech.

One strong inspiration for investigating the topic of this thesis was in fact *Journey*, and a question that piqued the author regarding it: *How could I communicate different kinds of emotion to the other player in games like Journey, where there is no text communication...?*. This question led mainly to imagining how visual and auditory communication forms could be used within *Journey* to communicate emotion. This eventually led up to this work, focusing on real-time visual communication. Such visual, emotional interactions open up a space of possibility for richer expression of player emotion.

![Figure 2: Journey by thatgamecompany.](image)

2.1.3 *Video games as personal expression*

While the exploration of diverse emotional content has been taking place in the industry at large, both in mainstream video games and in smaller, independent games, there has also been a stark rise of personal games. Personal video games are to the video game medium what poetry or short stories are to literature. Very auteur-oriented, they’re typically small games crafted by a single person, short in length and expressing something of the creator’s own experiences or thoughts. One particularly strong enabler for the rise in personal games has been the availability of high-level game creation tools. They make it easy for any individual to create games, without the need for programming
skills. Examples of such tools are Construct 2\textsuperscript{8}, Twine\textsuperscript{9} and Game Maker\textsuperscript{10}. Another strong enabler is the ease with which games can be put online and shared, such as through services like itch.io. This encourages individuals to create and share their games.

Often in these personal games, the game expresses its subject strongly and artistically, especially when the focus is on the person’s own emotional experience or impressions. They translate internal human experience into a combination of game mechanics and visuals. Through this, personal games can be extremely effective in communicating emotion to the player, which is why they were chosen as subject of analysis in Chapter 4 in order to inspect which aspects of these visual representations can be used for communication between players.

An example of such a game is What Now? by Arielle Grimes\textsuperscript{11}, shown in Figure 3. Through strong visuals and mechanics, she shows her experience of sensory overload. Visual distortions, uneasy sound effects and colour usage have a strong emotional load that express her feelings in those moments of anxiety.

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{game_screenshot.png}
\caption{What Now? by Arielle Grimes (in-game screenshot).}
\end{figure}

\textsuperscript{8} Construct 2. \url{https://www.scirra.com/construct2/}
\textsuperscript{9} Twine. \url{https://twinery.org/2/}
\textsuperscript{10} Game Maker. \url{http://www.yoyogames.com/gamemaker}
\textsuperscript{11} What Now? Arielle Grimes: \url{https://ariellegrimes.itch.io/what-now}
2.2 EMOTION IN SOCIAL INTERACTIONS

2.2.1 Expression in (non-)verbal communication

In face-to-face interactions, communication happens both verbally and non-verbally. Since language is the main communication method of human beings, speech features are almost always included in online games, either written or spoken. A large part of face-to-face communication however happens through non-verbal communication [6]. This includes, but isn’t limited to, the use of gestures, facial expressions, spatial behaviour and tone of voice. This process happens largely subconsciously, but can also be controlled with practice. Through body language, the experience of emotions is conveyed and read by others. Someone feeling uncertain and shy may display a slumped posture with enclosed arms as if protecting themselves, and head pointed down instead of held up. In contrast, someone feeling confident might put their chest forward, hold their chin up, use gestures as they speak and speak in a steady voice.

Figure 4 shows an overview of non-verbal communication forms in video games, based on a body of research on non-verbal communication in general [7]. Simulating all these aspects body language can quickly become complex. Besides the sheer volume and complexity of cues, a major challenge paired with bringing non-verbal communication into the virtual world is working around limited input capabilities of the player [8]. The player does not have as much control over the virtual avatar as over their own body. This is usually solved by using typed commands or buttons that execute certain body language cues, such as performing gestures or displaying postures. This is discussed further in Section 2.3. Another way to circumvent this problem is the use of physiological measurements of the player’s body to automate the activation of expressions in line with the player’s physical emotional state. This requires less or no input from the player at all, although it bears with it unique challenges of its own (technical and otherwise). One non-technical problem is the occurrence of involuntary expressions (emotions which the player feels but may not want to show), and the inability to express emotions one is not actually feeling. While this is a widely researched topic, it falls beyond the scope of this thesis.
Figure 4.: Non-verbal communication forms in video games [7].

Despite limited input capabilities, depicting body language of the player avatar or showing facial expressions has been used extensively to enrich communication in virtual worlds. In fact, most research that has been done on more expressive in-game communication is related to replicating aspects of body language within the virtual environment [9] [10] [7] [8] [11]. This is, perhaps, because next to spoken language, it is the method of communication we are most familiar with. Using visual cues in the virtual world is another viable avenue, which is the area of this thesis and is discussed in-depth in Chapter 3. It is less widely researched however.

Non-verbal communication can inform the design of visual cues for emotion expression however. For example the concept of clustering cues and keeping in mind context. There are the three rules for accurate reading of body language [6]. They are as follows:

1. **Read body language in clusters** e.g. look at the combination of posture, gestures and tone of voice, not at each in isolation as the same cue may play a different role in different clusters.

2. **Always read cues in relation to the current context**, since one cue can have different meanings in different contexts.

3. **Look for congruency between gestures and words**. Does body language perceived match the words spoken?
Rules 1 and 2 have particular relevance here, and can be translated to a more general perspective that can also be applied to the interpretation of visual cues as expressions of emotion:

1. **Clusters**: Separate cues can be combined to convey an emotion, while individual cues can be re-used in combination with other cues to display a different emotion. This can allow for a set of simple, independent cues to still convey a range of complex emotions. In terms of emotion expression in games, it is then important to consider what needs to be conveyed and whether simple or complex techniques are needed to do so.

2. **Context**: One cue (or a cluster of cues) may express multiple emotions depending on the context in which it is used. This is also highlighted in the Law of Situational Meaning, which is part of Frijda’s (1988) proposed laws of emotion [12]. It is then important to consider to what extent context can enhance or alter the meaning of a particular set of visual cues. This could mean sticking to simple expressions that gain different meanings in different contexts as opposed to providing a set of more complex expressions that are entirely independent of context.

### 2.2.2 Emotion exchange in playful experiences

Video games are playful experiences, and all forms of play (whether physical or virtual) involve the exchange of emotions. During play, we get a significant added satisfaction and motivation by seeing the response of those we’re playing with, be it in cooperative or competitive settings. Teasing, helping each other, showing empathy, supporting one another verbally, and so on, are all important aspects of social play [5]. Providing means for rich communication can support and enhance these aspects of play.

While play is a complex phenomenon which has been researched extensively, of main concern here is what and how emotion exchange contributes to the quality of shared playful experiences in a virtual setting. The playful experience framework (PLEX) [13] arranges playful experiences into distinct categories as seen in **Figure 5**. Each of these categories can be a component involved in a specific playful experience. The components of play that will most obviously benefit from the presence of rich emotion expression are Competition, Expression, Fellowship, Nurture and Sympathy, mainly but not solely because they involve other players.
It is then worth exploring how and if visual cues can enrich emotion exchange, as it could positively impact games where these components play a major role. It is also likely that it is in those type of video games that emotion expression through visual cues is most impactful. Perhaps also the reason why such visual cues have been most observed in artistic and personal games is because those experiences tend to span the components of play highlighted here. They are often about sharing an emotional experience (Sympathy), thus expressing emotion (Expression) and creating a sense of intimacy between the player and author (Nurture, Fellowship).

<table>
<thead>
<tr>
<th>Experience</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Captivation</td>
<td>Forgetting one’s surroundings</td>
</tr>
<tr>
<td>Challenge</td>
<td>Testing abilities in a demanding task</td>
</tr>
<tr>
<td>Competition</td>
<td>Contest with oneself or an opponent</td>
</tr>
<tr>
<td>Completion</td>
<td>Finishing a major task, closure</td>
</tr>
<tr>
<td>Control</td>
<td>Dominating, commanding, regulating</td>
</tr>
<tr>
<td>Cruelty</td>
<td>Causing mental or physical pain</td>
</tr>
<tr>
<td>Discovery</td>
<td>Finding something new or unknown</td>
</tr>
<tr>
<td>Eroticism</td>
<td>A sexually arousing experience</td>
</tr>
<tr>
<td>Exploration</td>
<td>Investigating an object or situation</td>
</tr>
<tr>
<td>Expression</td>
<td>Manifesting oneself creatively</td>
</tr>
<tr>
<td>Fantasy</td>
<td>An imagined experience</td>
</tr>
<tr>
<td>Fellowship</td>
<td>Friendship, communality or intimacy</td>
</tr>
<tr>
<td>Humor</td>
<td>Fun, joy, amusement, jokes, gags</td>
</tr>
<tr>
<td>Nurture</td>
<td>Taking care of oneself or others</td>
</tr>
<tr>
<td>Relaxation</td>
<td>Relief from bodily or mental work</td>
</tr>
<tr>
<td>Sensation</td>
<td>Excitement by stimulating senses</td>
</tr>
<tr>
<td>Simulation</td>
<td>An imitation of everyday life</td>
</tr>
<tr>
<td>Submission</td>
<td>Being part of a larger structure</td>
</tr>
<tr>
<td>Subversion</td>
<td>Breaking social rules and norms</td>
</tr>
<tr>
<td>Suffering</td>
<td>Experience of loss, frustration, anger</td>
</tr>
<tr>
<td>Sympathy</td>
<td>Sharing emotional feelings</td>
</tr>
<tr>
<td>Thrill</td>
<td>Excitement derived from risk, danger</td>
</tr>
</tbody>
</table>

Figure 5.: Summary of the revised PLEX framework featuring experience categories[13]. Highlighted categories are enhanced through rich emotional communication.
Emotion theories

Emotion is a broad and complex subject, and research on emotion has been carried out for decades. Many theories and classifications of emotion have been proposed. Two are highlighted here.

A theory of emotions as discrete states is suggested by Ekman (1992), which categorizes emotion into a set of basic emotions. Each basic emotion represents a family of related emotions [14], interpreted as variations on a central emotional theme. Different emotion families then differ in their central theme, each a grouping of similar affective experiences. In this system, the six basic emotions are Anger, Disgust, Fear, Joy, Sadness, and Surprise. While there are too many emotions to represent each of them in games, it may be useful to at least represent each of the basic emotions.

The model that will be used to inform parts of this text however is Russel (1980)’s circumplex model of affect [15]. In contrast to Ekman’s discrete emotions, the circumplex model of affect orders affective experience in a continuous, dimensional model (Figure 6). Emotions are then characterized by independent valence and arousal scales. In the model are positioned a range of affect words; words that describe one’s experience of particular emotions. A natural grouping of feelings occurs according to the physiological state that is attributed to the affective experience in question. Arousal points to the level of physiological activity, while valence points to whether pleasure or displeasure is associated with the emotion [15]. In these terms, anger is a highly aroused, negatively valenced state, while calmness is positively valenced with low arousal. This can be useful for representing emotion in games, as playing with the valence/arousal of a player’s character representation can potentially simulate a range of emotions. Changes to valence or arousal of an avatar can have specific visual changes to its appearance, which can loosely be interpreted to fall on this model. Several games studied in Chapter 4 present the avatar’s emotion in discrete positions within this quadrant: on the one hand a high arousal, positively valenced state, and on the other a low arousal, negatively valenced state. The circumplex model of affect informed the designs of the emotions available in the test environment Section 6 as well design of the online survey and user test that are part of the evaluation of this thesis.
Figure 6.: A circumplex model of affect [15].
This section highlights features that are currently most commonly found in online video games to allow for player-to-player communication and emotion expression to occur.

### 2.3.1 Voice and text

The most straightforward way to allow emotion expression between players in video games is to provide means for them to communicate using language. This is done either by chatting in a chatbox or by using voice communication through a microphone. In fact, very few online games come without a chat functionality, and voice communication is also often made available as an in-game feature. Although the latter is more prevalent in certain genres (such as first-person shooters) than in others.

Besides chatboxes and voice communication, which allow the player to use words freely, a more restrictive form are predefined verbal commands. These are often seen in shooters to give quick signals to other players or to AI-controlled characters. An example of which are radio commands in *Counter-Strike*, which the player activates by pressing the button a particular command is bound to, such as "Cover me!". When activated, a short verbal command is sent to the rest of the team. This allows for quick communication without relying on the need to type out the command or speak into the microphone.

### Online games without language

There are reasons however for online games to deliberately exclude any means of communication through language. Excluding language takes away all barriers between two players (language, cultural, racial) and distills their interactions to the core of human interaction. Another advantage when language is excluded is that players cannot break immersion by talking about matters not related to the game or their experience in question, and can help to prevent bullying and verbal violence (to a certain extent).

Some notable games that don't offer language-based communication deliberately are *Journey*, *The Endless Forest* and *Splatoon*. They are specifically designed without allowing any kind of language-based communication; all communication occurs through use of body language or simply by moving around. There is no chatbox and no voice feature. They offer highly interesting case studies to inspect how meaningful interaction in games is possible without the use of language.
In *Journey*, there is one mechanic that allows for communication between players besides that of spatial behaviour. The player can chirp by pressing a button on the controller. This is an example of a low complexity technique (little control over what can be expressed) that still has the potential for a wide range of expression because of changing context. The only thing the player can control is the rate and duration at which one chirps, while tone and pitch are randomly determined by the game. A player chirping furiously may mean both positive excitement or intense fear, depending on whether the players are happily sand surfing off a slope or under attack by dragons. A slow chirping may both be expressing calmness and contentedness, or sadness and concern, depending on whether players are gazing out over a beautiful view or whether they’re climbing a mountain together in a severe snowstorm and have lost the ability to jump. Language could do this as well, but it is not strictly necessary to share such sentiments.

*The Endless Forest* on the other hand uses predefined gesture and posture actions (as well as spatial behaviour) as the sole methods of communications. To allow for a great deal of expression, they provide almost twenty different actions the player can perform. These are activated by pressing the designated icon on a skill bar. A snapshot of the selection can be seen in Figure 7.

![Figure 7: A player expressing confusion by executing a predefined action.](image)

*Source: Tale of Tales.*
2.3.2 Body language actions

Many online games allow a set of predefined gesture and posture actions that the player can initiate on demand, such as waving, dancing, crossing the arms, scowling, or bowing. Often, these are performed either by typing commands in a chatbox, such as ‘/dance’, or by pressing a UI element that executes the action when clicked (Figure 7, Figure 8). Many of these, such as scowling, laughing or crossing the arms, can be regarded as equivalents of certain non-verbal communication signals that we use in the real world. Thus, these actions are direct translations of gestures and postures we are familiar with.

Figure 8.: Several available predefined expressive actions in Aion.

2.3.3 Spatial behaviour

If the player’s avatar can move within a 2D/3D virtual space within the game, they are likely to display spatial social behaviour toward each other as in the real world [9] [10]. For example, we keep distance from those we’re wary of, and seek closeness with those we have close bonds with [6]. In virtual environments, seeking closeness (as in Figure 9) may thus mean fondness of one another, running away may mean fear or dislike, circling around another player may transmit playfulness, and so on.

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12 Aion Gameplay Emotes, Pet Actions and Dance Moves. 
https://www.youtube.com/watch?v=r_TE1PJHE0A
Figure 9.: Players seeking closeness in The Endless Forest. Source: Tale of Tales.
A visual representation of a particular emotion is a way to communicate that emotion to others—it is something that ‘stands for’ the emotion. There are many aspects that come into play when representing emotion visually, and this work only touches the surface of some of the areas that are relevant. Visual communication as a broader field however spans information that is not necessarily meant to be emotional. But even if the content is purely informational, everything visual holds some sort of emotional weight—advertisements, website designs, logos, clothing, food packaging, office walls, architecture, interior design... all of these consist of visual stimuli that communicate emotion to the observer in addition to their main purpose, and often subconsciously. Sometimes they are designed specifically to elicit particular emotions, such as designing a room for relaxation. These visual stimuli can often be described with adjectives that point to mood or feelings, such as soothing, oppressive, energizing, unnerving. The main components that make up these stimuli are the colours and shapes they use and the way they move (if there is movement involved).

These components play a more deliberate role in the arts, such as in paintings, drawings, comics books, animation movies, sculptures, and also in video games. Figure 10 gives an example of paintings with clear high emotional content. Emotion can be read from these paintings through what they depict (a maze in a head, the silhouette of a person yelling) and how they depict this (colour palette, rough strokes). The latter part setting mood and being a large component of the emotional content it holds. Video games then, being a visual, virtual, and most notably interactive medium, lend themselves well to the real-time manipulation of such visual stimuli to convey emotion. And while it is generally known and accepted in game design that the visual nature of the virtual environment affects the players' emotions (used extensively in environmental design), it seems to be a largely unexplored area to use this visual nature of the medium as a specific means for communication between players. More specifically to allow players to communicate emotion to each other. Perhaps the only exception is the use of emoticons and smileys.
This idea was also hinted at by Manninen and Kujanpää, even though they worked specifically on a model for non-verbal communication forms in video games (shown previously in Figure 4): “The [non-verbal communication] model originates from the physical world where many of the things such as body, sense of touch and sensomotoric control are taken for granted. The model has to be expanded to cover the most basic primitives of virtual environments. Virtuality makes it possible to introduce new conventions of communication that are not realistic or possible in the physical world” [7]. In the context of this work, these ‘new conventions’ would mean using visual cues in real-time, and under the control of the player.

These visual cues can roughly be divided into two categories: manipulating visual properties (of objects, environment,..), and the addition of new objects, or symbols. In this work, symbolic cue is the term used for such objects and symbols, while subsymbolic cue is used to refer to the the visual properties of objects, such as colour and shape. These two types of cues are discussed in Section 3.1 and Section 3.3. From each category, a selection of cues was incorporated in the test environment (Chapter 6). Before discussing the nature of these cues, some notes are made on recognition and interpretation.

2 'Rage'. Sarah Goodyear: https://www.artdoxa.com/sallycantdance/large?page=1
Emotional communication is a two-way activity. Emotion is not only expressed, be it through nonverbal communication or visual stimuli, it is also perceived. Emotional intelligence (or EQ) is one’s ability to understand and regulate one’s own emotions and to recognize emotional cues [16]. While this concept is commonly interpreted in the context of human-to-human interaction, it also extends to ambiguous visual stimuli [17], and more specifically, to the recognition of emotional content in colors and abstract images. This is why paintings and drawings can communicate strong emotions. The observer interprets the visual stimuli present and interprets them on an emotional level. One important concept in the communication of emotion is the use of metaphor.

The role of metaphor
Metaphor is used as an aid to communicate those experiences that are abstract in nature or that are otherwise difficult to conceptualize [18]. Using metaphor is a way to make abstract concepts concrete and easier to talk about.

In the context of this work, these abstract concepts are emotional experiences, and metaphor is used to describe and communicate those emotional experiences. Metaphorical representations are used extensively in everyday language and are often based in perceptual experience such as sensations or imagery. Examples of such connections are relationships between affect and brightness, affect and vertical position, and affect and distance between the self and another object [18]. Saying that one feels on fire (brightness), down (vertical position), or on top of the world (distance between self and object) is not meant as a literal, physical experience, they are used as tools to communicate abstract feelings. We interpret them intuitively.

This process doesn’t only occur in language, but translates to visual works as well. Metaphor plays an important role in the interpretation and understanding of the emotional content imbued in a visual work. It can be observed in the use of specific symbols, such as a heart representing love or affection, or in the general visual characteristics of the image, such as overall brightness or colour palette used. Deeper discussions of the relation between visual properties and emotion are discussed in Section 3.2 and Section 3.3.
Example

Visually expressive works are interpreted without the need for literal explanation of what is being portrayed—through the use of colour, shape and movement of objects, meaning and emotion is conveyed. This can work by relying on relevant metaphors or mental associations, which are translated into visuals that act as representations of said emotion.

Figure 10 included above shows two paintings where this can be observed. Figure 10a expresses the feeling of being stuck or lost in one’s head by depicting the inside of the mind as a maze and using gloomy, somber colours and an overall dull impression. Figure 10b on the other hand conveys feelings of rage and anger using a chaotic and pressing display of colours in harsh lines that seem to escape from the body.

In virtual environments, player emotion can be expressed in similar ways through the visual components of the environment and player characters or by adding additional objects (symbols). What becomes interesting here however is giving the player control over the manipulation of them, in accordance with the feelings they want to express.
3.2 SYMBOLIC CUES

Symbolic cues are visual cues based on symbols. They are highly depictive in that they tend to represent highly specific things. This is in contrast to subsymbolic cues, such as the colour and shape of objects or environments which rely on a combination of stimuli to convey meaning. Subsymbolic cues are not as depictive, and rely more heavily on context to gain meaning. Two groups of symbolic cues informed this work. These are smileys and emoticons on the one hand, and comic symbols. There are other cues of a symbolic nature such as icons and signs, but these were not considered as they are not as relative to the goal of emotion communication.

3.2.1 Smileys and emoticons

In text communication, and more specifically in chat conversations, smileys and emoticons are used to add an emotional weight to messages. Emoticons are visual icons of faces, while smileys are their text-equivalents. Figure 11 shows several examples. Some are based solely on facial expressions, such as Smile, Cry and Unsure, while others rely on metaphor instead, most notably Heart (love, affection), Angel (innocence) and Devil (mischievous).

Figure 11.: Some popular emoticons with corresponding text smileys.

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3 All Facebook Chat Emoticons: [https://tipsvilla.wordpress.com/2011/10/30/all-facebook-chat-emoticons-smileys/](https://tipsvilla.wordpress.com/2011/10/30/all-facebook-chat-emoticons-smileys/)
3.2.2 Comic symbols

Comic books, manga, and animation films use emotion symbols in combination with facial expressions and other non-verbal cues for emotion expression of characters. Figure 12a shows some common examples. Comic symbols are often shown on or near the face. Symbol a) shows a cross-marked popping vein that conveys anger when placed on the side of the head, e) resembles a sweat mark and conveys anxiety when placed on the side of the head, g), when placed on the cheeks can convey shyness, and so on. These, in combination with facial expressions and other non-verbal cues can form a range of expressions. In animation films and series, these symbols are often animated for added effect.

Figure 12: Comic symbols are frequently used in comic books and manga to illustrate emotion of characters.
3.3 **Subsymbolic Cues**

In contrast to symbolic cues which are highly depictive and concentrated, subsymbolic cues are a combination of noncontinuous elements, such as the colour, shape and movement of objects. These elements work together to convey meaning. They are each discussed separately.

3.3.1 **Colour**

Colour is a complex subject, and many colour theories exist. Of main concern here is not what colour is made up of, but what effect colour has on the viewer, and specifically, their power to communicate emotional content. Applied correctly and in the appropriate context, the use of colour can achieve highly affective responses [21]. Although there is a large body of research relating specific colours to specific emotions, a highly practical resource that puts forward specific colour-emotion pairs, where each colour is associated with a range of emotions, are the *Psychological Properties Of Colours* outlined by Angela Wright [22]. See **Figure 13** for examples. Which emotion is associated with a colour then depends on the specific shade of the colour, what other colours are used in combination with it, and the context in which the overall stimuli appears.

![Figure 13: Examples of colour-emotion pairs [22].](image-url)
Multi-colored images therefore also communicate emotion, and it has been shown that people interpret the emotional content of such images similarly [23]. This also extends to virtual environments, where colours of the virtual environment affect the emotional state of the player and from which they interpret emotional content [24]. A circumplex model of emotion induction [24] is shown in Figure 14, which gives hints as to which colours can be used to elicit specific emotions. It is structured in the same way as the circumplex model of affect discussed in Section 2.2.3, but with colours spread out over the arousal / valence axes instead of emotion words. It then follows that orchestrating visual changes within a virtual environment affects the emotional content the player will read from the environment. This can involve changing the general colour palette or mood of the scene or of specific objects in it. When speaking of ‘colour’ of a visual cue or object, what is meant here is the overall colour or pattern of colours that the cue or object is made up of (e.g., an object coloured in chaotic black and red lines). The manipulation of colour in the environment is observed extensively in the artistic games that are the subject of analysis in Section 4. What is not so straightforward is whether or not giving the player control over these visual changes in the environment can communicate their own emotions effectively.

Figure 14.: A circumplex model for emotion induction through colour in video games and virtual environments [24].
3.3.2 **Shape**

Shapes and patterns of shapes also carry emotional weight to them. This can be read from features such as pointiness, swirliness, roundness, orientation, size and actual form of the shape. The *Atlas of Emotion* [25] by Paul Ekman et al. is a tool to increase awareness and understanding of the role emotions play in our lives. Shape is used here as an important feature to communicate the basic emotions and different intensities of these emotion groups in so-called emotion charts. **Figure 15** shows the basic emotions charts with characterizing colours and shape features as portrayed in the *Atlas of Emotion*. Within each chart are shown multiple shapes that encompass different intensities of that emotion, such as shown in **Figure 16**.

