



What is the title of this thesis?

The title of this thesis is:
The journey of Developing an Embodied virtual genetic counsellor.
From concept to assessment

Who is the author?

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For which study program?

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When was the thesis finished?

The thesis finished in **April 2024**

ABSTRACT

In this master's thesis, the central question revolves around the concept of "embodiment" within the context of a virtual genetic counsellor. To begin, it is essential to clearly understand what "embodiment" means in this specific context. This foundational step lays the groundwork for the subsequent research.

To gain insights into the preferences and expectations of potential users, focus group discussions were conducted. These discussions served as a platform for individuals to share their perspectives and experiences related to genetic counselling.

A thematic analysis was undertaken following the data collection from the focus group discussions. This analytical process aimed to uncover the fundamental and implicit needs and desires of individuals interacting with a virtual genetic counsellor.

The research progressed to a practical phase. An interactive prototype of the virtual genetic counsellor was developed. This prototype represented the envisioned counsellor, incorporating the insights gained from the focus groups and thematic analysis.

To evaluate the prototype, task-based evaluations were conducted. These sessions provided valuable feedback and shed light on areas that required refinement.

Finally, the research culminated in a comprehensive analysis of the evaluation results, to draw conclusions about the ideal embodiment of a virtual genetic counsellor.

PREFACE

Dear Reader,

Welcome to my Master thesis for the study of Interaction Technology at the University of Twente. I am excited to share the insights I have gathered during my research on virtual genetic counselling technologies as part of the eCG project.

Through co-creation sessions, I engaged with users to identify their needs, which guided the creation and testing of a virtual genetic counsellor prototype. This thesis emphasizes on the embodiment of a virtual genetic counsellor which fits the needs of the general population.

I am grateful for the support of my thesis committee, friends, and family, who have been instrumental in shaping this work. I hope this thesis contributes meaningfully to the field and sparks further exploration in this intriguing area.

Thank you for joining me on this journey.

Have fun reading,

Sam Loys Freriks

University of Twente

Wednesday, 10 April 2024

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GLOSSARY

At-risk relatives: Relatives of the index patient who are at high risk of carrying the genetic mutation for the specific condition in question.

Clinical geneticist: The specialist in clinical genetics diagnostics of (possible) hereditary disorders, giving genetic counselling to individuals, and families.

This term also refers to nurse specialists, physician assistants or genetic counsellors working in a clinical department.

Embodied conversational agent (ECA): Embodied conversational agents are computer-generated cartoonlike characters demonstrating many of the same properties as humans in face-to-face conversation, including the ability to produce and respond to verbal and/or nonverbal communication.

eCG Project: eCG Project is an abbreviation for “Electronic Cardiovascular Genetic family clinic project”. The eCG Project is the underlying project for this thesis.

First-degree relatives: The index patient's children, brothers/sisters and parents.

Genetic counsellor: A genetic specialist who works directly with patients and families, offering genetic/genomic information and support to make health decisions.

Index patient: The person in the family diagnosed with a genetic condition.

Inquirer: The at-risk relative who seeks consultation with a clinical geneticist for genetic counselling or assessment.

Pedigree: A chart that diagrams the inheritance of a trait or health condition through generations of a family. The pedigree mainly shows the relationships among family members and indicates which individuals have a feature (s) of interest when the information is available.

Relatives: Refers to blood relatives, excluding adopted or in-law family members, but includes children of sperm or egg donors.

Second-degree relatives: Grandchildren, children of (half) brothers/sisters, uncles/aunts, and grandparents of the index patient.

UMC Utrecht: UMC Utrecht is an abbreviation for University Medical Centre Utrecht.

Virtual assistant (VA): A digital tool or program designed to provide information, guidance, and support to individuals and families. Virtual assistants like the Virtual Genetic Counsellor (VGC) can offer genetic and genomic information to assist in making health-related decisions.

Virtual genetic counsellor (VGC): The virtual genetic counsellor is a virtual assistant which offers genetic/genomic information and support to make health decisions.

1 INTRODUCTION

This thesis is in collaboration with the Electronic Cardiovascular Genetic family clinic project, also called the eCG project. The eCG project is in collaboration with the University of Twente and University Medical Centre Utrecht (UMC Utrecht). This chapter introduces the context of the eCG project and gives an overview of what is discussed in the remaining chapters.

1.1 CONTEXT OF THE ECG PROJECT

The core of the eCG project revolves around providing information about inherited heart diseases to the at-risk relatives of the so-called index patients. In this case, an index patient has a confirmed inherited heart condition. A digital platform is being developed to inform at-risk relatives about conditions and consequences. Part of this digital platform is a VGC (Virtual genetic counsellor), a VGC in the context of this thesis VA (virtual assistant) specifically for genetic information. The VGC is the main topic of this thesis.

The role of this VGC is the role of a genetic counsellor; the VGC will ask questions and provide information to at-risk relatives as a real-life genetic counsellor would. The goal of this role is that with the provided information, the at-risk relatives gain enough knowledge to make an informed decision about whether to take further medical actions. For example, further actions could include DNA testing or regularly making an appointment with a cardiologist.

Depending on the personal wants and needs of the at-risk relatives, the VGC should be able to change the formulation of the wording and ask different questions. The wants and needs of the at-risk relatives could depend on their age, knowledge of the subject, and preferred language.

The VGC should also be able to track if the at-risk relative has any questions or feels uncomfortable about a specific topic. For example, this could be done by asking the at-risk relative if any questions are left after discussing a particular topic. Another example could be that before starting a new topic, the assistant asks if the at-risk relative feels comfortable talking about that topic. The goal of collecting this information makes it so that a real-life genetic counsellor can use this information in a follow-up meeting.

1.2 PROBLEM STATEMENT AND RESEARCH QUESTIONS

The eCG project aims to address the issue of low attendance at current genetic counselling sessions and the shortage of genetic counsellors by developing a virtual genetic counselling solution for patients with a high risk of a genetic heart condition.

The aim of this thesis is to create and evaluate a visual design of a virtual genetic counsellor that can inform at-risk relatives about genetic conditions. The visual design of the virtual genetic counsellor will be created based on the opinions of the general population on the preferred levels of the aspects of embodiment. To create a well-informed design, the following research question has been created.

“Which different levels of the aspects of embodiment should be used in the visual design of a virtual genetic counsellor, according to the preferences of the general population?”

As this research question covers a large topic, three sub questions have been created which together help answer the main research question. The sub questions are as follows:

- What are the different aspects of embodiment and into which levels can these aspects be divided?
- Which levels of the aspects of embodiment are preferred by the general population in the context of a virtual genetic counsellor?
- How do the identified requirements of the virtual genetic counsellor, obtained during the co-creation session, align with the preferences and feedback of users during the prototype evaluation?

1.3 REPORT ORGANISATION

The remainder of this report is organised as follows. Chapter 2 contains the results from the preliminary research topics and hereby provides background information about virtual genetic counsellors and the genetic counselling process.

Chapters 3, 4, and 6 are dedicated to the three sub-questions, each chapter covers the methods, results, findings and a conclusion and discussion. Chapter 5 consist of the development process of the prototype.

Chapter 7 contains discussion of this thesis. Chapter 8 contains the conclusion of this thesis. The chapters are followed by the references the appendix and the annexes.

2 BACKGROUND INFORMATION

Preliminary to this thesis, a study (research topics) was conducted on the topic of virtual genetic counselling. The research topics covered information regarding genetic counselling, state-of-the-art patient-facing virtual healthcare counselling assistants and the evaluation of patient-facing virtual healthcare counselling assistants. This chapter will summarise the research topics to get the reader up to speed with the conclusions and background knowledge.

This chapter is divided into three subchapters, each corresponding to a main chapter from the research topics. The first subchapter provides an overview of the current genetic counselling setup at UMCU. The second subchapter examines the state-of-the-art solutions for virtual genetic counselling. Finally, the third subchapter looks at the various evaluation methods that can be used to evaluate virtual genetic counselling solutions. Together, these subchapters provide a comprehensive summary of the preliminary research topic.

2.1 INFORMATION ON GENETIC COUNSELLING

This section will introduce the concept of genetic counselling. First several important concepts of genetic counselling will be described, followed by the procedure before the genetic counselling session, followed by a description of a genetic counselling session and ending with information about what happens after a genetic counselling session.

2.1.1 Important aspects of genetic counselling

There are several important aspects to understanding the predictive DNA research process. The following will give an overview of the most important aspects to better understand the context of predictive DNA research.

DNA research involves autonomy, the right to know, and the right not to know. Autonomy means that the decision to undergo DNA research is made by the person who will undergo it. The right to know means people have the right to know if they have a genetic mutation. The right not to know allows people to refuse DNA research. Undergoing DNA research should be the informed decision made by the person who will undergo the research. As conflicts can arise when the right to know conflicts with the right not to know, it is the task of clinical geneticists to ensure autonomous decisions are made regarding DNA testing.[1, p. 6].

Secondly are the aspects of treatability. Treatability refers to whether a genetic condition has available treatments. Preventive treatments can help prevent, delay, or lower the risk of complications from genetic conditions. Early diagnosis and regular check-ups may increase the success of treatments. DNA research can lead to health benefits if a genetic condition is treatable. In addition, research may provide peace of mind or influence lifestyle choices for untreatable conditions.[1, p. 7].

Thirdly is the aspect of the reliability of the DNA test. The reliability of the test should be optimal. Therefore, DNA research is only allowed if a relative has been diagnosed with the condition to ensure better conformation. Besides the reliability of the test, the predictive value of the test can differ between genetic conditions. The predictive value refers to the chance of getting medical complications while having the mutation. Therefore, during the counselling session, the geneticist

should inform the inquirer about the predictive value of the DNA research on the specific condition [1, p. 8].

Fourth is the aspect of motivation. Although the severity of the condition plays a big part in wanting to conduct DNA research or not, several personal factors can also motivate in wanting to conduct DNA research [1, p. 9].

2.1.2 Before the genetic counselling session

Guidelines are available to uniform the process from detecting a genetic condition until the at-risk relatives are informed. The following will summarise the most important guidelines to overview this process. [2]

The process starts with the index patient. An index patient refers to a patient with a confirmed genetic cardiovascular condition. From the moment the patient is diagnosed with a genetic cardiovascular condition, the patient is referred to as the index patient. Relatives of the index patient are therefore called at-risk relatives.

The index patient and the clinical geneticist will identify at-risk family members together. During this process, the clinical geneticist will construct a family tree of the index patient. This family tree consists of first and second-degree relatives. The family tree should be expanded to include additional relatives if the genetic condition has also been found in an at-risk relative. In some cases, when the condition has high severity, the family tree gets expanded to cover all relatives with a 25% chance or higher.

Once the at-risk relatives have been identified, the index patient and clinical geneticist discuss how to inform them. Psychological help is available. The index patient is preferred to inform relatives themselves, and parents to inform children. If the index patient does not want to inform at-risk relatives, the clinical geneticist may do so, breaking client confidentiality if necessary, depending on the health danger of the at-risk relative's [2, p. 33].

If the index patient chooses to inform at-risk relatives themselves, a timeframe will be set. If not all at-risk relatives have been informed, the clinical geneticist will help with a plan of approach or inform remaining relatives [2, p. 68].

Family letters are used to inform at-risk relatives about a possible mutation. In addition, these letters provide information on the condition, treatment and prevention options, and how to contact the health clinic. They also have additional information or resources to prepare for a genetic counselling meeting and a sign-up form that a family doctor can sign as a referral to genetic clinics [2, p. 124].

After receiving the information letter, it is the choice of the at-risk relative to decide if they want to pursue further actions. Suppose the at-risk relative decides to attend a genetic counselling session. In that case, he/she will make an appointment with a genetic counsellor for a counselling session. Some at-risk relatives decide not to attend a genetic counselling session; for them, this is the end of the process. However, the at-risk relatives can change their minds and attend a counselling session at another moment.

2.1.3 The genetic counselling session

Because the at-risk relative has no confirmed mutation during the genetic counselling session, the at-risk relative is referred to as an inquirer instead of a patient. During the counselling session, the genetic counsellor will inform the inquirer about the genetic condition and the potential

consequences the condition might give or can give in the future. To get a better overview of the personal situation and adequately inform the inquirer, the genetic counsellor asks for personal information about the inquirer during the session.

How the conversation develops depends on the patient and the genetic counsellor. However, several topics are standard in all counselling sessions. A list of important topics is available during counselling sessions as a guideline for genetic counsellors. However, because there are many different genetical conditions, not all topics are always relevant. Depending on the professional opinion of the clinical geneticist, the conversation can deviate from the guidelines. The following lists these topics to give an impression of the counselling sessions. [1, p. 3]

- The condition's characteristics, symptoms, debut age, and treatability.
- Genetical aspects of the condition.
 - Incursion, the chance of getting symptoms with the genetic condition.
 - Modification, the risk of mutation on first-degree relatives.
- Personal motivation to conduct genetic research.
 - Why now?
 - Sanity compared to the psychological load of the research.
- The attitude of the partner/others that are important for the inquirer about the research.
- Expected benefits of the DNA research.
- Consequences of a favourable or unfavourable result with regards to:
 - personal well-being
 - relationships with family and others
 - professional practice
- Possibility of social stigma
 - restrictions on access to life insurance / other insurance
 - laws about the genetic condition.
- Consequences concerning wish for children.
- Privacy aspects, e.g., information to third parties.
- Presence of a safety net, who will be there for support in case of an unfavourable result.
- State of affairs during the research, the communication of the results, the reporting.

This counselling phase ends with formal permission for the inquirer to start the DNA research, but only if the clinical geneticist is convinced that the inquirer has a solid understanding of the DNA research and is mentally capable of conducting DNA research [1, p. 12]. It is essential to know that steering the inquirer in a specific choice is not the intention of the genetic counselling meeting. The decision to conduct DNA research should be entirely up to the inquirer.

2.1.4 After the genetic counselling session

After the counselling session, the inquirer can decide whether to conduct DNA research or not.

Suppose the inquirer decides to continue with DNA research. In that case, the patient will be invited to the health clinic to take a blood sample and start the research. The period between starting the DNA research and getting the result is usually very tense or scary for the inquirer. Once the research is complete, the inquirer gets a phone call from the healthcare provider with the results. There are several outcomes from the test. At first, the test could be negative, meaning no genetic mutation is found. Therefore, the patient will not have to take further steps with a negative result. Secondly, the test results could be positive. In the case of a positive result, the patient is diagnosed with a genetic mutation. The third option is an unknown answer; with this, the research could not

conclude if the patient has a genetic disorder. The medical treatment can start if the patient gets a positive test result, however, this is not mandatory. If the patient does not want to begin medical treatment, it is strongly advised to schedule periodic check-ups with a cardiologist.

Alternatively, the at-risk relative can decide not to go for DNA testing. In that case, there is the possibility of scheduling periodic check-ups with a cardiologist.

2.2 STATE-OF-THE-ART GENETIC COUNSELLING ASSISTANTS

This section will summarise the findings after analysing ten virtual genetic counselling assistants. The chapter's goal from the research topics was to identify key characteristics of these assistants that can be used to compare and evaluate them. Therefore, ten state-of-the-art virtual counselling solutions were selected for analysis. The solutions that were analysed are as follows:

1. Genetic information assistant (GIA) [3] [4]
2. ROSA [5]
3. EDNA [6]
4. AI [7]
5. Genomics ADviSER [8]
6. Genetic Adviser [9], [10]
7. Virtual counsellor for knowing your family history (VICKY) [11]
8. Adaptive pedagogical agent [12], [13]
9. Virtual nurse [14]
10. Chatbot mental health [15]

From the analysis, it is concluded that most papers use terms made by the authors to describe different aspects of the solution, making it difficult to compare the solutions. Because of this, several definitions for comparing the solutions have been created in the research topics which can be used for classification. This classification allows for direct comparison between the solutions. The following subchapters explain the different classifications that have been created for the research topics.

2.2.1 Types of solutions

The research topics identified three main types of virtual counselling solutions: chatbots, embodied conversational agents, and digital platforms. The different types are mostly defined by the user's interaction possibilities and the solution's overall UI design. First are the chatbots. In chatbots, the overall design looks like most chat applications where the information is shown in "text bubbles", and the interaction feels mainly like a conversation. Secondly, there are embodied conversational agents. Embodied conversational agents mostly have an embodiment beyond just a static illustration, and the user interface's main emphasis is on the embodiment. Thirdly are the digital platforms. The digital platforms mostly do not have an embodiment and have an interaction where the user goes through predefined steps to receive the information. The design of the digital platforms is mainly like a survey with various questions and various information sources.

2.2.2 Steps in the counselling process

It is concluded that virtual counselling solutions vary in their coverage of the counselling process, with some being comprehensive and others focusing on specific steps. The study classified the counselling process into two main categories: pre-test and post-test, referring to steps that occur before and after genetic testing. Table 1 was created listing all the steps addressed by the solutions, which is labelled (CS) for reference in the report, and the table is colour-coded to indicate pre-test and post-test. The table provides a comprehensive overview of the steps addressed in the solutions. The colours in the table indicate pre and post-test. The lighter the background colour, the more nested the topics are.