![Figure 15](image1.png)

**Figure 15.** Charts of the basic emotions in *The Atlas of Emotion* [26].

![Figure 16](image2.png)

**Figure 16.** Detailed view of the *Anger* chart with different intensities [25].
An application of the combination of shape and colour in the specific context of person-to-person communication was investigated with the eMoto chat system [1]. It was designed to enrich SMS communication with a visual background so that emotional content could be included with each text message. The sender can create and include a background image from a provided emotional palette consisting of shapes and colours (Figure 17a). See Figure 17b for a usage example. This emotional palette is, like the circumplex model of emotion induction discussed earlier, is also laid out according Russel’s circumplex model of affect. Additionally, one can see striking similarities between this emotion palette and the shape and colours used in the Atlas of Emotion.

![Emotional palette and scenario of use](image)

(a) An emotional palette of colours and shapes, each area representing a certain emotional state. (b) Scenario of use. A message is sent with a purple-ish background to convey the irony of the text message.

Figure 17.: The eMoto system [1].

This research is especially relevant to this work, as they investigated several aspects of incorporating emotional content in SMS communication, the text equivalent of what is being purposed here (manipulating visual properties of virtual environments to communicate emotion). An important result that is that subjects in the study were able to build the desired (sometimes subtle or ambiguous) emotional responses from the emotional palette provided. This hints that using such subsymbolic messages (colours, shapes) could also be used successfully in the context of virtual environments.

An important difference between this study and the work being purposed here is that of **interactivity** and the **cognitive load** that this kind of communication adds. Text messaging is asynchronous—the sender takes time to build their message and then sends it, which ends the communication on their part until a reply is received. In virtual environments, players are continuously in dialogue through gameplay, synchronously, so one player ‘building’ their emotional mes-
sage means time taken away from engaging in gameplay. An important concern is then if this is detrimental for the experience. One can say that text communication in virtual environments poses the same challenges, and to an extent it does. But adding a third communication layer (that of visual emotion exchange, which could entail choosing a position on the emotional palette which then changes the virtual environment or character), could add too much of a cognitive burden to the player as he now has control over three channels: gameplay, text, and emotion exchange. This might work better in a virtual setting where text communication is (purposely) not included, and communication is limited to gameplay and emotional communication (e.g. using an emotional palette).

3.3.3 Movement

In addition to colour and shape, the movement of shapes also communicates emotion. Research on dance has been particularly concerned with this, as dance is all about expression through body movement (both emotional and informational). Laban Movement Analysis is widely used to analyze and characterize human movement, and is also used in dance research. Of particular interest here are the Laban movement dimensions of time, space, weight and flow, which describe the subtle characteristics of movement. Figure 18 shows the typical manifestations of these four dimensions in the emotion categories of Anger, Fear, Grief and Joy [27].

<table>
<thead>
<tr>
<th>Emotion</th>
<th>Feature Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anger</td>
<td>short duration of time</td>
</tr>
<tr>
<td></td>
<td>frequent tempo changes, short stops between changes</td>
</tr>
<tr>
<td></td>
<td>movements reaching out from body centre</td>
</tr>
<tr>
<td></td>
<td>dynamic and high tension in the movement; tension builds up and then ‘explodes’</td>
</tr>
<tr>
<td>Fear</td>
<td>frequent tempo changes, long stops between changes</td>
</tr>
<tr>
<td></td>
<td>movements kept close to body centre</td>
</tr>
<tr>
<td></td>
<td>sustained high tension in movements</td>
</tr>
<tr>
<td>Grief</td>
<td>long duration of time</td>
</tr>
<tr>
<td></td>
<td>few tempo changes, ‘smooth tempo’</td>
</tr>
<tr>
<td></td>
<td>continuously low tension in the movements</td>
</tr>
<tr>
<td>Joy</td>
<td>frequent tempo changes, longer stops between changes</td>
</tr>
<tr>
<td></td>
<td>movements reaching out from body centre</td>
</tr>
<tr>
<td></td>
<td>dynamic tension in movements; changes between high and low tension</td>
</tr>
</tbody>
</table>

Figure 18.: Laban movement dimensions of time, space, weight and flow associated with different emotion categories [27].
While the above focuses on human body movement, it also applies to abstract shapes. A demonstration of this is the Heider & Simmel experiment [28]. This involves a simple animation of abstract shapes, after which subjects were asked to interpret the animation (Figure 19). The animation can be viewed on YouTube. Subjects were found to describe the animation in terms of a story, which ended up being highly similar among subjects. Interesting for this discussion is that subjects used words like angry, dominating, brave, fearful, shy, timid to describe the characters in the animation [28], demonstrating that movement of simple, abstract shapes can also communicate emotion effectively.

Figure 19.: A frame from the Heider-Simmel animation.

3.4 CUE CLUSTERS

When combining the above symbolic and subsymbolic cues for emotional communication in a virtual environment, what becomes increasingly important are the clusters that these cues form. This was already mentioned in Section 2.2.1, where the case of body language clusters was generalised to visual cues used as expressions of emotion. One can see that the possibility space for individual visual cues within the aforementioned categories is very large, which results in an even bigger set of possible cue clusters. The implementation (Chapter 6) and evaluation (Chapter 7, Chapter 8) therefore explore only a tiny portion of this.

In the remainder of this text, the term expression is meant as a cluster of visual cues, with individual cues being symbolic or subsymbolic. An expression of affection could for instance be made up of one symbolic and one subsymbolic cue: a heart symbol and a pink, wavy aura surrounding a character. With some imagination, one can see that there are many different expressions possible for affection from a variety of visual cues.

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4 Heider & Simmel (1944): https://www.youtube.com/watch?v=wp8ebj_yRI4
The nature of these cues would also be highly dependent on the virtual environment in question: whether it is a 2D or 3D environment, the amount of realism in the characters and their surroundings, the overall colour palette used in the world, the camera perspective used, and so on.

Since these cues don’t work on their own to convey expressions, but operate in a cluster of cues, and since the possibility space of cues is large, it’s worthwhile investigating common characteristics across cues and their effects on perceived emotion. One specific study that works towards this was discovered at the end of writing this thesis\(^5\). It is included here briefly due to its high relevance, although it did not inform the content of this work or any decisions made throughout the analysis, implementation or evaluation.

The study [29] is concerned with investigating the influence of the individual subsymbolic cues of colour, shape, pulse size and pulse speed in abstract 2D characters that combined these cues. They varied these parameters across 32 different character representations and gathered arousal / valence ratings for each through a survey. The effects of changing these cues individually were then mapped onto a dimensional model with arousal / valence scales akin to the circumplex model of affect (\textbf{Section 2.2.3}), shown in \textbf{Figure 20}. By comparing points that vary either in colour or in one letter, the effect of changing one cue can be observed in terms of changes in arousal / valence ratings of the character representation.

Seen by the distribution of these points on the model is that a variety of emotional states\(^6\) can be conveyed by changing the parameters of a small set of cues. One can then imagine that a player given control over these cues\(^7\) could be able to express a variety of emotions non-verbally. The ways in which a player can be given control of these cues can also vary greatly. It is this type of visual communication specifically that this work seeks to explore.

\(^5\) It was published after the literature review for this work, and discovered during the analysis of the evaluation.

\(^6\) Such as anger in the top left quadrant in comparison to calm in the bottom right quadrant.

\(^7\) Either individually or in groups.
Figure 20: Each point represents the average arousal / valence ratings for one of the 32 character representations. Colour: Blue, Green, Grey, Red. Letters represent shape, pulse size and pulse speed. Shape: jagged (J) / smooth (S), Pulse Size: small (S) / large (L) - Pulse Speed: slow (S) / fast (F). For example: SSS is Smooth, Small, Slow, JLF is Jagged, Large, Fast [29].
GAME-TO-PLAYER COMMUNICATION: AN ANALYSIS

From the previous chapter, it’s clear that nearly all current standards for communication between players in online games mimics nonverbal body language cues and verbal communication. These are the two modes of communication we are most familiar with in the physical world. However, keeping in mind that “emotional communication between people depends on what media is used and the specific qualities that characterize that media channel” [1], video games and virtual environments in general have great potential to utilise visual cues as communication between players. As mentioned, the use of visual cues to convey emotion is seen more readily in artistic and personal games than in mainstream games, even though communication there is not between players, between the game and the player.

This chapter details the analysis of a selection of several artistic single-player games that use visual communication to convey emotions. The focus here is not on traditional cues such as body language or speech, but on more subtle, non-explicit cues such as colour changes, style of movement, visual appearance of surroundings, etc. The aim of this analysis is to explore what kind of subtle visual cues have been used as emotion expression in a successful way.

In Section 4.1, the selection procedure of the games is explained and the characteristics that were focused on during playthrough of these selected games are put forward.

In Section 4.2, the observations are detailed on a per-game basis. The selection of games consists of: Gravitation, Lim, What Now?, Anxiety Attacks, Beyond Eyes and Mary Woke Up Today.

Section 4.3 provides a summary of the representations found during observations, along with the individual elements they are made up of.

In Section 4.4, the identified representations are then taken apart and their individual elements are categorised into a general set of visual communication channels. This will form the basis for the next chapter, which will generalise them for use in a broader context.
4.1 METHODOLOGY

4.1.1 Selection procedure

Conditions for selection
The NVC model that was discussed in Section 2.2.1 was used to guide the selection process. Figure 21 shows this NVC model with several forms highlighted. Highlighted in grey are those forms which the player often has some range of control over and through which they can convey emotion. Physical appearance for example does not belong to this category, because manipulation of this is usually for decorative purposes or identity building. Highlighted in blue are those forms that are expected to be most suitable for visual manipulation, and are based on components of visual communication discussed in Section 3. They mainly span the areas of Environmental details, Physical appearance and Body movement. Eye shape and Mouth shape are considered as part of physical appearance because they offer interesting use of visual changes sometimes seen in animation series or chat emoticons. For example, changing the eyes into hearts or stars to convey love or excitement, or the mouth into a thick cross to indicate silence.

For a game to be selected it had to communicate emotion through visual manipulation across one or a combination of these highlighted areas. Concretely, this means manipulations of colour, shape, pattern, animation,…of the environment or avatar appearances. Coincidentally, they should be different from the traditional methods mentioned in Section 2.3, which are highlighted in grey here.

Completeness
If the selection of games contains emotion representations that spans all of the blue areas, we can say that they represent an acceptable sample from which conclusions are reliable to a certain extent. However, additional conclusions may be drawn from a larger sample of games.

Sources
Several sources were explored. This included the Art Games section on Newgrounds1, and itch.io2 with tag "artgame" and filters "Payment=Free", "Duration=A few minutes". In this search it was very difficult however to find games which matched the conditions above, in part due to the large volume of games present on those platforms. In the end, the games selected come entirely from the author’s history of games played, some of which had been a big motivator for the thesis topic.

1 Newgrounds, Art Games section: http://www.newgrounds.com/collection/artgames
2 itch.io, a digital marketplace for creators of independent games: https://itch.io/
4.1.2 Characteristics of focus

For each game that was selected, the center of focus was the visualisation of a specific emotion. The aspects of the visualisation that were examined are the following:

- **Portrayed emotion**: the emotion that is being visualised, such as fear, love, anxiety, passion, mood, . . .
- **Duration**: the duration of the visualisation, usually discrete or continuous, or a mixture of both.
- **Trigger**: the way in which the emotion visualisation is activated. For example as a result of player input, influenced by player input or entirely independent of it.
- **Visual representation**: the visual characteristics of the portrayal of emotion. For example, through avatar appearance, use of symbols, colour changes, pattern overlays, . . .
- **Use of metaphor / mental associations**: whether the visualisation seems to be informed by certain metaphors or mental associations. Note that if a link seems to be found, we cannot know for certain whether the designer intended it or if it was a subconscious process.
4.2 OBSERVATIONS

4.2.1 What Now?

*What Now?* by Arielle Grimes is "an adventure in sensory overload and emotional breakdown". It portrays *overwhelm and sensory overload*. The player begins in a neutral emotional state (*Figure 22a*), and as they walk around the apartment, the character becomes more and more distorted until a complete mental breakdown occurs. This is accompanied by increasingly unsettling sound effects and distortion of the environment, ending in a complete shutdown of the player’s character (*Figure 22b*).

**Overwhelm / Sensory overload**

- **Duration**: Continuous. Strength increases as player moves.

- **Trigger**: Player movement. The more the player moves, the stronger the portrayal of sensory overload becomes.

- **Representation**: Increasing distortion of character and world. On movement: screen shake, harsh sound effects. At a certain point camera view starts to decrease and suffocating words appear.

- **Metaphor/associations**: The representation is based on the sensations one feels during the experience sensory overload, such as altered perceptions of world and self, and negative thoughts that arise during those moments.

![Figure 22: Progressive worsening of mental state in What Now?](https://ariellegrimes.itch.io/what-now)
4.2.2 Gravitation

Gravitation is a short game by Jason Rohrer\(^4\). It’s “a video game about mania, melancholia, and the creative process”. Affection and passion were observed here.

Affection

Figure 23a shows affection displayed when playing ball with the child.

- **Duration**: Discrete, heart appears only briefly when triggered.
- **Trigger**: Activated every time the player plays ball with the child.
- **Representation**: Heart symbol above child’s head.
- **Metaphor/association**: Love is typically symbolised by a heart.

Passion (presence vs absence)

Figure 23 shows the difference between presence and absence of passion.

- **Duration**: continuous, active throughout the whole playthrough.
- **Trigger**: automatically controlled by the game system, but player’s actions influence the speed of transitions between presence/absence of passion.
- **Representation**: *Presence*: high jumping height, bright and colourful world, bouncy and high energy music, fiery hair, full camera view. *Absence*: low jumping height, dreary world, low energy music, constrained camera view. The game gradually changes from one extreme to the other.
- **Metaphor/associations**: Aspects of the representation are closely associated with the experience of being in a high vs low energy mood.

![Figure 23.: Gravitation (in-game screenshots).](image)

\(^4\) Gravitation, Jason Rohrer: [http://hcsoftware.sourceforge.net/gravitation/](http://hcsoftware.sourceforge.net/gravitation/)
4.2.3 *LIM*

*LIM* by Merritt Kopas⁵ is a game that shows the difficulties of standing out in a crowd and the potential violence associated with failing to blend in. It also shows the mental toll it takes to try and blend in with a group of people; hiding certain parts of oneself or pretending to be someone you’re not in order to be accepted. The player can press the Z button to ‘blend in’, after which the game portrays that attempting to blend in comes at a cost. This can be phrased as extreme self-consciousness: the character is mentally exerting themselves through extreme self-awareness to try and blend in with the surrounding social situations.

**Extreme self-consciousness**

- **Duration:** Discrete, occurs for as long as player activates blending-in mode.
- **Trigger:** Player input, active when ‘Z’ button is held down.
- **Representation:** Zooming in on avatar, slowed movement, camera shake (in correspondence with increasing heart rate),
- **Metaphor/associations:** The representation is based on the sensations and perceptual experience of increased self-consciousness: focusing increasingly on one’s own manners (zooming in on avatar) with an accompanying subjective feeling of moving more slowly (slower avatar movement) and increasing heart rate (increasing screen shake accompanied with heartbeat noise).

![Figure 24: Dynamic field of vision in LIM.](https://a-dire-fawn.itch.io/lim)

⁵ *LIM*, Merritt Kopas: [https://a-dire-fawn.itch.io/lim](https://a-dire-fawn.itch.io/lim)
4.2.4 *Anxiety Attacks*

*Anxiety Attacks* by Alessandro Salvati\(^6\) is a game that attempts to portray what having an anxiety attack feels like on a perceptual level. It is aimed specifically at those who have never experienced one, in order to raise awareness and understanding. A breathing mechanic asks the player to sync his breathing with that shown on-screen. When an anxiety attack occurs, breathing speeds up as well, and the player can fend it off by slowing down his breathing (breath is input by the player by holding and releasing a specific key, the game trusts that the player will sync his breath to that rhythm).

**Anxiety**

- **Duration:** Discrete, on/off state.
- **Trigger:** Game sets off an anxiety attack automatically without player input. Can be shut off by the player by engaging with the breathing mechanic and calming himself.
- **Representation:** Dark, highly limited and blurry vision, suffocating floating words, orange/reddish colour palette.
- **Metaphor/associations:** The representation is based on the sensations and perceptual experience during an anxiety attack: hostile, distorted and blurry world, tunnel vision, difficulty navigating, out of control breathing.

![Normal mental state, normal vision.](image1.png)

![Anxiety attack: decreased field of view, suffocating colours and thoughts.](image2.png)

Figure 25.: Contrasts of mental states in *Anxiety Attacks*.

\(^6\) Anxiety Attacks, Alessandro Salvati: [https://neatwolf.itch.io/anxiety-attacks](https://neatwolf.itch.io/anxiety-attacks)
Beyond Eyes by Sherida Halatoe is a game revolving around the experience of a blind child. The player plays a blind girl that sets out to find the girl’s cat friend after it does not return to her garden for a long period of time.

**Fear**

- **Duration**: Discrete, on/off state.
- **Trigger**: Activated when player is in proximity of a scary object or animal.
- **Representation**: Darkness encircles the player, posture changes in correspondence with fear response.
- **Metaphor/associations**: Fear as ‘caving in’ on oneself, hiding, seeing things grimly.

![Carefree exploration, normal vision.](image1) ![Fear of unknown noises, environment darkens and looks more hostile.](image2)

(Figure 26.: Changing environment in Beyond Eyes)

Mary Woke Up Today is a short game about continuously having false awakenings from dreams.

**Frustration**

- **Duration**: Continuous during one specific scene.
- **Trigger**: Game rules, start of a specific scene.
- **Representation**: Harsh red/black/blue lines all across the character.

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7 Beyond Eyes, Sherida Halatoe: [http://www.beyondeyes-game.com/](http://www.beyondeyes-game.com/)
8 Mary Woke Up Today, Sarah Hiebl: [http://gamejolt.com/games/mary-woke-up-today/59420](http://gamejolt.com/games/mary-woke-up-today/59420)
• **Metaphor/associations**: Based on internal experience of frustration: uneasiness (harsh lines). Red is used here as associated with anger/frustration, interpretation due to context.

![Figure 27. Mary Woke Up Today (in-game screenshot).](image)

**Fear**

- **Duration**: Continuous during several scene.
- **Trigger**: Game rules, start specific scenes.
- **Representation**: Hostile-looking, dark red / black environments.
- **Metaphor/associations**: Environment is made to look hostile to reflect inner emotional state of character. Colour palette can be associated with hostility.

![Figure 28. Changing environment in Mary Woke Up Today (in-game screenshots).](image)
The previous section detailed examples of visual representations of a variety of emotions seen in the games studied. Among them were representations of passion, affection, fear and anxiety. These are summarised in Figure 29. Shown along with each representation are the individual elements that make up the representation. For completeness, non-visual elements have also been included.

Figure 29.: Summary of the representations found in the examples of the previous section.
4.4 Discussion and Categorisation

The individual elements summarised in Figure 29 are now categorised based on the highlighted areas in Figure 21. The categories are Avatar appearance, Altered environment and Avatar movement. The result can be seen in Table 1. The reason for inclusion of avatar movement is because it was part of the representations in a different way than changes in posture, gestures or spatial behaviour usually is in online games. Observed here is changes in the nature of avatar (body) movement, such as the jumping height or the speed of movement, which is a subset of Kinesics in the model.

<table>
<thead>
<tr>
<th>Avatar Appearance</th>
<th>Altered Environment</th>
<th>Avatar Movement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiery hair, heart, colour flashes, distortion, oppressive colours, chaotic patterns</td>
<td>Dreary vs colourful environment, distorted environment, oppressive colours and text, dark edges around environment, shrinking vs expanded window, zooming in and out</td>
<td>Low vs high jumping height, slow vs normal movement speed</td>
</tr>
</tbody>
</table>

Table 1.: Separate elements of each representation categorised across general visual channels.

Altering the appearance of the virtual environment is seen in all the examples. This might seem like a strange concept at first. The intention behind it, as was clear in all examples, is to simulate the internal experience of an emotion. Emotions often entail having an altered perceptions of reality in subtle ways. This altered perception is conveyed by changes in the visual appearance of the environment. This is a striking difference with how communication usually occurs in games, and shows that their is potential in communicating emotions visually.

On closer examination of Table 1, a finer distinction can be observed among the categories. Avatar appearance can be broken down in distinct changes in the visual properties of the player avatar on the one hand, such as distortion or colour changes, and the addition of certain artifacts on the other, such as a heart of fiery hair. Altered vision can be divided into changing visual properties of the game world, attributes of the camera (occlusion and zoom level), and added artifacts such as oppressive text). Avatar movement is not broken down further, as each element clearly pertains only to the avatar movement capabilities. Table 2 shows these additional distinctions.
This finer distinction is shown in an alternative format in Figure 30, and involves *avatar appearance, world appearance, avatar movement, camera attributes* and *added artifacts*. They are essentially visual communication channels through which emotion can be conveyed to the player.
### World Appearance

<table>
<thead>
<tr>
<th>Visual Properties</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Distorted World</td>
<td>Darker World</td>
</tr>
<tr>
<td>(Overwhelm)</td>
<td>(Fear)</td>
</tr>
<tr>
<td>Hostile Colours</td>
<td>Oppressive Colours</td>
</tr>
<tr>
<td>(Fear)</td>
<td>(Anxiety)</td>
</tr>
<tr>
<td>Darkened Edges</td>
<td>Chaotic Patterns</td>
</tr>
<tr>
<td>(Anxiety)</td>
<td>(Frustration)</td>
</tr>
<tr>
<td>Brighter World</td>
<td>Fiery Hair</td>
</tr>
<tr>
<td>(Passion)</td>
<td>(Passion)</td>
</tr>
</tbody>
</table>

### Avatar Appearance

<table>
<thead>
<tr>
<th>Visual Properties</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Distorted Avatar</td>
<td></td>
</tr>
<tr>
<td>(Anxiety)</td>
<td></td>
</tr>
<tr>
<td>Chaotic Patterns</td>
<td></td>
</tr>
<tr>
<td>(Frustration)</td>
<td></td>
</tr>
</tbody>
</table>

### Added Artifacts

<table>
<thead>
<tr>
<th>Added Text</th>
<th>Added Symbols</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative Words</td>
<td>Heart</td>
</tr>
<tr>
<td>(Breakdown)</td>
<td>(Affection)</td>
</tr>
<tr>
<td>Oppressive Words</td>
<td></td>
</tr>
<tr>
<td>(Anxiety)</td>
<td></td>
</tr>
</tbody>
</table>

### Camera Attributes

<table>
<thead>
<tr>
<th>Amount of Occlusion</th>
<th>Zoom Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shrinking Window</td>
<td>Increased Zoom</td>
</tr>
<tr>
<td>(Breakdown)</td>
<td>(Mental Exertion)</td>
</tr>
<tr>
<td>Shrinking Window</td>
<td></td>
</tr>
<tr>
<td>(Low Energy)</td>
<td></td>
</tr>
</tbody>
</table>

Figure 30: Visual communication channels with examples from the analysed games.
ABSTRACT VISUAL EXPRESSIONS

The specific representations of a variety of emotions discussed in Chapter 4.2 are only a small subset of what is possible using the identified visual communication channels. This chapter aims to explore representations that utilise those channels more generally. Particular attention is given to player-to-player communication (with the goal of emotion expression). The terms ‘expression’ or ‘expressive action’ are used interchangeably from this point on, and are used to mean the entire representation of an emotion within the virtual environment. An expression can be affection, fear, shyness... and so on. Such an expression then utilises any combination of visual cues within the aforementioned visual communication channels (change in avatar appearance, world appearance, avatar movement...).

Section 5.1 explores the specific components that make up a particular expression.

Section 5.2 discusses the process of designing expressions while listing design challenges that are relevant to each part.

Section 5.3 then explores their usage in a multiplayer context.

5.1 EXPRESSION CHARACTERISTICS

The visual channels identified in Chapter 4 are a means to an end: they are ways to facilitate the expression of a particular emotion. As pointed out just now, the examples discussed form just a small subset of the expressions possible through said channels. Therefore, the aim of this section is to situate them in the broader context of emotion expression. Figure 31 shows each of the separate components that an expression is made up of beyond its visual representation alone. The communication channels previously identified are situated under Visual Representation.
Each of these components is now discussed separately. It may be helpful to keep in mind specific examples from Section 4.2, but to see them as expressions that players can initiate themselves: portrayal of passion through fiery hair, increase/decrease in movement speed and brightening/darkening of environment based on mood, distorted avatar appearance to signal anxiety, darkening of environment when frightened, and so on. Also note that player movement is categorised separately from Visual Representation. This is more convenient for thinking about expressions in a general context, but doesn’t take away the emotional content that can be communicated through alterations of player movement. This is why the arrow leading to Gameplay is labeled may affect.

5.1.1 Visual Representation

The visual representation of such expressions can manifest itself through the visuals communication channels specified earlier: avatar appearance, world appearance, added artifacts, camera attributes and player movement. It is however not limited to those. Traditional means used in games such as avatar posture, gestures, and so on are also possible. Figure 32 shows an overview. The individual visual channels on the left of the figure are now discussed more generally than they were in the previous section.
Figure 32.: Components through which an expression can be visualised. Left: channels based on visual communication as identified in Chapter 4 (player movement excluded). Right: traditional channels based on non-verbal communication in the real world.

**Avatar appearance**
As seen in Chapter 4, the appearance (both static and animated) of the player’s avatar can convey emotional content in ways different from traditional means. Its colour, the pattern used, overall shape, scale and even opacity can be altered in creative ways. Colour distortions, upscaling / downscaling, wavey contortions etc are examples of this. Specific body parts of the avatar can be altered as well as the avatar as a whole. Scaling up the head in a pulsing manner and reddening it could convey anger. Shrinking the whole avatar may convey shyness, fear or submission. Of course, avatar appearance can be changed in conjunction with other channels to achieve a stronger / more specific effect.

**World appearance**
Changing the appearance of the virtual world to communicate emotion is perhaps the most underused and least explored method in player-to-player communication. It bears with it the challenge of keeping it clear why the world is changing (which player is responsible for this visual change). However, this can be a very strong conveyor of emotion, as seen in the examples previously. Changing the colour palette of an area around the player, distorting it, darkening it or making it more or less colourful, are all interesting ways to communicate emotion. They can have an even stronger effect when used in conjunction with the other channels.

There are several approaches to making this visual change visible to other players.
One possibility is to show all players exactly what the player performing the expression is seeing. This however runs the risk of canceling out or blending in with other visual changes due to other players performing expressions themselves. Perhaps this can be an interesting option to explore, but it is not the most straightforward one.

An easier way to approach this is to show a full-screen visual change only to the player who is executing the expression, and to change their avatar’s appearance and/or the area directly around it in such a way that the other players can see how that player is viewing the world (e.g., a dark cloud around the player, a small, distorted area,...). This is similar to observing another person in the real world and gauging their emotional state by reading their body language, even though different types of cues are being read here (visual changes in their direct environment). Another way of dealing with this is to provide an ‘empathise’ feature. When activated, this would duplicate what the player executing an expression sees on their screen, and replicate this for the player(s) pressing the ‘empathise’ button so that their view of the game world in exactly the same way well. This way, another player literally ‘undergoes’ the emotional state of the other player. While this is not at all possible in the real world, it could be an interesting component to player-to-player communication.

**Camera attributes**

Zoom level and amount of occlusion of the player’s camera can be utilised for the player executing the expression to enhance their experience of it. It is however not directly suited for player-to-player communication as it doesn’t make sense to apply this change to other players’ cameras. It could however be part of an ‘empathise on demand’ feature as just discussed. Increasing zoom level of the camera could mean increased concentration or focus, as was utilised in the example of LIM in Section 4.2, while zooming out can represent a kind of ‘defocussing’. Occlusion of the camera offers much more possibilities, and was seen in many of the examples earlier, namely in Gravitation, Anxiety Attacks, What Now?. There is both the visual nature of the occlusion and amount of occlusion to play with.

**Added artifacts**

Added artifacts can both be attached to the player avatar (fiery hair in Gravitation) or floating in the environment (oppressive words in Anxiety Attacks, floating heart as effection in Gravitation). This can involve any type of visual artifact such as symbols or simply words. There is however a fine line between artifacts added to the player avatar and ‘avatar appearance’; even though fiery hair is categorised here as an added artifact, it could just as well be interpreted as a change in avatar appearance. Other examples of added artifacts are question marks that convey confusion, or a sweatdrop on the avatar’s head that conveys stress.
As mentioned in Section 2.2.1, nonverbal communication cues should be read in clusters, and context should also be taken into account. The same applies to each of these visual cues; they should not be seen as isolated from each other—they communicate a particular emotion best when used in conjunction with each other and in the right ways, as demonstrated by representations seen in the examples discussed. Most of them consisted of multiple visual cues to convey a single emotion.

5.1.2 Effect on gameplay

As mentioned, the way a character moves (fast, slow, wavey, erratic) can harbour a wealth of information about the emotional state of that character. This was demonstrated by the Heider-Simmel experiment mentioned in Section 3. This was also present in the examples discussed in Section 4, where expressions came across more strongly by player movement such as jumping height or movement speed. As long as this doesn’t disturb the game’s balance between players, it can be a strong conveyor of emotion.

5.1.3 Duration

The duration of a particular expression can vary greatly; expressions can for example be one-time, short displays of emotion or a continuous visualisation of mood.

Discrete expressions execute for a short amount of time, such as a heart appearing for just a moment above a character’s head as an expression of love (Figure 33a), or a display of momentary surprise. They have a clear beginning and end, and are triggered by the player through a specific input, perhaps by pressing a button or activating a specific object in the game, or for as long a certain button is pressed.

Continuous expressions are constantly visible and can change through time based on various factors. Examples are the complex visual mood changes in Gravitation, which is always visible and changing within the range of passionate, energetic (fiery hair, colourful environment, high jumping height,...) and dreary, low-energy (limited vision, dreary visuals, low jumping height), and the fear state of the main character in Beyond Eyes (Figure 33b). In the case of continuous expression, the visualisation may be based on a wider range of player actions which the system then generates (like the mood transitions in Gravitation), or which the player inputs specifically, such as a single click that changes their avatar’s visible state to ‘sad’ or ‘angry’.
5.1.4 Trigger

The Trigger of an expression is the action that initiates said expression. In Chapter 4, these triggers were specific rules of the games in question, and they were issued automatically and beyond the player’s control. In the case of expressions regulated by the player, these triggers are specific input cues from the player with the deliberate intention to activate the expression. This can be any input such as a button press, holding of a button or selection from a menu. This subject is more broadly discussed in Section 5.3.2.
5.1.5 Metaphor and associations

Metaphor is intertwined with nearly every aspect of representing emotion visually—but it is worth thinking about it separately from the component of visual representation and to use it to inform the construction of the visual representation. Any representation will rely on metaphor to a certain extent. Using the colour red to mean anger is use of associations, while a heart or star can be metaphorical representations of love/affection and achievement.

As an example, to translate shyness into a visual representation, one can find ways to represent visually those words that we may (metaphorically or literally) associate with being shy: shrinking, hiding, self-consciousness, stuttering, blushing. These can translate to shrinking avatar size, reducing transparency, making the player’s avatar stand out more, clumsy movement, adding a reddish layer of blush and increasing the zoom level of the player’s camera. Because we know how shyness feels and how to recognise in others, we can associate these visual stimuli (given a correct context) with being shy.

5.2 Designing expressions

The different components outlined in the previous section can be used as an aid when designing specific player expressions. This section discusses the design of expressions, including several design challenges inherent to the visual aspect of these expressions. Figure 34 shows an overview of this design process.

![Designing expressions](image)

Figure 34: The process of designing expressions for a particular game.
5.2.1 Selection

Before designing specific, individual expressions, it should be known which expression(s) the player will be able to make. These can be highly specific (sadness, surprise, shyness), or more vague (negative mood, positive mood). Many decisions regarding the specifics of each expression will be based on which other expressions are available, so this selection process can be used as the starting point and overarching vision of the nature of social interactions in the game.

Example design questions:

- Which expressions do we want the player to be able to make?
- Will expressions be discrete, such as short a display of ‘sadness’, ‘anger’, ‘affection’, or will they be continuous such as ‘high energy’, ‘low energy’ moods?
- Can the chosen expressions easily be distinguished from one another?
- For each chosen expression, does it make sense to include it within the context of the game? In *Journey* for example, giving players the specific ability to express anger toward each other could break the experience the designers intended.

5.2.2 Building the expression

Once it has been decided which expressions the player will be able to make, the key challenge becomes correctly representing these expressions within the context of the game and making them accurately identifiable by players. Choosing a proper representation can enhance the social experience of the player and decreases the likelihood of misinterpretation and miscommunication. All components previously discussed in Section 5.1 apply, so they will not be discussed again here. There are however some additional considerations to take into account.

**Level of abstraction**

With low levels of abstraction, expressions depict highly specific emotions, while with high levels of abstraction, the expressions are more open to interpretation and become more sensitive to context. The higher the abstraction level, the more freely players will be able to express themselves. A heart appearing above a character’s head is very likely to be interpreted as love or affection, while the darkening of the environment can be left up to interpretation depending on context; fear, depression, anxiety,... this is also closely tied to usage of metaphors and associations.
Complexity
As the previous sections have made clear, there are many visual properties one can play with in order to achieve representations of an emotion. Another related aspect to consider is the level of complexity of the representation in question. To represent ‘love’ or ‘affection’, a discrete event such as a red heart appearing above a character’s head is much less complex than a continuous visualisation that changes the visual properties of both the player avatar and the environment as well as tweaking player movement. These can both be equally valid representations the same emotional expression (‘affection’), but as mentioned in Section 2.2.1, a low complexity expression could still gain a wide range of possible meanings depending on the context it is used in, and may therefore be the better choice than a more complex expression.

Example design questions:

- Who is the target audience? Can I make assumptions about how the visuals will be interpreted (e.g. usage of certain symbols), or should I stick to utilise validated, general techniques? (e.g. universal colour-emotion pairs)

- Are there specific metaphors or mental associations the expression can be based on visually or gameplay-wise? E.g., do certain colours, shapes, patterns or types of movement characterise this expression? Wavey, slumped, shrinking, slowness, darkness, distortion,...

- How do these elements translate to the game in terms of avatar appearance, player vision, world appearance or player movement (Figure 30)? To which of these can they be mapped sensibly?

- Does the chosen representation correctly represent the expression?

- Does certain research backup the parts in the representation chosen? E.g., colour research, mental associations, metaphor,...

- ...

5.2.3 Giving the player control

The last component is giving the player the means to trigger the available expressions, without breaking gameplay. This is a challenging topic, and is handled more generally in the next section.
5.3 SUITABILITY FOR PLAYER-TO-PLAYER COMMUNICATION

The representations in the examples effectively communicate emotion in a single-player setting, but this doesn’t necessarily mean they will be as effective in a multiplayer setting. The rest of this section highlights several issues that could occur when translating these to the realm of player-to-player communication.

5.3.1 Visibility

From Figure 30, the visualisations readily translatable to a multiplayer setting are Avatar appearance, World appearance, Add artefacts and Avatar movement. Each of these visual changes can be observed by other players directly, such as fiery hair, distorted avatar appearance, distorted environment. The Player vision category however (zoom level or occlusion level of the world) cannot. Examples in this category involved a dynamically changing window (amount of camera occlusion) or varying levels of camera zoom (zoom level). Need this be conveyed to other players, or are the other visual cues enough? World appearance is also a tricky category, since it can become unclear which player is responsible for the visual changes in the world. While these two methods (player vision, world appearance) are strong conveyors of emotion for the player controlling the avatar, if they are to be utilised for communication between players, more thought needs to be spent on how these are shown to the other player(s). This was discussed in Section 5.1.1.

5.3.2 Player-controlled triggers

In examples of Chapter 4, the player had no direct control over any of its character’s expressions, it was entirely programmed into the game rules (‘move this much’, ‘collect this much’ and the emotional state changes). Sometimes this took into account the player’s behaviour, while in others it operated automatically. To give the player control over the expressions for use in player-to-player communication, triggers need to be player-controlled without breaking the gameplay. This is the topic of the current section.

There are several high-level interaction tasks that can be regarded as triggers for executing an expression.
Executing a discrete expression
If the expression is in the form of discrete expressive action events, the player’s task is to activate the desired action at will. Examples could be a display of ‘affection’, ‘surprise’, ‘blushing’, ‘disappointment’, and so on. These displays end shortly after their activation, or they last for as long a certain button is held.

Switching between predefined emotional states
If the expression provided by the game is in the form of continuous visualisation of a particular emotional state, the player’s task can be to oversee that the active state reflects their current emotions. For example, if the game provides different states for ‘angry’, ‘excited’, ‘calm’, ‘sad’ and ‘neutral’, and the player is always in one of these states, the interaction task is to select any one of these states at any given time to activate the desired one.

Regulating an expression
If the game provides the player not only with the ability to select an emotional state or perform an expressive action, but also the ability to set the strength of these expressions, an additional task is to select the desired strength of the emotion display. For example, if ‘anger’ is an emotional state the player can activate, he may also be able to regulate just how angry he feels. For discrete expressions, it may be possible to execute a specific expression with a desired strength. This task involves selecting from a range of discrete choices or a continuum.

Not all interaction tasks need to be present in each game. Once it is chosen which tasks are available to the player, a suitable input scheme can be devised along with the presentation of the available expressions and how they are to be triggered. This presentation includes any visual on-screen elements or explanation of available shortcuts. There are many ways to present the available expressions on-screen, and an exhaustive overview is outside the scope of this text. Examples are skillbars that feature icons for each ‘skill’ (in this case: expression), on-demand menus, or no visual elements at all but instead relying on typed commands (such as /shy, /happy, /surprise), or direct mappings to buttons of the input device(s). Input schemes will depend on this presentation, and the specifics of both is highly dependent on the game in question, the amount of other gameplay actions available to the player, and how those other actions are presented.
5.3.3 Naturalness of use

When putting these expressions under control of the player, it is also important to ask is whether it is natural for the player to control such expressions on a conscious level: “Making the user responsible for handling the normally unconscious actions forces him or her to regularly analyse his or her feelings, which can be experienced as an unnatural task and necessitates a great deal of the user’s attention.” [8]. In contrast, non-verbal communication replicated within games, such as making one’s avatar laugh, dance, or scowl, can feel quite natural due to familiarity with these actions in the real world. Because of the abstract nature of these visual expressions however, there is the possibility that executing them may not feel natural to the player. We don’t put our hair on fire in the real world to show another person we’re passionate, and the world doesn’t turn dark for others when we feel down. These visualisations tend to show a state of mind, the expression of which is not controlled consciously in the real world, unless it is done through explanation using words. Therefore, a key concern is finding out whether players find such abstract ways of expressing emotion natural, for which types of expressions they are best suited, and whether using them is an effective means of communicating those emotions.
5.4 Demonstration of Usage

A specific use case was implemented that demonstrates how the models and techniques could be used in a wider context than the expressions in the studied games. This is a single-player game where the player has no direct control over the expressions. The evaluation will focused on player-to-player communication.

5.4.1 Game-to-player example: Compass

The game Compass was made as an abstract, subjective experience of overcoming fears\footnote{Linsey Raymaekers, Compass: \url{https://linseyray.itch.io/compass}}. The game starts out with the player shrouded in darkness (Figure 35 left). This represents the situation where one is very much restricted in life by their fears. The player then overcomes these fears that alter their experience of the world by approaching specific fear objects spread out in the game (Figure 36a). As the player runs into the fear, the fear is experienced Figure 36b, after which it disappears. The game turns gradually more bright and friendly-looking as the player overcomes more fears, as shown in Figure 35.

![Figure 35.: Visual representation of the process of being less and less gripped by fear in Compass.](image)

The fear object

The fear object in the game relies heavily on visual appearance to convey its unfriendliness. Chaotic animated lines and purple, reddish colours convey a sense of hostility from the object (Figure 36a), something one would normally avoid. The game however revolves around overcoming (beating) the fear, which is done by experiencing it (moving into it). This is not a pleasant experience (as it is not in real life either), represented by the fear taking up the entire screen space with harsh sound effects and animations (Figure 36b).
5.4 Demonstration of Usage

The overall experience of fear in the game (Figure 35) is portrayed through visual representation as well. This is done mostly through alteration of World appearance / Player vision (Section 5.1.1). As mentioned previously, there is a fine line between World appearance and Player vision (camera occlusion in this case), so the darkened world can be categorised as either. When most gripped by fear at the start of the game, the world is barely visible at all, with high levels of occlusion and darkness (Figure 35 left). Additionally, there is a dotted pattern over the whole view to provide more occlusion. As the player gets rid of more and more fears, the darkness fades to the corners of the screen, the dotted pattern disappears, and the actual colours of the world are revealed (Figure 35 middle). Eventually, none of the darkness is left, leaving a bright world (Figure 35 right). At this stage, fears look less scary, and the animation of beating them is very quick and light, as opposed to in the beginning. This whole process is a metaphor representative of fears becoming more easy to face the more one practices it, leaving one less restricted in their lives by said fears.

Figure 36.: Fear in Compass.
IMPLEMENTATION

A top-down 2D test environment was built for the evaluation (Figure 37). In this environment, players control an abstract avatar. The avatar is moved using the WASD or ZQSD keys, depending on the user’s keyboard layout (qwerty vs. azerty). The character can be sped up by holding the Shift key. Users can call up a number of visual cues on their avatar. The visual representation of all cues was deliberately limited to Avatar Appearance, Added Artifacts and Player Movement (Section 5.1.1). Investigating how World Appearance and Camera Attributes can be utilised in player-to-player communication is an interesting research direction, but has not been selected as the point of focus in this work.

Figure 37: Test environment with UI.
6.1 Subsymbolic Cues (States)

The first set of visual cues available to the user are in the form of four continuous emotional states, plus an additional Neutral state. The selection of these states was made using the circumplex model of affect, previously discussed in Section 2.2.3. The states will be referred to through the remainder of the text as Anger, Excitement, Calmness and Sadness, each representing one of the four quadrants of the circumplex model of affect (as shown in Figure 38). These labels are not intended to be the specific emotions that players should interpret the states as, but rather they represent the group of related emotions within each quadrant, of which the labels are seen as a descriptor of that group. The decision to use these labels was made because these states will be mentioned often throughout the remainder of the text, and using names like “quadrant I” or “high-arousal/low-valence”, and so on, can become confusing and lengthy.

![Adapted circumplex model of affect, one label per quadrant](image)

Figure 38.: Adapted circumplex model of affect, one label per quadrant [30].
Figure 39 shows the implemented visual representation of these states. The player can choose to switch between them at any time using a simple state switcher (Figure 40). States are selected by holding the right-mouse button (which shows the state switcher under the mouse cursor) and releasing the right-mouse button while hovering over the desired state.

While there are many visual cues that can be utilised, this evaluation singled out a select few. Each state alters the colour of the avatar, colour of surrounding aura, pulse rate, base movement speed, and (for Anger only) movement behaviour. Other changes to Avatar Appearance such as pattern, shape and opacity (mentioned in Section 5.1.1) are not altered in this implementation. Across these states, arousal is portrayed through speed of movement and pulse rate. The decision to alter pulse rate is based on metaphor, where pulse rate is hoped to be interpreted as heart beat: a high heart beat conveying high arousal, low heart beat conveying low arousal. Valence is portrayed through colour. The representations are as follows:

![Figure 39: Visual representations of the four emotional states.](image)
Figure 40.: The UI element used to switch between states, shown only when left mouse button is held down.

- **Neutral**: White avatar appearance (neutral valence). Normal pulse rate (neutral arousal). Normal movement speed.

- **Angry**: Red avatar appearance. High pulse rate (high arousal). Fast movement speed. Sharp, erratic movement (negative valence comes from the combination of these cues).

- **Excited**: Yellow avatar appearance (positive valence). High pulse rate (high arousal). Fast movement speed. Smooth movement.

- **Calm**: Green avatar appearance (positive valence). Normal pulse rate (low to neutral arousal). Normal movement speed.

- **Sad**: Dark blue avatar appearance (negative valence). Low pulse rate (low arousal). Slow movement speed.

The individual elements of these representations are based on findings in Chapter 3 and mental associations with the desired states. Anger is chaotic, uncontrolled, and often depicted with red (although red can mean passion, in combination with the other cues it is intended to convey anger). Happy/Excitement is a high-energy, bright state, often associated with the sun. Calmness is soothing, controlled and slowly-paced, often associated with nature. Sadness is dark, pressing and low-energy. Some decisions regarding movement characteristics of states were based on Laban Movement Analysis (Section 3.3.3). This specifically includes erratic movement for Anger (‘frequent tempo changes, short stops, high dynamic tension’), higher pulse sizes for Anger and Excited (Anger/Joy: ‘movements reaching out from body centre’), and slower, less flexible movement for Sad (Grief: few tempo changes, low tension movements’). Erratic movement for Anger was also included to achieve ‘sharp’ movement: sharpness in shape is associated with anger (Section 3.3.2), and including erratic movement caused subtle sharp edges in the character’s trail. Sharpness and shape in general can also be incorporated in the visual appearance of the character, but this approach was not chosen here to keep differentiating factors to a minimum.
6.2 SYMBOLIC CUES (SYMBOLS)

The player can also execute several discrete expressions, in the form of Added Attributes. These are based on comic symbols and emoticons as discussed in Section 3.2. The selection of symbols was limited to five and was based on 1) whether they relied on facial expressions or whether they could be conveyed solely through a symbol (this is why a :-) face was not chosen) and 2) predicted frequency of use of the symbol for communicating emotions in a virtual environment. Figure 41 and Figure 42 show the available symbols: QuestionMark (Confusion/Curiosity), ExclamationMark (Attention), Hearts (Affection), Sweat-Drop (Stress), PoppedVeins (GrowingAnger/Frustration). These labels will be used throughout the remainder of the text. The player executes the cues using a skillbar-type UI element that is often seen in video games. The term "skill"bar is used here, because it is usually used to activate skills or abilities in video games. When a discrete expression is executed, the symbol appears around the character for about two seconds, then disappears.

Figure 41.: Available symbolic cues: executed.

Figure 42.: Available symbolic cues: UI icons.
As mentioned in Section 3.2, symbolic cues are more depictive in comparison to subsymbolic cues. They represent emotions more specifically. Context however still relied on to determine the exact meaning of these cues. QuestionMark, for example, can be suitable for both Curiosity and Confusion. Context however can distinguish which emotion is the case. Besides context, the way in which they are combined with emotional state is also predicted to affect their specific interpretations. QuestionMark+Yellow would be closer to Curiosity, whereas Anger+QuestionMark could be Alarmed. This is similar to the way in which body language cues work. Separate cues may mean different things depending on what cluster of body language cues they are used in, as mentioned in Section 2.2.1. It is expected that more complex, nuanced emotional expressions can be built by combining these two types of cues.

6.3 Tools and Iterations

The test environment has had several iterations. The implementation discussed here is what was eventually used in the survey and user test. Note that the UI seen above was hidden in the recordings used in the survey. At one point, multiplayer features and different in-game scenarios were implemented for use in the user test. This was later redesigned however, in favour of a simpler setup that could focus more narrowly on investigating usage of the visual cues in specific expressions (Chapter 8). In the end, participants had the ability record specific expressions that would then be shown to another participant for interpretation, instead of playing together through a fictional scenario. The environment was built in Unity3D / C#\(^1\). The recording of video clips was done from within the program, and implemented using the VideoCapture plugin\(^2\).

\(^1\) Unity3D, Unity Technologies: https://www.unity3d.com/

\(^2\) VideoCapture, RockVR: https://www.assetstore.unity3d.com/en/#!/content/75653
EVALUATION I: PASSIVE RECOGNITION

7.1 METHOD: ONLINE SURVEY

7.1.1 Overview

The first evaluation conducted was an online survey on the passive recognition of several emotions expressed through the cues available in the test environment. The aim was to investigate if certain emotions could be recognised from these cues (both subsymbolic and symbolic). Short video clips of a character moving within the prototype environment were used. In each clip the character was portrayed with a specific set of visual cues to convey a certain emotion or state. There was some context provided, although minimal: the characters move around a large round boulder. This was done to provide a neutral target to which emotions are expressed. To keep the completion of the survey within a reasonable timespan, not all combinations of cues were used. Included are a limited set of colour, pulse rate, symbol and movement cues. Movement cues included movement speed\(^1\) and movement pattern\(^2\). The circumplex model of affect, discussed in Section 2.2.3, was used to inform the nature and structure of questions. The survey was divided into three parts, each investigating a central question. These parts are discussed separately in the remainder of this section. The video clips that were part of the survey are linked to in each part, but snapshots of them are be included for the discussion. Note however that these snapshots lack movement and pulse rate cues, and are therefore not fully representative of the character’s portrayed emotional state.

\(^{1}\) Dependent on the active emotion state and whether or not the character was sped up by holding shift.

\(^{2}\) The overall movement behaviour of the avatar, executed manually during the recording. Examples are curved, chaotic, smooth,...
7.1.2 Participants

LimeSurvey\(^3\) was used to build and host the survey. It was spread through Twitter on the author’s personal game development account, and through Facebook. From a total of 161 respondents, 82 completed the full survey and 79 left partial responses. Only the 82 full responses were included for analysis. The survey was anonymous, but some demographic information was gathered at the end of the survey. Of the 82 respondents included in the analysis, 46 were men, 32 were women, and 4 marked ‘Other’. The most represented age groups were in the ranges of 16–25 (40 respondents) and 26–36 (34 respondents). Others fell in the following ranges: 36–45 (3), 45–55 (4), 56+ (1). Figure 43 and Figure 44 show genre and amount of time spent playing video games.

![Figure 43](https://www.limesurvey.org/)

(a) On average, how often do you play video games in general?

![Figure 44](https://www.limesurvey.org/)

(b) On average, how often do you play online or local multiplayer video games?