Table 1- Steps in the genetic counselling process – lighter versions of the same colour equal nested items

Pre-test (CS-1)	Intake (CS-1.1)	Gather personal information (CS-1.1.1)
		Collect family health history (CS-1.1.2)
		Construct family tree (CS-1.1.3)
		Give advice on if the patient is eligible for DNA testing (CS-1.1.4)
	Education (CS-1.2)	Genetic condition education (CS-1.2.1)
		Risk education (CS-1.2.2)
		Education about testing (CS-1.2.3)
	Guidance (CS-1.3)	Motivate patient to follow guidelines (CS-1.3.1)
		Answer open questions (CS-1.3.2)
		Quiz users about their knowledge (CS-1.3.3)
Show which categories the user has questions about (CS-1.3.4)		
Rereview given information (CS-1.3.5)		
Post-test (CS-2)	Results (CS-2.1)	Give an overview of the results (CS-2.1.1)
	Post-test education (CS-2.2)	Give information about future actions. (CS-2.2.1)

Legend Table 1:

	Pre-test
	Post-test

2.2.3 Modality

In the state-of-the-art solutions, several modalities are used. Table 2 below has been created by ordering all the modalities present to represent better which modalities are used. The different modalities are labelled (prefixed with MO for modality) to be referenced in the remainder of the report. The yellow background colour refers to input modalities, and the orange background colour refers to output modalities. The lighter the background colour, the more nested the item.

Table 2 - Overview of used modalities in the identified solutions – lighter versions of the same colour equal nested items

Input (MO-1)	Touchscreen or Keyboard/mouse (MO-1.1)	Buttons (MO-1.1.1)	Likert scale buttons
			True false buttons
			Buttons with text
		Open text (MO-1.2.2)	Type open questions
			Provide text input to answer specific question

	Speech (MO-1.2)	Open speech input (MO-1.2.1)	Asking open question through speech
Output (MO-2)	Textual (MO-2.1)	Providing information (MO-2.1.1)	Provide information in the form of text
		Gathering information (MO-2.1.2)	Ask questions in the form of text
	Graphical (MO-2.2)	Images (MO-2.2.1)	Graphs to visualise numeric data
			Images to support information
		Videos (MO-2.2.2)	Videos for information delivery
		Embodiment (MO-2.3.1)	Hand gestures
	Non-verbal ques		
	Facial expressions		
	Posture shifts		
	Audio (MO-2.3)	Synthetic speech (MO-2.3.1)	Providing information with synthetic speech
Audio paired with video (MO-2.3.2)		Audio to support video	

Legend Table 2:

	Input modalities
	Output modalities

2.2.4 Embodiment

There are several different types of embodiments found in the solutions. All kinds of embodiment differ slightly from each other. What can be seen from the solutions is that specific embodiments have more features to express themselves than others. Using the observations, four different levels of embodiment have been made to classify the embodiment. The classes have been constructed by observing the different solutions with their embodiment and the capabilities of the embodiments. The following classes have been constructed: no embodiment, slight embodied, moderate embodied and highly embodied. With this classification system, all solutions fit into a particular classification. Table 3 below explains the criteria used to classify an embodiment.

Table 3 - Embodiment classification

Type of embodiment	Definition
No embodiment	No embodiment available
Minimal embodiment	There is a visual embodiment available. The visualisation is static and does not change during the conversation
Moderate embodiment	Embodiment has different states and changes visually during the conversation. The embodiment can express certain facial expressions.
High embodiment	Embodiment is animated so visual changes are smooth. Embodiment can use non-verbal gestures to provide information.

2.2.5 Interactions

The interaction of a solution is highly dependent on the other aspects of the solution. The interaction depends on the embodiment, modalities, steps, and type of solution. However, despite all these differences, one common factor exists between the interaction patterns. The interaction the user has with the platform is either open or closed. A closed interaction is where the user cannot ask open questions. In this case, the user can only choose between predefined answers. An open interaction refers to an interaction where the user does have the ability to ask any question.

2.2.6 User interface

The type of solution is apparent when looking at the user interface design. The chatbot-type solutions all look like regular chat apps where information is provided in chat bubbles, and the user can interact with the chat input field and /or chat buttons. The digital platforms consist of a multi-page survey look and feel where the user interacts with buttons in the survey. The embodied conversational agents consist of a character on the screen's left side, with some buttons on the right side of the screen for the user to interact with. Between designs of a particular type, there is not much difference in the designs. It can also be noted that some solutions were specifically designed for mobile, some for desktop, and several were responsive to mobile and desktop.

2.3 EVALUATION OF GENETIC COUNSELLING ASSISTANTS

This chapter will summarise the findings of the research topics regarding the evaluation of genetic counselling assistants. The aim is to get an overview of which aspects of state-of-the-art patient-facing virtual healthcare solutions are evaluated and how they are evaluated. This information is important as, with the created overviews, informed decisions can be made during the development of a new virtual assistant.

At first, a classification of evaluation aspects was created. Table 4 divides the aspects into three main categories, performance, user, and knowledge-related aspects. To better specify these aspects, these aspects have nested sub-categories. These aspects have been chosen to cover all the evaluation aspects used in the solutions.

Table 5 classifies the different evaluation methods. The nested items in the table explain how the evaluation method can be used. All the explanations come from the various literature used in the analysis of the research topics. Most studies made their own evaluation measurement to fit their need. For example, EV-7.1.2, was only used in a single study, and was constructed by the researchers of that study.

Table 6 gives an overview of which evaluation methods can measure specific aspects of the solution. As seen from Table 6, most evaluation methods are specific to a single aspect of evaluation. However, only EV-2.1 and EV-2.2 are used for multiple aspects of evaluation. This can be explained by the fact that EV-2.1 and EV-2.2 are comparative evaluation methods which can be executed in various ways.

Table 4 - Classification of evaluation aspects - lighter versions of the same colour indicate nested items.

Performance related aspects (AP-1)	Accuracy of answering questions (AP-1.1)
	Accuracy of generated content (AP-1.2)
User related aspects (AP-2)	Usability/ acceptability (AP-2.1)
	Experience/ satisfaction (AP-2.2)
	Duration of conversation (AP-2.3)
Knowledge related aspects (AP-3)	Health literacy (AP-3.1)
	Knowledge about genetic condition (AP-3.2)

Legend Table 4:

	Performance related aspects
	User related aspects
	Knowledge related aspects

Table 5 - Classification of evaluation methods - lighter versions of the same colour indicate nested items.

Expert opinion (EV-1)	Manually measure the answers given by the system with the help of an expert. (EV-1.1)	
Comparative evaluations (EV-2)	A/B testing (EV-2.1) Comparing two versions of the same system.	Comparing two versions of the system to measure the difference in duration of the conversation. (EV-2.1.1)
		Compare the health literacy gain between multiple versions of a system (EV-2.1.2)
		Evaluate knowledge gained between versions of the system. (EV-2.1.3)
		Evaluate experience between versions of the system, one group interacts with version 1, and the other group interacts with version 2 (EV-2.1.4)
	Gold standard evaluation (EV-2.2) Comparing the system with an industry standard.	Using multiple test scenarios, compare the generated pedigree with that of a genetic counsellor. (EV-2.2.1)
		Comparing the systems generated pedigree with the generated pedigree that of an already proven system (EV-2.2.2)
		Comparing the duration of the conversation between the solutions with a genetic counsellor (EV-2.2.3)
		Compare the health literacy gain between the system and that of a conversation with a genetic counsellor. (EV-2.2.4)
Focus group (EV-3)	Showing images of the prototype, afterwards asking the participants about their opinion of the prototype (EV-3.1)	
	Letting participants interact with the system while thinking aloud, gathering various insights into the system (EV-3.2)	
User testing (EV-4)	Participants test the system in their environment without interruptions, observers and moderators (EV-4.1)	
Formal usability testing (EV-5)	In formal usability testing participants test the system by performing predefined tasks under observation. Formal usability testing is mostly followed by a series of questions asked by the observer. These questions can be about various aspects of the system (EV-5.1)	
Interviews (EV-6)	Cognitive interviews, in the cognitive interview the participants answer survey questions in the presence of an observer, using the think-aloud method, measuring how well the questions work (EV-6.1).	
	Semi-structured interviews, interviews about the experience of the user (EV-6.2).	
Retrospective surveys (EV-7)	Retrospective quantitative observational evaluation, at the end of the interaction the participants can give their opinion about the system using a point system. (EV-7.1)	Star rating system, participants can choose between 1 to 5 stars to evaluate their experience. (EV-7.1.1)
		Emoji rating system, participants can choose between three different emojis, sad (1 point), neutral (3 points) and happy (5 points), which can be used to measure the outcomes. (EV-7.1.2)
	Survey about satisfaction with healthcare decisions (EV-7.2)	
	Custom-made surveys to measure the experience with the solutions (EV-7.3)	

	Survey about the clarity, and length of the conversation. (EV-7.4)
	Surveys to measure the decisional conflict (EV-7.5)
Before and after interaction evaluation (EV-8)	Measure the level of health literacy before and after the interaction with the system using a survey. (EV-8.1)
	Custom-made survey to measure the knowledge gained. (EV-8.2)
Coding (post evaluation) (EV-9)	Transcribing and coding recordings of interactions to extract recurring themes. (EV-9.1)

Legend Table 5:











	Expert opinion		Interviews
	Comparative evaluations		Retrospective evaluations
	Focus group		Before and after evaluations
	User testing		Combined evaluations
	Formal usability testing		Coding

Table 6 - The aspects of evaluation and corresponding evaluation methods

Aspect	EV-1.1	EV-2.1	EV-2.2	EV-3.1	EV-3.2	EV-4.1	EV-5.1	EV-6.1	EV-6.2	EV-7.1	EV-7.2	EV-7.3	EV-7.4	EV-7.5	EV-8.1	EV-8.2	EV-9.1
Accuracy of answering questions (AP-1.1)	X																
Accuracy of generated content (AP-1.2)			X														
Usability/ acceptability (AP-2.1)				X	X	X	X	X					X				X
Experience/satisfaction (AP-2.2)		X							X	X	X	X		X			X
Duration of conversation (A-2.3)		X	X														
Health literacy (AP-3.1)		X	X												X		
Knowledge about genetic condition (AP-3.2)		X														X	

3 ASPECTS OF EMBODIMENT

In the context of this thesis, embodiment refers to how the virtual genetic counsellor is presented to the user. This chapter focuses on exploring the existing literature around embodiment of virtual assistants and conversational agents. By exploring the existing literature this chapter aims to provide an answer to the first sub-question of this thesis:

What are the different aspects of embodiment and into which levels can these aspects be divided?

The methods used to address this research questions will be discussed first, followed by the results, findings, and conclusion. Through a review of the relevant literature, this chapter seeks to provide an overview of the field and tries to create an overview and organized structure of the aspects of embodiment.

3.1 METHODS

The primary objective of this chapter is to explore the different aspects of embodiment and to categorize them into distinct levels. To address this sub-question, desk research has been conducted to explore existing literature around the definition and the aspects that define embodiment in virtual assistants.

The first step of conducting the desk research was to identify the relevant literature on the topic of “embodiment in virtual assistants” and “embodied conversational agents”. Even though the genetic virtual assistant is not exactly an embodied conversational agent, the term embodied conversational agent is used during the search for literature, as this term is associated with embodiment in this line of research.

Primarily two online databases have been used for this desk research, Google Scholar and IEEE Explore. The search criteria included the following keywords ‘embodiment’, ‘embodied virtual assistants’, ‘aspects of embodiment’, ‘axis of embodiment’, ‘visual design of embodiment’, ‘embodiment in embodied conversational agents’, ‘structure of embodiment’, ‘embodied chat systems’, ‘avatars’, ‘embodied avatars’.

The gathering of different literature was stopped once there was enough information found to construct an overview of embodiment, its aspects and the different levels of the aspects of embodiment.

The analysis of the found literature consisted of a review, which included reading and summarising the literature to identify a common theme. The findings were then organised to create an overview of the definition of embodiment and which aspects make an embodiment and which levels of these aspects exist. This was followed by findings examples for each aspect and evaluating their relevance to the main research topic of the thesis.

3.2 RESULTS

As the name suggests, embodied conversational agents are conversational agents with an embodied. Provoost, Lau, Ruwaard and Riper [16] define embodied conversational agents as *“more or less autonomous and intelligent software entities with an embodiment used to communicate with the user”*.

Embodied conversational agents are used in a wide range of applications in the real world. Several examples are interactive characters in video games, digital assistants on a web page or virtual assistants like Amazon Alexa.

Provoost et al. [16] state that embodied conversational agents (ECA) have three main components. First, there is the application interface. The application interface refers to how the ECA is displayed to the user. There is a variety of ways this can be done. The application interface can range from a web-based questionnaire to an application with real-time video and audio in- and output. Thus, the application interface mostly means the user can communicate with the ECA.

Secondly, ECA's rely on a computer model responsible for their “mental” capability. This computer model provides the user information based on its “observations” gathered from the application interface. There is a wide variety of these computer models. There are fairly ‘simple’ models like a small decision tree that outputs different responses based on the answers of a questionnaire, till very complex machine learning algorithms that can give very complex answers based on several input factors and which can change their response based on e.g., the emotion of the user, allowing the ECA to react empathically.

Thirdly, and for this thesis the most important factor, is the embodiment of the ECA. The embodiment part makes the difference between an embodied conversational agent and a regular conversational agent. The embodiment is the visual and audio representation of an ECA. The embodied allows the ECA to communicate verbally and non-verbally with the users. There are many aspects involved in creating the embodiment, and therefore there are many possibilities for different embodiments. For example, the embodiment can take the form of virtual human characters that appear on computer screens, such as in video games or virtual reality experiences. They can also be robots, physical machines programmed to perform various tasks. Additionally, embodiments can include multiple forms of communication, such as text messages, and more modalities, such as speech, gestures, and facial expressions.

As read above, according to Provoost et al. [16], there are three main core concepts of embodied conversational agents. The application interface (the agent part), the mental model (the conversational part) and the embodiment (the representation part). The mental model can quite easily be extracted from this equation, and it is easy to imagine an ECA which is either very complex or not so complex. However, the interface and the embodiment part are more tied together. It is only sometimes immediately apparent what aspects are the embodiment and what aspects are part of the application interface. Furthermore, many ECA's are digital on screen, the application interface might overlap with the embodiment. As a rule of thumb, the embodiment is really the representation of an ECA, and the application interface is a collection of in and outputs. Still, overlap can occur, and this definition is not strictly defined.

There are advantages and disadvantages to implementing different levels in the three aspects. For example, very advanced ECAs with multi-modal, real-time user input, a complex “mental” model, and a realistic embodiment can be more believable and engaging than “simple” ECAs. Still, the

complexity requires way more development time, greater technological expertise, and the chance of misinterpretation becomes more likely. “Simple” approaches with more simple graphics and fewer answering options are less time-consuming, less prone to errors, and have a less realistic experience. Therefore, there are many different trade-offs when an ECA needs to be developed for a specific task.

3.2.1 Aspects of embodiment

Now that the different parts of embodied conversational agents have been defined in the previous section, we can focus on the aspect of “embodiment”. Therefore, this subsection explains the various aspects that make up the embodiment level.

According to Ruttkay, Dormann and Noot [17], embodiment is built from multiple smaller aspects. As quoted from Ruttkay et al. [17], *“We use the term embodiment in a broad sense, for all low-level aspects which contribute to the physical appearance of the character, namely: body design and rendering, voice, head, face, hand gestures and body postures, the quality of the corresponding motions. Each of these aspects may have an effect on the perception of mental aspects of the ECA, or directly on the performance effect achieved by the ECA.”*

According to Ruttkay et al. [17] the embodiment itself can be split into two main categories, the look of the embodiment and the communication of the embodiment. The following will explain the details of this classification.

3.2.2 Look

At first there is the look of embodiment. The look of the embodiment can be divided into personification, physical details, realism, dimensions, and general deformability.

3.2.2.1 Personification

At first, there is personification, which refers to the “object” the embodiment represents. This personification can be a human being, another living creature or a non-living object. Most of the ECAs represent a human being, with the human being representing a professional in the context of the ECA, like a doctor or a sales professional. An example of human being personification is the ECA VICKY [11].

Secondly, there is personification in the form of another living creature. An example of another living creature could be the embodiment in the form of an animal like a bird. An example of a bird as embodiment is the popular app Duo Lingo, where the user interacts with a character embodied as a bird.

Lastly is the embodiment in the form of a non-living object. A well-known example of a non-living object as embodiment is Microsoft’s office assistant “Clippie”.

According to Ruttkay et al. [17] the benefit of having an embodiment as a non-human being is that it might be more appealing and entertaining, thus making it more engaging. Another advantage is that a non-human being might avoid users assuming and expecting highly intelligent mental capabilities. In a sense, a non-human creature might prevent disappointments in the mental capabilities of the ECA. On the other hand, a downside of a non-human creature is that people generally attribute more trust and intelligence to a human-like embodiment [18].

3.2.2.2 Physical details

The second aspect of the embodiment's look is the physical details. The physical details refer to which parts of the "body" are represented in the embodiment. The categories are head, head plus neck, torso, and full body.

The head is the most used part of an embodiment, the head provides the ability to add facial expressions and nonverbal cues to the embodiment. According to Ruttkay et al. [17], it is not true that "the more of the body is used, the better". It depends on the context of the ECA, and studies confirm that looking at an ECA is mostly focused on the ECA's face. However, adding a body, or at least a torso, allows the ECA to use its hands for pointing and additional non-verbal cues.