Figure 43.: Amount of time respondents spend playing video games (%).

\(^3\) LimeSurvey. [https://www.limesurvey.org/](https://www.limesurvey.org/)
Figure 44.: Game genres played by the respondents (%).
Question: Are the four dominant emotional states of the circumplex model of affect recognizable from colour, pulse rate and movement cues?

Setup: This part consisted of four video clips (one for each quadrant of the circumplex model of affect), each followed by two questions: 1) ‘How happy does this character seem to you?’ and 2) ‘How excited does this character seem to you?’ (see Figure 46 for an example question). These were chosen to correspond to the valence / arousal scales of the circumplex model of affect so they be could mapped onto it easily. Answers fell on a 6-point scale of ‘very unhappy’ to ‘very happy’. The representations of the four states are the same as discussed in detail in Section 6. Figure 45 is included again for reference. In addition, movement in the clips was made to resemble the four states in the following manner: wide energetic movements (Excited, Anger) vs small, careful movements (Sad) vs smooth movement (Calmness). This was regulated only by direction of movement and holding or not holding shift to speed up. Base movement speed was innate to the states as discussed previously. The clips used can be viewed online.

Figure 45: Snapshots of the four questioned states.

Clip1 (Excited): https://www.youtube.com/watch?v=R-o_OsZTUuA
Clip2 (Sad): https://www.youtube.com/watch?v=40YCNB_p0Hs
Clip3 (Angry): https://www.youtube.com/watch?v=E1a91WRRuFs
Clip4 (Calm): https://www.youtube.com/watch?v=Weo2LXx9CsY
Results: The responses were interpreted using the circumplex model of affect in order to verify whether they fell in the expected quadrants. Each individual response was mapped onto the model, where ‘somewhat unhappy’, ‘unhappy’ and ‘very unhappy’ were taken as negative valence (not taking into account intensity), and ‘somewhat happy’, ‘happy’, and ‘very happy’ were taken as positive valence. The same was done for arousal (‘very calm’ to ‘very excited’), and these pairs of positive/negative valence, positive/negative arousal then fell into one of the four quadrants of the model. The result of this interpretation can be seen in Figure 47. Note that ‘Excited’, ‘Calm’, ‘Sad’ and ‘Anger’ are used to point not to a specific emotional state, but rather to the family of related emotional states situated in the quadrants they represent. Anger for example could be interpreted as ‘frustrated’, ‘distressed’, ‘angry’, ‘tense’, and so on, while Excited could be ‘astonished’, ‘happy’, ‘delighted’, and so on.
It can be seen that overall, responses fell in the expected quadrants of the model. The Excited state seems to be the most clear, 84% of responses rating it as such. The others were a bit more divided, but still the majority of responses rated the characters’ state as intended.

For each state, it stands out that responses consistently spanned across two states. The Anger character (red) being interpreted as Excited (valence assigned more positively than intended) may have to do with red being associated with both anger on the one hand, and passion on the other. This results in those who interpret it as passion or love rating it higher on the valence scale. This pushes it into the quadrant of Excited. The Sad character (blue) being interpreted as Calm (positive valence instead of negative) may indicate the colour was not clearly negative. Perhaps the blue used should have been more dark or purplish to convey negative emotion rather than feelings of calmness, as blue can also associated with tranquility. The Calm character (green) being perceived as excited (27%), but the Excited character (yellow) being perceived as calm much less (only 14%), may have to do with the ambiguity of the colour green on the one hand, or with the movement cues of the Green state still being too energetic to be perceived as low arousal. Yellow is quite a happy and energetic colour, and combined with fast movement speed it seems to have been perceived as Calm less. Although green is often associated with nature, it does not have such clear associations with energy levels as yellow. These are only speculations however, and must not be seen as explanations for the different responses. These results will be taken into account during the analysis of the user test in the second part of the evaluation.
Conclusions: These observations support that the four dominant emotional states of the circumplex model of affect (Anger, Excitement, Calmness and Sadness) can be successfully communicated using specific colour, pulse rate and movement cues. Interpretation rate in decreasing order was: Excited (84%), Anger (72%), Sad (70%) and Calm (67%). Remaining responses always piled up in just one of the other states, and some possible explanations were given on why each of these states could have been interpreted as that state instead of the intended one. Some improvements were also mentioned, such as using a darker or purplish blue for the Sad state. An important note is that these results arose from characters in a neutral context. Context is likely to give additional meaning to these states, and may lead to less (or more) ambiguous interpretations.
7.3 PART 2: EMOTIONAL INTENSITY

Question: Are subtle differences in intensity within the above emotional states recognizable from symbols and differences in movement cues?

Setup: This part of the survey consisted of three ranking questions. Each question showed three video clips with characters in a similar emotional state, where each character differed in the intensity of that emotional state (see Figure 48 for an example question). This was done for the states Anger, Excited and Sad. The difference in intensity was conveyed through addition of symbolic cues as well as changes in movement speed and pattern (informed by Laban Movement Analysis (Section 3.3.3). Colour was kept constant across the three clips a ranking. Some clips differed only in symbolic cues, some only in movement cues, and others differed in both. Participants were asked to rank the clips from “most X” to “least X”. The corresponding clips can be viewed online.

Figure 48: Example question from Part 2: gauging emotional intensity

5 Ranking1 (Anger).
Clip1 (most): https://www.youtube.com/watch?v=nhAQHiMSy6k
Clip2 (least): https://www.youtube.com/watch?v=yyTgFsFDCE
Clip3 (middle): https://www.youtube.com/watch?v=7eFD0rXoAm0
Ranking2 (Excitement).
Clip1 (middle): https://www.youtube.com/watch?v=D4aMXiimgbQ
Clip2 (most): https://www.youtube.com/watch?v=laipW1ULtyQ
Clip3 (least): https://www.youtube.com/watch?v=LA2_XRM467A
Ranking3 (Sadness).
Clip1 (most): https://www.youtube.com/watch?v=BhmkP5SG7aQ
Clip2 (middle): https://www.youtube.com/watch?v=jPEIsdKj5nc
Clip3 (least): https://www.youtube.com/watch?v=VySK0myBpiI
An overview of the exact cues used in each clip can be seen in Figure 49. Note that there was no ranking for Calm. This was omitted for two reasons: 1) it was difficult to find clear variations of cues to display different intensities of relaxation, and 2) to keep survey completion time at a minimum, which was important to gather complete responses from those who started filling in the survey.

<table>
<thead>
<tr>
<th></th>
<th>High intensity</th>
<th>Middle intensity</th>
<th>Low intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angry</td>
<td><strong>Clip1</strong>&lt;br&gt;Anger ExclamationMark PoppedVeins pounding</td>
<td><strong>Clip3</strong>&lt;br&gt;Anger PoppedVeins pounding</td>
<td><strong>Clip2</strong>&lt;br&gt;Anger pounding</td>
</tr>
<tr>
<td>Excited</td>
<td><strong>Clip2</strong>&lt;br&gt;Yellow ExclamationMark sped up wide</td>
<td><strong>Clip1</strong>&lt;br&gt;Yellow sped up wide</td>
<td><strong>Clip3</strong>&lt;br&gt;Yellow wide</td>
</tr>
<tr>
<td>Sad</td>
<td><strong>Clip1</strong>&lt;br&gt;Blue careful</td>
<td><strong>Clip2</strong>&lt;br&gt;Blue wide</td>
<td><strong>Clip3</strong>&lt;br&gt;Blue sped up wavy</td>
</tr>
</tbody>
</table>

Figure 49.: Cues present in each clip of the three rankings. ‘Sped up movement’ means that the shift-key was held down to speed up the character.

Results: Figure 50 shows the responses based on their ranking order. They’ve been divided into the categories of ‘Expected order’, ‘One deviation’ and ‘Scrambled’. ‘One deviation’ means two clips were flipped in order. In the case of the expected order of 123, this would mean the respondent ranked the clips as 213, 132, or 321. ‘Scrambled’ means that no clip was in the expected place in the ranking. For each ranking question, the ‘One deviation’ and ‘Scrambled’ responses are shown in detail in Figure 51, Figure 52 and Figure 53. Results are now discussed for each of the rankings, with a focus on anomalies.

![Figure 50: Responses of part 2: emotional intensity.](image-url)
Ranking 1 (Anger, expected order: 132)
The ranking for Anger had most mixed responses. A total of 42% of respondents ordered the clips differently from what was intended. Figure 51 shows a breakdown of those responses. Even among these, the ranking order was very mixed.

Clip 2 (least intensity) was perceived more angry than clip 1 (most intensity) in 14 out of 82 responses, and more angry and clip 3 (middle intensity) in 25. Upon re-examination of the clips, it can be seen that the character in clip 2 is pounding the center boulder more frequently compared to clip 1 and clip 2 (although pounding movement was aimed at in each of the clips). This was unintended, but may have affected some responses since pounding is akin to hitting, a clear association with anger. If this was indeed an influencing factor, it suggests that movement cues (movement pattern in particular) have a very strong influence on interpretation of anger intensity. But this remains a speculation, as it is unclear whether the meanings of symbols had an impact on the ranking.

![Figure 51: Breakdown of the 34 deviating responses for Ranking 1 (Anger).](image)

Ranking 2 (Excitement, expected order: 213)
For ranking 2 there was a lot more consensus among the responses. 79% of respondents ranked clips according to the intended order. Clip 2 (with an added ExclamationMark) was considered the most excited character by all but 7 participants. 10 deviating responses (bottom bar in Figure 52) concerned the positioning of clip 1 and clip 3. These differed only in movement speed. The different interpretations here could point out that the differences in movement cues between clip 1 and clip 3 were too subtle and not noticeable enough. The addition of ExclamationMark seemed to have successfully differentiated it as most excited, although movement cues could also have had an effect. This is not clear from the available data.
Figure 52.: Breakdown of the 17 deviating responses for Ranking2 (Excitement).

**Ranking3 (Sadness, expected order: 123)**
Most consensus was reached over ranking3. The characters in these clips differed only in movement speed and pattern. Deviating responses can be seen in Figure 53. There was some inclination to see a faster moving character (clip3) as more sad than a slower moving character (clip1), which may point out that some of the differences in movement speed were not picked up on, or that interpretations of Sadness may involve higher energy levels as opposed to low energy levels for some.

Figure 53.: Breakdown of the 12 deviating responses for Ranking3 (Sadness).
Conclusions: The majority of respondents could discern different intensities within each of the rankings in the expected orders. Differences in intensity of Sadness were most clearly conveyed (85%), followed closely by Excitement (79%). Rankings of Anger had less consensus, only 58% ordered the clips as intended.

Symbols:
Symbols were used in two clips of the Anger ranking, in one clip of the Excitement ranking, and in none of the clips in the Sadness ranking. Least consensus being reached for Anger, but most for Sadness, seems to suggest the use of symbols was not entirely suited to convey differences in emotion intensity. This is at least the case for Anger. Addition of ExclamationMark did however seem to clearly convey elevated levels of Excitement, but movement cues may have also played a role in that clip. It is speculated that changing the visual appearance of characters would be more suited to convey differences in emotion intensities than the addition of symbols. It is however unclear whether the PoppedVeins symbol was interpreted as Anger (the intention). If this is not the case, that may also explain the deviating responses for the Anger ranking.

Movement cues
Movement cues (both movement speed and pattern) seemed to be a large influencer both of the correct rankings of Sadness and for the deviating responses in the Anger ranking. For Anger, one clip (intended as least Angry, no symbols) with more aggressive pounding movement was consistently ranked higher than the other clips (PoppedVeins, ExclamationMark symbols) among the deviating responses. For Sadness, movement cues were the only deviating factor between clips, and this ranking reached highest consensus. Also in the Excited ranking question, a character with the same visual appearance (yellow) but moving faster and more boldly was generally considered more excited than the same character (yellow) moving at normal speed and less wildly.

This suggests that movement cues could be an addition to user’s self-expression by giving them more detailed control over their movements speed and patterns. Beyond allowing changes in speed, this could involve an option to move erratically, or in a flowing manner. The Anger state for example had a slight ‘erratic movement’ effect to create sharper movements in line with the emotional state. This would likely only be an option for games where slowing or increasing movement speed does not cause imbalances in gameplay.
Cue subtleties

Although movement cues had a large effect on rankings, some issues inherent to the subtleties of movement cues were revealed by looking at the deviating rankings:

- Not all participants may perceive differences in cue intensity (due to their subtle nature).
- Some cues in a cue cluster may stand out more to some users than to others, meaning they have a larger impact on interpretation than the other cues in the cluster. This could be because some cues are not understood (which may be the case for PoppedVeins in the Anger rankings), or because they are simply not picked up on (too subtle).

Failure to recognize differences in movement cues in these clips may thus have been because they were not performed with enough exaggeration for all respondents to adequately perceive differences. Others actors that influence this could be a person’s eyesight, screen resolution and/or quality, attention to detail or others. This may not only concern movement speeds, but could also translate to differences in pulse rates between the different states. This is speculated to be an influencing factor in the interpretation of visual cues in general. Perhaps comparing these results to research on body language cues or other research done on subtle visual cues may reveal similarities (and perhaps also solutions).
7.4 Part 3: Word Associations

7.4.1 Page I: nuanced expressions

Question: Can nuanced emotions like curiosity, confusion, caution,… be distinguished from combinations of symbolic and subsymbolic cues?

Setup: In this part, seven clips were shown. For each clip on this page the respondent received the following instruction: 'Please indicate for the clip below to which extent the presented words describe the character'. The words presented were Cautious, Curious, Confused, Distressed and Frustrated (see Figure 54). The respondent was then asked to answer on a 5-point Likert scale from 'Not at all' to 'Very much'. Also asked for each clip which of the words Angry, Calm, Excited, Fearful or Sad best described the character.

Figure 54.: Example question from Part 3: word associations (I)
Each clip had the intention of conveying a certain subtle emotion, shown in Figure 56 (shown on the next page along with snapshots of each clip in Figure 57). The full clips can be watched online. The different rows in the table represent different groups of clips that were set up for comparison during analysis. Only clips from the same variant group will be compared in detail.

Clips were recorded in an effort to convey that particular emotion. This resulted in a set of variations on usage of states, symbols and movement cues. In each group, there was always a stable factor. This was usage of the Red state for the Anger-variants, usage of QuestionMark in the Question-variants, and usage of ExclamationMark in the Attention-variants. Movement in the clips was performed in such a manner that seemed to best convey the emotion word it was trying to convey. This was informed to some extent by Laban Movement Analysis (Section 3.3.3) and shape features (Section 3.3.2) associated with certain states. Figure 55 shows the specific cues used for movements Aggressive, Careful and Inspective, and the factors that influenced those decisions. These three words will be used throughout the discussion to indicate patterns of movement behaviour in the clips.

<table>
<thead>
<tr>
<th>LMA</th>
<th>shape features</th>
<th>result</th>
</tr>
</thead>
<tbody>
<tr>
<td>aggressive</td>
<td>Anger: frequent tempo change, short stops, movement reaches out from body</td>
<td>Anger: sharpness</td>
</tr>
<tr>
<td>careful</td>
<td>Fear: frequent tempo changes, long stops, movement close to body</td>
<td>Fear: subtle ragged edges</td>
</tr>
<tr>
<td>inspective</td>
<td>Fear/Joy: frequent tempo changes, long stops, movement reaches out from body</td>
<td>Joy: round</td>
</tr>
</tbody>
</table>

Figure 55.: Laban Movement Analysis (LMA) and shape features that influenced movement execution in the video clips.

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6 Clip1: https://www.youtube.com/watch?v=AcTv6CBhM88
Clip2: https://www.youtube.com/watch?v=YiGUXGFUzs
Clip3: https://www.youtube.com/watch?v=oU9pIfp8njo
Clip4: https://www.youtube.com/watch?v=t5e62Qe6DVA
Clip5: https://www.youtube.com/watch?v=Xqz7o5YX5s
Clip6: https://www.youtube.com/watch?v=bLq4iC3PxE
Clip7: https://www.youtube.com/watch?v=Ama3M-aAo70
### Figure 56
Cues present in the clips. The left-hand column shows the variant group as well as the cue types that differed across each clip in the group. Rows above the clips show intended emotion.

<table>
<thead>
<tr>
<th>Anger-variants</th>
<th>Distressed</th>
<th>Cautious</th>
<th>Frustrated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symbol, Movement</td>
<td>Clip1 Anger QuestionMark ExclamationMark Aggressive</td>
<td>Clip2 Anger ExclamationMark Careful</td>
<td>Clip7 Anger QuestionMark Aggressive</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question-variants</th>
<th>Confused</th>
<th>Curious</th>
<th>Frustrated</th>
</tr>
</thead>
<tbody>
<tr>
<td>State, Movement</td>
<td>Clip5 Sad QuestionMark Careful</td>
<td>Clip6 Excited QuestionMark Inspective</td>
<td>Clip7 Anger QuestionMark Aggressive</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Attention-variants</th>
<th>Cautious</th>
<th>Excited/Curious</th>
<th>Cautious/Curious</th>
</tr>
</thead>
<tbody>
<tr>
<td>State, Movement</td>
<td>Clip2 Anger ExclamationMark Careful</td>
<td>Clip3 Excited ExclamationMark Inspective</td>
<td>Clip4 Neutral ExclamationMark Inspective</td>
</tr>
</tbody>
</table>

### Figure 57
Snapshots of the clips, shown in same rows (groups) and order as in Figure 56.
Results: Figure 58 shows the ratings for the words Frustrated, Distressed, Confused, Curious and Cautious. The main goal of analysis of these results is to verify whether the above stated intented emotions within each variant group are reflected in the ratings from the respondents. Note that the data gathered allows for deeper analysis than was possible within the time constraints of this work. Similarly as above, responses were mapped to yes (‘somewhat’, ‘very much’) and no (‘not really’, ‘not at all’) to simplify the analysis.

For the Anger-variants (1-2-7), only symbol usage and movement cues differed. The Anger state was present in all clips. The intentions for these clips were: (1) Distressed, (2) Cautious, (7) Frustrated.

Distressed
Both clip1 and clip7 were rated as Distressed by almost all participants. Clip2 by a bit more than half. While clip1 was intended as Distressed and clip7 as Frustrated, clip7 was perceived as Distressed by slightly more respondents than clip1. This seems to suggest that (within this variant group) the aggressive movements in combination with QuestionMark were clearest markers for Distressed, as they were the differentiating factors with clip2. Combinating QuestionMark+ExclamationMark in clip1 (intended as Distressed) seemed not to increase the association Distressed.

Cautious
Clip2 was most often perceived as Cautious among the three clips. Clip1 was perceived as Cautious by a bit less than half, while clip7 almost not at all. While both clip1 and clip7 were not intended as Cautious and both have aggressive movements (which is in contrast to the behaviour of one who is cautious), the Cautious rating of clip 1 may be explained by the presence of the ExclamationMark in clip1 but not in clip7. These ratings suggest that Careful movement in addition to ExclamationMark were markers for Cautious: clip2 combined the two cues and was rated highest, clip1 only used ExclamationMark, and clip7 had none of these cues present.

Frustrated
Clip7 was most perceived as Frustrated, followed closely by clip1. Clip2 was rated as Frustrated by half of the respondents. The addition of ExclamationMark was the only difference between clip1 and clip7, and seemed to make the character look slightly less Frustrated. This suggests that Aggressive and QuestionMark are markers for Frustrated, as they were the only differentiating cues with clip2.

The Question-variants (5-6-7) differed only in state and movement cues. The QuestionMark was present in all clips. The intentions for the clips where: (5) Confused, (6) Curious, (7) Frustrated.

Confused
All three clips in this group were rated Confused by almost all respondents.
Clip 5 was rated slightly more Confused, followed closely by clip 7 and then clip 6. This suggests the presence of QuestionMark is enough to convey Confused, as interpretations don’t seem to different across different state (Sad, Excited, Anger) and movement cue (Careful, Inspective, Aggressive) combinations. Movement cues and states alone thus don’t seem to be enough to convey Confused.

Curious
For Curious, there was a marked difference between clips. Clip 6 was rated as Curious by 3/4th of respondents, while clip 5 and clip 7 were rated as such by half. There seemed to be more disagreement for clip 5 than clip 7. QuestionMark seems to be interpreted as Curious more strongly in the presence of Excited+Inspective cues, as in clip 6. Sad+Careful (clip 5) seem to be less associated with Curious than Anger+Aggressive. This subtle difference may be due to the low arousal state (Sad) in clip 5 or because clip 5 has much higher associations with Cautious than clip 7.

Frustrated
Clip 7 was strongly associated with Frustrated. Clip 6 almost not at all, and clip 5 only slightly. This affirms that Aggressive+QuestionMark seem to be good markers for Frustrated, as noted above for the Anger-variants. Additionally, in this group the Anger state is present only in clip 7. This suggests the Anger state is a good marker for Frustrated.

The Attention-variants (2-3-4) clips, like the Question-variants, differed only in state and movement cues. ExclamationMark was present in all clips. Intentions were (2) Cautious, (3) Excited/Curious and (4) Cautious/Curious.

Cautious
Clip 2 was associated with Cautious by nearly 3/4th of respondents, followed closely by clip 4. Clip 3 was rated Cautious by only half of the respondents. This suggests that positive valenced states (here: Excited) are less associated with Cautious than negative valence (Anger) and Neutral. Neutral state (clip 4) did not decrease associations with Cautious (compared to Anger in clip 2). Here it is again suggests that Careful movement and ExclamationMark is associated with Cautious.

Curious
Clip 3 (intention Curious) was rated Curious by nearly all respondents. Clip 4 followed closely, rated as such by 3/4th of respondents. Clip 2 was not seen as very Curious; only half of respondents associated it with Curious. The latter again suggests that negatively valenced states (here: Anger in clip 2, above: Sad in clip 5) decrease associations with Curiosity, as does Careful movement. This again suggested by the Excited state (clip 3) being associations with Curiosity slightly more so the Neutral state (clip 4).
Figure 58.: Ratings of the seven clips (X-axis) for specific emotion words (stacked on Y-axis). Exact numbers were left out for clarity. Horizontal slices (such as the Frustrated row) range from 0%-100% top-to-bottom, the bold dashed line in the middle representing the 50% mark, and the less bold dashed lines representing 25% and 75%. Responses marked (-) are the *undecided* responses.
For each of the clips, respondents were also asked to indicate which of the states Excited, Calm, Sad, Angry and Fearful most suited the clips. Figure 59 shows the results. Fearful was included in addition to the four implemented states for two reason: 1) some of these nuanced expressions were believed to be more akin to a Fearful state than to the four implemented states (such as Cautious), but it was not certain whether the implemented cues would be able to convey Fear, and 2) as a result, it could be observed whether a combination of cues not specifically designed with the intention to convey Fear could be combined to express it. If this is the case, it could be a representative of the versatility of cue usage.

There is some indication that respondents’ state associations matched the intended nuanced emotions. Clip1 (Distressed) was associated with Fearful by about half of the respondents, and around 1/4th associated it Excited and Angry. Clip2 (Cautious) was also rated as Fearful by around half of the respondents, but the rest was more divided across Excited, Calm and Anger. Clip3 (Excited/Curious) was divided among Excited and Calm with more inclination toward Excited, which may be due to the Excited state being interpreted as Calm sometimes, also observed in Section 7.2. Clip4 (Cautious/Curious) was identical to clip3 except for the difference in state (here: Neutral), and was notably perceived as Calm (%54) more often than Excited (%19). Clip5 (Confused) came across as Sad and Fearful most often, but also to a notable amount as Calm. Clip6 (Curious) was seen equally as Excited or Calm. Clip7 (Frustrated) was associated with Anger by a bit over half of respondents, the rest labelling it Fearful and Excited equally. For each of these clips, the states associated with them by respondents are in the majority of cases tightly linked to the emotion words they intended to convey. Most notable examples are clip7 (Frustrated) being perceived as Anger, clip1 (Distressed) and clip2 (Cautious) as Fearful, clip3 (Curious) and clip6 (Excited/Curious) as Excited/Calm. This gives further indication that combinations of cues can convey nuances in emotion. Also of note is that Distressed and Cautious were highly associated with Fear. This shows that although the implemented cues were not designed with the expression of Fear in mind, they were still capable of expressing it.

Comparing clip3 (Excited/Curious) and clip4 (Cautious/Curious), clip4 was associated much more with Calm than with Excited, whereas clip4 did seem to convey Excitement to just over half of the participants. All cues but state usage (Excited in clip3, Neutral in clip4) were the same. Clip3 was also seen as Cautious by slightly less respondents than clip4.

---

7 None of the implemented cues were designed to convey Fear.
More analysis can be done here by comparing which cues were most recurring in the clips where a certain word was rated high, but this fell outside of the time constraints for this analysis.

**Conclusions:** Some success was found in conveying and distinguishing nuanced emotions through certain combinations of abstract visual cues. These were Frustrated, Distressed, Confused, Curious, and Cautious. Figure 60 shows the percentage of respondents that associated clips with their intended emotion association (see Figure 58 for detailed association rates). Most successfully conveyed (92% association rate) was Confused (Sad+QuestionMark+Careful). This is followed by Distressed, Curious and Frustrated, all hovering around 80% association rates. Somewhat more mixed results were found for associations with Cautious, none of the clips scoring higher than 71% association rates. One clip (clip4) aimed to convey a Cautious/Excited state, which was somewhat picked up on with association rates of 67%/71%.

Figure 60.: Association of the clips with their intended emotion. Clip4 is split up to show Cautious/Curious values.
Association cues:
Some support was found for specific cues that clearly either increased or decreased respondents’ associations with the emotion words. Association increasing cues found were:

- **Frustrated**: Anger, Aggressive, QuestionMark
- **Distressed**: Aggressive, QuestionMark
- **Confused**: QuestionMark
- **Curious**: QuestionMark (but only in combination with positively valenced states), Inspective
- **Cautious**: Careful, ExclamationMark

Association decreasing cues found were:

- **Frustrated**: ExclamationMark
- **Curious**: Careful, negatively valenced states (Anger, Sad)
- **Cautious**: Aggressive, positively valenced states

Movement cues
Like in Section 7.3, movement cues were found to be a large influencing factor on interpretations (Careful, Aggressive, Inspective). They also seemed to have a large effect on conveying nuanced expressions, as movement was found to be an influencing factor (increasing or decreasing) in many cases.

Symbol usage
While symbol usage was not as effective in conveying emotion intensities, it seems to be well suited for conveying nuanced expressions (in combination with other cues).

Cue versatility
Although cues were not designed with the expression of Fear in mind, they were still able to express it. Several emotion words which could have relations to Fear (depending on context) where associated with Fearful: Distressed (52%), Cautious (44%), Confused (33%) and Frustrated (23%).

Limitations: Respondents were presented with certain words and did not give free description. This was to force respondents to think about the characters in terms of specific emotions. It is not certain whether these emotion words would be attributed to the characters if free descriptions were allowed. The intention here was instead to tap into the subconscious levels of interpretation—it is not certain how much, in a real scenario, these associations would be recognized by other users. It is speculated however that these interpretations would indeed occur on a subconscious level. Additionally, only clips from certain variant groups were compared, a deeper analysis of the results where each clip is compared per emotion word might add more to these findings.
7.4.2 Page II: degrees of affection

**Question:** Can combinations of symbolic and subsymbolic cues convey differences between affection and passion?

**Setup:** The next page showed two clips. The main intention to find out whether a difference in colour (Neutral vs Red) would affect associations with Affection, Passion and Flirtatious. The question accompanying the two clips was the same as on the previous page, but the words presented were Affectionate, Flirtatious and Passionate (see Figure 62). Figure 61 shows snapshot of the two clips used. They can be viewed online. In the clip for Passion, the Anger state was slightly adapted to better fit a representation of passion: pulse rate was lowered and erratic movement disabled.

![Snapshots of the clips from word association page II.](image1)

**Figure 61.: Snapshots of the clips from word association page II.**

![Example question from Part 3: word associations II](image2)

**Figure 62.: Example question from Part 3: word associations II**

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8 Clip1 (Passionate): [https://www.youtube.com/watch?v=vmU1F8V8L2c](https://www.youtube.com/watch?v=vmU1F8V8L2c)
Clip2 (Affectionate): [https://www.youtube.com/watch?v=is7MYPI1eB4](https://www.youtube.com/watch?v=is7MYPI1eB4)
**Results**: Responses were mapped to ‘yes’, ‘no’ and ‘undecided’ values as previously. Figure 63 shows the responses. The first observation is that in general, both clips were perceived overall as being romantic/showing affection. This is probably attributed to the presence of hearts, which are often associated with affection or likability—be it in a romantic context or otherwise. Noticeable is that clip1 (Passion) was indeed perceived more often as flirtatious (+13%) and more passionate (+16%) than clip2 (Affection). Clip2 (Affection) on the other hand was associated with Passion by 63% of respondents. There is then some indication that the colour Red has had a minor influence on associations with Passion, Flirtatious and Affection. Especially when viewed in terms of self-expression in a multiplayer setting, where players can affect their appearance to convey emotion, these two clips may be suitable to show different intensities of affection that are open to interpretation and sensitive to context.

![Figure 63: Results from Part 3: word associations (page two).](image)

**Conclusions**: There was a slight indication that Passion, Flirtatious. Could be differentiated solely by combining Hearts with Neutral or Red. Both were seen as Affection by an equal number of respondents. This may be because Passion assumes the presence of Affection. Results do suggest however that the absence or presence of Red (in combination with Hearts), may be used to control the intensity of affection expression (such as ‘like’, ‘affection’, ‘passion’,...). In **Section 7.3** it was speculated that changing visual appearances instead of addition of symbols may be more suited to convey differences in emotion intensity. While these results are not enough to support that, it does seem to hint towards it.
7.5 Conclusions

Results and conclusions were discussed throughout this chapter. This section gives a brief summary.

Sufficient evidence was found in part 1 of the survey (Section 7.2) that the valence / arousal characteristics of the four implemented emotional states can be communicated using colour, pulse rate and movement cues. Some ambiguities in the interpretations were picked up however, and results for each states tended to be split across the intended state and one other.

Symbols were not so effective in conveying different intensities of emotion in part 2 of the survey (Section 7.3), while movement cues were observed to have a large effect. Movement cues seem therefore more suited to convey emotional intensities than symbols. The same is speculated for other visual changes to avatar appearance (such as changing colours, intensity of colour,...). Some observations hinted that visual cues (in this case, movement cues), especially when they are subtle, may not be picked up by all observants. This may cause differences in interpretations.

Symbols, in combination with movement cues and states, were found well suited to convey nuanced expressions in part 3 of the survey Section 7.4.1. All of the clips were highly associated with their intended emotion words by the respondents, some more so than others. Several association increasing and decreasing cues were found for these emotion words, but further analysis of the available data would be needed for a more complete overview. Among these association increasing and decreasing factors was a strong presence of symbols and movement cues. The effects of states was usually attributed to whether they were positively or negatively valenced.

The implemented cues were able to convey Fear without being designed with the expression of Fear in mind. This shows that cue combinations can have versatile usage.

There was only a slight indication in part 3 of the survey (Section 7.4.2) that differences between Passion and Flirtatious could be conveyed through colour changes to the avatar in combination with Hearts symbols. Results did seem to support the speculation in part 2, that colour changes may be well suited to convey intensities of emotion.
7.6 LIMITATIONS

Because the timespan of the survey was restricted to increase likelihood of participation, not all implemented cues could be included. This shows in that some parts of the survey may seem as only partial comparisons or explorations. For example, in Section 7.3, the intensity rankings did not involve the Calm state. However, this decision was partly made because it was felt that different intensities of Calmness were hard to convey with the implemented cues (which, when looking to keep questions to a minimum, seemed like a reasonable question to omit). In Section 7.4 as well, the Calm state was not present in the group variants. This was partly because the words investigated seemed to have no clear association with Calm. should have been taken to investigate whether respondents also thought so. More care should have been taken to structure the survey in such a manner that more complete explorations could have been made, such as omitting Page II of Section 7.4 (degrees of affection). It is however not believed that this nullifies the results, but more complete results could have been gathered if more care had been taken in this regard.
EVALUATION II: ACTIVE EXPRESSION

8.1 METHOD: USER TEST

The survey focused on aspects of passive recognition of a variety of abstract visual cues. In the user test part of the evaluation, focus is directed at 1) how users choose to actively express a set of given emotion words in a neutral test environment with the cues from the test environment, and 2) whether a second user viewing these expressions interprets them as intended. The user test is carried out in the same test environment in which the survey videos were recorded, although subtle ambient effects and the large center boulder were removed. Figure 64 shows the test environment with UI included. The cues made available to the participants are the same as discussed in Chapter 6: four states that can be activated through a state switcher, and five discrete symbols activated by pressing an icon on a skillbar. Participants were not told what these states or symbols meant—they had to interpret and use them on their own.

Figure 64.: The user test environment: exploration phase. A user in the Excited state about to switch to Anger.
8.1.1 Overview

The user test consisted of 30-minute sessions where two participants sat across from each other, each with a laptop and paper handouts (Figure 65). A session was made up of three parts: 1) instructions to express certain emotions which were recorded within the program (Section 8.2), 2) questions about their experience with building these expressions (Section 8.3), and 3) questions about their interpretation of the other participant’s expressions (Section 8.4). The handouts reflected these three parts, and served both as a guide instructing the participant what to do and as a questionnaire to collect data. Appendix A contains all five pages of the handouts that were given to participants.

Figure 65.: A session in progress. Image used with permission.

During each session, the two participants were divided across groups A and B. These groups differed only in the instructions given in part 1 (emotion to express). This way they did not know what expressions the other participant was asked to execute during their interpretations in part 3. Besides the instructions, the setup and survey questions were identical for both groups. Before beginning with part 1, participants were asked to explore the test environment in terms of controls and the available actions. This involved movement, usage of the state switcher and symbols. After several minutes of exploration, participants were asked to follow the instructions on the paper handouts until part 3, for which they would switch laptops to interpret each other’s expressions. Note again that in certain parts the data gathered allows for deeper analysis than was possible within the time constraints of this work. The data gathered here was also more complex than that of the survey, in that results (formed expressions, descriptions) were less predictable. Due to this, its analysis is also more voluminous. This is reflected in the structure of this chapter: discussion is more spread out across sections. Observations from throughout the user test are sometimes referenced across parts to help understand certain other observations.
8.1.2 Participants

There were a total of 14 participants involved in the user test. Care was taken that respondents who had filled out the survey would not participate in the user test. This was done to avoid the survey having influenced participants in their usage and interpretations of cues.

Participants fell in the age ranges of 18—25 (8), 26—35 (5) and 36—4 (1). There were 8 men and 6 women. Participants reported playing video games often (4), sometimes (8) and rarely (2). Online video games were played often (3), sometimes (4) and rarely (7). The backgrounds of participants was spread over HCI researchers, computer science students and several outside of these fields.

Due to the small number of participants in the user test (14) in comparison to the survey (82), graphs in this chapter are not shown in percentages but rather in the number of participants.
8.2 Part 1: Expression Execution

Question: How do participants build expressions for a set of emotions given the cues in the test environment from Chapter 6?

To this end, participants were asked to form expressions for three different emotion words and to execute them toward specific neutral characters in the environment. Each group had a different set of words and target character (see Figure 3). The instructions were phrased as follows: "You are excited toward character 2". Note that instructions did not specify the intensity of the emotion.

<table>
<thead>
<tr>
<th>Group</th>
<th>Expression 1 (target)</th>
<th>Expression 2 (target)</th>
<th>Expression 3 (target)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>Excited (2)</td>
<td>Sad (5)</td>
<td>Affectionate (9)</td>
</tr>
<tr>
<td>Group B</td>
<td>Angry (3)</td>
<td>Curious (5)</td>
<td>Cautious (7)</td>
</tr>
</tbody>
</table>

Table 3.: Expressions the participants were asked to form.

The expressions were limited to 3 per participant in order to keep session time within a reasonable limit while still including a questionnaire. By dividing participants over group A and B and giving them different expressions, the number of total expressions that could be investigated was increased to 6. This also enabled the opportunity to have participants in the same session interpret each other’s expressions, because they were given different sets. For selection of these instructions, three states (Angry, Excited, Sad) and three more nuanced expressions (Curious, Cautious, Affectionate) were chosen. Curious and Cautious were selected somewhat at random from Part 3: word associations: I (Section 7.4). Cautious specifically is a very nuanced emotion from the list used there (Frustrated, Distressed, Confused, Curious, Cautious), and it is hoped the user test will show whether this can be communicated successfully using the available cues without providing the word Cautious itself (this was the case in the survey, as respondents had to rate "how cautious" a character was). Affectionate was chosen because Passion and Affection were well recognized in Part 3: word associations: II, and the intention is to compare the participants’ expressions with the expressions used in the survey, as well as the participants’ recognition rates for those expressions. The Calm state was not included in the instructions so that one more nuanced expression could be chosen (instead of just two, if all four states were included). In this manner, observations could also be made on whether there would be overlapping cues (especially states, such as Red for both Angry and Affectionate) for the different expressions. This also explains the way expressions were divided across the two groups: to investigate whether the pairs of Excited/Curious, Sad/Cautious, Affectionate/Angry will have cue overlap.
Note that, in contrast to the survey discussion, states in this chapter will be referred to by their colour (Red, Yellow, Green, Blue) instead of their design intentions (Anger, Excited, Sad and Calm). This is to avoid confusion with the instructions of Angry, Excited and Sad.

Participants were free to take their time to find the combination of cues they would use to express these emotions during the exploration phase. Once the participants felt confident with their expressions, they started the recording after which 10 characters became visible. These characters were placed in a row from left to right and numbered 1 to 10 in order (Figure 66). When they had executed their three expressions toward the target characters, they stopped the recording and began the questionnaire in part 2. This recording was then viewed by the other participant in the session once both participants reached part 3 on their handouts.

![Figure 66: The first 5 target characters in a recording in progress. The character in the center is the user.](image)

8.2.1 Expressions

Figure 67 shows the cues each individual participant used to build their expressions. These were obtained by viewing the videos they recorded. Figure 68 shows an overview of cues used per instruction. Angry (group A), Affectionate (group B) and Sad (group A) had most reliable usage of specific states. In contrast to state usage, symbol usage seemed more specific. This was especially the case for ExclamationMark, SweatDrop, Hearts and QuestionMark. None of the participants combined multiple symbols in one expression. Some used movement cues\(^1\). More discussion about cue combinations follows later in this section. First, general state and symbol usage is discussed for each instruction.

\(^1\) Only included when notably different movement was observed across their expressions.
<table>
<thead>
<tr>
<th>Group A</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Excited</td>
<td>Sad</td>
<td>Affectionate</td>
</tr>
<tr>
<td>Session1</td>
<td>Yellow</td>
<td>Blue</td>
<td>Red</td>
</tr>
<tr>
<td></td>
<td>Back &amp; forth movement</td>
<td>SweatDrop</td>
<td>Hearts</td>
</tr>
<tr>
<td>Session2</td>
<td>Red</td>
<td>Blue</td>
<td>Red</td>
</tr>
<tr>
<td></td>
<td>ExclamationMark</td>
<td>SweatDrop</td>
<td>Hearts</td>
</tr>
<tr>
<td>Session3</td>
<td>Green</td>
<td>Neutral</td>
<td>Neutral</td>
</tr>
<tr>
<td></td>
<td>ExclamationMark</td>
<td>SweatDrop</td>
<td>Hearts</td>
</tr>
<tr>
<td>Session4</td>
<td>Red</td>
<td>Blue</td>
<td>Neutral</td>
</tr>
<tr>
<td></td>
<td>ExclamationMark</td>
<td>-</td>
<td>Hearts</td>
</tr>
<tr>
<td>Session5</td>
<td>Neutral</td>
<td>Green</td>
<td>Red</td>
</tr>
<tr>
<td></td>
<td>ExclamationMark</td>
<td>SweatDrop</td>
<td>Hearts</td>
</tr>
<tr>
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<td>Red</td>
</tr>
<tr>
<td></td>
<td>ExclamationMark</td>
<td>Hearts</td>
<td>Hearts</td>
</tr>
<tr>
<td></td>
<td>Back &amp; forth movement</td>
<td></td>
<td>Circling</td>
</tr>
<tr>
<td>Session7</td>
<td>Yellow</td>
<td>Blue</td>
<td>Red</td>
</tr>
<tr>
<td></td>
<td>ExclamationMark</td>
<td>SweatDrop</td>
<td>Hearts</td>
</tr>
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<td>Slow approach</td>
<td>Very slow approach</td>
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<td>Cautious</td>
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<td>Green</td>
</tr>
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<td>ExclamationMark</td>
</tr>
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<td>Neutral</td>
<td>Neutral</td>
</tr>
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<td>QuestionMark</td>
<td>SweatDrop</td>
</tr>
<tr>
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<td>Blue</td>
</tr>
<tr>
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<td>QuestionMark</td>
<td>ExclamationMark</td>
</tr>
<tr>
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<td>Red</td>
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<td>Blue</td>
</tr>
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<td></td>
<td>PoppedVeins</td>
<td>QuestionMark</td>
<td>QuestionMark</td>
</tr>
<tr>
<td></td>
<td>Pounding</td>
<td>Circling</td>
<td>Careful circling</td>
</tr>
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<td>Session5</td>
<td>Red</td>
<td>Green</td>
<td>Yellow</td>
</tr>
<tr>
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<td>QuestionMark</td>
<td>QuestionMark</td>
</tr>
<tr>
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<td>Yellow</td>
<td>Yellow</td>
</tr>
<tr>
<td></td>
<td>ExclamationMark</td>
<td>QuestionMark</td>
<td>PoppedVeins</td>
</tr>
<tr>
<td>Session7</td>
<td>Red</td>
<td>Yellow</td>
<td>Blue</td>
</tr>
<tr>
<td></td>
<td>ExclamationMark</td>
<td>QuestionMark</td>
<td>SweatDrop</td>
</tr>
</tbody>
</table>

Figure 67.: Cues used by group A (above) and B (below) to form their expressions. Each expression includes State, Symbol and Movement cue usage.
Expression 1A: Excited

All but two participants used a high arousal state for the Excited expression. 3 participants used Yellow, all three of them describing this state as “happy” in the questionnaire. 2 participants used Red however (for which the design intention was Anger), describing the Yellow state as “scared” and “friendship”. One of them described the Red state explicitly as “excitement”. Since Red is another high-arousal state (high pulse rate, fast movement), usage of this state for Excited is not entirely unexpected, especially since the survey found that 28% of respondents interpreted the Angry state as high arousal, but positive valence. One participant used the Neutral state, in combination with ExclamationMark. This participant described Yellow as ”anger” and ExclamationMark as ”excited”, which explains their choice of cues used. One participant used Green for Excited, describing the Yellow state as ”zen” and the Green state as ”positive”. It is to be speculated what caused this interpretation. Did this participant notice the difference in pulse rate between the two states (high for Yellow and low for Green)? Or was colour the deciding factor in their choice? There could have been further insight if the questionnaire had asked ’Did you notice the different states had different pulse rate and pulse size’, but it was not part of the question set. This was overlooked while composing the questions. What this does suggest however (which was also observed in the survey) is that interpretations of a cluster of cues can differ among users, whether due to not noticing certain cues in the cluster (here: perhaps pulse rate or movement speed differences), or due to different associations with individual cues (here: likely colour, but this could be the case for other cues as well).
ExclamationMark was used for Excited by all participants but one. This participant used only the Yellow state to convey Excited. Perhaps the state on its own was found to convey Excited clearly enough without the need for a symbol.

Movement was utilised by 3 participants to express Excited. Two of them used a “back & forth” movement style, which entailed moving left-to-right in front of the target character. The other participant slowly approached the target character while executing the ExclamationMark several times.

**Expression 2A: Sad**
For Sad, results show semi-consistent usage of the Blue state. 4 out of 7 participants used Blue to convey Sad. The 3 other participants did however describe the state as “sad” in the questionnaire. 2 out of these 3 used SweatDrop in their Sad expression however (Neutral+SweatDrop and Green+SweatDrop) and both described SweatDrop as “tears”. This may suggest these two participants felt combining Blue+SweatDrop was too negative to mean sadness (and would perhaps rather mean “depressed”). Moreover, the participant using Green+SweatDrop described Green as “sad” (as well as Blue)–and the survey found that 27% of respondents associated the Green state with Sad. The last of these three participants who did not use SweatDrop used Red+Hearts, describing Red as “angry” and Hearts as “love”. There is reason to believe this participant accidentally performed the Affectionate instruction twice.

SweatDrop was used for Sad by 5 out of 7 participants. One participant used Hearts; this case was discussed above. The last participant used no symbol, but did choose Blue to express Sad: this participant likely felt Blue was enough to convey Sad. The case of SweatDrop being interpreted as “tears” (instead of “stress”) is discussed in Section 8.2.2.

One participant used movement in their expression of Sad, in combination with Blue+SweatDrop. This participant very slowly approached the target character while executing the SweatDrop multiple times.

**Expression 3A: Affectionate**
For Affectionate, all participants used Hearts for their Affectionate expression. 2 participants used it with the Neutral state, the remaining 5 opting for the Red state even though the design intention for Red was Anger (high pulse rate, large pulse size and erratic and shaky movement). This intention seems to have been picked up on by some of these participants despite using the state for Affectionate: in the questionnaire, 3 participants out of the 5 who used Red for Affectionate described the state as “anger” (the other two as “love”). One of these participants noted that “the red state was too active for Affectionate, pink would have been a better fit”. One participant who used Red+Hearts for Affectionate and described the Red state as “love” noted during interpretation
of group B’s Anger expression (Red+ExclamationMark) that “Red needs !!! to mean anger, or it could also mean love”.

In the survey, both Neutral+Hearts as well as Red+Hearts were rated highly and equally on affection, while Red+Hearts was rated slightly more often as passionate and flirtatious than Neutral+Hearts. All participants here used either one of these to represent Affectionate. This supports that affection is well represented by Hearts in combination with either Red or Neutral states. The suggestion was made in the survey that addition of Red with Hearts (as opposed to Neutral) could increase intensity of affection (to for example mean passion). Data collected here does not dispute nor support this: the intensity of emotion was not present in the instruction, and different participants may associate different contexts or intensities with the word Affectionate (such as affection directed at a child, a friend, a lover).

Two participants used movement in their Affectionate expression. Both made close contact with the target character, one did this by circling closely around the character, the other remained relatively still. These movements seem to be akin to hugging, which can be an expression of affection.

**Expression 1B: Angry**

Anger was portrayed using the Red state by all participants but one, who used Neutral+PoppedVeins. This participant described both the Red state and PoppedVeins symbol as “anger” in the questionnaire. It’s possible he found the PoppedVeins symbol portraying anger with enough intensity without feeling the need to combine the cue with the Red state. However, when asked how he felt using the state switcher, he marked “not really” and noted that he “didn’t think of combining states with icons”.

Mixed usage was observed of the ExclamationMark and PoppedVeins symbol. 4 participants used the ExclamationMark, while only 3 used the PoppedVeins symbol (for which the design intention was growing anger/frustration). All 3 participants who used the PoppedVeins symbol for Anger also described it as “anger” in the questionnaire, while only 1 of the 4 participants who used ExclamationMark described the PoppedVeins symbol as “anger” (the others described it as “targeted”, “confused”, or left no answer). Additionally, only 1 of the 7 group A participants described the PoppedVeins symbol as “anger” in part 2. This makes a total of 5 out of 14 interpreting the symbol as intended. This clearly shows that the PoppedVeins symbol was not clearly representing Anger/Frustration. The 4 correct interpretations within group B may have been influenced by them having the instruction “Angry”, while group A participants didn’t.

Two participants displayed a Pounding movement toward the target character. This is akin to hitting, which can be an expression of Anger.
None of the participants used Excited to convey Anger, while the survey found that 28% of participants interpreted the Anger state as high arousal, positively valenced (Excited). Since the Yellow state was not used for Anger in any of the Angry expressions, there is added support that the Anger state is successful in displaying high arousal, negative valence. Two participants used Red for the Excited instruction, which may indicate that the word “Excited” does not necessarily entail negative valence for those participants.

Expression 2B: Curious
Out of all expressions, Curious had the least amount of state usage. All but one participant used the QuestionMark symbol to convey Curious; the remaining participant opted for ExclamationMark, but noted that “QuestionMark suits both Curiosity/Cautious, I would have liked another icon to distinguish them”. 3 participants chose Neutral+QuestionMark, the remaining participants were split across Yellow and Green (ExclamationMark being used with Green). It’s speculated whether, by those who used Neutral, the QuestionMark was found clear enough without needing an additional state. Curious seems to be expressed as positively valenced: the only participants who used a state chose a positive valence state (twice Green, twice Yellow).

One participant used movement to convey Curious, and displayed a circling behaviour around the character while executing the QuestionMark. This is akin to “inspection” behaviour.

In the survey, association increasing factors found for Curiosity were QuestionMark in combination with positive valence states, and the Inspective movement behaviour. Decreasing association factors were Careful movement and negative valence states. The observations here support these findings.

Expression 3B: Cautious
Blue was used most often to convey Cautious (3 times), followed by Yellow (2) and Green (1). Symbol usage was most mixed for Cautious. Participants used all the symbols but Hearts: QuestionMark (2), ExclamationMark (2), SweatDrop (2) and PoppedVeins (1). Two participants noted specifically in the questionnaire that they could not find cues to display Cautious. These observations seem to suggest Cautious was most difficult to convey with the available cues. One participant did use CarefulCircling behaviour to convey Cautious, which meant the participant moved very slowly (nervously) around the target character at a distance.