3.2.2.3 Realism

Realism refers to the styling of the embodiment. This can be very realistic (photo-like), artistic, or exaggerated cartoon-like. The embodiment can also consist of a combination of both, where the face has a different realism level than the rest of the body. As with many artistic features, there is an extensive range of possibilities between realistic and cartoon-like.

3.2.2.4 Dimensions

The factor of dimensions is fairly straightforward. The embodiment can either be 2D or 3D.

3.2.2.5 General deformability

The deformability refers to which aspects of the embodiment can be deformed. This can be the movement of the fingers, hands, or arms or a change in the shape of facial expressions. Highly deformable embodiments can 'bend' into multiple forms, while other rigged embodiments might not be able to move and stay in the same position all the time.

3.2.3 Communication

The second main aspect to describe embodiment is the aspect of communication. The main aspects divide how the ECA can communicate with the user. The sub-aspects of communication are language, textual or verbal output, facial display, hands, body and modality coordination and motion generation.

3.2.3.1 Language

The first aspect of communication is language. Several aspects are related to language, such as does the ECA use natural language, how rich the language is, how many different things the language can express and what the variations are. The language output may be generated through pre-defined samples or patterns or by an ML algorithm.

In some cases, the ECA can use language to reflect mental and personal characteristics to the user. Therefore, language plays a role in the ECA's personality and social aspects. The language of the ECA can also have cultural implications. For example, specific terms might only be used in certain cultural settings.

3.2.3.2 Textual or verbal

The second aspect of communication is the method the ECA uses to communicate. An ECA can use 'speech' or 'present' in communication. When 'speech' is the chosen method, a text-to-speech engine is often used to convert dialogue to speech. It is also possible that audio snippets are pre-recorded and used for communication. Snippets of pre-recorded audio could sound better than a text-to-speech engine. However, this limits ECA's sentences, as a text-to-speech engine can convert any sentence to speech. When choosing a text-to-speech engine, it is important to notice that many

factors determine the audio quality. The audio must be understandable, sound natural, and the 'voice' must fit the embodiment's other characteristics. A study by [19] has shown that these voice characteristics use enough for users to bind a certain personality to an ECA, thus inducing a different response by the user. Certain expressions can also be expressed using 'speech', intonations and speech rate, emphasis, and emotions. Some aspects of speech, like gap-filling sounds, breathing sounds, and laughter, could also be included in the 'speech' to create a more natural-sounding audio.

When the ECA 'presents' its communication instead of audio, it is often presented with text or text bubbles close to the embodiment. When numerical data needs to be presented by the ECA, text or tables/figures are often used. In some cases, the ECA supports textual and audio communication. An advantage of both textual and audio communication is increased accessibility, as people with either bad eyesight or bad hearing can still read or hear what the ECA is trying to communicate.

3.2.3.3 Facial display

The third aspect of communication is the 'face' or the ECA. The face can be used to express nonverbal cues. For example, if the ECA also uses speech, the face can use mouth movements to show certain expressions. The face can also be used to express emotions and cognitive states. A wide variety of little cues like eye movement, pupil movement, head movement, and eyebrow-raising can express a variety of expressions and be used to make the ECA feel more human-like. Research from [20] has shown that facial cues can successfully depict friendly and unfriendly aspects to the user. Specifically, on the eyes, the eyes' gaze is specifically important for expressing personality.

3.2.3.4 Hands

The fourth aspect of communication consists of the hands. The hands can show non-verbal cues, like pointing to a specific object or helping with expressive language. The precision from the hands can range from individual finger motion to effectively no motion in the hands.

3.2.3.5 Body

The fifth aspect of communication consists of the body and the movement of the body. Several aspects of the body can determine how realistic the embodiment might feel. This includes how well the body coordinates with the speech, hand movements and other modalities and having an idle state. The body can also represent the movement of the ECA, like walking, running, and sitting.

3.2.3.6 Modality coordination and motion generation

The sixth and last aspect of communication is the aspect of modality coordination and motion generation. This last aspect overlaps with the other aspects of the communication aspect. Modality coordination refers to how well the different modalities are coordinated. For example, how well the facial and hand movements are coordinated with speech. Motion generation refers to how the embodiment can move (show motion); this can be as simple as a set amount of state that will get swapped around, or a full dynamic modal that can bend and move into any position. An advantage of a full dynamic model is the wide range of motion. The disadvantage of a full dynamic model is that it is not predefined in which state the ECA will enter, so the ECA could make movements that would seem unnatural.

3.3 FINDINGS

Section 3.2 has defined the different aspects involved in creating the embodiment of an ECA. This section aims to provide additional information on these aspects by giving examples of these aspects, defining how the levels of the aspects can be defined and providing information about which aspects are relevant for this thesis and which aspects are out of scope for the visual design of the virtual genetic counsellor.

3.3.1 Looks – Personification

The personification can be subdivided into three options, human like personification, living creature personification and non-living object personification. For this reason, the aspect of personification can be subdivided into three **options**. The aspect of personification is relevant for the design of the virtual assistant, as it determines the building blocks of the visual design.

In the human like personification, the personification mimics a human being. At this level, several options are available: gender, age, clothing, skin tone and many more. Figure 1 gives an example of human like personification, a screenshot of the spanish virtual coach for knowing your family history (VICKY) [21].



Figure 1 - Human like personification

In the level of living creature personification, the personification is presented as a living creature, like an animal. Figure 2 gives an example of a living creature personification, the mascotte of Duolingo[22].

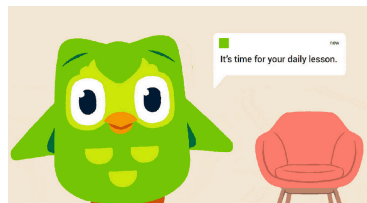


Figure 2 - Living creature personification

In non-living object personification, the looks of the embodiment represent a non-living object. A well-known example is the office assistant Clippy from Microsoft [23] , see

Figure 3.

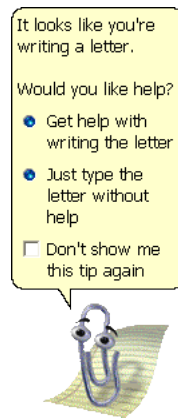


Figure 3 - Non-living object personification

3.3.2 Looks – Physical details

The physical details of the embodiment determine how much of the embodiment is visible to the user. The literature from the previous section determines that there are mainly four different levels in this aspect, for this reason the levels in this aspect can be subdivided into four different options to choose from. The options are head, head and neck, torso, and full body. The meaning is as the name suggests.

Figure 4 gives four examples of the different levels. The aspect of physical details is interesting for the visual design of the virtual genetic counsellor as this aspect determines how much of the design will be visible for the user.

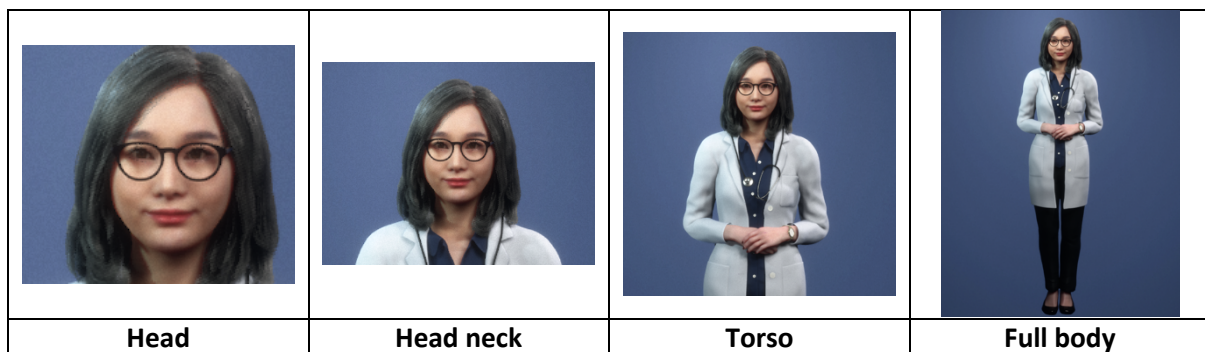


Figure 4 - Physical details, image from [24]

3.3.3 Looks – realism

The aspect of realism determines how realistic the embodiment looks like. As there are many different levels in this aspect, these aspects can be determined through a **scale** value, from most realistic to least realistic. In high realism, the representation aims to be as true to nature as possible. The less realistic, the more stylization will be part of the design. The aspect of realism is important for the visual design of the genetic counsellor, as it mostly determines how the overall realism of the virtual genetic counsellor should look like. Figure 5 gives an example of the different realism levels of the same drawing.



Figure 5 - Levels of realism [25]

3.3.4 Looks – dimensions

The aspect of dimension contains two levels, 2d and 3d, therefore the levels of this aspect can be divided into two **options**. 3D refers to the embodiment to be available in 3D, meaning there is a front, side, back, top and anything in between. 2D refers to a flat image. 3D is mostly achieved with a 3D model, while 2D is mostly an illustration. Figure 6 shows the famous character Mario represented in 2D and 3D for the purpose of giving a visual example.



Figure 6 - 2D vs 3D

3.3.5 Looks – general deformability

The aspect of general deformability refers to how many and which aspects of the embodiment can be deformed. For example, can every finger to moved individually or only the arm, or not at all? Another example would be a 3D character which can deform in any direction compared to a 2D illustration with multiple states. The aspect of general deformability can be divided as a **scale**, ranging from full deformability (animation) to no deformability (static).

3.3.6 Communication – language

The aspect of language refers to the richness of the language of the virtual genetic counsellor. As there is a wide range from very high richness to very low richness, the levels in this aspect can be divided using a **scale**. Very high richness can have expressive language, personal characteristics used in the language, the ability to create its own dialogue based on the conversation. Examples of very low, or a lack of richness can be only use of a predefined set of sentences, no emotions, no characteristics in the language.

3.3.7 Communication – language modality

The modality of the language refers to how the information is given by the virtual genetic counsellor towards the user. The literature defined three different levels in this aspect, namely verbal, textual and a combination of both. For this reason, the levels can be chosen using one of these **options**. The aspect of language modality will be of importance for the visual design of the virtual genetic counsellor, as the choice in level will determine if space for text should remain reserved in the design.

3.3.8 Communication – Facial display

The aspect of facial display determines if the face of the embodiment can express emotions, display non-verbal cues, or use the face for other expressions. As there is no defined set of options in facial display, the levels can best be determined using a **scale**. On one side of the scale, the high embodiment side, the facial display can express emotions, non-verbal cues and any other expression that can be made with the face. On the other side of the scale, the facial display cannot show any facial expression or non-verbal cues, mostly by having a static appearance. The aspect of facial display is important for the visual design of the virtual genetic counsellor as it can help determine how much detail should be put into the design of the face, and if multiple states should be created.

3.3.9 Communication – Hands

The aspect of hands refers to if the embodiment has hands, and what the embodiment can do with these hands. The levels in these aspects can be defined using a **scale**, ranging from full hand movements, which can be used to point or express non-verbal cues, to no hands/ hands which are not able to move. The aspect of hands is of importance for the visual design of the virtual genetic counsellor as it can help determine if the design should include hands, and if so, what the hands should be able to do.

3.3.10 Communication – body

The aspect of body refers to the movements of the body and the posture changes. There are no set options for the body movements, therefore the level can be defined using a **scale**. One side of the scale refers to full body movement, including showing posture changes, and the ability to move and relocate. The other side of the scale refers to no body movement or changes in body posture.

3.3.11 Communication – Modality coordination and motion generation

The aspect of modality coordination and motion generation refers to the range of motions and the coordination of the different aspects of embodiment. The levels in this aspect are divided using a **scale**. Ranging from fully coordinated animation between the different aspects of embodiment, and a dynamic embodiment that can use a wide range of motion, to uncoordinated motions that do not take the states of the other aspect of embodiment into account.

3.3.12 Out of scope aspects

Several aspects of embodiment mentioned in this project are beyond its scope. Table 7 below presents a clear distinction of whether each aspect falls within the project's scope or not, along with the reasoning behind the decisions. The green colour represents the aspect of appearance, while the blue colour represents communication. These colours have been added for quick and easy differentiation.

Table 7 - Aspects of embodiment and scope

Aspects: Look	Personification	✓ In the scope of the project.
	Physical details	✓ In the scope of the project.
	Realism	✓ In the scope of the project.
	dimensions	✗ Out of scope. Even that the aspect of dimensions might seem important for the visual design of a virtual genetic counsellor, this aspect is out of scope of this thesis. As the focus of this thesis is on the general visual design, the aspect of 2D or 3D is not yet relevant in the current stage of development.
	General deformability	✗ Out of scope. For the visual design of the virtual genetic counsellor, this aspect is out of scope of this thesis. This aspect goes deep into the animation capabilities of the created design, and in the current stage of the development this is not yet relevant, and the study first focusses on the general appearance of the virtual genetic counsellor.
Aspect: Communication	language	✗ Out of scope. The aspect of language is out-of-scope for this thesis. The language is mostly determined by the language model behind the virtual genetic counsellor. As this thesis focusses on the visual representation, and the aspect of language will not determine the visual representation, the aspect of language will not be covered in this thesis
	Language modality	✓ In the scope of the project.
	Facial display	✓ In the scope of the project.
	Hands	✓ In the scope of the project.
	Body	✗ Out of scope. The aspect of body will be out of scope for this thesis. As the focus lies on the appearance of the virtual genetic counsellor, and it is not yet clear if the virtual genetic counsellor will be a human being, focussing on body movements is most likely a detail that goes too deep into the animation of the virtual genetic counsellor in the current stage of development.
	Modality coordination and motion generation	✗ Out of scope. The aspect of modality coordination and motion generation is out of scope for this thesis. As the focus of this thesis is mostly on the appearance of the virtual assistant, and it is not defined which motions, if any, should be created, this aspect is out of scope.

3.4 DISCUSSION AND CONCLUSION

From the literature, it has been concluded that embodiment can be split into two main categories with in total eleven different aspects. The two main categories are look and communication. Look consists of personification, physical details, realism, dimensions, and general deformability. The aspect of communication can be divided into the aspects of language, language modality, facial display, hands, body and modality creation and motion generation.

All the found aspects have sublevels or so-called levels. Three different types of levels have been defined, levels that consist of **options**, and levels that contain a **scale**. Levels that are built upon options have a fixed set of options to choose from, while scale has an unlimited number of options between two extremes.

In this section, it is defined that five of the eleven aspects are out of scope or irrelevant for the purpose of this thesis. The aspects that are out of scope are, look – general deformability, look – dimension, communication – language, communication – body, and communication – modality coordination and motion generation.

At first, the aspect of general deformability is out of scope as this aspect goes deep into the animation capabilities of the created design, and in the current stage of the development this is not yet relevant, and the study first focusses on the general appearance of the virtual genetic counsellor.

Secondly, the aspect of dimension is out of scope as the focus of the thesis is on the general appearance of the virtual assistant where the appropriate dimension will be chosen based on the other aspects of the embodiment.

Thirdly, the aspect of language is out of scope as the aspect of language is mostly determined by the language model behind the virtual genetic counsellor. As this thesis focusses on the visual representation, and the aspect of language will not determine the visual representation.

Fourthly the aspect body is out of scope, as the focus lays on the appearance of the virtual genetic counsellor, and it is not yet clear if the virtual genetic counsellor will be a human being, focussing on body movements is most likely a detail that goes to deep into the animation of the virtual genetic counsellor in the current stage of development.

Lastly, the aspect of modality coordination and motion generation is out of scope for this thesis. As the focus of this thesis is mostly on the appearance of the virtual assistant, and it is not defined which motions, if any, should be created.

This section serves to clearly define what aspects will be covered in the thesis. By limiting the scope of the study to relevant aspects, the results will be more focused and relevant to the purpose of the thesis.

4 PREFERENCES OF THE GENERAL POPULATION

This chapter focuses on gathering and analysing data gathered from the general population about their preferences regarding the different aspects and levels of embodiment. The sub-study aims to answer the sub-question:

Which levels of the aspects of embodiment are preferred by the general population in the context of a virtual genetic counsellor?

This chapter will begin by presenting the methods used for this study, followed by the results of the thematic analysis, a list of requirements for the embodiment based on the thematic analysis, a discussion, and a conclusion. The aim of this sub-study is to provide an overview of the recurring themes and interests of the general population on the topic of the embodiment of a virtual genetic counsellor and to combine these findings with the aspects found in 3 to provide a list of requirements for the embodiment of the virtual genetic counsellor.

4.1 METHODS

The purpose of this study is to determine how people would prefer the embodiment of the virtual genetic counsellor and the reasoning behind it. The results will help make informed design choices for the virtual genetic counsellor.

In Chapter 3, we described 11 different aspects of embodiment, from which six were defined as in scope for this project. These aspects include personification, physical details, realism, language modality, facial display, and hand movements.

To further explore the six aspects, co-creation sessions were conducted, followed by a thematic analysis of the data collected. This approach helped to gain a deeper understanding of user perspectives and preferences for the virtual genetic counsellor.