The survey found that association increasing cues for Cautious were Careful movement and ExclamationMark (used here twice), and association decreasing cues Aggressive movement and positively valenced states. From the participants here that used Yellow (2) and Green (1) for Cautious, one described Green as “jealous” (negative valence) and the others described Yellow as “doubt” (negative valence) and “bright” (positive valence). This leaves only one participant
who used a positively valenced state for Cautious. Combined observations then support the findings from the survey.

8.2.2  Cue usage

State usage

**Red** was used 14 times in total: Angry (6), Affectionate (5) and Excited (2). Apart from its frequent usage in the Affectionate expression (which is likely due to red’s association with love), Red was only used for high-arousal states. This mirrors the results of the survey in Section 7.2: the Anger state was perceived there by the majority (72% of participants) as Anger, and by a smaller group (28%) as Excited. The Red state is thus highly effective at conveying high arousal, and (when not in combination with Hearts) convey negative valence to the majority of people.

**Yellow** was used 7 times, and only for Excited (3), Curious (2) and Cautious (2). Yellow’s use for Excitement is in line with part 1 of the survey (84% rated the Excited state as such). Its usage in the Curious expressions (2) seems to support earlier observations in the survey (Section 7.4.1), where it was suggested that Excited is an increasing factor for associations with Curiosity when combined with QuestionMark (as is the case here). Usage of Yellow in Cautious expressions (2) is not wholly unexpected, here used as Yellow+QuestionMark (Yellow described as “unsure”, QuestionMark as “doubt”) and Yellow+PoppedVeins (participants did not know what PoppedVeins meant). In the survey, clips 3 and 6 that used the Excited state with either QuestionMark or ExclamationMark were rated by half of respondents as Cautious.

**Blue** was used 7 times and had the most specific usage. It was used only for Sad (4) and Cautious (3). These are both negative valence and low arousal states (the exact arousal of Cautious could be context-sensitive however). In the survey, clip 5 (Blue+QuestionMark) was the only clip using the Sad state, and was rated as Cautious most out of all clips. Here, usage for Cautious was Blue with QuestionMark, ExclamationMark or SweatDrop. This seems to indicate that Sad is an increasing factor for associations with Cautious, which could not be concluded from the survey results alone. The Blue state then seems very clear in conveying negative valence, low arousal.

**Green** had the least usage. It was used 5 times in a total of 42 expressions, and also most sporadically: Curious (2), Excited (1), Sad (1), Cautious (1). This does not give clear indicators to its usage, in part because it was not included in part 2 of the survey in the investigation of nuanced expressions (Section 7.4.1). It can only be speculated if it would have been used more should a Relaxed, Calm, or other low arousal, positive valence instructions have been given.
Symbol usage

**QuestionMark** had quite specific usage, and was used in 2 instructions: for Curious (6) and Cautious (2). It was also found in the survey to be an association increasing factor for Curiosity when combined with positive valence states, which these observations supports, and association increasing for Frustrated, Distressed and Confused—results not supported or disputed here. Since Cautious can be said to have an element of confusion in it, perhaps usage of the QuestionMark for Cautious supports its positive association with Confusion to an extent. QuestionMark thus seems to flexibly indicate a questioning attention-directing behaviour, both in positive and negative valenced emotions.

**ExclamationMark** was used most flexibly, appearing in 4 out of 6 of the instructions: Excited (6), Angry (4), Curious (1), Cautious (2). It then seems most used to indicate high arousal (Excited, Angry) on the one hand, and also to direct attention to something (Curious, Cautious). ExclamationMark was found to be an association increasing cue for Cautious in the survey.

**Hearts** had most specific usage: it was used in 1 instruction: Affectionate (7), though it did appear once in another expression. This was by the participant who likely has used Red+Hearts for their Sad expression accidentally (because Affectionate was the next instruction, where this participants used the same cues)

**SweatDrop** was used in 2 instructions: Sad (4) and Cautious (3). SweatDrop was largely interpreted as “tears” instead of “stress”: Only one of the 5 participants using SweatDrop did not describe the SweatDrop as “tears” in the questionnaire (but as ”sweaty”). It seems the icon design does not reflect that of sweat drops well enough to be interpreted as such, even though the drop appeared on the side of the head. Using several smaller drops in that same location may prevent misinterpretation. Another reason this icon may have been interpreted as tears is the absence of eyes and mouth, which makes it less clear where exactly the drop is positioned. It did not appear in the survey, so no results can be compared.

**PoppedVeins** was also used in 2 instructions: Angry (3) and Cautious (1). Usage in Cautious seemed sporadic, as this participant did not describe PoppedVeins (which seems to indicate he did not know what the symbol meant). Only 3 participants used it in the Angry expression (4 others choosing ExclamationMark for Angry). PoppedVeins then seems not to convey its intention of Anger/Frustration well.

Movement cues

Very few participants used movement cues in addition to the other visual cues. Most participants moved up to the target character and stood still either on it or at a small distance from it, then executed a symbol and/or switched to a state and moved on to repeat the progress at the next target character. This
may be due to many factors: the closed test environment, lack of a second player, lack of exploration with the controls, little experience with moving in virtual environments, and so on. Participants were also not instructed to use movement in their expressions. Behaviour may be different in a real scenario setting.

Some participants did however make clear use of movement cues. In a total of 10 expressions (across five different participants), there was clear usage of movement cues. This involved four types of movement: 1) **back & forth movement** in front of the character (seen in two expressions of Excitement), 2) **pounding movement** (in two expressions of Anger), 3) **circling around a character** (three times; once in Curiosity, in Cautious and in Affectionate), and 4) **slow approach** (once in an expression of Excited and once in Sad), and 5) **seeking close contact** (once in an expression of Affection). Only two participants (session 7A and 4B) used movement in all three of their expressions.

Moreover, the movement cues used here were found in the discussions above to be in line with Laban Movement Analysis (Section 3.3.3). Usages also mirror the Careful, Aggressive and Inspective movement behaviours described in part 2 of the survey (Section 7.4.1). Movement cues were found in the survey to have large effect both when conveying emotional intensity and nuanced expressions. These combined observations indicate that movement behaviour plays a large and important role in conveying emotion in virtual environments where no text communication is present.

**Cue combinations**

*Figure 69* shows an overview of how many times states, symbols and movement cues were used across the 42 expressions. Most often, participants combined a state with a symbol. None of the participants used two symbols for one expression. Ten expressions had movement cues. The tendency to use both a state and a symbol may be because participants felt they had to use one of both to increase test results. This may be concluded from several participants choosing an icon or state they did not know the meaning of, or noting in the questionnaire something along the lines of “I did not find a cue for expression X”—and still used that cue (state or symbol) or another one instead of not using one at all.

*Figure 70* shows usage of cue groups for each expression. There since there were only 14 participants results are too sparse to draw solid conclusions. There are some observations to be made however. Movement was used at least once in all expressions, and the nature of that movement always reflected the instruction well. Only Excited and Sad were (once) conveyed by just a state: the states intended as such (Yellow and Blue respectively).
8.2 Part 1: Expression Execution

Figure 69.: Cue usage per type across all 42 expressions. ‘combination’ indicates a combination of symbol and state usage.

Figure 70.: Cue usage per type for each instruction. ‘combination’ indicates a combination of symbol and state usage.

8.2.3 Execution time

An attempt was made to gather execution times for each participant’s expression from the available recordings. This proved to be too difficult to measure because it wasn’t clear from the recordings when an expression started and ended\(^2\). Many participants were observed to do some amount of exploring during their recordings, even though there was an exploration phase where participants were instructed to explore their expressions.

\(^2\) The entire execution session is one recording per participant, they were not instructed to record their expressions separately.
8.2 Part 1: Expression Execution

8.2.4 Summary

Observations have been discussed in detail above. This section gives a brief summary.

Expressions

How did the participants express the emotion words they were instructed with?

Most similar expressions were observed for the Sad, Affectionate, Angry and Curious instructions. Mixed expressions arose for Excited and Cautious.

- **Excited** was most expressed with the ExclamationMark (6) in combination with high-arousal states Yellow (3) and Red (2). Three participants used movement (Back & forth and playful approach).

- **Sad** was expressed by the Blue state and SweatDrop symbol in the majority of expressions. There is reason to believe the two participants who used Neutral/Green+SweatDrop did not use Blue+SweatDrop because it would be too strongly Sad (depression). One participant used movement (very slow approach).

- **Affectionate** was expressed by all participants using the Red or Neutral states in combination with Hearts. Two participants also included a circling movement, seeking close contact.

- **Angry** was always expressed with the Red (6) and Neutral (1) states, and always in combination with ExclamationMark (4) or PoppedVeins (3). Two participants showed a pounding movement pattern.

- **Curious** was mostly expressed using the QuestionMark (6) and always with a positively valenced (4) or neutral state (3). One participant showed circling movement behaviour.

- **Cautious** had most mixed expressions of all the instructions. Common factors were observed however: a tendency to use negative valenced states in combination with ExclamationMark (2), QuestionMark (2) or SweatDrop (2). One participant used careful circling in their expression.

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3 SweatDrop was described as “tears” by the majority of participants, which explains its usage in the Sad expression.
4 Many of the participants who used Red for Affectionate did notice its inclination toward Anger, however.
5 Two participants who used Yellow/Green states also described them as “doubt” and “jealous”—their intention thus being a negatively valenced state.
Cue usage

What did participants use the individual cues for?

Among the four different states, Blue and Red had most specific usage, Yellow had somewhat versatile (but explainable) usage, and Green was used most sporadically across the expressions:

- **Blue** was used only for negative valence, low arousal emotions: Sad (4) and Cautious (3).

- **Red** seemed clear in conveying high arousal, negative valence: Anger (6), although it was used as Excited (2) as well. However, the design intention of the Red state as Anger was problematic in that it was equally used as love by group A for Affectionate (5).

- **Yellow** had more versatile usage: Excited (3), Curious (2) and Cautious (2). It seems suitable for positive valence, mid to high arousal states, but was sometimes used as “doubt” or “scared” (in the Cautious expressions).

- **Green** was used most sporadically: Curious (2), Excited (1), Sad (1), Cautious (1).

Some symbols seemed to have more flexibility than others. Hearts had most specific usage, ExclamationMark was most versatile, while QuestionMark, SweatDrop and PoppedVeins were consistently divided across two expressions:

- **QuestionMark** seems to indicate a questioning attention-directing behaviour, both in positive and negative valenced emotions: Curious (6), Cautious (2).

- **ExclamationMark** had two main usages, 1) indicating high arousal: Excited (6), Angry (4), and 2) attention-directing: Curious (1), Cautious (2).

- **Hearts** was used exclusively to indicate Affectionate (7)6.

- **SweatDrop** had dual usage of tears and stress in Sad (4) and Cautious (3) respectively. This symbol was not clearly representing sweat. This does however suggest a symbol specifically designed to convey tears will have highly specific usage (Sad). It is also indicated that, on improvement of the sweat symbol, it would be used in stressful situations (Cautious).

- **PoppedVeins** was not clearly recognizable as Anger/Frustration. Those who did recognise it as such did use it in their Anger expression. It was also used in Cautious (1), but the participant stated not knowing what the symbol meant.

These observations indicate that overall, symbols are used for specific meanings which gain more nuanced meaning by being combined with states.

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6 There was one case of Hearts for Sad, but this was believed to be accidental, as discussed earlier.
Multiple possible reasons were attributed to the lack of movement cues in the expressions (used in 10 of 42 expressions), but when used it was highly representative of the emotion to be expressed. Movement included: Back & forth, Circling, SlowApproach, Circling and CloseContact. Movement cues might have been used more extensively if participants had been given the instruction to try and include movement in their expressions. Combined with the survey results, it is indicated that movement behaviour plays an important role in emotional communication in virtual environments when there is no text-communication available.
8.3 PART 2: USAGE QUESTIONNAIRE

Goal: How do participants interpret individual cues? How do participants feel about executing their expressions? Were there cues missing?

After executing the three expressions in part 1, participants went on to fill out a questionnaire about their experience of building and executing the expressions. The goal was to gain insight into usage and interpretations of the available cues, both in terms of the presented UI elements and the resulting visual cues on the character. Answers were in the format of Yes/No, Likert scale, one-word descriptions, and free description.

8.3.1 States: one-word descriptions

First, participants were asked to give one-word descriptions of the different states. These results have informed the above discussion, and will also be referred to during participants’ interpretations of the others’ expressions in part 3 (Section 8.3). One-word descriptions were also asked for the 5 symbols, discussed later in this section.

Figure 71 shows the one-word descriptions participants left for each of the four different states (the visual changes to the avatar, not the UI elements). Figure 72 shows these words mapped onto the four quadrants of the circumplex model of effect. The descriptions for states Red and Blue matched best their intended design intentions (Anger and Sad). This was also reflected in the expressions of Angry and Sad discussed above, where they were found to have most consistent usage of Red and Blue respectively. Excited and Calm have most varying interpretations. This is in contrast to the results from the survey in Section 7.2, where Excited (Yellow) was most accurately interpreted in terms of arousal and valence (84%), followed by Anger (Red) at 72%, Sad (Blue) at 70% and Calm (Green) at 67%. This may be due to two reasons. 1) There was a difference in how interpretations were collected. In the survey participants were asked to rate valence and arousal scales (unhappy to happy, calm to excited) and these answers were mapped onto the circumplex model of affect. Here, participants were specifically asked to give one-word descriptions. Using ratings on arousal / valence scales in the user test may have allowed for a more direct comparison. Secondly, the clips shown in the survey were recorded with great attention to movement cues: characters were made to move very slow or fast, smooth or shaky, explosive or careful, depending on which emotion was to be conveyed. During the user test, participants were free to move how they wanted as they explored the states. This absence of movement cues may have caused the states to be less clearly represented here than they were in the survey.
Figure 71.: One-word descriptions for the different states. Note that some participants wrote down multiple words. These have been included.

Figure 72.: One-word descriptions for the different states mapped onto the 4 quadrants of the circumplex model of affect. Some words were omitted because they did not seem to map neatly onto one of the quadrants. These were: love, friendship, unsure, neutral, jealous. Words that were counted are as follows. Anger: anger, scared, cautious, alarmed. Excited: excitement, happy, bright. Calm: zen/calm/content, positive, relieved, safe. Sad: sad, depression, blue, cold.
Descriptions are now discussed in more detail for each state. To provide more insight into this discussion, one-word descriptions by each group separately are shown in Figure 73 and Figure 74.

Figure 73.: Group A: one-word descriptions of each state. Instructions: Excited, Sad, Affectionate.

Figure 74.: Group B: one-word descriptions for each state. Instructions: Angry, Curious, Cautious.
State Red (intention: Anger)
While state Red was most often described as Anger (11 out of 14 participants), there are some peculiarities to note:

- ”Love” was assigned to state Red only by two participants from group A, which had Affectionate as an instruction. In contrast, all participants from group B (who had Anger as an instruction) described the state as ”anger”.
- Additionally, another participant from group A (who had the Excited instruction) described the Red state as ”excitement”. This participant used Red to build their expression Excitement (Red+ExclamationMark).

These observations are an indication that participants were influenced by the instructions they received when interpreting the visual cues. This is likely to have occurred because they were actively looking for cues to match their instructions. This phenomenon is recurrent throughout the analysis of results and will be mentioned a number of times.

State Yellow (intention: Excitement)
The Yellow state was described as a variant of Excitement by 6 out of 14 participants: ”happy” (5), ”bright” (1). Other descriptions were dissimilar: ”unsure” (1), ”alarmed” (1), ”cautious” (1), ”scared” (1), ”friendship” (1) and ”anger” (1). 5 of these descriptions are negatively valenced, and there is no clear indication that instructions caused these associations with Yellow. This was also seen above in the expressions, where Yellow was used in Excited (3), Curious (2) and Cautious (2). It seems that the Yellow state is for some also associated with fear and uncertainty (unsure, alarmed, cautious, scared).

State Blue (intention: Sadness)
For state Blue, 9 out of 14 participants described it as some word related to sadness: ”sad” (6), ”blue” (1), ”cold” (1), ”depression” (1). 3 of the remaining participants did not give an answer, and the last participant described the state as ”anger”. This participants did however use the Blue state to convey their Sadness expression. It is unclear from the available data why this contradiction occurred. Looking at the interpretations of the state on a group-basis, it seems there is again an indication that received instructions influenced participants’ interpretations of cues:

- All but one participant from group A (who had the Sad instruction) described the state as some form of sadness.
- 4 out of 7 participants from group B (who did not have the Sad instruction) did not describe it as sadness: 3 gave no answer, 1 described it as ”calm”.
State Green (intention: Calm)
The Green state was described as some word related to calmness by 6 out of 14 participants: zen/calm/content (3), relieved (1), safe (1), positive (1). As with Yellow, the other descriptions were dissimilar: happy (2), scared (1), sad (1), unsure (1), neutral (1) and jealous (1), and one participant gave no answer. This seems to be in line with observations made earlier: the Green state had no consistent usage among the instructions: Curious (2), Excited (1), Sad (1) and Cautious (1), and was also used least of all states. In contrast to Red and Blue, there is no overly clear indication that received instructions caused different interpretations of this state.
8.3.2 Symbols: one-word descriptions

To gain insight into interpretation of the symbols, participants were again asked to describe the symbols (when executed) in one word. The same phenomenon that was observed for state descriptions is observed here: descriptions are influenced by the expressions participants had to build in part 1. This was especially true for QuestionMark, ExclamationMark and PoppedVeins.

Figure 75.: One-word descriptions for the different discrete expressions. Note that some participants wrote down multiple words.
Figure 76.: Group A: one-word descriptions for each symbol. Instructions: Excited, Sad, Affectionate.

Figure 77.: Group B: one-word descriptions for each symbol. Instructions: Angry, Curious, Cautious.
QuestionMark (intention: Curiosity, Confusion)
In group B, who had the Curiosity instruction, 5 participants out of 7 marked it as Curiosity specifically, while two described it in the negative variants of “doubt” and “confusion”. In contrast, all participants in group A (without Curiosity instruction) described the symbol negatively (“confusion”, “doubt” or “uncertainty”).

ExclamationMark (Attention)
This symbol is described mainly in positive and neutral terms in group A (excitement, attention, loud), who had the instruction Excitement. In group B however, where participants had the Anger instruction, it was described solely in negative terms (anger, alarm, nervous and shouting).

Hearts (intention: Love, Affection)
Hearts was most clearly described out of all symbols, all but one participant describing it as “love”. One participant described it as “happiness”.

SweatDrop (intention: Stress)
As mentioned during discussion of the expressions, the SweatDrop symbol was interpreted overall as “tears” (9 participants). This did not seem to depend on whether participants were given the Sad instruction. Other participants (4) described the SweatDrop as “sweaty”, “worried”, “stressed”, “ashamed”. These states involve sweat in the physical experience of them, so we may derive that these 4 participants interpreted it as sweat. Two participants described this symbol as “confusion”, “doubt”.

PoppedVeins (intention: Anger, Frustration, Annoyed)
4 out of 7 participants from group B (with the Angry instruction) described this symbol as anger, while 4 did not. In contrast, only 1 participants from group A described it as “anger”. This again shows that the instructions received influenced descriptions. In this case, it seems to have helped participants associate the PoppedVeins with Anger, perhaps because they were considering the symbol in the context of each of their expressions as they looked for a suitable symbol. A user looking to express anger and seeing the PoppedVeins symbol may be reminded of seeing it used to mean anger in comic books or animation movies, whereas a user simply seeing the icon can find it hard to place its meaning without a hint. The latter seems to have been the case for all but one of the group A participants.
8.3.3 Missing cues

Participants were asked whether they felt something was missing while they were building their expressions. Answers were taken as free text. All participants left a comment for this question, some left several.

Missing colour
5 participants stated they couldn’t find a certain colour (state) to represent a particular emotion. Two participants noted they couldn’t find a colour for Excited and used Green and Neutral colours in their Excited expressions, both in combination with ExclamationMark. The participant using Neutral suggested the use of orange for the Excited state. Another participant suggested pink for Affectionate, nothing that “the Red state is too active for Affectionate, pinked would be better”. One participant stated they couldn’t find a colour for Curiosity, and used Neutral+QuestionMark during execution. Another participant, who used Blue+ExclamationMark for Cautious, mentioned that he would use a “not-so-extensive red colour” for this expression. Not all participants left notes of what they lacked, one noting that “more colours would be useful if more expressions are needed”.

Missing symbols
5 participants had remarks regarding missing icons (symbols). One participant noted using the SweatDrop (+Blue) in their Sad expression, even though “the drop looks worried”. He then noted “more icons to express more emotions”. Another participant also found there was “no real icon for sadness”, but also used the SweatDrop (+Blue) to convey it. Regarding the Cautious expression, one participant couldn’t find a suitable icon to express it (and used Blue+QuestionMark). Another participant used Neutral+SweatDrop for Cautious, but noted that “!?” could be a suitable symbol for it. Interestingly this participant did not use the QuestionMark and ExclamationMark cues in short sequence of each other, so that both would appear on the avatar at the same time. None of the participants combined multiple symbols. Another participant noted he found “nothing for Cautious”, so neither colour nor symbol (he used Yellow+PoppedVeins). One participant found it difficult to build different expressions for Curious and Cautious, stating that “QuestionMark is suitable for both. I used colours to differentiate between them, but an additional icon would be nice”. This participant unexpectedly used Yellow+QuestionMark for Cautious, and Green+QuestionMark for Curiosity, describing the Yellow state as “unsure” and the Green state as “content” in part 2.
Other remarks
The remaining remarks are more general observations regarding the cues available. One participant would have liked to use sound cues, such as a “woohoo” sound for Excited. Three participants would have liked some amount of facial expressions, one additionally suggesting “more body language cues”. One of these participants remarked that for some expressions (Angry) there were enough cues, but for others (Cautious) additional cues were needed, and suggested facial expressions as a solution. There was one participant who mentioned pulsation: “maybe different pulsations would be nice”. It is unclear whether this participant wanted to have greater control over the pulsations that were present, or whether he did not notice the different states had different pulsing behaviours and would have liked them to be different.

8.3.4 UI and interaction

Participants were asked how easy it was in general to execute the expressions they received as instructions—this includes usage of any symbol or state that they chose to incorporate in that expression. Figure 78 shows the responses. Participants were asked to leave notes in case they answered "not really" or "not at all", but since no participant had this answer, no further insights can be gained from this data.

![Bar chart showing ease of executing expressions.](image)

Figure 78.: Was it easy to execute your expressions?

State switcher
The above figure seems to suggest participants had no notable difficulties in executing their expressions. More is revealed however when asked about usage of the state switcher (see Section 6.1 for details). While only one participant noted to have accidentally switched to the wrong state (Figure 79a), Figure 79b shows mixed feelings about the ease of use of the state switcher. Participants that answered ‘not really’ (5) or ‘not at all’ (0) were asked to describe why:
Two participants noted poor visibility of the state switcher. This is due to the state switcher being hidden, becoming visible only while holding the right mouse button.

One participant found the coloured rectangles to be positioned too closely to the central, neutral rectangle.

One participant was bothered by having to execute states and discrete cues separately, noting that "colours / symbols cannot be executed simultaneously".

One participant commented "I’d prefer switching between states with another hand, so I could move and switch". It is not clear what was meant here, as movement and state switching happened with the left and right hand respectively. Some participants were observed to be left-handed however. Perhaps this was a left-handed participant struggling to use the UI.

Nearly half of participants were bothered by states remaining active until changing to another one Figure 79c. This divided response hints there may be individual preferences as to whether certain cues should be discrete or continuous. For this user test, cues were either fully continuous (remained active indefinitely) or discrete (disappeared after a short time). Another option could be to allow for cues to be activated for as long as a certain button is held down. Finding out suitable cue durations could be a topic for further research.

(a) Did you accidentally switch to the wrong state? (b) Was it easy to switch between states? (c) Did it bother you that states remained active?

Figure 79.: Responses regarding usage of the state switcher.

Figure 80 shows responses for whether the icons for the four states of the state switcher set correct expectations about the state that it activates. This data shows that only the Red UI element of the state switcher seemed to give a reliable indication. Responses were independent from whether the participants described the Red state as "love" or "anger". For this question, participants were not asked to clarify their answer if they marked "not really" or "not at all". On reflection, this should have been the case. One participant did note verbally that the Blue icon looked too black to represent the blueness of the resulting avatar colour. Choosing a more fitting blue could improve user’s expectations of the
Sad state. No more insights could be gained from the available data however. It is to be speculated whether the consensus of the red icon is due to red being commonly associated with both anger and love, depending on context.

![Figure 80: Did this icon set a correct expectation of what state would follow when pressed?](image)

**Symbol skillbar**
Participants were similarly asked about the execution of the discrete symbols and their representation in the UI. See Chapter 6.2 for details on this UI element. Two participants reported having pressed a wrong icon at some point during the user test (Figure 81a). Participants were asked here if they were bothered that the symbols disappeared automatically (Figure 81c). This seemed not to be the case, in contrast to the clearly mixed feelings about states remaining active until changed. What was not asked here was the equivalent of the question *Was it easy to switch between states?* that was asked for the state switcher. On reflection, this should have been asked for usage of the skillbar as well. This would have allowed for deeper insights (as above), but also for a more direct comparison of two UI elements.