4.1.1 Participants

As the target group of the eCG project is the general population, the target group of this study was the general population as well. As everybody has the chance of having a genetic disease, there were no specific backgrounds or regions used for the target group; the only requirement was being able to read and write English or Dutch. The participants were mostly sampled in a non-random way, in which the availability of the participants played a significant role. During the sampling of the participants, the focus was put on gathering participants from various educational backgrounds and age groups to obtain a “general population”. In total, three different focus groups were conducted with a minimum of four people per focus group, as suggested by Baxter, Courage and Caine [26, p. 364].

4.1.2 Measurements

Three co-creation sessions were conducted. During the co-creation session, the following data was collected:

- The participant's preference on the various levels of the aspects of the embodiment.
- The participant's reasoning behind their preferences.
- The importance of the aspects according to the participants.

- Audio recordings of the sessions.

4.1.3 Materials

To conduct a successful co-creation session where participants could discuss their opinions about embodiment and brainstorm together on the embodiment of the virtual genetic counsellor, participants were provided with the necessary materials. These materials included a PowerPoint presentation that explains the concept of embodiment and supports the creative process. The presentation can be found in Appendix B – Co-creation presentation.

Besides a presentation, the participation sheet was given to the participants. The participation sheet consisted of two parts, first for the appearance and second for the communication of the embodiment. The participant sheet can be found in Appendix A – Co-creation sheet.

Example questions from the participation sheet are shown in Figure 7, every aspect of embodiment follows a specific order. Firstly, participants were asked about their preference for a particular aspect of embodiment. Then, they were requested to rate the importance of this aspect to them. Finally, an open-ended question was given for participants to share their reasoning. The main goal of the form is to encourage participants to think about specific aspects of embodiment and form an initial opinion for discussion that followed filling in the sheet.

The topics covered in the participation sheet were for the first part, personification, physical details, and the style. For the second part of communication, the topics were communication modalities, facial movements, and hand movements.

Part 1 – Look

1. The personification – preference
 The personification determines how the virtual agent is embodied.
 Which personification would you prefer if you needed to interact with a virtual genetic counsellor?
Please circle your choice:

A. Human being	B. Living creature	C. Non-living object
For example: <ul style="list-style-type: none"> • A doctor • A patient • Male • Female 	For example: <ul style="list-style-type: none"> • A dog • A bird 	For example: <ul style="list-style-type: none"> • A paperclip • Amazon Alexa

2. The personification – Importance
 How important is this aspect for you? *Please circle your choice*

Not important	1	2	3	4	5	6	7	Very important
---------------	---	---	---	---	---	---	---	----------------

3. The personification – description
 Please write or draw how you would like the virtual genetic counsellor to look. Think about clothing, objects, colours, and general appearance. Everything is correct.
You can write or draw in the grey area below:

Figure 7 - First part of participant sheet

4.1.4 Procedure

The process of the co-creation session is outlined in Figure 8. The entire co-creation session is audio recorded for documentation purposes.

Before the co-creation session could begin, the participants needed to sign the consent form and read the information letter. The consent form can be found in Appendix C – Co-creation consent form and the information letter can be found in Appendix D – Co-creation information letter.

The co-creation began with an introduction and some information about the eCG project. Next, participants were given information about virtual genetic counselling and examples of virtual genetic counsellors.

Participants were then provided with the participation sheet detailing different aspects of embodiment. For each aspect, they indicated their preferred level, the importance of the aspect to them, and their reasoning for these choices. After each aspect, participants engaged in a small discussion to explain their reasoning.

Once all aspects were discussed, participants were asked if they have additional remarks before the session ends. The six aspects were divided into two main topics, looks and communication, to maintain engagement and reduce repetition. The session aimed to last less than 90 minutes.

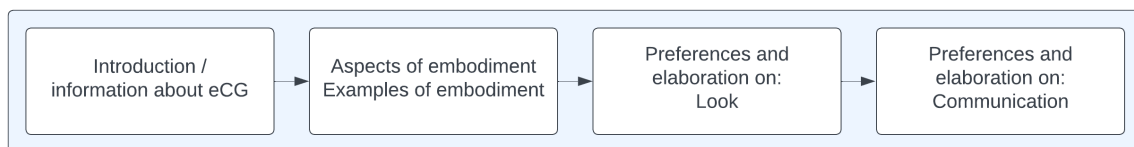


Figure 8 - Outline co-creation session.

4.1.5 Data analysis

The data analysis process for this thesis involved a thematic analysis on the transcripts of the co-creation sessions, the thematic analysis involved coding the data and identifying recurring themes.

To begin the thematic analysis, all recordings were transcribed to make the data easier to work with, the transcription process was also part of familiarizing with the data. The transcriptions can be found in Appendix E – Co-creation transcripts.

Next, the transcriptions were read thoroughly to comprehensively understand the information. Based on this reading, several codes were created to capture the key ideas and concepts that emerged during the focus groups. Iteratively these codes were developed with additional codes being created and merged until a comprehensive set of codes was developed. The software tool ATLAS.ti [27] was used to organise the codes and quotations.

After the codes were finalised, they were organised into themes based on their similarity and relevance. These themes were identified as the recurring topics that emerged during the focus groups. The creation of the themes and codes was an iterative process with multiple iterations in order to create the final themes and codes. The themes guided the data interpretation and developed meaningful conclusions that addressed the research questions.

4.2 RESULTS – DEMOGRAPHICS

In this section, an overview of the demographics of the study participants is provided. This section aims to outline the characteristics and backgrounds of the individuals involved in the research. Examining the demographics makes it easier to understand the diversity and representation of the global population in the co-creation sessions.

The co-creation sessions involved 13 participants. The participants were distributed among three focus groups, with the first group consisting of six participants, five males and one female. The second focus group included three participants: two males and one female. Lastly, the third focus group comprised four participants: three females and one male. Overall, there were eight male and five female participants in the study. This data is also visually represented in Figure 9.

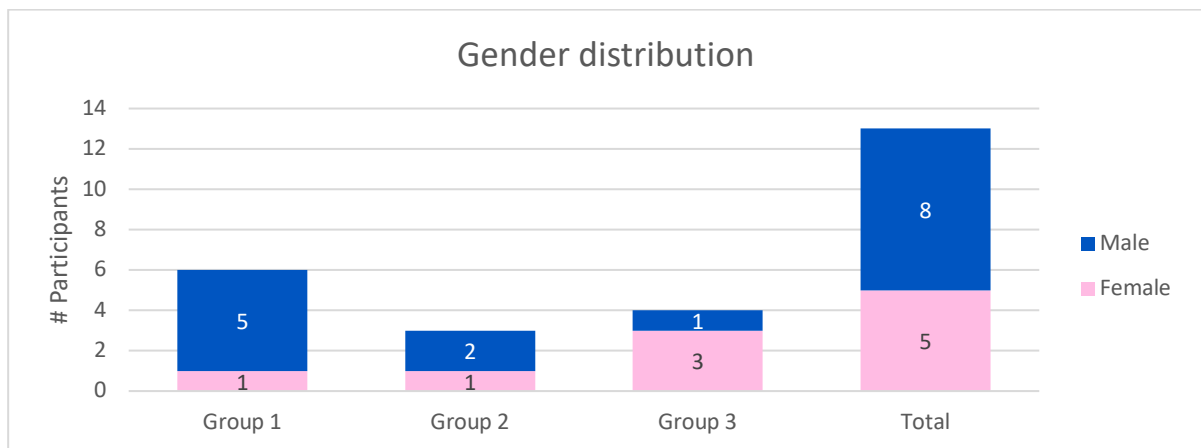


Figure 9 - Gender distribution among participants

To explore the participant demographics further, the age distribution is visually presented in Figure 10. The average age of the participants was 30.3, with a median of 25 and a standard deviation of 12.8. The age range varied from a minimum of 23 to a maximum of 62 years, illustrating a diverse range of ages within the participant sample.

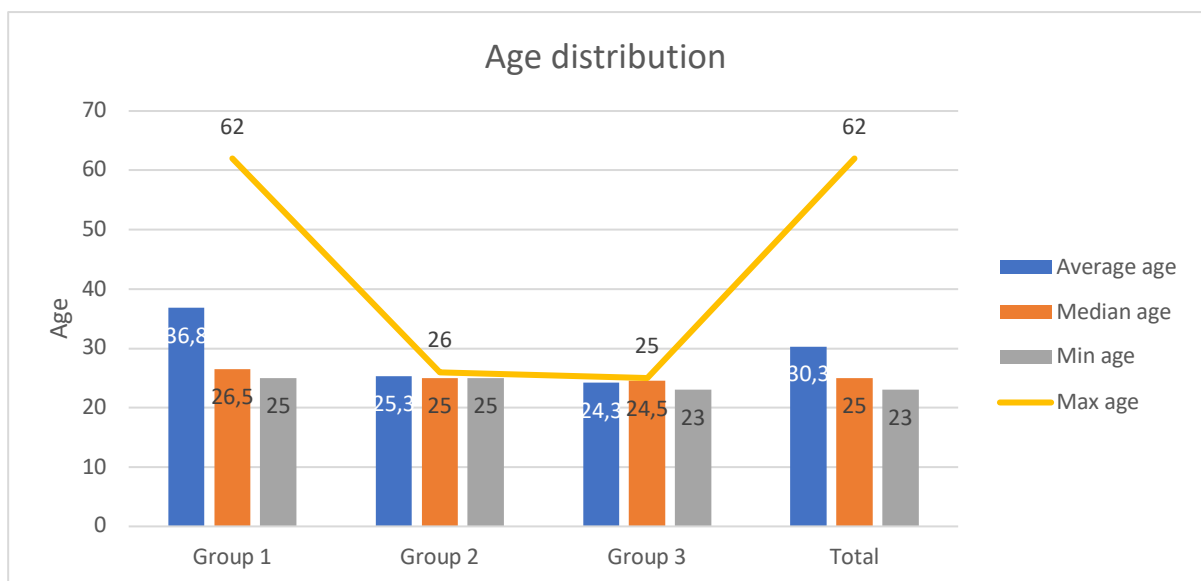


Figure 10 - Age distribution among co-creation sessions

4.3 RESULTS – QUANTITATIVE DATA

In this section, the results of the participant sheet are presented. This data aims to provide an understanding of the participants' initial perspectives. Although the qualitative data from the thematic analysis gives the most insights, this section can help quantify the results. The raw data of the co-creation participant sheets can be found in Appendix F – Co-creation data

4.3.1 Personification

In the question about the preferred personification, participants were given three options to choose from: human being, animal, and non-living object. The distribution of preferences can be seen in Figure 11. The average importance of this aspect was rated 5.1 out of 7 (SD of 1.14).

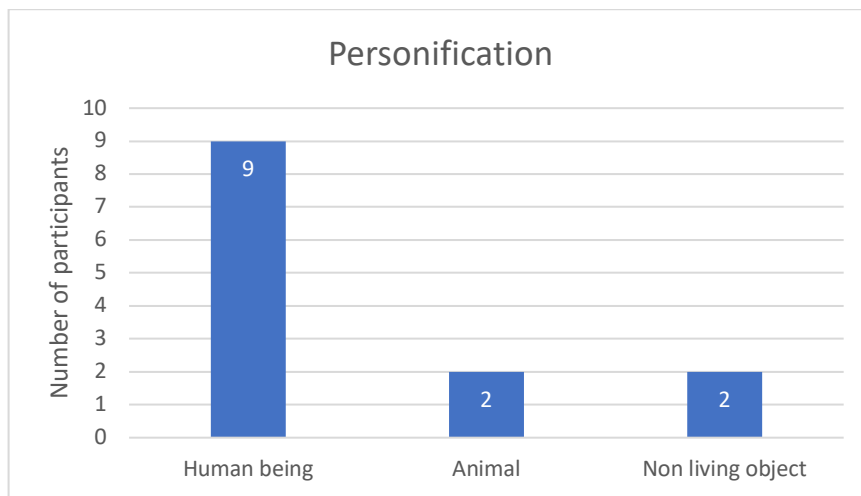


Figure 11 - Results participation sheet: personification

4.3.2 Physical details

Participants could select from, head only, head and neck, torso, or full body when answering the question about physical details. A graph depicting the distribution of preferences is shown in Figure 12. The average importance of physical details was rated at 4.46 out of 7 (SD of 1.8). Interestingly, some participants selected both 'head and neck' and 'torso'. For this reason, combined options have been added to the graph. Participants mentioned they found it difficult to make a choice, for this reason some participants selected multiple options. Lastly, one participant indicated they could not select a non-living object and chose "not applicable."

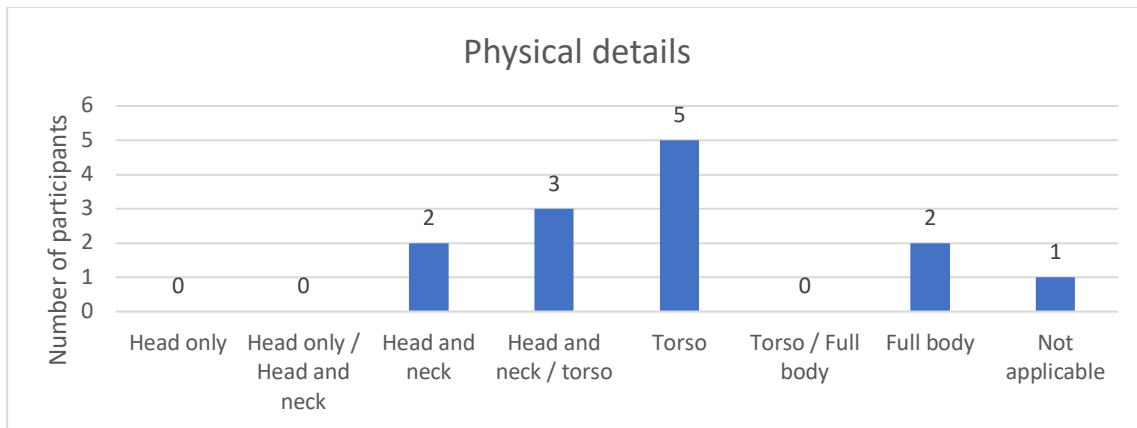


Figure 12 - Results participation sheet: physical details

4.3.3 The style

To gather the participants' preferences about the style of the embodiment, the participants could answer using a Likert scale with options ranging from 1 (very realistic) to 7 (very cartoonish). The average score was 4 (SD of 2.2), right in between very realistic and very cartoonish. Figure 13 shows the results of the question. On average, the question was rated as 5.76 out of 7 (SD of 1.2) in terms of importance. It should be noted that a few participants selected more than one option. For this reason, the x-axis has increments of 0.5 points.

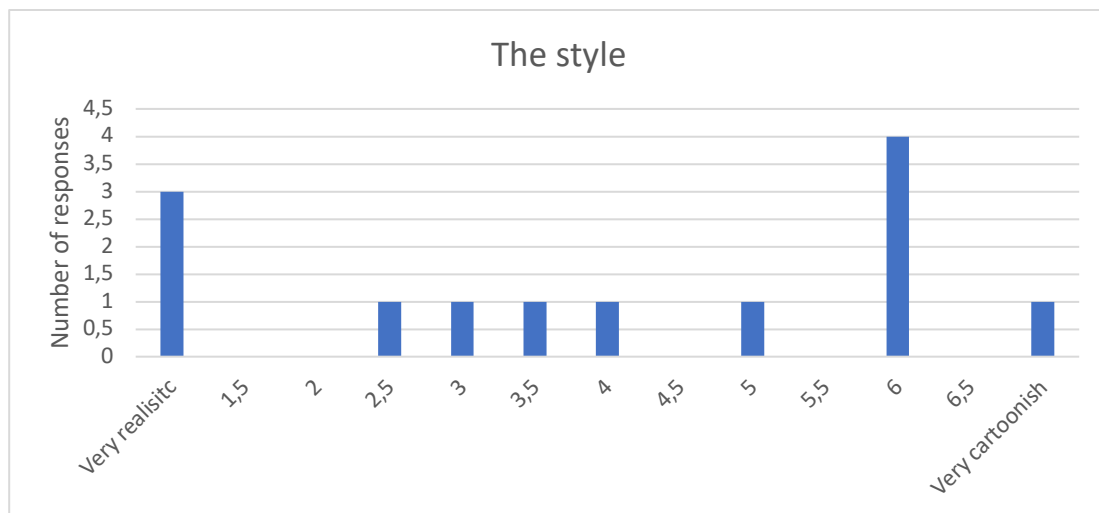


Figure 13 - Results participation sheet: the style

4.3.4 Communication modality

To answer the question about communication modality, participants were given the option to choose between textual, textual and verbal, and only verbal. The distribution of their responses can be seen in Figure 14. On average, this aspect was rated with a 6 out of 7 (SD of 1.2) in importance.

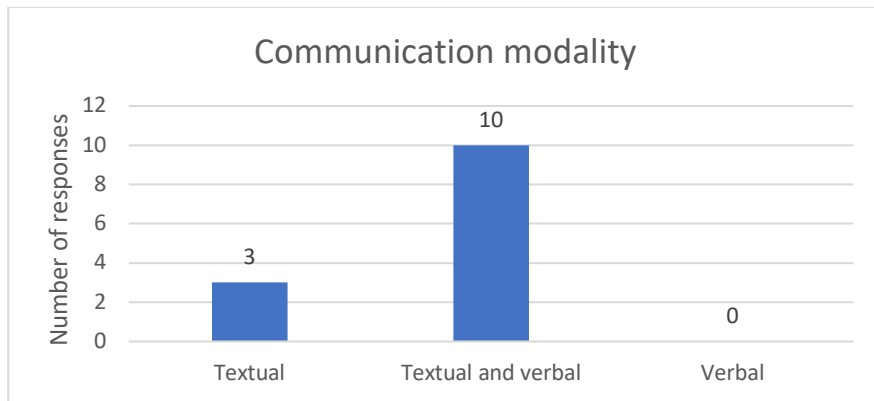


Figure 14 - Results participation sheet: communication modality

4.3.5 Facial movements

Participants were asked to rate how many facial movements they would prefer in the embodiment on a scale of 1 to 7, with 1 being no facial movements and 7 being full facial movements. With an average of 3.7 (SD of 1.6), the answer is slightly more towards the no facial movements side. To account for a participant who gave a response between two values, the x-axis was incremented by 0.5 points. Figure 15 displays the distribution of the answers, and the average importance for this question is 4.6 out of 7 (SD of 1.6).

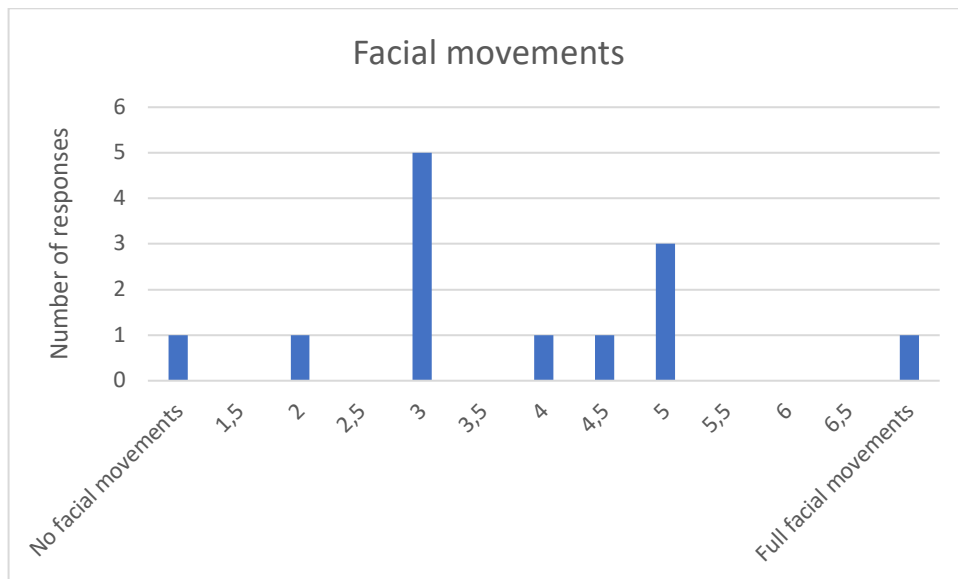


Figure 15 – Results participation sheet: facial movements

4.3.6 Hand movements

Regarding hand movements, participants were asked to rate their preference on a scale of 1 (no hand movements) to 7 (full hand movements). With an average response of 2.9 (SD of 1.7), the participants preferred a reduced amount of hand movements. The results of the question can be found in Figure 16. The average level of importance for this aspect is 4.6 out of 7 (SD of 1.9).

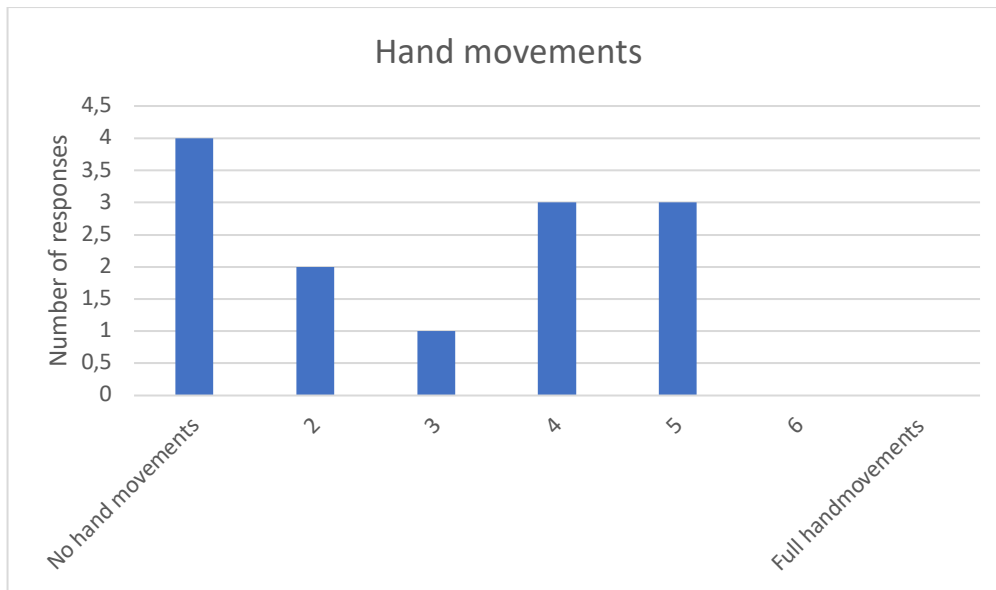


Figure 16 - Results participation sheet: hand movements

4.3.7 Importance of the aspects

To give a better overview of how important the various aspects were for the participants, Table 8 displays the average scores per aspect. All values are averaged from 1 to 7, where 1 is not important at all, and a 7 is very important.

Table 8 - Participation sheet: average importance

Aspect	Average importance (out of 7)	Standard deviation
Personification	5.15	1.14
Physical details	4.46	1.81
Style	5.77	1.24
Communication modality	6.00	1.22
Facial movements	4.65	1.57
Hand movements	4.65	1.97

4.4 RESULTS - THEMATIC ANALYSIS

The thematic analysis approach was used to identify and analyse the recurring themes that emerged from the focus groups. This involved reading through the transcriptions thoroughly and creating codes to capture the key ideas and concepts that were mentioned by the participants.

4.4.1 Recurring notes after the focus groups

Before reading through all the transcriptions, but after conducting the co-creation session, several themes appeared in multiple co-creation sessions. This section describes the themes that were found as initial themes after conducting the three co-creation sessions.

One of the themes that emerged from the focus groups was the importance of audio of the voice in the embodiment. Participants suggested that the chatbot should have a professional voice and that it should be able to convey a range of emotions and tones to help create a more dynamic and engaging conversation. Participants also noted that the chatbot's voice should be neutral and natural and that it should not be too fast or too slow.

In addition, participants suggested that having a choice of voice actors would be helpful and that the chatbot should avoid using a robot-like voice, as this could be off-putting to users. Participants also noted the importance of avoiding any bias or prejudice in the chatbot's voice, as this could lead to users feeling uncomfortable or alienated.

Another recurring theme from the focus groups was the importance of visual cues and nonverbal communication. Participants noted that while nonverbal cues could be helpful in certain situations, they should be kept to a minimum to avoid distracting from the content of the conversation. Participants also suggested that hand gestures could help point out specific information but that these should be kept professional and not too distracting.

Regarding the chatbot's appearance, participants in the second and third focus groups suggested that the chatbot should avoid looking too cartoonish or unrealistic but not too realistic, as this could be off-putting to users. They suggested that a torso or portrait shot of the chatbot would be more appropriate and professional than a full body shot.

Participants also noted the importance of gender representation, with some suggesting that female users might prefer a female chatbot. However, they also noted that a gender-neutral chatbot might be preferable in some situations.

In terms of communication, participants highlighted the importance of making the chatbot's responses clear and easy to understand. They suggested that highlighting keywords and providing additional information on difficult words could be helpful and that a text-based option should be available for users who prefer not to use voice.

Finally, participants in all three focus groups noted the importance of the chatbot being professional and not appearing too friendly or casual. They suggested that while a small amount of emotion could be appropriate in certain situations, the chatbot should not appear overly friendly or too much like a friend. They also noted the importance of the chatbot providing a clear summary of the conversation at the end and potentially providing a printout or transcript of the conversation for users to refer back to.

Overall, the focus groups provided useful insights into how to design a professional and effective counselling chatbot. These recurring themes will be used during the thematic analysis as a starting point.

4.4.2 Initial themes

After analysing the transcriptions, several themes emerged from the data. Because the information was now analysed more in-depth, it is noted that these new themes differ quite a lot from the initial themes initially created using the notes from the sessions.

The first theme that was identified was **simplicity**. Participants stated that they preferred a simple visual design for the embodiment rather than a highly detailed one. They felt that too many details would be distracting and take away from the focus on the content of the embodiment.

The second theme that emerged was **professionalism**. Many participants mentioned that as the topic was serious, the embodiment should behave and look professional. This was an essential factor in establishing credibility and trustworthiness with the users.

The third theme that emerged was **distraction**. Participants noted that they wanted to focus on the information and did not want to be distracted by animations or "weird" looking embodiments. They felt that this would take away from the information's credibility.

The fourth theme that emerged was **human connection**. Participants noted that they would only talk to the embodiment if a connection was established between them and the embodiment. This was essential in establishing trust and rapport between the user and the embodiment.

The fifth and final theme that emerged was a preference for a **natural feeling**. Participants noted that they preferred if the embodiment sounded and looked natural rather than robotic. They felt a robotic voice would be impersonal and less engaging than a more natural-sounding one.

4.4.3 Final themes

After the process of reorganising the codes, combining similar codes, and creating new unique codes, a final set of themes and codes emerged. This sub-chapter provides information about these finalized themes, which are now referred to as the themes.

In total, six different themes were found during the thematic analysis. Table 9 gives a global overview of the various themes that were found. In the following sub-chapter, the codes of the themes are discussed, and quotations of the codes are provided to provide a body to the subject. The themes are ordered in alphabetical order. As one of the co-creation sessions was in Dutch, the quotations were first translated into English to fit the report.

Table 9 - Global themes

Theme name	Number of codes	Number of quotes
Accessibility	3	15
Building a connection with the user	3	51
Gaining information from the session	5	74
Giving control to the user	2	12
Non-verbal communication	4	39
Visual appearance	7	112
Total	24	303

4.4.4 Theme 1: Accessibility

The first theme is the theme of accessibility. This theme occurred after various mentions that embodiment and the platform should be accessible to all individuals who may find themselves using the platform.

Table 10 displays the theme and its codes, along with the number of quotes supporting each code and how the quotes are distributed among the different co-creation sessions.

Table 10 - Theme 1: Accessibility

Theme 1: Accessibility				
Code	# of quotes	Group 1	Group 2	Group 3
Device compatibility	4	-	3	1
Bad hearing/reading skills	9	6	2	1
Elderly	2	1	-	1
Total	15	7	5	3

Code: Device compatibility

Under the code of "Device compatibility", the emphasis lies in designing the embodiment with multiple devices in mind. Considering the limited screen size, participants raised concerns regarding hand movements on mobile devices. One participant highlighted the importance of highlighting instead of relying on hand movements, as it might not be feasible on smaller screens:

*"I feel like highlighting should be a good option here, because this is a computer screen right? (points at image of an embodiment with hands on a desktop device), if there's barely space to point here how would there be space to point on the screen like your phone."
- Participant 9*

Furthermore, participants mentioned that audio should not be forced on users, as some devices might not have audio output. Additionally, some users may prefer reading over listening:

*"Both as well (audio and textual), because I also think for some people they would read faster than they would hear, so they wouldn't want to wait to have to hear. But also some people might not have access to audio at the moment."
- Participant 12*

Code: Bad hearing/reading skills

In the code of "Bad hearing/reading skills", the focus is on ensuring accessibility for users who have difficulty hearing or reading. It was suggested that both audio and text should be available to cater to individuals who cannot hear or read effectively:

*"I have verbal and textual as well [participant mentions chosen option on participant sheet]. First off, deaf people with texts and illiterate people want a voice. Very clear."
- Participant 11*

Code: Elderly

The subcode "Elderly" was created in response to participants' desire for the platform and its features to be appropriate for older users. The participants expressed their belief that the platform should be user-friendly for seniors.

*"But similar to that, what I asked before, what about age? Like I would really imagine elderly to not wanting to talk to something that looks like a circle or something. They really want to see some face. They really appreciate those face-to-face contact, even though this is still some automated thing."
- Participant 11*

4.4.5 Theme 2: Building a connection with the user.

The second theme is about creating a connection between the user and the embodiment on the screen. This emotional bond is crucial because it helps establish trust in the responses given by the embodiment and encourages users to reach out for help when needed.

Table 11 displays the theme and its codes, along with the number of quotes supporting each code and how the quotes are distributed among the different focus groups.

Table 11 - Theme 2: Building a connection with the user

Theme 2: Building a connection with the user				
Code	# of quotes	Group 1	Group 2	Group 3
Connection with the embodiment	32	19	8	5
Extended embodiment recognition	6	5	1	-
Voice of the embodiment	17	10	1	6
Total	51	32	10	11

Code: Connection with the embodiment

The main topic of the "Connection with the embodiment" code is to create a sense of trust between the user and the embodiment. This trust needs to be established during the session. Participants suggested that seeing a human being is the first step in building a connection.

*"I think it builds trust when you see people"
- Participant 1 (translated)*

*"I personally believe that if you're dealing with a non-living being, no matter how cute or beautiful you make it, you won't establish that connection or manage to capture people's attention."
- Participant 5 (translated)*

The participants stressed the significance of the embodiment introducing itself, so the user can identify with whom they are interacting.

*"First an introduction, and then you know who you're talking to."
- Participant 6 (translated)*

During the discussion, the participants emphasised the importance of introducing oneself in the online patient room, drawing a comparison to the behaviour of real doctors. This creates a similar experience for patients in both settings.

"Introducing yourself is something you would do with a real doctor too. I am Doctor So-and-So, and you are now entering your patient room because of this and that. You should do the exact same thing in your online patient room."

- Participant 4 (translated)

Connecting with the embodiment can make users feel more at ease when asking questions.

"Imagine you receive that letter, you're probably feeling emotional and reading that line five times. In that case, I think it's better to explain it or something, then I would be more likely to click if it has a connection."

- Participant 5 (translated)

Code: Extended embodiment recognition

The objective of "Extended embodiment recognition" code is to establish a connection with the user by expanding the presence of the embodiment beyond the platform. This can be achieved by displaying the embodiment in the initial information letter, making it recognisable to users from their first visit to the platform.

"But that there is already an image (on the family letter). This is the story I am going to tell. So an association between the image and the situation. And the image will continue to be there on the platform."

- Participant 2 (translated)

Another suggestion involves utilising the embodiment as a mascot for the hospital, creating a connection between users and the institution:

"Does UMCU have a mascot or something? You could use something like that, it maintains consistency."

- Participant 2 (translated)

Code: Voice of the embodiment

In the "Voice of the embodiment" code, participants agreed that the voice should sound natural and be spoken by a voice actor. They emphasised the importance of avoiding distractions and ensuring the voice complements the text.

"Because if you pre-record it, you can also choose a voice or use a voice actor that makes the user feel at ease."

- Participant 2 (translated)

Some participants noted that a distracting or robotic voice could come across as less personal than simply reading the text.

"if you read the text and you hear some weird voice that you're not super familiar with, then you can even get more distracted in a way that if you read, you hear something, then you're like, okay, what is actually"

happening? So for me, a text is just easier and I can sit down and quietly read it"
 - Participant 10

"I find that a robot voice is even more impersonal than text."
 - Participant 3 (translated)

"Then you get a Google robot voice, but that's just missing the mark." -
 Participant 5 (translated)

"And sometimes how funny it may sound when it has this bot-like voice, I'm getting annoyed. Like what is this accent, like, Google Translator, so sometimes it's even incorrectly pronounced."
 - Participant 10

4.4.6 Theme 3: Gaining information from the session.

The theme of "gaining information from the session" is focused on helping the user retain and acquire new insights and knowledge from their session with the platform. Participants provided examples such as promoting proactive learning by encouraging the user to think critically and making the experience engaging without being overly distracting.

Table 12 displays the theme and its codes, along with the number of quotes supporting each code and how the quotes are distributed among the different focus groups.

Table 12 - Theme 3: Gaining information from the session

Theme 3: Gaining information from the session				
Code	# of quotes	Group 1	Group 2	Group 3
Focussing on the information	10	4	5	1
Highlighting information	19	7	11	1
Importance of the information	12	6	3	3
Learning modalities	20	9	6	5
Proactive learning	29	17	3	9
Total	74	43	28	19

Code: Focussing on the information

"Focusing on the information" refers to the necessary engagement and attention required to obtain information from the session. Two participants noted that attention should be drawn towards the information within a matter of seconds.

"That in a matter of seconds your attention is drawn to the information. And that you start to read."
 - Participant 2 (translated)

"And that it revolves around that one glance. That you have something recognizable. That you immediately know what it's about. And what that app is for again. "

- Participant 4 (translated)

It was noted that having an animal as embodiment might help with keeping the users engaged in the platform:

"Yeah, I also picked the living creature. I kept in mind more like, how can I be engaged? I was more thinking, how can it keep my attention? Because I made a lot of e-learnings. I compare the platform with e-learners that you get information and I get bored very easily because of it. And I thought, well, an animal would keep my attention better to it. So I thought a living creature would, yeah, be better for me."