![Figure 81: Responses regarding usage of the symbols.](image)
Figure 82 shows responses regarding the icon representations of the symbolic cues on the skillbar. Hearts, Questionmark and SweatDrop seemed to set most reliable expectations. ExclamationMark was rated as least predictive, which may be due to difference between the symbol used on the character and the symbol used in the skillbar. Of all symbols, the ExclamationMark differed the most. There is however no clear explanation as to why PoppedVeins set such mixed expectations also, as this symbol was exactly the same on the character as on the icon in the skillbar. What may have been the case however is that participants did not know what would happen on execution of the symbol because they did not know what the symbol meant. Responses earlier in this section revealed that PoppedVeins was the least recognized symbol. This explanation does not carry over to the case of ExclamationMark just discussed, however. One reason this explanation seems plausible for the case of PoppedVeins is because all participants felt the Hearts icon to set correct expectations, and this symbol was also the most recognized of all. Deeper insights may have been gained if the participants had been asked to explain their answers if they answered “not really” or “not at all”.

Figure 82.: Did this icon set a correct expectation of what expression would follow when pressed?
8.3.5 Summary

Participants were clearly influenced by the instructions they received when interpreting individual cues. This was true both for states and symbols. This is likely to have an effect on interpretations of the other participant’s expressions in the next section. For symbols especially, instructions caused divisions in meaning across the two groups. This was especially the case for with “tears” vs “sweat” for SweatDrop, “excitement” vs “anger” for ExclamationMark, and “curiosity” vs “confusion” for QuestionMark. For states, this was especially the case for Anger (“love” vs “anger”) and Sadness (“sadness” vs no answer and “calm”)

Comparing the one-word description for individual states to the data collected in the survey, one-word descriptions did not describe the intention of each state as accurately as the ratings given on arousal and valence scales (calm to excited, unhappy to happy) in the survey. This was especially the case for Yellow and Green. This may be due to several reasons: 1) strong presence of movement cues in the survey recordings compared to the recordings from participants of the user test 2) the differences in data collection (arousal / valence scales compared to one-word descriptions). For the latter, the states’ sensitivity to context of use may have played a role: perhaps participants had multiple ideas about what the state could mean, but, being asked to describe it in one word, had to choose one of these options (some did leave multiple answers).

These one-word descriptions are therefore not considered in all cases to be a highly reliable representation of what the participants thought the states meant to them exactly. Moreover, the meaning of individual cues are not as important as the ways in which they are used, more specifically, in what cue cluster they appear. This is also the case for body language cues Section 2.2.1. It is speculated that this is also true for symbols. More importance is thus given to how participants chose to use the cues. These one-word descriptions were useful in gaining insight about participants’ state usage in their expressions, as was clear by the many references to participants’ descriptions of states in section (Section 8.2).

Some participants felt they lacked icons and colours, or stated that they’d like more cues if they were to express more emotions. Some also noted they would like to have facial or sound expressions.

The most useful insight from questions about the UI was that half of participants did not like that states remained active until they switched it to another one. More investigation is thus needed regarding interaction techniques.
8.4 Part 3: Expression Interpretations

In the last part of the user test, participants viewed the recording of the other participant in their session. In this manner, participants from group A had to interpret the expressions executed by participants from group B, and vice versa. Three identical questions were asked for each expression, resulting in three groups of three questions (one group of questions for each expression).

8.4.1 Target recognition

First, participants were asked toward which character the expression was made. All participants but one marked the correct character. On inspection of this deviating case, it did indeed seem the executing participant was executing their expression to the character the observing participant marked as target. It is unclear whether the executing participant accidentally moved to the wrong target, or whether being far from the target character (and on top of another) was their intention in conveying the expression to the target character. More interesting results might have been observed if characters had been positioned varying distances from each other. Now there was an even distance between all characters, and characters were spread out quite a lot.

8.4.2 Expression descriptions

Next, participants were asked to describe each of the three expressions in the recording, and also to note down what in the expression they felt expressed that emotion. The questions asked were 1) ‘What was the user expressing toward this character? If you are unsure, you can write down multiple possibilities.’ and 2) ‘What in the chosen expression do you feel expresses that emotion?’ Participants could answer in free text. There were a total of 42 individual expressions (3 expressions for all 14 participants).

Figure 83 and Figure 84 show an overview of all the expressions formed, and the descriptions of these expressions by the other participant from the same session. Most participants left one-word answers. When they did not leave one-word answers, they usually described they were uncertain about the expression. Figure 85 shows these one-word interpretations in relation to the intended expression.
Figure 8.3.: Interpretations by group A. Top row shows the intended emotion. Description of the expression by the group A participant is seen in the grey boxed label above the cues that made up the expression.
<table>
<thead>
<tr>
<th>Group B interpretations</th>
<th>Excited</th>
<th>Sad</th>
<th>Affectionate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Session 1</strong></td>
<td>Happy, Excited</td>
<td>Sad</td>
<td>Love</td>
</tr>
<tr>
<td></td>
<td>Yellow</td>
<td>Blue Drop</td>
<td>Red Hearts</td>
</tr>
<tr>
<td></td>
<td>Back &amp; forth movement</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Session 2</strong></td>
<td>Angry</td>
<td>Sad</td>
<td>Love</td>
</tr>
<tr>
<td></td>
<td>Red ExclamationMark</td>
<td>Blue Drop</td>
<td>Red Hearts</td>
</tr>
<tr>
<td><strong>Session 3</strong></td>
<td>Friendly</td>
<td>Sad</td>
<td>Love</td>
</tr>
<tr>
<td></td>
<td>Green ExclamationMark</td>
<td>Neutral SweatDrop</td>
<td>Neutral Hearts</td>
</tr>
<tr>
<td><strong>Session 4</strong></td>
<td>Angry</td>
<td>Cautious</td>
<td>Love</td>
</tr>
<tr>
<td></td>
<td>Red ExclamationMark</td>
<td>Blue</td>
<td>Neutral Hearts</td>
</tr>
<tr>
<td><strong>Session 5</strong></td>
<td>Cautious</td>
<td>Sad / Tears of Happiness</td>
<td>Love</td>
</tr>
<tr>
<td></td>
<td>Neutral ExclamationMark</td>
<td>Green SweatDrop</td>
<td>Red Hearts</td>
</tr>
<tr>
<td><strong>Session 6</strong></td>
<td>Attention-seeking</td>
<td>Love</td>
<td>Love</td>
</tr>
<tr>
<td></td>
<td>Yellow ExclamationMark Back &amp; forth movement</td>
<td>Red Hearts</td>
<td>Red Hearts Circling</td>
</tr>
<tr>
<td><strong>Session 7</strong></td>
<td>Happy</td>
<td>Scared</td>
<td>Love</td>
</tr>
<tr>
<td></td>
<td>Yellow ExclamationMark Slow approach</td>
<td>Blue SweatDrop Very slow approach</td>
<td>Red Hearts Close contact</td>
</tr>
</tbody>
</table>

Figure 8.4: Interpretations by group B. Top row shows the intended emotion. Description of the expression by the group B participant is seen in the grey boxed label above the cues that made up the expression.
8.4 Part 3: Expression Interpretations

Figure 85: Relation between intended expression (right-hand) and interpretation of the observer (Y-axis).

Figure 86 shows an overview of the number of expressions communicated successfully for each instruction. Angry and Affectionate were most successfully communicated, followed by Sad as well as Curious and Excited when taking into account related interpretations. Cautious was communicated least of all. Interpretations for each instruction are now discussed in detail with possible explanations for the cases of related and incorrect interpretations.

Figure 86: Number of expressions correctly described by the interpreting participants. "Related" indicates the description was some form of the intended emotion. Cases counted as related are as follows: Curious as "confused" (4), Cautious as "scared" (2) and "doubt" (1), Excited as "happy" (1), "attention-seeking" (1) and "friendly" (1). Omitted was the (likely accidental) case of Red+Hearts for Sad, described earlier.
Expression 1A: Excited
The Excited expression was described specifically as "excited" by only one participant (this participant additionally wrote down "happy"). 3 others described it as a state related to excitement: "happy" (1), "friendly" (1) and "attention-seeking" (1). A notable observation is that all expressions that had Yellow in them were interpreted as one of these states. Other notable cases are:

- Two Red+ExclamationMark expressions were interpreted as "anger", which is a clear case of miscommunication since the group A participants who formed these expressions meant to convey Excited. They described the Red state as "love" and "excited", likely due to their Excited and Affectionate instructions.

- In the case just described, the two interpreting group B participants used Neutral+PoppedVeins and Red+PoppedVeins in their own Anger expressions, but also interpreted these participants' Red+ExclamationMark as Anger: this shows that an expression (here: Anger) can be communicated using different sets of cues.

- One expression (Neutral+ExclamationMark) was interpreted as "caution". The interpreting participant described ExclamationMark as "angry" (this participant had the Angry instruction), while the executing participant described it as "excitement" explicitly (and had the Excited instruction). This is a case of miscommunication due to different interpretation of a symbol. It seems that the source of this were the instructions given to these participants, which influenced their interpretations.

- The case just described was the only time an expression was described explicitly as caution. The interpreting participant noted that "the exclamation mark and the choice not to use a colour (Red would mean anger)" conveyed Cautious. It is likely that Cautious being one of this participant’s instructions influenced his interpretation and word choice. He did however use Yellow+QuestionMark to convey his own expression of Cautious, which, as was the case for the two interpretations of Anger above, shows that different sets of cues can be interpreted as the same emotion (here: Cautious).

Expression 2A: Sad
4 out of 6 group B participants described the expressions specifically as "sad". One of these participants (interpreting Green+SweatDrop) described the expression as "sad, or tears of happiness" and noted that "tears is sad, but green is positive, so maybe tears of happiness?" (the case of "tears of happiness" was excluded from Figure 86 because Sad was their first answer). This interpret-
The participant interpreting Blue+SweatDrop as “scared” described the SweatDrop as “doubtful, worried”, The group A participant forming the expression described it as “sad” (and had the Sad expression). This is a miscommunication due to different interpretations of symbols (SweatDrop), likely caused by the instructions received.

One participant interpreted the Sad expression (Blue) as “cautious?”, while describing Blue as “calm” in the questionnaire. He noted during interpretation that “the player is standing still at a distance and not interacting with the character”, which led him to interpret the situation as one of caution. This is case of movement influencing the participant’s interpretation—in this case it led to a different interpretation than the intended expression. Note however that the movement of the group A participant was not observed to be different in his expression of Sad compared to his expressions of Excited and Affectionate. The interpreting group A participant did make extensive use of movement in his own expressions (Pounding for Anger, Circling for Curious and Careful circling for Sad). This may have led him to be more attentive to movement cues while interpreting the expressions of the group B participant.

Expression 3A: Affectionate
This expression was interpreted correctly by all participants of group B. This is likely due to the fact that all Affectionate expressions from group A involved the Hearts symbol. Whether or not the group A users used the Red or Neutral state did not affect interpretation results.

Expression 1B: Angry
Anger was described as such by 6 out of 7 participants from group A. One participant described it as “hurt”, noting that he did not know what the symbol meant. This participant described the PoppedVeins symbol as “flowerish”. The expression this participant viewed was Neutral+PoppedVeins, which explains why he did not know what this expression meant. Interpretations of this state as “anger” did not depend on whether the expression contained an ExclamationMark or PoppedVeins symbol—either symbol, combined with the Red state, seemed to represent Anger clearly. Two participants here also noted movement (“back and forth”, “toward the character”) as conveying the anger emotion.

Expression 2B: Curious
Only one interpreting participant described a Curious expression as such. Other interpretations included “confused” (4) and “doubt” (2). The expression that
was correctly interpreted as Curious was Yellow+QuestionMark. One could say there is only one correct interpretation since only one participant described the expression as curious. However, crucial to note is that the differences between confusion and curiosity are highly nuanced. Context is likely to aid in ensuring the interpretation among these similar expressions, this is why Confused was counted as a “related” interpretation in Figure 86. There were two cases of miscommunication:

- For both cases, the expressions (which were Neutral+QuestionMark and Green+ExclamationMark) were described as “doubt”. The interpreting participants described the QuestionMark as “doubt”, the executing participants described it as “curious”. These are two cases of miscommunication due to different interpretations of a symbol. These are however not cases of miscommunication because of the presence of the instruction Curious—the interpreting participants were not influenced by their instructions in their descriptions of QuestionMark as “doubt” (even though the executing participants may have described QuestionMark as “curious” due to their Curious instruction, this was not the cause of miscommunication).

For all four cases of related communication, where the expressions were interpreted as Confused, the interpreting participant had described the QuestionMark symbol a “confused”, while all but one of the executing participants described it as “curious” (likely due to them having the Curiosity instruction). The remaining executing participant in these cases did described QuestionMark explicitly as “confused”, but found it suitable for Curiosity and used it in their Curious expression. This indicates that the participant found confusion and curiosity highly similar.

Expression 3B: Cautious

None of the Cautious expressions were interpreted exactly as such by any of the group A participants. However, descriptions such as “scared” (2) and “doubt/uncertainty” (1) may be seen as related to Caution. They were counted as such in Figure 86. Cases of miscommunication are as follows:

- In one case, the expression contained Yellow+PoppedVeins. The interpreting participant described the expression as “anger”, while also describing the PoppedVeins symbol as “anger” in the questionnaire. He noted here that “Yellow is too neutral, but PoppedVeins means anger... not sure what this combination means”, but ended up using “anger” to describe it. The executing participant in this case did not describe the PoppedVeins symbol, instead putting “/”, probably because he was not sure what it meant. This shows how important it is that users know what the available cues mean fundamentally, otherwise miscommunication is sure to ensue.

- Three expressions that were meant to convey Caution were interpreted as “sad”. These expressions all used SweatDrop (2 times combined with Blue,
once combined with Neutral). All three interpreting participants (who had the Sad instruction) all described SweatDrop as "sad" in the questionnaire. Executing participants described the SweatDrop as "stressed", "confused", and "doubtful". This again seems to indicate that the instructions the participants received influenced their interpretations of the available cues. It is not certain however whether the executing participants would have associated SweatDrop with tears of stress, had they not been given the Sad instruction. Nevertheless, these cases will be counted as being influenced by the instructions received. Also of note is that all group B participants that did describe the SweatDrop as tears (4) did not use it in their Cautious expressions.

8.4.3 Cue indicators

The above discussion focused on answers to the question ‘What was the user expressing toward this character?’. Now discussed are the answers to question 2 of this part of the questionnaire: ‘What in the chosen expression do you feel expresses that emotion?’. These answers gave more insight into which cues influenced the interpretations on a conscious level. It is to note however that cues that were not explicitly mentioned may still have had an influence subconsciously. Figure 87 shows an overview of the responses grouped per cue mentioned.

Figure 87.: Total number of times a cue was mentioned to play a role in the participant’s interpretation of the expression.
Colour and symbol usage was mentioned most often, appearing 30 and 31 times respectively (out of 42) answers. Note that mentions of a lack of colour were also counted.

Motion was noted as influencing their interpretation by 8 participants, but only in 3 of these cases motion was an actual intention of the executing participant. This was the case for the two (correct) interpretations of the Anger expression, where motion was mentioned as “back & forth movement” and “motion toward character” (described above as Pounding), and also for one of the two expressions of Excited that used “back & forth” movement. There were a total of 10 cases where the executing participant intended movement, so in 7 of these cases the observing participant did not note down movement influenced their interpretation. This was the case for the two (correct) interpretations of the Anger expression, where motion was mentioned as “back & forth movement” and “motion toward character” (described above as Pounding), and also for one of the two expressions of Excited that used “back & forth” movement. There were a total of 10 cases where the executing participant intended movement, so in 7 of these cases the observing participant did not note down movement influenced their interpretation. This was the case for Curious (Circling), Cautious (Careful Circling), two times in Excited expressions (once Back&Forth, once SlowApproach), in one Sad expression (VerySlowApproach), and twice in an Affectionate expression (Circling, CloseContact). Those participants who used movement in their own expressions seemed to pay more attention to movement during their interpretation of the other participant’s expressions.

Pulse rate was mentioned 6 times. 3 times in expressions of Anger, 3 times in expressions of Affectionate. In all 6 cases, the Red state was used (which has both the highest pulse rate and size).

One participant mentioned timing when interpreting one the expression Curious as “confused”, noting “comes closer to the character and only changes the expression when arriving at the character”.

Lack of interaction was also mentioned in one case. This was an interpretation of Sadness as “cautious”. This ‘lack of interaction’ was not intended by the executing participant, as he was not using movement in any of his expressions. The observing participant however (4B) used movement in all three of his expressions.

\[^{8}\text{Seen as intention only if movement of the executing participant was clearly different across their three expressions.}\]
8.4.4 Summary

Out of the 42 expressions, 19 were communicated successfully, 10 were interpreted as a related emotion, and 12 were incorrectly interpreted. Note that one expression (Red+Hearts for Sad) was omitted. Figure 89, presented earlier, is included again for clarity.

Figure 88.: Total number of expressions interpreted correctly, as a related emotion, and incorrectly.

Figure 89.: Number of expressions correctly described by the interpreting participants. “Related” indicates the description was some form of the intended emotion. Cases counted as related are as follows: Curious as “confused” (4), Cautious as “scared” (2) and “doubt” (1), Excited as “happy” (1), “attention-seeking” (1) and “friendly” (1). Omitted was the (likely accidental) case of Red+Hearts for Sad, described earlier.
An overview of the causes of miscommunication is shown in Figure 90. These involved different interpretations of states (2) and symbols (9) between the executing and observing participant, and in one case an (incorrect) interpretation of movement. 7 out of these 12 cases of miscommunication were believed to be influenced by the instructions given to participants. This was the case for SweatDrop (4), Red (2) and ExclamationMark (1). In 2 out of these 12 cases a participant did not know what the PoppedVeins symbol meant. The specific cues that caused these miscommunications as well as the differing interpretations are shown in Figure 91.

![Figure 90: Causes of miscommunication per instruction.](image)

<table>
<thead>
<tr>
<th>cue</th>
<th>#</th>
<th>intended meaning</th>
<th>Interpretation</th>
<th>Instruction influence</th>
</tr>
</thead>
<tbody>
<tr>
<td>QuestionMark</td>
<td>2</td>
<td>curious</td>
<td>doubt</td>
<td></td>
</tr>
<tr>
<td>ExclamationMark</td>
<td>1</td>
<td>anger</td>
<td>excitement</td>
<td>yes</td>
</tr>
<tr>
<td>SweatDrop</td>
<td>4</td>
<td>tears</td>
<td>stressed, confused, doubt</td>
<td>yes</td>
</tr>
<tr>
<td>PoppedVeins</td>
<td>2</td>
<td>anger</td>
<td>“don’t know”</td>
<td></td>
</tr>
<tr>
<td>Red</td>
<td>2</td>
<td>anger</td>
<td>love, excitement</td>
<td>yes</td>
</tr>
<tr>
<td>movement</td>
<td>1</td>
<td>no intention</td>
<td>careful</td>
<td></td>
</tr>
</tbody>
</table>

![Figure 91: Specific cues that caused the miscommunications.](image)
8.5 conclusions

Instructions clearly had an influence on participants' interpretations of individual cues, which may have caused up to 7 of the 12 cases of miscommunication. This also had an impact on the related interpretations, but it was not investigated in many cases this could have potentially occurred.

Observations showed that lining up intention and interpretation is tricky when utilising abstract visual cues. For some expressions, interpretations of expressions spanned a set of related emotions. This would not necessarily form a problem in real usage scenarios where context could ensure correct interpretations, but this remains unclear.

Out of 41 considered expressions, 19 were communicated successfully, 10 were interpreted as related emotions and 12 were interpreted incorrectly. Expressions that were communicated most clearly were Affectionate and Angry. Cautious and Excited had most cases of miscommunication (4 and 3 respectively).

Cases of miscommunication were caused mainly by differences in interpretations of the individual cues in the expressions. Certain states and symbols had different interpretations, which, when used in an expression, resulted in miscommunication. Cues that were observed to cause miscommunications were SweatDrop (4), PoppedVeins (2), QuestionMark (2), PoppedVeins (1) and once a movement cue.

In some cases, multiple combinations of cues still led to the same interpretations. One example were the Angry expressions where both the ExclamationMark and PoppedVeins symbols in combination with the Red state led to interpretations of "anger".

8.5.1 Influencing factors

The user test took place in a neutral test environment with no context available to aid in the interpretation of expressions. It is expected that context of use will have a large influence on expressions and interpretations.

Also the short exploration time of the available cues (a few minutes) may not have been long enough for participants to get adequately familiar with the available cues. In general, we as human beings are not used to communicating via visual cues of this nature. There is expected to be some amount of learning to occur before being able (and comfortable) with such visual communication. To be taken into account also is the lack of socially learned usage of the cues. In game worlds or virtual environments, users are likely to learn about cue usage from other players in their social sphere, which may form group-specific 'dialects' or 'signs'.
8.6 Limitations

The user test had only 14 participants, while the survey had 82 responses. The number of participants was left low half intentionally—this allowed for free descriptions to be included in the questionnaire. Results from the user test did in several places align with findings from the survey. Ideally however the data would have come from more participants.

Even though there were less participants in the user test than in the survey, data of the user test proved more complex to analyse than the survey results. This was in part because the survey caused answers to flow into easily analysable data (only closed answers such as checkboxes, bullet points and scale ratings).

Instructions were observed to influence participants’ descriptions of individual cues. This likely has had an impact on both their own expressions and their interpretations of the other participant’s expressions. The effect could have been prevented (regarding how they built their own expressions, at least) if participants were asked to first explore the UI and immediately describe the states and symbols before reading the instructions of emotions they were to execute.

In the user test questionnaire, descriptions were asked for all states and symbols except for the Neutral state. This was an oversight. Since Neutral was used in the expressions, the meaning of this state should have been asked. It is therefore not certain whether usage of the Neutral state always indicated the participant meant to convey neutral arousal, neutral valence. The discussions assumed this was the case.

The survey and user test should have been designed with more care to the comparison of their results. This shows in several ways. Questions in the survey were asked differently than in the user test, such as rating states on arousal / valence scales (survey), rating associations with specific words (survey), in comparison to one-word descriptions of states and symbols (user test) and describing expressions as free description but not rating them on association with specific words (user test). Additionally, the full range of cues available in the user test (4 states, 5 symbols) was not present in the survey. These limitations arose from the decision to keep the survey and user test completion times low. More care should have been taken to design them in such ways that comparisons could be carried out more fully.
CONCLUSIONS

9.1 SUMMARY AND FINDINGS

This work explored the usage of real-time visual communication to enable richer expression of emotion in video games and virtual environments. Three parts of the work made efforts in this direction.

First, an overview of several relevant aspects of visual emotion representation were compiled in Chapter 3. These formed the basis of the analysis, implementation and evaluation parts.

Secondly, an analysis of a selection of six artistic single-player video games was carried out in Chapter 4. There it was examined how they utilise visual communication to express complex emotions. Findings were a set of visual communication channels through which these emotions were conveyed. They are: Avatar appearance, World appearance, Avatar movement, Added artifacts and Camera attributes. These findings were incorporated into a general model for visual emotion expressions in Chapter 5. Components of this model are: Visual representation, Duration, Effect on gameplay, Trigger and Metaphor and associations. The visual communication channels observed in the analysed games were mostly situated under Visual representation of this model, except for Avatar movement, which fell under Effect on gameplay. The model can be used during the design of expressions of emotion in video games or virtual environments that utilise real-time visual cues.

Lastly, an evaluation was carried out using a 2D test environment (Chapter 6) in which a set of symbolic and subsymbolic cues could be visualised on an abstract character. These cues were in the form of four continuous states Excited, Calm, Sad and Angry which combined several subsymbolic cues (colour, pulse size, pulse rate, movement speed), and five discrete symbolic cues QuestionMark, ExclamationMark, Hearts, SweatDrop and PoppedVeins. The evaluation consisted of 1) a survey to investigate the passive recognition of the implemented cues (Chapter 7), and 2) a user test to investigate expressions of specific emotion words using these cues and the interpretation of them (Chapter 8).
The survey confirmed that the four implemented states adequately represented states of high / low valence and high / low arousal. The implemented symbolic cues were not effective in conveying intensities of emotion. They seemed well suited however to convey nuanced expressions such as Confusion, Cautious and Curiosity depending on how they were combined with symbolic cues. Movement cues specifically were found to have a large effect on perceived emotion intensity, and there was some support that colour changes of a character could be suited for this as well.

The user test involved expression of a set of six of emotion words which were assigned to groups A (Excited, Sad, Affectionate) and B (Angry, Curious, Cautious). Users interpreted the expressions of the other group. 19 out of 41 considered expressions were interpreted correctly, 10 had related interpretations, and in 12 cases miscommunication occurred. Causes for miscommunication involved different interpretations of symbols (9 cases), states (2 cases) and movement cues (1 case). 7 of these miscommunications were thought to be influenced by the emotion words the participants received as instructions. These results show some success in emotion communication utilising real-time visual cues within a 2D virtual environment.