- Participant 8

Code: Highlighting information

The code "highlighting information" focuses on making important pieces of textual information stand out from the other information. Some participants suggested using colours or bold text to emphasise key points.

"I will go for the highlight just because it is what people are used to."

- Participant 9

"Like a bold thing. If not, it could be a little bit intimidating to read if it's a really long text. So if the important keywords are highlighted, it would be easier to read."

- Participant 13

The participants expressed their preference for not allowing the embodiment to use its hands to point at important information.

"What you can do is, if a piece of text is important, change that piece of text from colour. I think that would be more clear than a floating hand that points towards a line in the text."

- Participant 4

One of the participants suggested that incorporating hands into the embodiment would enhance accessibility. However, it was recommended that object pointing should be accomplished using highlights.

"Pointing at objects to make something clear might be nice, but I would do it in a different way, maybe highlighting the text. Because with pointing I would be annoyed that it will block some of the text. Using an open hand to create a natural feeling conversation might be good, but looking at how ugly some of the avatars are (points to existing embodiments), then maybe you can leave it out."

- Participant 5 (translated)

Indicating things by pointing can sometimes be bothersome for the user.

"Adding hands for accessibility for your character is, I believe, very important. However, using hands to clarify things would be annoying to me."
- Participant 4 (translated)

The highlights would be easier to view if they were adjusted to fit on the screen properly.

"I feel like highlighting should be a good option here, because this is a computer screen right? [points at image of an embodiment with hands on a desktop device], if there's barely space to point here how would there be space to point on the screen like your phone."
- Participant 9

Code: Importance of information

The code "importance of information" emphasises that the platform's primary purpose is to inform users rather than focusing on the embodiment itself. Participants suggested portraying the embodiment as a human rather than an animal to maintain a serious tone would be better.

"But I could totally understand because it's very important information and it needs to be brought in a serious way and as easy as to do if it is a serious human being."
- Participant 9

"it brings just more seriousness to the whole topic when you see a human being, let's say, even though it's not a real human who is actually talking in that moment of, but still it brings more, yeah, seriousness to the whole situation."
- Participant 10

One participant suggested that the embodiment should not be too fancy, as it might distract from the information.

"I thought the design would not be important at all, it is very serious information and it is important that you tell the information, and it is not about how fancy the embodiment is."
- Participant 4 (translated)

Code: Learning modalities

The code "learning modalities" is about the participants' preferences of learning by reading and learning by hearing.

Participants noted that having only audio might create the risk of misunderstanding the information.

"And if you're going to read it out loud, you also run the risk of it being misunderstood. The pronunciation may not be entirely accurate, especially

with those automatic voices trying to pronounce a complex disease. You simply run the risk of interpretational errors."

- Participant 2 (translated)

Text information should consist of short and concise sentences.

"When you have a lengthy text and you want to convey the message concisely, I believe it should be in simple language, like Nijntje language (dutch expression for simple language), for people to understand. However, if you allow people to chat or ask questions about that piece of text, I would choose to include standard questions underneath it as well."

- Participant 4

"It needs to be very short texts, short and concise."

- Participant 6

One of the participants suggested that reading along with spoken text can be helpful in processing information.

"if you can hear it and you can read along it's way easier to process the information"

- Participant 9

Code: Proactive learning

The concept of "proactive learning" encourages users to engage deeply with a subject in order to enhance their understanding. This is achieved through tailored questions and information that prompt the user to think critically about the topic. By offering the option to ask specific questions, users are prompted to reflect on the subject matter, which can aid in retaining the information.

"Like what you would have in a video game, for example, when you have a conversation with a character and often get the option to provide feedback, it's helpful to have those predefined questions available. This actually prompts you to reflect on what was mentioned in the text. So, let's say the text is about heart disease. If there's a question below like, "Oh, if I have this specific type of heart disease," by creating standard questions, you're giving people those "aha" moments, where they realize, "Oh yeah, that's actually useful information to know."

- Participant 4 (translated)

Including questions that are tailored to the user's circumstances is an effective method for providing relevant information. This approach generates interest and engagement by presenting precise details on the topic at hand.

"But if you were to include an example question below, like "Can genetic heart conditions affect my mortgage?" or something similar, I would think, "Hey, that's actually a good question. Could that be true?" And then I would click on it because I would want to know if that's the case. Because that would be relevant to me."

- Participant 4 (translated)

Several participants proposed that a summary presented at the conversation's conclusion would enhance their learning experience. Such a summary would enable the user to review and better retain the information.

"Yeah, like very much that you could download a shorter version of it because I know, for example, my grandparents, they still print out everything. Yeah, they could find information online, but they still so if you want to access some of the information later, you don't have to go into the conversation again."
 - Participant 12

"I would like it if they could summarise everything at the end. Because I might not remember, people might forget what they asked and what the answers to everything are. So maybe a summary that you can download."
 - Participant 13

It is important for the chat system to be of good quality to ensure that the user receives the desired answer to their question.

"When asking a question, it's important to ensure that you receive the correct answer and not end up listening to a monologue for half an hour without getting any certainty. Otherwise, you might still be left thinking, "I still don't have the answer.""
 - Participant 5 (translated)

4.4.7 Theme 4: Giving control to the user.

The theme "Giving control to the user" means that users can personalise their experience by customising the appearance, audio, and text.

Table 13 displays the theme and its codes, along with the number of quotes supporting each code and how the quotes are distributed among the different focus groups.

Table 13 - Theme 4: Giving control to the user

Theme 4: Giving control to the user				
Code	# of quotes	Group 1	Group 2	Group 3
Choice in appearance	8	6	-	2
Choice in verbal or textual	4	-	3	1
Total	12	6	3	3

Code: Choice in appearance

The term "Choice in appearance" means that users can select the appearance of the embodiment or choose from multiple options. This allows users to find a better fit with the embodiment. A participant suggested having a selection of 5 male and 5 female options to choose from.

"I don't think giving someone the option is a bad idea at all. Having ten defaults, five men and five women, from which you can choose the one you find appealing, seems quite reasonable to me."
 - Participant 4 (translated)

One of the participants expressed a preference to choose between two characters only, as having more options would make it feel too much like a game.

"Or maybe the same way that you would choose the language of the page. Well, not exactly like this choose your character because of too much gamification, but choose which of the two you want."

- Participant 12

A few of the participants stated that having the choice to select the look of their embodiment would cause them inconvenience and become a burden.

"I think that is too much hassle, do you also want to dark and light theme on the platform?"

- Participant 2 (translated)

"Yes too much hassle, you get invited and the first thing you need to do is create a bitmoji."

- Participant 3 (translated)

Offering too many options could lead to some individuals struggling to decide on their desired appearance.

"And the people that are not able to choose are already stuck on the first screen."

- Participant 6 (translated)

Another participant suggested that the focus of the platform should be on the information, and having to select an appearance would be a distraction and take away from the platform's main purpose.

"How do you envision that? Because when you receive those letters, you might already be taken aback, and then you visit the website, but what you really want is to gather more information. And then you find yourself stuck in a selection menu, asking if you want the man with the moustache, while all you really want is more information."

- Participant 5 (translated)

A participant mentioned that selecting one's own appearance may not be a significant concern since those who are not bothered by it would make a choice.

"But by phrasing it that way, I think you're making it seem bigger than it actually is. Now you're thinking that you have to create a whole character from scratch. But if you simply have one screen where you can choose at a glance, it also works for people who don't care much about it - they can just click on the first option available."

- Participant 4 (translated)

Code: Choice in verbal or textual information

The code "Choice in verbal or textual information" indicates that users can choose the type of information they want to receive. During the study, a participant suggested that having the option to pause and resume audio would be useful. This feature allows the user to re-read a sentence if needed. Additionally, because people have different preferences, the ability to pause and change the speed of the audio would also be helpful.

"I think this part is important to have a lot of options for persons because a lot of persons of people have very individual preferences from how they would want to have the information so exactly like the option to turn off the texts or just turn it on and the speech the variables or whatever a lot of options where they can choose how they would like to have I think that would be the best."
 - Participant 8

4.4.8 Theme 5: Nonverbal communication

The theme of "nonverbal communication" pertains to how we communicate without using words, such as through hand gestures, facial expressions, body language, and emotional displays.

Table 14 displays the theme and its codes, along with the number of quotes supporting each code and how the quotes are distributed among the different focus groups.

Table 14 - Theme 5: Nonverbal communication

Theme 5: Nonverbal communication				
Code	# of quotes	Group 1	Group 2	Group 3
Body movements	6	2	2	2
Facial movements	8	5	2	1
Hand movements	11	5	4	2
Showing emotions	20	10	3	7
Total	39	22	11	12

Code: Body movements

The term "Body movements" refers to the use of body language to communicate or express emotions. A participant emphasised the importance of maintaining a relaxed and open posture during embodiment as it helps to create a more natural and engaging experience.

"Of course the embodiment needs to stand a bit open and not very closed"
 - Participant 1 (translated)

Code: Facial movements

In the context of nonverbal communication and displaying emotions, the code "Facial movements" pertains to the use of facial expressions. During a discussion, a participant mentioned that even simple facial movements like raising eyebrows could add a lot of depth to the conversation and convey the seriousness of the topic.

"And it's not just the chat section; there's also a significant part dedicated to providing information. By simply raising an eyebrow, you can

already convey a clear sense to someone. Like, "Okay, this part is serious. I really need to read it." Meanwhile, if you're just on the app's homepage and the character looks a bit friendlier, it adds a touch of dynamism to highlight what's important."
- Participant 4 (translated)

Another participant noted that a simple smile would already bring some realism to the conversation.

"Having some refined facial expressions would also be beneficial. For instance, a smile could be added. If we aim for realism, incorporating subtle facial movements would allow for the portrayal of refined motor skills. It could include expressions like a questioning look as well."
- Participant 1 (translated)

One participant was uncomfortable with too many movements, as they found it scary or distracting.

"but also I wouldn't want a lot of movements like a lot of eyebrow movements, I think it would look weird a person or an animal whatever would have a lot going on here I would be scared maybe, and too distracting"
- Participant 8

Code: Hand movements

In this context, 'Hand movements' refers to using hand gestures to convey emotions. According to participants, incorporating animations into hand movements greatly enhances the embodiment.

"Making hands to create an engaging character, I believe, is crucial. However, using hands excessively to clarify things could be perceived as irritating."
- Participant 4 (translated)

A different participant suggested that keeping hand movements to a minimum would be best.

"It should not be exaggerated like Italians"
- Participant 7

Another participant mentioned they would prefer no hand movements at all as it might be confusing or distracting.

"I prefer no hand movement because I think I could. Yeah, I don't see how you could animate that for it not to be confusing. And also it's distracting."
- Participant 13

Code: Showing emotions

The term "showing emotions" pertains to non-verbal cues that express one's emotions and the intensity of such emotions. During the study, a participant mentioned that they were only interested in the information and not concerned about the emotions portrayed by the embodiment.

"But when I have a question, I find it important to receive the information I need. Whether the character furrows their brow, looks sad, or looks happy, it doesn't really matter. I just want to be able to ask my question and get an answer. So, the emotion conveyed through their expression doesn't concern me much. What matters is that it feels like interacting with a human, but their gaze doesn't need to be filled with excessive animation or emotion." – Participant 5 (translated)

Some participants mentioned that emotions are important, but they should not be exaggerated, as they could become distracting.

"By incorporating a smile or a furrowed expression, you can already convey a wide range of emotions. Adding subtle movements to these expressions can further enhance the emotional portrayal. However, excessive focus on the movements can shift attention away from the actual content and lead to an excessive emphasis on observing the character's actions."
– Participant 3 (translated)

"Simple emotions can be nice."
– Participant 6 (translated)

"It does not have to be an extrovert person."
– Participant 1 (translated)

Individuals interpret emotions differently. Therefore, it is important to use caution when conveying emotions to avoid any misinterpretation.

"I think also, it could be very hard to animate that because people could also, people read expressions differently. So there could be people that read certain expressions like wrong. I don't know what it's supposed to be. It could be a little bit. I don't know. Not nice."
– Participant 13

"I think it is just the thing that I mentioned before that when you have the additional thing of hands or facial expressions. It might be a little bit distracting at least for me and then you focus too much on those. How does he move the eyebrow or did he blame me? He moved his hands or so. Then I would say it's as I said before as well like everyone has different perception of things. So if you see that little icon raising the eyebrows, then you might think, oh, something is wrong. But maybe for the icon, it was just like a regular sequence of movements. So I would say it would be a little bit distracting plus a little bit misleading."
– Participant 10

4.4.9 Theme 6: Visual appearance

The topic of "Visual appearance" pertains to the physical appearance of something or someone. Subtopics included within this theme cover a wide range of aspects related to the visual appearance of the subject.

Table 15 displays the theme and its codes, along with the number of quotes supporting each code and how the quotes are distributed among the different focus groups.

Table 15 - Theme 6: Visual appearance

Theme 6: Visual appearance				
Code	# of quotes	Group 1	Group 2	Group 3
Animal	16	1	12	3
Animations	15	7	6	2
Distraction	16	7	3	6
Gender	6	0	6	0
Physical details / visibility	12	1	4	7
Professional	34	13	7	14
Styling	36	22	7	7
Total	112	64	51	56

Code: Animal

The term "animal" refers to the views of the participants on the use of animals as a representation of the embodiment. The participants expressed their opinions on whether using an animal as a symbol would be appropriate, given the medical nature of the subject matter. One participant was concerned that using an animal or object in the study could be considered too casual, considering the seriousness of the medical context.

*“So I have something myself, like an object or a person or an animal or whatever. That's just a little too frivolous or something like that”
- Participant 2 (translated)*

A participant pointed out that using an animal as a representation may be suitable for kids, but may not connect well with adult users.

*“That's also why I said like if it's a dog or something, it feels like it's more targeted to a younger user audience. So in that case, yeah. For me, personally, no.”
- Participant 12*

On the other hand, a few participants mentioned that using an animal representation could be more beneficial since it may not trigger any negative emotions among users.

*“So then I'm thinking of if they want to get mad at someone, if they want to get mad at anything, then I'm going to get mad at a small little animal thing that's telling them about their upcoming disease. But if it's a human shape there, then they will, in my opinion, form their bad emotions”
- Participant 9*

Code: Animations

The code "Animations" deals with how the embodiment moves and discusses the pros and cons of different approaches. A participant highlighted the significance of correctly implementing animations.

*“Well, here you have your example in practice [participant was shown an animation that he/she did not like]. If you animate something, do it well.”
- Participant 4 (translated)*

Some participants proposed that the embodiment should adjust its level of animation according to the displayed content on the screen. For example, when giving a general explanation, the embodiment could use full-body movements, but as the conversation becomes more specific, the focus could shift to torso movements.

"Like they give you a general explanation, and then when they go more specific, you also go visually more specific into the screen"
- Participant 9

The participants agreed that animations can enhance the conversation's dynamics. They recognised that too many animations during text-based chat could be distracting but acknowledged the benefits of incorporating dynamics when using the application.

"During the chat, I agree [that there should not be many animations], but if you are using the app, if the embodiment would have some dynamics, that would be of added value"
- Participant 4 (translated)

Code: Distractions

In the section titled "Distractions", we examine how the visual appearance of the embodiment can cause various types of distractions. During the focus groups, participants preferred a straightforward object that will not overwhelm the user with excessive details or distractions.

"A very simple object that does not distract the user."
- Participant 6 (translated)

"But don't make that character so realistic. That you spend too much time looking at all the details that character has, you know."
- Participant 4 (translated)

A suggestion was made by one of the participants that a static frame would be a better option instead of a dynamic one, as it could distract the user.

"Static images are preferred. So that the user doesn't get distracted in the middle of the explanation of a text or a reading passage, you know. At most, a transition from one frame to another image."
- Participant 2 (translated)

A participant mentioned that having too many moving parts could be distracting or even scary.

"but also I wouldn't want a lot of movements like a lot of eyebrow movements, I think it would look weird a person or an animal whatever would have a lot going on here I would be scared maybe, and to distracting"
- Participant 8

Code: Gender

The term "gender" refers to the participant's personal preference for the gender of their embodiment. Some participants feel more comfortable with a female embodiment, or feel like a female embodiment is more emphatic.

"I think most women have mostly a preference for women. And I don't think men, I don't know. Maybe some, but not everyone. I don't think they mind having a female. And I think, yeah, it's just better if it's just most, if most people are more comfortable with the females, just do female."
- Participant 13

"Feels a little bit more open somehow, female, as well as a bit more empathic, even though there's no empathy because it's a chatbot"
- Participant 12

It was observed that the choice of gender preference could vary depending on the conversation's context. It was noted that if the topic becomes more intimate, a female is preferred.

"And I think it depends as well, like what exactly you're talking about. Because here it was about cardiovascular problems. So in that case, like I wouldn't mind who I am talking to. But of course, when you get like other conditions and yet sometimes maybe you would like to get a female."
- Participant 10

Code: Physical details

The code of physical details is about how much of the embodiment is visible to the user.

Some participants preferred that only the head and neck to be visible because it would look like a professional portrait shot.

"I said head and neck, like a portrait shot, like it will give some form of a professional look to it"
- Participant 11

The same participant also noted that a physical object should not be between the user and the embodiment, like a table, as this would not feel very personal.

"If you go to the doctor and if the doctor is sitting behind a big desk, sitting far away from you, it doesn't feel as personal. You don't feel as open to it. And in medical experience, we also don't sit across the table from the person, but we sit next to the person. So they already feel more on the same level to the ground and not having a literal barrier in between. So to actually be able to see the whole body of the, in this way, maybe some mini doctor or at least some medical worker could give some more trust or something, more confidence to speak up about the things."
- Participant 11

One reason provided for focusing on the head and neck in a project was that including the whole body would be too distracting while limiting it to less than the head and neck would be too intimidating.

"I don't think I circled the full body because I think distraction is very important for me. I think with the full body, I could get very distracted. I would look at the details of the body of the AI and stuff like that. So I think the less the head only is a bit too imitating, but I think head and neck. Head and neck would be less. It would be less easy for me to get distracted"

- Participant 13

Code: Professional

The code "professional" refers to the requirement that the virtual assistant should resemble and act like a healthcare professional. While some participants noted that it is not mandatory for the assistant to be a doctor, they strongly preferred that it be a healthcare professional.

"I think it's nice if it's correlated to the profession and the whole theme of the conversation so, if it's a nurse or someone with like a white coat that is doctor-like or something like that. I think that's quite relevant."

- Participant 10

"It doesn't, for me, necessarily need to be a doctor, but a professional, I guess, because if it's just somebody in casual clothes, it kind of dissociates from the actual subject that it's about."

- Participant 12

"Yeah, it doesn't need the doctor's clothing because it's not the doctor yet, but it is getting there."

- Participant 11

Code: Styling

When it comes to the appearance of the embodiment, the code "styling" plays a significant role. A few participants suggested that it should not be excessively realistic since it may come across as unsettling or distracting.

"Well, I think if you do it realistically, then it has to be either, you know, really, really photo-realistic because otherwise you end up in the uncanny valley, you know, and then it immediately becomes a bit creepy, you know?"

- Participant 3 (translated)

"Because it's kind of creepy, and now you have those realistic robots that speak to you, and it's so weird to look at them. So I was thinking that too realistic, who gives that sensation and you're being distracted."

- Participant 7

A few participants expressed concern that if the styling was too realistic, it might resemble someone they know.

*"It's also really awkward that there's also a chance that the AI could look like someone they actually know in real life."
- Participant 13*

Participants suggested that simplifying the embodiment would make it easier for them to associate themselves with it.

*"I think if you keep it very simple, you naturally start working on it a bit, the more details you add, the more you hinder someone from forming that identification with someone."
- Participant 4 (translated)*

In summary, the participant preferred a cartoonish style with proportionate body parts to avoid looking too childish while maintaining a professional appearance.

*"I like that it's flat with the human-like the right proportion shapes and stuff but it's not they didn't try to emulate all the depth of the shirt or the creases of the nose and the wrinkles around the eyes you know they just said this is a human shape and these are human features and this is colours that humans wear."
- Participant 9*

*"So I'm also more into the stylised approach. For example, if you look at that picture here on the screen (points to image on screen), it's just stylised. That's perfectly fine. It doesn't make it realistic, because then it becomes a problem."
- Participant 3*

4.5 FINDINGS OF THE THEMATIC ANALYSIS

The following describes a summary of the results of the thematic analysis.

Accessibility

Participants emphasised the importance of making the embodiment and platform accessible to all users. Codes within this theme include "Device compatibility", "Bad hearing/reading skills", and "Elderly."

Under "Device compatibility", participants expressed concerns about hand movements on smaller screens and suggested using alternatives such as highlighting. They also highlighted the need for both audio and text options, considering device limitations and user preferences.

Regarding "Bad hearing/reading skills", participants emphasised the importance of providing accessibility options for individuals with difficulties in hearing or reading. Suggestions included having both audio and text available to cater to their needs.

The code "Elderly" reflected participants' desire for the platform to be user-friendly for older individuals. They emphasised incorporating visual elements and face-to-face interactions to accommodate their preferences.

Overall, the findings emphasise the significance of accessibility considerations, including device compatibility, alternative communication modes, and user-friendly design, to ensure an inclusive user experience on the platform. The findings go beyond the embodiment of the agent, and also regard the design of the eCG platform.

Building a connection with the user

An emotional bond is beneficial for establishing trust in the responses given by the figure and encouraging users to seek help when needed.

Under the code "Building trust," participants highlighted the importance of seeing a human figure to establish a connection. They emphasised the need for the embodiment to introduce itself, similar to how real doctors introduce themselves to patients. Introducing oneself in the online patient room creates a sense of familiarity and trust. Participants believed this connection with the embodiment would make users feel more at ease when asking questions.

The code "Extended embodiment recognition" aimed to expand the presence of the embodiment beyond the platform. Participants suggested displaying the embodiment in the initial information letter to make it recognisable to users from their first visit. They also proposed utilising the embodiment as a mascot for the hospital to create a connection between users and the institution. Participants thought they could maintain consistency and establish a stronger connection by associating the embodiment with the hospital.

In the code "Voice of the embodiment," participants agreed that the voice should sound natural and be spoken by a voice actor. They emphasised the importance of avoiding distracting or robotic voices that could hinder personal connection. Participants found that a robotic voice was less personal and could be more distracting than simply reading the text. They preferred a voice that made them feel at ease and enhanced the user experience.

Overall, the findings highlight the significance of connecting the user and the embodiment through introductions, recognisable presence, and natural voices. Establishing this emotional bond fosters trust and comfort, ultimately enhancing the user's experience on the platform.

Gaining information from the session

The findings revolve around the theme of "gaining information from the session" and highlight various aspects that contribute to helping users retain and acquire new insights and knowledge. Participants emphasised the importance of promoting proactive learning, engaging the experience without being overly distracting, and focusing on the information.

Under the code "Focusing on the information," participants stressed the need to capture attention quickly and clarify the platform's purpose. Some suggested using an animal embodiment to keep users engaged and focused on the information. Additionally, participants discussed the significance of highlighting important information using colours or bold text.

The code "Importance of information" emphasised that the platform's primary goal is to convey critical information rather than focusing on the embodiment. Participants preferred a serious tone and human embodiment to maintain the seriousness of the topic. They also suggested avoiding fancy designs that might distract from the medical information.

In the code "Learning modalities," participants expressed preferences for learning through both reading and hearing. They noted the risks of relying solely on audio, such as potential misunderstandings due to pronunciation. Participants recommended using short and concise sentences for text information and suggested that providing the option to read along with spoken text can aid in processing the information.

"Proactive learning" emerged as a code for enhancing understanding and engagement. Participants highlighted the importance of tailored questions that prompt users to think critically about the topic. They also suggested including a summary at the end of the conversation to facilitate easy review and retention of the information.

Overall, the findings underscore the significance of focusing on the information, maintaining a serious tone, utilising multiple learning modalities, and promoting proactive learning strategies to enhance the user's ability to retain and acquire knowledge during their session with the platform.

Giving control to the user

"Giving control to the user" highlights the importance of allowing users to personalise their experience by customising the appearance, audio, and text. Some participants emphasised the significance of choice in appearance and verbal or textual information, but others preferred no choice.

Under the code "Choice in appearance", participants expressed different perspectives on the number of options available for selecting the appearance of the embodiment. Some participants suggested offering a range of options, such as 5 male and 5 female embodiments, while others preferred a simpler choice between two characters. However, a few participants felt that providing too many appearance options would be inconvenient and burdensome. They emphasised the importance of focusing on the platform's main purpose of providing information rather than getting caught up in selecting an appearance.

In the code "Choice in verbal or textual information", participants emphasised the need for options for presenting the information. They suggested features such as the ability to pause and resume

audio, re-read sentences, and adjust the speed of the audio. Participants recognised that individuals have different preferences, and providing flexibility in delivering information would enhance the user experience.

Overall, the findings underscore the importance of giving users control over their experience by allowing them to customise the appearance, audio, and text according to their preferences. Participants expressed a desire to balance providing options and avoiding overwhelming choices while ensuring that the focus remains on delivering the intended information effectively.

Non-verbal communication

"Nonverbal communication" consists of various aspects, including body movements, facial movements, hand movements, and showing emotions. Participants shared their perspectives on the effectiveness and impact of incorporating these nonverbal cues into the embodiment.

Under the code "Body movements", participants highlighted the importance of maintaining a relaxed and open posture during embodiment to create a natural and engaging experience. They emphasised the significance of body language in communication.

Regarding "Facial movements", participants recognised the value of simple facial expressions, such as raising eyebrows or smiling, in adding depth and conveying emotions during conversations. However, some participants expressed concerns about excessive facial movements, finding them distracting or scary.

In terms of "Hand movements", participants had varying opinions. Some believed that incorporating animated hand gestures enhances the embodiment, while others preferred keeping hand movements to a minimum or eliminating them altogether, considering them confusing or distracting. Note that showing these opinions are specifically on the movements of the hands, and not about showing the hands or not.

When discussing "Showing emotions", participants had different viewpoints. Some participants emphasised the importance of conveying emotions through facial expressions and subtle movements, as they can enhance the emotional portrayal. However, they cautioned against exaggeration and excessive emphasis on emotions, as it may divert attention from the actual content and become distracting. Participants also acknowledged that individuals interpret emotions differently, so care should be taken to avoid misinterpretation.

The findings suggest that nonverbal communication plays a significant role in the embodiment experience. Participants highlighted the importance of maintaining a natural and engaging posture, incorporating subtle facial expressions and hand movements, and conveying emotions in a balanced manner. It is essential to consider individual preferences and avoid excessive or overwhelming nonverbal cues to ensure a meaningful and effective interaction with the embodiment.

Visual appearance

"Visual appearance" pertains to the physical appearance of something or someone. Subtopics included within this theme cover a wide range of aspects related to the visual appearance of the VGC.

Regarding the topic "animals", participants had mixed opinions regarding using animals as a representation. Some felt that using an animal or object in the study could be considered too casual, considering the seriousness of the medical context. One participant expressed concerns about using an animal representation, as it may not connect well with adult users. However, a few participants

mentioned that animal representation could be more beneficial since it may not trigger negative emotions among users.

Participants emphasised the significance of well-executed animations when discussing animations (code: “Animations”). They proposed that the level of animation should adjust according to the content being displayed. For example, during a general explanation, the embodiment could use full-body movements, but as the conversation becomes more specific, the focus could shift to torso movements. Participants recognised that incorporating animations could enhance conversation dynamics, but they also cautioned against excessive animations in text-based chats, which could be distracting.

Regarding the code “distractions”, participants preferred a straightforward object that doesn't overwhelm the user with excessive details or distractions. They suggested that static images or minimal transitions would be less distracting during explanations or reading passages. Participants mentioned that too many moving parts could be distracting or even frightening.

For code “gender”, the gender preferences varied among participants. Some participants felt more comfortable or empathetic with a female embodiment, while others did not mind the gender. Some participants noted that the gender preference could change depending on the topic of the information.

Regarding the code “physical details”, some participants preferred only the embodiment's head and neck to be visible, as this would give it a professional portrait shot appearance. Most other participants preferred the torso to be visible, as this gives a good trade-off between too distance and too close. Additionally, participants mentioned that having a physical object, like a table, between the user and the embodiment would make the interaction feel less personal.

Participants emphasised the importance of a professional appearance (code: Professional) for the virtual assistant. While it wasn't necessary for the assistant to be a doctor, participants preferred it to resemble a healthcare professional, such as a nurse or someone wearing a doctor-like white coat. They felt that a professional appearance would better align with the subject matter.

Regarding the code “styling”, participants expressed concerns about excessive realism, as it could be unsettling or distracting. They preferred a stylised or cartoonish approach, where the embodiment maintains proportionate body parts without excessive detail. Simplifying the embodiment made it easier for participants to associate themselves with it.

To sum up, the participants favoured a visually straightforward and sophisticated look with a stylised or cartoonish touch. They recommended concentrating on the head, neck, and torso, while avoiding excessive movements or distractions. Gender preferences varied depending on the conversation's context. These findings demonstrate the significance of maintaining a professional appearance while balancing realism and stylisation.

In the following chapter, the results from Chapter 3 will be combined with the preferences from Chapter 4. This creates a clear overview of the preferences of the participant paired with the different aspects of embodiment.

4.6 DEFINING THE REQUIREMENTS

In the following sub-chapter, the found aspects of embodiment from Chapter 3 and the user preferences of the thematical analysis are combined. First, per embodiment aspect, the option or scale the participants prefer is described, concluding with a design choice.

To refresh memory, the following aspects of embodiment were defined as in scope for this project: personification, physical details, realism, language modality, facial display, and hand movements.

4.6.1 Design choice per aspect of embodiment

Personification

The literature from Chapter 3 stated that personification has three main options: human being, living creature and non-living object.

From the data of the participant sheet, it is noted that the option of a human being is a preference for most participants, as 9 out of the 13 participants indicated that they would prefer a human being.

The thematic analysis noted that having a human being promotes face-to-face contact and would increase the connection with the embodiment.

In some cases, a non-living object was preferred as it would reduce the distractions the embodiment could give. In another case, it was noted that an animal would prevent users from assigning bad emotions to the embodiment.

Overall, the main conclusion from the data and the thematical analysis was that human being was preferred in most cases. Therefore, the design choice for the personification in the prototype will be a human being.

Physical details

In Chapter 3 it is defined that there are four main options for the physical details, head, head and neck, torso, and full body.

According to the results of the participation sheet, most participants preferred 'torso'. This also reflects the data from the thematic analysis. Most participants noted that only the head or head and neck would be intimidating, while the full body visible might be too distant or distracting, as the whole body is visible.

For these reasons, an embodiment where the torso is visible would be the best fit.

Realism

In Chapter 3 is defined that the choices for realism can be put on a scale ranging from very realistic to very stylistic.

The participation sheet results show that the average preference is right in the middle between very realistic and very cartoonish. A few participants answered that they would prefer very realistic, and a few prefer very cartoonish. But most participants answered somewhere in between. These findings do comply with the conclusions of the thematic analysis. Most participants noted that if the realism would be very realistic, it must be done well. Otherwise, the embodiment might look creepy, thus preferring a more stylistic look. Participants who chose very cartoonish mostly said this would cause fewer distractions.

Most participants noted that some details in the embodiment would be preferred but to keep it to a minimum, as this would allow for non-verbal cues and allows to see the embodiment as a human being, but without it being too distracting or creepy to look at.

For these reasons, the embodiment should mostly be stylistic but should also have some details to it, but to a limited extent.

Language modality

In Chapter 3 it is defined that the choices for language modality can be either, textual, verbal and textual, and verbal.

From the results of the participation sheet in Chapter 4.3, there is a clear preference for verbal and textual. 10 of the 13 participants noted that they would prefer both verbal and textual information.

The results of the thematic analysis also support this choice, this would improve the accessibility and connection to the user. It is to be noted, that the voice should sound like an actual human being. Most participants noted that if the voice sounds like a 'robot' this brings a lot a distance to the user.

It can be concluded that the language modality of the embodiment should be verbal and textual, with the remark that the voice should sound like a real human voice.

Facial display

The facial display has a scale as options, ranging from (1) no facial movements, till (7) full facial movements. According to the participation sheet from, most people preferred level 3.

This is in accordance with the thematic analysis. Too much facial movements would bring to many distractions and interpretation errors. While no facial emotions at all would defeat the purpose of the embodiment. Most participants noted that the facial display should remain professional with some movements, but the facial display should not look like a very extrovert person with lots of moments and emotions going on.

As a conclusion, the embodiment should show some emotions, but keep the emotions minimal to prevent interpretation errors and to not distract the user too much.

Hand movements

The levels of hand movements are on a scale from no hand movements till full hand movements. According to the participation sheet, there was no participant that had full hand movements as their preference and the preferences are more skewed towards little to no hand movements. In the thematic analysis the participants noted that too many hand movements would be too distracting, especially if the hand movements would be used to point at specific places in the dashboard.

In conclusion, hand movements should be used but limited to small non-verbal cues. Pointing towards object should not be done, and another technique like highlighting should be used.

Summarized

Table 16 below summarises the required levels of embodiment according to the general population.

Table 16 - Summarized requirements for the aspects of embodiment

Aspect	Design choice/requirement
Personification	Human being
Physical details	Torso
Realism	Mostly stylistic but should also have some details to it, but to a limited extend.
Language modality	Verbal and textual, with the remark that the voice should sound like a real human voice, as most participants noted that if the voice sounds like a 'robot' this brings a lot a distance to the user.
Facial display	Show some emotions, but keep the emotions minimal to prevent interpretation errors and to not distract the user to much
Hand movements	hand movements should be used but limited to small non-verbal ques. Pointing towards object should not be done, and another technique like highlighting should be used.

4.6.2 Design choice per theme

Even though the focus of this study is to design the prototype based on the levels of embodiment, the themes of the thematic analysis also revealed several design requirements. Table 17 displays the different design choice and requirements per theme and code.