This work contributes to rich emotional communication in virtual environments using real-time visual cues. Due to the wide range of possibilities when creating expressions based on visual cues, it is suggested that there is a large variety of specific visual emotion expressions possible. This work could investigate only a small and highly specific subset of that, although attempts were made at generalising findings. It should be kept in mind however that the specifics of such visual cues and emotion expressions should always be informed by the game or virtual environment they will be used in.
Main limitations of this work are as follows:

**Small number of games in analysis**
The number of games analysed in Chapter 4 is limited to six. Even though many representations were found in them, analysing a wider range of games might improve the findings further. The reason so few games were examined is in part due to the rareness of such expressive games and in part due to their low discoverability amongst the mass presence of other types of games. There may be plenty of small games that use similar methods, or even additional ones, but the difficulty is finding them. The games selected came from the author’s own history of artistic games played.

**Small number of participants in user test**
While the survey gathered 82 responses, the user test involved only 14 participants. It is unclear how results would be impacted with a larger amount of participants.

**Incomplete analysis of survey and user test results**
The results from the survey and the user test were in part not completely analysed due to time constraints of this work. An example were mappings of Likert scale ratings to ‘yes’ ‘undecided’ and ‘no’ answers and incomplete investigation of word associations clips in the survey. The results from the survey and user test were also not compared in-depth, although some links were made throughout the discussion of the user test.

**Results may be 2D-specific**
Implementation and evaluation was carried out in a 2D virtual environment. It is not clear how these results translate to 3D.

**Effect of context uncertain**
Usage of visual cues were analysed in an isolated test environment with no gameplay or context. Usage in a real scenario where gameplay and context are present will offer many additional considerations and challenges.

**Small set of cues investigated**
The evaluation was concerned only with a small set of basic visual cues: distinct changes in colour (red, yellow, green, blue, white), subtle changes in pulse rate (high, medium, low), in movement speed (high, medium, low), and movement pattern (sharp, smooth, wavy, wide,..). The selection of cues was kept (relatively) small on purpose, because the set of possible cue combinations is very large. The list of sets of cues to convey a single emotion then is very large as well. Further investigation should be done to compare to a wider variety of cues and emotions.
Since only a small set of real-time visual cues could be investigated in this work while the set of individual cues and cue combinations in clusters (expressions) is large, there are many ways in which this design space can be explored further. Some suggestions are:

**Visual representations**
Perhaps the clearest path for further research is investigating different visual representations and their suitability for emotion expression.

**Input modalities**
In the test environment that was built for the evaluation, users could switch between different emotional states to change the cluster of subsymbolic cues visible on their characters. They could also show several symbolic cues. They could not however change any of the subsymbolic cues used in the states individually. It could be explored how and if users can be given greater control over such individual cues in order to express emotion such as manipulations of colour, shape, pulse size and pulse rate. Also a topic of further exploration is the usage of discrete versus continuous cues. This is because half of participants in the user test did not like that the states remained active indefinitely, while they did not mind that symbols disappeared after several seconds. More insights could be gained in this direction upon further exploration. Also of concern is how the control of real-time visual cues can be combined with other forms of input that are more directly linked to gameplay.

**Different contexts**
The focus of this work was specifically on the expression of emotion between players in video games. These findings can be applied to emotional communication in virtual environments in general, including collaborative environments and simulations. The findings may also be useful for communication beyond that of expressing emotion. Perhaps other types of information can be communicated using these visual communication channels as well.

**Combination with physiological measurements**
It may also be interesting to examine the usage of these kinds of visual expressions as a response to physiological measurements of the user’s body. In the case this is applied in a multiplayer setting however, privacy of inner emotional state should be respected, and the player should be made aware that their emotional state is being shown to other players.
BIBLIOGRAPHY


Appendices
Only page 1 differed between group A and B. All other pages were the same across groups.

USER TEST SURVEY – Emotion Exchange in Video Games

**Demographics**

- What is your gender?  M | F
- What is your age?  18-25 | 26-35 | 36-45 | 46-55 | 56+
- How often do you play video games?  often | sometimes | rarely | never
- How often do you play multiplayer or online video games?  often | sometimes | rarely | never

**PART I:**

This part asks you to perform three expressions in the program toward designated characters.

1) Before pressing 'Start', please take some time to explore all controls and expressions available to you in the program. We're going to ask you to show several expressions toward specific numbered characters that are arranged in a sequence on the next screen. First, decide how you will communicate the following expressions: excited, sad, affectionate.

2) When you are ready, press 'Start' to begin. You'll now see a row of ten static, neutral characters. Please move past these ten characters and communicate the following three expressions to the designated characters as if they were other players in a game, as follows:

   - Expression 1: You are excited toward character 2
   - Expression 2: You are sad toward character 5
   - Expression 3: You are affectionate toward character 9

3) When you are done, press 'Stop' and continue with the questions in Part II.
USER TEST SURVEY – Emotion Exchange in Video Games

Demographics

x) What is your gender?    M | F
x) What is your age?  18-25 | 26-35 | 36-45 | 46-55 | 56+

x) How often do you play video games?  often | sometimes | rarely | never
x) How often do you play multiplayer or online video games?  often | sometimes | rarely | never

PART I:

This part asks you to perform three expressions in the program toward designated characters.

1) Before pressing ‘Start’, please take some time to explore all controls and expressions available to you in the program. We’re going to ask you to show several expressions toward specific numbered characters that are arranged in a sequence on the next screen. First, decide how you will communicate the following expressions: angry, curious, cautious.

2) When you are ready, press ‘Start’ to begin. You’ll now see a row of ten static, neutral characters. Please move past these ten characters and communicate the following three expressions to the designated characters as if they were other players in a game, as follows:

Expression 1: You are angry toward character 3
Expression 2: You are curious about character 5
Expression 3: You are cautious about character 7

3) When you are done, press ‘Stop’ and continue with the questions in Part II.
PART II:

This part asks several questions regarding these expressions and how easy it was to execute them.

x) While you were building your three expressions, was there something you felt was missing? This could be a certain colour, icon, or anything that you felt you wanted to use in your expression.

x) Was it easy to execute your expressions? very easy | a little | not really | not at all
If you answered ’not really’ or ’not at all’, please specify why.

STATE SWITCHING

These questions ask about the continuous states that are selected through the state switcher by pressing the right mouse button.

x) Did it bother you that these states remained active until you changed to another one? Y | N
x) Did you sometimes accidentally switch to the wrong state? Y | N

x) Was it easy to switch between states? very easy | a little | not really | not at all
If you answered ’not really’ or ’not at all’, please specify why.

x) Did this icon set a correct expectation of what state would follow when pressed?
very well | a little | neutral | not really | not at all
x) Please use one word to describe this state.

x) Did this icon set a correct expectation of what state would follow when pressed?
very well | a little | neutral | not really | not at all
x) Please use one word to describe this state.

x) Did this icon set a correct expectation of what state would follow when pressed?
very well | a little | neutral | not really | not at all
x) Please use one word to describe this state.

x) Did this icon set a correct expectation of what state would follow when pressed?
very well | a little | neutral | not really | not at all
x) Please use one word to describe this state.
DISCRETE EXPRESSIONS
These questions pertain to the expressions activated through the icons on the bottom of the screen.

x) How was the duration of these expressions? too long | too short | just right
x) Did it bother you that they disappeared automatically? Y | N
x) Did you sometimes accidentally press the wrong icon? Y | N

x) Did this icon set a correct expectation of what expression would follow when pressed?
    very well | a little | neutral | not really | not at all
x) When pressed, did the visual changes to the avatar make sense? Y | N
x) Please use one word to describe this expression. .............................

x) Did this icon set a correct expectation of what expression would follow when pressed?
    very well | a little | neutral | not really | not at all
x) When pressed, did the visual changes to the avatar make sense? Y | N
x) Please use one word to describe this expression. .............................

x) Did this icon set a correct expectation of what expression would follow when pressed?
    very well | a little | neutral | not really | not at all
x) When pressed, did the visual changes to the avatar make sense? Y | N
x) Please use one word to describe this expression. .............................

x) Did this icon set a correct expectation of what expression would follow when pressed?
    very well | a little | neutral | not really | not at all
x) When pressed, did the visual changes to the avatar make sense? Y | N
x) Please use one word to describe this expression. .............................
PART III:
in this part, we ask you to watch a recording
of the other user's expressions and to answer
several questions related to them.

Expression 1

x) To which character was this expression directed?  1  2  3  4  5  6  7  8  9  10
Please choose only one number.

x) What was the user expressing toward this character?
If you are unsure, you can write down multiple possibilities.

x) What in the chosen expression do you feel expresses that emotion?
Try to be as specific as possible.

Expression 2

x) To which character was this expression directed?  1  2  3  4  5  6  7  8  9  10
Please choose only one number.

x) What was the user expressing toward this character?
If you are unsure, you can write down multiple possibilities.

x) What in the chosen expression do you feel expresses that emotion?
Try to be as specific as possible.
**Expression 3**

x) **To which character was this expression directed?**  1 2 3 4 5 6 7 8 9 10
Please choose only one number.

x) **What was the user expressing toward this character?**
If you are unsure, you can write down multiple possibilities.

x) **What in the chosen expression do you feel expresses that emotion?**
Try to be as specific as possible.

---

**THANK YOU!**
*Feel free to grab a cookie before leaving! :)*

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If you have any remarks or suggestions, you can leave them here.
Communicatie in video games is typisch gezien gelimiteerd tot het gebruik van lichaamstaal van de speler avatar en spraak, zij het via chat of voice features. Aangezien video games een interactief, visueel medium is, zijn er echter meerdere vormen van communicatie mogelijk, zoals visuele verandering in the wereld. Dit kan de communicatie tussen spelers verrijken met o.a. meer emotionele inhoud. Het opzet van deze masterproef bestaat erin het gebruik van real-time visuele communicatie voor emotionele expressie binnen virtuele werelden te onderzoeken. Drie onderdelen van de masterproef werken hier- naar: 1) een analyse van zes artistieke games die op een succesvolle manier emoties uitdrukken via visuele methodes, 2) een online survey en 3) een user test. Deze twee laatsten geven samen dieper inzicht in de herkenning en het gebruik van een specifieke set van visuele signalen die in een testomgeving geïmplementeerd werden.
PLAYER-TO-PLAYER COMMUNICATIE: TYPISCHE METHODEN

De typische methodes toegepast om communicatie tussen spelers van online games toe te laten zijn zoals vermeld vooral gebaseerd op communicatie in de echte wereld. Tekst chat, voice chat en lichaamstaal zijn de meest gebruikte methodes. Lichaamstaal wordt vaak omgezet tot het on-demand vertonen van bepaalde houdingen, gebaren of gezichtsuitdrukkingen van de speler avatar. Deze kan de speler typisch oproepen door het drukken op een visuele knop of door het geven van een commando in de chatbox (zoals /smile). Een onbewuste methode is het ruimtelijk gedrag van de speler, die kan aantonen dat hij bijvoorbeeld speels of voorzichtig is ten opzichte van een andere speler.

Onderzoek dat gerelateerd is aan het verrijken van player-to-player communicatie is voornamelijk te vinden in het bredere domein van communicatie in virtuele omgevingen. Maar ook hier is de focus vaak op het gebruik van lichaamstaal in virtuele context. Sommige studies richten zich echter wel op het verrijken van communicatie via visuele methoden, zoals de toevoeging van gekleurde achtergronden bij tekstberichten op een mobiele telefoon [1]. Specifiek binnen video game onderzoek is er bijvoorbeeld onderzoek gedaan naar de impact van kleur op de speler in virtuele werelden [24].

GAME-TO-PLAYER COMMUNICATIE: EEN ANALYSE

De games die geanalyseerd werden zijn Gravitation, Lim, What Now?, Anxiety Attacks, Beyond Eyes and Mary Woke Up Today. Tijdens het spelen van deze games werd er uitdrukkelijk gezocht naar emotie expressies, en op welke wijze deze gebeurden. Een overzicht van de bevindingen is te zien in Figuur 92. Wat deze expressies gemeen hebben is dat ze allemaal vrij complexe emoties weergeven via real-time aanpassing van Avatar appearance, World appearance, Additional attributes, Avatar movement, en Camera attributes.
Veralgemening
Toepassing van deze methodes in een bredere context vereist een loskoppeling en veralgemening tot een algemeen toepasbaar model. Deze is te zien in Figuur 93, en is gebaseerd op de expressies te zien in de bestudeerde voorbeelden.
De **duratie** van een expressie kan discreet of doorlopend zijn. Een discrete emotie expressie is bijvoorbeeld een korte uitdrukking van affectie, zoals het verschijnen van een hart boven de avatar. Een doorlopende expressie is bijvoorbeeld het voortdurend visualiseren van het energiepeil van de speler (lage vs hoge energie). Eventueel is er een **effect op gameplay**, wat bijvoorbeeld een aanpassing aan de beweegsnelheid of springhoogte van de avatar kan zijn. De **visuele representatie** is het visueel uitzicht van de expressie, overeenkomend met de technieken geïdentificeerd in de voorafgaande analyse. De **trigger** is datgeen wat de expressie in gang zet of aanpast. In de bestudeerde voorbeelden was dit steeds onder controle van de game logic en had de speler hier geen controle over. Soms werd het gedrag van de speler in acht genomen, soms was dit geheeld geautomatiseerd. In de context van player-to-player communicatie kan de trigger specifieke input van de speler zijn, zoals een knopdruk of menu selectie. Als interactietaak heeft de speler de mogelijkheid een discrete expressie uit te voeren, te wisselen tussen continu zichtbare emotionele staten of de specifieke uitvoering van een expressie te beïnvloeden. De expressie is ook vaak gebaseerd op een bepaalde **metafoor of mentale associatie**. Affectie of liefde wordt in het algemeen voorgesteld door een hart, passie is vurig, woede is vaak rood, chaotisch en ongecontroleerd. Deze omschrijvingen kunnen omgezet worden tot specifieke elementen die zich uiten tijdens het uitvoeren van de expressie.
Dit model met de bijhorende visuele representaties werd toegepast in een singleplayer context om enkele mogelijkheden van de visuele technieken te demonstreren. Deze applicatie is Compass\textsuperscript{1}, een singleplayer game waarin een gedetailleerde visualisatie van angst (en het overwinnen van angst) centraal staat. Deze visualisatie maakt gebruik van World appearance en Camera attributes om het gevoel van angst uit te drukken en is niet controleerbaar door de speler. Aan het begin van het spel is de speler gegrepen door angst, afgebeeld door een zeer donker zicht op de wereld. Naarmate de speler meer angsten overwint wordt de wereld helderder (Figuur 94). Angsten worden overwonnen door over een angst object heen te wandelen, waarbij er een onaangename animatie en geluid wordt afgespeeld (Figuur 95).

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure94}
\caption{Visuele representatie van het overwinnen van angsten in Compass.}
\end{figure}

\begin{figure}
\centering
\begin{subfigure}{0.4\textwidth}
\includegraphics[width=\textwidth]{figure95a}
\caption{Een angst object.}
\end{subfigure}
\begin{subfigure}{0.4\textwidth}
\includegraphics[width=\textwidth]{figure95b}
\caption{Visuele representatie van het overwinnen van een angst.}
\end{subfigure}
\caption{Angst in Compass.}
\end{figure}

\textsuperscript{1} Linsey Raymaekers, Compass: \url{https://linseyray.itch.io/compass}
TESTOMGEVING

Voor uitvoering van de online survey en user test werd er een testomgeving ontwikkeld. Hierin heeft de speler controle over welke emotionele staat hij toont aan andere spelers. Deze staten zijn: Kwaad, Gelukkig/Opgewonden, Kalm en Droevig (Figuur 96). Ze maken gebruik van Avatar appearance, World appearance en Avatar movement om de emoties visueel over te brengen, en zijn gebaseerd op mentale associaties met deze emoties. Elke staat heeft een eigen kleur, bewegingssnelheid en pulseersnelheid. Zo is Kwaadheid rood, met een hoge (maar erratiche) bewegingsnelheid en een hoge pulseersnelheid. Gelukkigheid / Opgewondenheid is geel, met soepele beweging en hoge pulseersnelheid. Kalmte is groen, met een normale bewegings- en pulseersnelheid. Droevigheid is donker, met trage bewegingen en pulseringen. De speler kan tussen de staten wisselen door de linkermuisknop in te houden, waarbij er een UI element verschijnt met de beschikbare staten. Door de muisknop los te laten boven een bepaalde staat wordt deze geselecteerd.

Figure 96.: Gerealiseerde emotionele staten.
Hiernaast werden er ook vijf discrete symbolen geïmplementeerd dewelke gebaseerd zijn op veelgebruikte emoticons en stripsymbolen (Figuur 97). Deze bestaan uit: Vraagteken, Uitroepteken, Hartjes, Zweetdruppel en UitpuilendeAders.

Figure 97.: Geïmplementeerde discrete symbolen.

Merk op dat de visualisaties binnen deze testomgeving slechts een voorbeeld zijn van hoe emotie expressies geïmplementeerd kunnen worden aan de hand van de voorgestelde visuele kanalen en modellen. De online survey en user test onderzoeken het gebruik van deze set signalen in de context van player-to-player communicatie.

ONLINE SURVEY

De survey werd online verspreid en had 82 deelnemers (46 deelnemers mannen, 32 vrouwen en 4 anders). De survey bestond uit drie delen: het onderzoeken van 1) de effectiviteit van de vier emotionele staten, 2) het overbrengen van emotie intensiteit binnen deze staten en 3) het overbrengen van eerder genuanceerde emoties. Elk deel maakte gebruik van video clips genomen binnen de testomgeving. In deze video clips was telkens een avatar te zien met bepaalde visuele signalen (zoals hierboven).

Uit deel 1 werd afgeleid dat de representaties van de vier emotionele staten door de meeste deelnemers zoals bedoeld werden geïnterpreteerd (Figuur 98). Hiervoor werden vier video clips getoond, 1 video clip voor elke staat. Opvallend was dat antwoorden per staat verdeeld waren over twee verschillende staten, zoals Kwaad die zowel als Kwaad als Opgewonden aangeduid werd. Hieruit bleek dat de representaties nog verbeteringen nodig hebben om de miscommunicaties te voorkomen.
Figure 98.: Samenvatting van de antwoorden uit deel 1: emotionele staat.

In deel 2 werden drie verschillende rankings van elk drie video clips getoond, dewelke de deelnemers telkens moesten rangschikken volgens ‘meest’ tot ‘minst’ Kwaad, Opgewonden of Droef Figuur 99. Hieruit werd afgeleid dat het bewegingsgedrag van het karakter een sterkere invloed heeft op de interpretatie van emotionele intensiteit dan de geïmplementeerde staten en symbolen.

Figure 99.: Antwoorden voor deel 2: emotionele intensiteit.

In deel 3 ten slotte werden verschillende video clips getoond en moesten de deelnemers antwoorden in hoeverre ze deze clips associëerden met de emotiewoord- den Nieuwsgierigheid, Verwarring Voorzichtigheid, Frustratie en Nood. Elke video clip had een bepaalde emotie die het trachtte over te brengen. Deze video clips slaagden grotendeels in om deze emoties over te brengen (Figuur 100). Hieruit bleek dat vooral de symbolen geschikt zijn om de gekozen emotiewoord- den uit te drukken, afhankelijk van de manier waarop ze gecombineerd werden met de staten en bewegingsgedrag.
Er waren 14 deelnemers in de user test (8 mannen, 6 vrouwen). Het voornaamste doel van de user test bestond erin te onderzoeken of, gegeven bepaalde emotiewoorden als instructie, gebruikers deze correct konden communiceren aan een observerende gebruiker. Hiertoe werden ze in twee groepen opgedeeld waarbij elke groep drie emotiewoorden als instructie kreeg. Hierna hadden de gebruikers controle over de testomgeving om de gegeven emoties uit te voeren, dewelke opgenomen werden binnen de testomgeving. Tot slot bekeken de deelnemers een opname van de expressie van een gebruiker van de andere groep, en moesten ze deze interpreteren. De gebruikers vulden ook een vragenlijst in over het gebruik van de testomgeving en hun interpretaties van de individuele staten en symbolen.

Uit een totaal van 41 expressies (groep A: Excited, Sad, Affectionate en groep B: Angry, Curious, Cautious) werden 19 expressies correct gecommuniceerd. Dit hield in dat de interpreterende gebruiker de geobserveerde expressie in de letterlijke woorden omschreef als de gegeven instructie. 10 van deze expressies werden als een gerelateerde emotie omschreven, en 12 werden geheel fout overgebracht. Zie hiervoor Figuur 101 en Figuur 102. Hiernaast werden nog vele andere observaties gedaan, waarvoor verwezen wordt naar de volledige tekst.
Figure 101.: Totaal aantal expressies omschreven als de bedoelde emotie, als een gerelateerde emotie, en als een compleet ongerelateerde emotie.

Figure 102.: Detailfiguur. Omschrijvingen geteld als “gerelateerd” zijn: Curious als “confused” (4), Cautious als “scared” (2) en “doubt” (1), Excited als “happy” (1), “attention-seeking” (1) en “friendly” (1). 1 expressie van Sad werd niet in acht genomen.

De oorzaak van de 12 miscommunicatie gevallen was vooral te wijten aan verschillende interpretaties van individuele signalen door de uitvoerende en observerende gebruiker. Zie Figuur 103 en Figuur 104. Vooral de symbolen waren oorzaak van miscommunicatie, in het bijzonder het ZweetDruppel symbool. Dit werd vaak als “traan” omschreven (en vooral door de gebruikers in de groep met instructie “Sad”).
Figure 103.: Oorzaken van miscommunicatie per instructie.

<table>
<thead>
<tr>
<th>cue</th>
<th>#</th>
<th>intended meaning</th>
<th>Interpretation</th>
<th>Instruction influence</th>
</tr>
</thead>
<tbody>
<tr>
<td>QuestionMark</td>
<td>2</td>
<td>curious</td>
<td>doubt</td>
<td></td>
</tr>
<tr>
<td>ExclamationMark</td>
<td>1</td>
<td>anger</td>
<td>excitement</td>
<td>yes</td>
</tr>
<tr>
<td>SweatDrop</td>
<td>4</td>
<td>tears</td>
<td>stressed, confused, doubt</td>
<td>yes</td>
</tr>
<tr>
<td>PoppedVeins</td>
<td>2</td>
<td>anger</td>
<td>“don't know”</td>
<td></td>
</tr>
<tr>
<td>Red</td>
<td>2</td>
<td>anger</td>
<td>love, excitement</td>
<td>yes</td>
</tr>
<tr>
<td>movement</td>
<td>1</td>
<td>no intention</td>
<td>carefull</td>
<td></td>
</tr>
</tbody>
</table>

Figure 104.: Specifieke signalen die miscommunicatie veroorzaakten. Getoond zijn het aantal keer dat het signaal een miscommunicatie veroorzaakte, de bedoelde emotie van de uitvoerende gebruiker, de interpretatie van de observerende gebruiker, en of het waarschijnlijk is dat de instructies een rol hebben gespeeld in het verschil in interpretatie.
CONCLUSIES


Een set van vier emotionele staten en vijf discrete symbolen werden geïmplementeerd in een testomgeving. Aan de hand hiervan werd er een online survey en user test uitgevoerd. Deze gaven dieper inzicht in het gebruik van deze signalen met als doel emotie expressie.

Uit de survey bleek dat de geïmplementeerde emotionele staten er goed in slaagden de bedoelde emoties over te brengen. De symbolen waren niet zo effectief in het overbengen van emotie intentisiteit, maar het gebruik van bewegingspatronen bleek hier wel zeer geschikt voor. Symbolen waren dan weer wel effectief in het communiceren van bepaalde genuanceerde emotiewoorden, zoals Nieuwsgierigheid, Verwarring en Voorzichtigheid, afhankelijk van de staten en bewegingspatronen waarmee ze gecombineerd werden.

In de user test was gemengd succes ondervonden in het communiceren van specifieke emoties van gebruiker tot gebruiker (in de survey stelde de auteur de geobserveerde video clips op). Er was echter wel voldoende resultaat om te concluderen dat het gebruik van visuele signalen voor emotie expressie een waardig onderzoekspad is.

Een grote uitdaging hierin is onder andere het voorkomen van miscommunicatie, wat tijdens de user test vooral te wijten was aan verschillende omschrijvingen van individuele signalen. Andere uitdagingen zijn het onderzoeken van meerdere visuele representaties, aangezien de geïmplementeerde signalen hier slechts beperkt waren. Zo ook het gebruik van verschillende inputmodaliteiten. Mogelijk verder onderzoek kan zich dus tot deze gebieden richten.
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Voor akkoord,

Raymaekers, Linsey

Datum: 2/02/2017