Table 17 Design choice and requirement per theme

Theme / code	Design choice/requirement
Accessibility	
Device compatibility	<ul style="list-style-type: none"> The design should be responsive and should work on the same list of devices as are supported by the eCG platform.
Bad hearing/reading skills	<ul style="list-style-type: none"> Audio of the text should be available for people with bad reading skills Text should be available for people with bad hearing skills
Elderly	<ul style="list-style-type: none"> Preferably, face-to-face contact should be available with the embodiment.
Building a connection with the user	
Connection with the embodiment	<ul style="list-style-type: none"> The embodiment should introduce itself at the beginning of the trajectory, so the user knows with whom they are talking.
Extended embodiment recognition	<ul style="list-style-type: none"> If possible, the embodiment should be visible on multiple stages of the trajectory the user goes through, for example the embodiment could already be visible in the family letter
Voice of the embodiment	<ul style="list-style-type: none"> When opting to include audio, it's important to select a calm, human-like voice. Robotic voices should be reserved exclusively for accessibility purposes. The use of robotic voices can lead to a heightened sense of detachment compared to text, as they lack the emotional nuances inherent in human speech.
Gaining information from the session	
Focussing on the information	<ul style="list-style-type: none"> It should be immediately clear when information on the webpage is important at what information is not important
Highlighting information	<ul style="list-style-type: none"> The embodiment should not use its hand to points towards certain pieces of information. If certain places of the app need additional attention, this should be done using a highlight on the page.

Importance of the information	<ul style="list-style-type: none"> The embodiment should look serious and professional, this will help in showing to the user that the information is about a serious topic.
Learning modalities	<ul style="list-style-type: none"> The textual information should be short and understandable. If audio is available, the information told in the audio should also be readable somewhere on the page.
Proactive learning	<ul style="list-style-type: none"> Questions asked to the user should be tailored to the user to increase the likelihood an interesting for the user.
Giving control to the user	
Choice in appearance	<ul style="list-style-type: none"> The users should not be able to choose between multiple embodiments, this increases the threshold for certain users and the focus of the platform should remain the information, and not the embodiment itself.
Choice in verbal of textual	<ul style="list-style-type: none"> When audio is available, users should be able to pause and continue the audio. Audio should not be forced on users, and this can feel annoying.
Non-verbal communication	
Body movements	<ul style="list-style-type: none"> When body movements are applied, the embodiment should keep its body movements to a minimum to prevent distractions When applied, the body language of the embodiment should be 'open'
Facial movements	<ul style="list-style-type: none"> Small emotions should be visible in the face of the embodiment, to prevent users thinking they are talking to a 'wall'
Hand movements	<ul style="list-style-type: none"> The embodiment should use small hand movements during talking to show some life. Hands should not be used to point towards certain places off the app.
Showing emotions	<ul style="list-style-type: none"> The embodiment should be able to display small emotions like a smile. Emotions should be kept to a minimum to prevent misinterpretation and to keep the embodiment professional.
Visual appearance	
Animal	<ul style="list-style-type: none"> The embodiment should not consist of an animal as this is not professional and not suitable for the importance of the platform
Animations	<ul style="list-style-type: none"> There should be no 'fluent' animations in the flatform. All animations should be done with replacing static images. This is to reduce the number of distractions for the user.
Distraction	<ul style="list-style-type: none"> Movements should be kept to a minimum to prevent distractions. Details should be kept to a minimum to prevent distractions.
Gender	<ul style="list-style-type: none"> The gender of the embodiment should be female. Participants noted that a female is preferred.
Physical details / visibility	<ul style="list-style-type: none"> The torso of the embodiment should be visible. Closer than a torso is seen as too intimate, and further away is too distant.
Professional	<ul style="list-style-type: none"> The embodiment should represent a professional in the field of genetic counselling.
Styling	<ul style="list-style-type: none"> The embodiment should be in the middle on a scale from realism till stylistic. Some details should be visible like facial expressions. The embodiment should clearly be a human being with the right aspect ratios in the body.

4.6.3 Design asset

With the requirements defined, a design asset has been selected that aligns with the established criteria. Figure 17 presents the chosen asset that will serve as the foundation for the design of the embodiment. The asset has been bought on Envato market, and provides the license to create a single end-product, the VGC in this case [28].

The selected design asset shows a female human doctor. It incorporates the desired physical details, focusing on the torso to encompass the head, shoulders, and arms, allowing for effective nonverbal communication cues and gestures. The asset strikes a balance between stylistic and realistic elements, presenting a visual representation that is both engaging and familiar to users.

Examining the facial display of the chosen asset, the asset allows for simple facial expressions to communicate with the user. Simultaneously, distractions are kept to a minimum, by not including too many details like wrinkles or other details.

Likewise, the hand movements integrated into the design asset exhibit an ideal balance between dynamic gestures and minimal distraction. The hands show enough detail for simple emotions but keep the details minimal.

Overall, the chosen design asset follows the defined requirements. It combines the desired personification, physical details, realism, facial display, and hand movements, this design asset will provide a strong base for the prototype.



Figure 17 - Chosen design asset of the embodiment.

4.7 DISCUSSION

The co-creation session conducted on the embodiment of the virtual genetic counsellor uncovered valuable insights into various themes, including accessibility, building a connection with the user, gaining information from the user, giving control to the user, nonverbal communication, and visual appearance. While the analysis provides valuable information, it is essential to consider the limitations and implications of these findings.

One limitation is that only one annotator has worked on created the themes of the thematic analysis. As it can be debatable which themes are reoccurring, a different researcher could have come up with a different set of themes and codes to conclude. Although the themes and codes were created as neutral as possible, another researcher might have created different codes.

Another limitation is the age distribution among the participants, as the participants were for the most part relatively young, the results might bias towards a younger audience.

Despite the limitations, the thematic analysis is important in informing the design and development of the embodiment and platform. The identified themes provide valuable insights into user expectations, preferences, and needs, allowing designers and developers to create a more user-centred experience.

4.8 CONCLUSION

The thematic analysis revealed several key findings across different embodiment and platform experience themes. The findings underscored the importance of accessibility considerations, such as device compatibility, providing options for individuals with hearing or reading difficulties and accommodating older users.

The following will answer the research question: *“Which levels of the aspects of embodiment are preferred by the general population in the context of a virtual genetic counsellor”*

When considering the personification of the virtual genetic counsellor, it is important to establish that the embodiment should resemble a human being. This choice is driven by the intention to create a relatable and familiar presence for users, enabling them to establish a stronger connection and engage more effectively with the virtual counsellor.

In terms of physical details, focusing on a torso as the primary visual representation is a sensible choice. By emphasizing the upper body, including the head, shoulders, and arms, the embodiment can effectively convey nonverbal cues and gestures, which play a significant role in human communication. The torso also hides unnecessary elements like the legs to keep the distractions to a minimum and prevent too much distance between the user and the embodiment.

Regarding the level of realism, striking a balance between a stylistic and realistic approach is found to be preferred. A completely realistic representation may risk falling into the uncanny valley, where users may find the embodiment unsettling or off-putting. On the other hand, a purely stylized approach may compromise the sense of familiarity and believability. Finding a middle ground, where the embodiment possesses enough realism to be recognizable as human, yet incorporates stylistic elements to enhance visual appeal and engagement, is preferred.

Considering the language modality, incorporating both verbal and textual elements is crucial. This allows for flexibility in accommodating different user preferences and accessibility needs. While verbal communication provides a more natural and interactive experience, the option to display textual information can assist users who prefer reading or have hearing impairments. By providing multiple modalities, the virtual genetic counsellor can cater to a wider range of user preferences.

When addressing facial displays, it is important to strike a delicate balance between conveying some emotions and minimizing distractions. The virtual counsellor should be capable of displaying subtle facial expressions that reflect empathy, understanding, and attentiveness. However, excessive or exaggerated facial movements could potentially divert users' attention or interfere with the counselling experience. Ensuring that the facial expressions are appropriately calibrated to convey emotion without overshadowing the content of the interaction is key.

Similarly, hand movements can contribute to a sense of dynamism and engagement during the counselling session. However, these movements should be purposeful and thoughtfully integrated, aiming to enhance communication and emphasize key points. Keeping distractions to a minimum is crucial to prevent users from being overly focused on the gestures rather than the substance of the counselling.

These findings provide valuable insights for designing an inclusive, engaging, and user-centred embodiment and platform experience.

5 PROTOTYPE DEVELOPMENT

This chapter focuses on creating a prototype for the virtual genetic counsellor based on the information gathered in chapters 3 and 4. The goal of this chapter give insight in the development process of the prototype.

This chapter will begin by presenting the methods used for the study, followed by explaining the goals of the prototype, the adjusted requirements, the development process, and a conclusion.

The prototype created in this chapter will be used for the user evaluation in Chapter 6.

5.1 METHODS

The process of designing and developing the prototype was divided into four steps, which are explained below:

To start, we identified the goals and outcomes we wanted to achieve with the prototype. This helped guide the development process in the right direction by providing clear and well-defined objectives.

For the second step, we determined the requirements that would guide the development of the prototype. We considered the requirements mentioned Chapter 4.6, but also recognized that not all of them were relevant to this thesis. To address this, we adjusted the requirements based on the results of the thematic analysis. This allowed us to align the prototype more accurately with its intended goal.

For the third step, we needed to choose the best technology to create the prototype. The technology we chose would need to be able to create a prototype with the defined requirements.

After selecting the appropriate technology, we began to develop the prototype. We used Figma [29], a robust design and prototyping tool, to create it. Figma's versatility and user-friendly interface allowed us to easily implement the necessary modifications, resulting in a visually appealing and interactive prototype.

5.2 GOALS OF THE PROTOTYPE

The primary objective of the prototype is to facilitate user evaluation, focusing on the looks of the embodiment and the interactions of the embodiment. Therefore, enabling user interaction with the prototype is crucial. The specific goals of the prototype are as follows:

We want to know what the users think about the looks of the embodiment and how it is implemented in the platform. For example, how does the prototype blend in with the other parts of the eCG platform and how does the prototype look?

We want to know what the users think about their interactions with the prototype. The prototype needs to be able to interact with the user and primarily provide information, in addition to the information already on the platform. The prototype needs to fit in the current design of the eCG platform, which is already in development, this way the information gathered during the evaluation will be more valuable for the eCG team.

The prototype needs to focus on the main users of the platform, in the current stage of development there is no need to specifically deep dive into accessibility for disabled people.

By achieving these goals, the prototype aims to provide a realistic and interactive representation of the virtual genetic counsellor's functionalities, ensuring a clear understanding of how the embodiment functions and interacts with users. This will pave the way for valuable user feedback and refinement before deployment in the actual platform.

5.3 ADJUSTED REQUIREMENTS










The requirements made in Chapter 4.6 are adjusted based on the goals of the prototype. Table 18 below displays the adjusted requirements per aspect of embodiment and Table 19 below displays the adjusted requirements regarding the themes from the thematic analysis of the previous chapter.

Table 18 - Final requirements for the prototype per aspect

Aspect	Design choice/requirement	Adjustment
Personification	Human being	✓ Remains the same
Physical details	Torso	✓ Remains the same
Realism	Mostly stylistic but should also have some details to it, but to a limited extend.	✓ Remains the same
Language modality	Verbal and textual, with the remark that the voice should sound like a real human voice, as most participants noted that if the voice sounds like a 'robot' this brings a lot a distance to the user.	✗ Adjusted According to the goals of the prototype, the language modality does not play a significant part in the prototype. As the language modality was mostly a requirement for accessibility, this requirement will not be part of the prototype.
Facial display	Show some emotions, but keep the emotions minimal to prevent interpretation errors and not distract the user too much	✓ Remains the same
Hand movements	Hand movements should be used but limited to small non-verbal ques. Pointing towards objects should not be done, and another technique like highlighting should be used.	✓ Remains the same

Table 19 Final requirements for the prototype per theme

Theme	Original requirement	Adjustment
Accessibility		
Device compatibility	<ul style="list-style-type: none"> The design should be responsive and should work on the same list of devices as are supported by the eCG platform. 	<p>✗ Adjusted</p> <p>The goal of the prototype is to evaluate the virtual assistant in the current eCG platform, which is made primarily for desktops. For this reason, it is not necessary in the scope of the eCG project to create a prototype for mobile.</p> <p>The prototype will only be created for desktop</p>
Bad hearing/reading skills	<ul style="list-style-type: none"> Audio of the text should be available for people with bad reading skills Text should be available for people with bad hearing skills 	<p>✗ Adjusted</p> <p>As on average the general population does not have a hearing impairment, and the prototype will only be evaluation by the general population, the prototype will not contain audio.</p>
Elderly	<ul style="list-style-type: none"> Preferably, face-to-face contact should be available with the embodiment. 	<p>✓ Remains the same</p>
Building a connection with the user		
Connection with the embodiment	<ul style="list-style-type: none"> The embodiment should introduce itself at the beginning of the trajectory, so the user knows with whom they are talking. 	<p>✓ Remains the same</p>
Extended embodiment recognition	<ul style="list-style-type: none"> If possible, the embodiment should be visible on multiple stages of the trajectory the user goes through, for example the embodiment could already be visible in the family letter 	<p>✗ Adjusted</p> <p>The prototype will be focus on the online platform and will not contain aspects outside the platform.</p>
Voice of the embodiment	<ul style="list-style-type: none"> The voice of the embodiment needs to be a calm and human-like sounding voice. If only a robot voice is available, it should only be used for accessibility purposes, as a robot voice sounds more distant than text. 	<p>✗ Adjusted</p> <p>As on average the general population does not have a hearing impairment, and the prototype will only be evaluation by the general population, the prototype will not contain audio.</p>
Gaining information from the session		
Focussing on the information	<ul style="list-style-type: none"> It should be immediately clear when information on the webpage is important at what information is not important 	<p>✓ Remains the same</p>

Highlighting information	<ul style="list-style-type: none"> The embodiment should not use its hand to point towards certain pieces of information. If certain places of the app need additional attention, this should be done using a highlight on the page. 	 Remains the same
Importance of the information	<ul style="list-style-type: none"> The embodiment should look serious and professional, this will help in showing to the user that the information is about a serious topic. 	 Remains the same
Learning modalities	<ul style="list-style-type: none"> The textual information should be short and understandable. If audio is available, the information told in the audio should also be readable somewhere on the page. 	 Remains the same
Proactive learning	<ul style="list-style-type: none"> Questions asked to the user should be tailored to the user to increase the likelihood an interesting for the user. 	 Adjusted As the prototype is focussed on the embodiment and not the chat technology behind it, the prototype will not adjust its behaviour per user.
Giving control to the user		
Choice in appearance	<ul style="list-style-type: none"> The users should not be able to choose between multiple embodiments, this increases the threshold for certain users and the focus of the platform should remain the information, and not the embodiment itself. 	 Remains the same
Choice in verbal of textual	<ul style="list-style-type: none"> When audio is available, users should be able to pause and continue the audio. Audio should not be forced on users, and this can feel annoying. 	 Adjusted As on average the general population does not have a hearing impairment, and the prototype will only be evaluation by the general population, the prototype will not contain audio.
Non-verbal communication		
Body movements	<ul style="list-style-type: none"> The embodiment should keep its body movements to a minimum to prevent distractions. The body language of the embodiment should be 'open' 	 Remains the same
Facial movements	<ul style="list-style-type: none"> Small emotions should be visible in the face of the embodiment, to prevent users thinking they are talking to a 'wall' 	 Remains the same
Hand movements	<ul style="list-style-type: none"> The embodiment should use small hand movements during talking to show some life. 	 Remains the same

	<ul style="list-style-type: none"> Hands should not be used to point towards certain places off the app. 	
Showing emotions	<ul style="list-style-type: none"> The embodiment should be able to display small emotions like a smile. Emotions should be kept to a minimum to prevent misinterpretation and to keep the embodiment professional. 	<input checked="" type="checkbox"/> Remains the same
Visual appearance		
Animal	<ul style="list-style-type: none"> The embodiment should not consist of an animal as this is not professional and not suitable for the importance of the platform 	<input checked="" type="checkbox"/> Remains the same
Animations	<ul style="list-style-type: none"> There should be no 'fluent' animations in the platform. All animations should be done by replacing static images. This is to reduce the number of distractions for the user. 	<input checked="" type="checkbox"/> Remains the same
Distraction	<ul style="list-style-type: none"> Movements should be kept to a minimum to prevent distractions. Details should be kept to a minimum to prevent distractions. 	<input checked="" type="checkbox"/> Remains the same
Gender	<ul style="list-style-type: none"> The gender of the embodiment should be female. Participants noted that a female is preferred. 	<input checked="" type="checkbox"/> Remains the same
Physical details / visibility	<ul style="list-style-type: none"> The torso of the embodiment should be visible. Closer than a torso is seen as too intimidating, and further away is too distant. 	<input checked="" type="checkbox"/> Remains the same
Professional	<ul style="list-style-type: none"> The embodiment should represent a professional in the field of genetic counselling. 	<input checked="" type="checkbox"/> Remains the same
Styling	<ul style="list-style-type: none"> The embodiment should be in the middle on a scale from realism to stylistic. Some details should be visible like facial expressions. The embodiment should be a human being with the right aspect ratios in the body. 	<input checked="" type="checkbox"/> Remains the same

5.4 TECHNOLOGY SELECTION

The technology chosen for the prototype needs to be able to create a clickable prototype, in which the virtual genetic counsellor is integrated into the eCG platform. Because the prototype is for evaluation purposes, it is not needed to create the prototype with code. The decision has been made to use Figma, Figma allows for the creation of user interfaces and to creation of clickable prototypes.

5.5 PROTOTYPE CREATION

This section focuses on the development of the prototype for the virtual genetic counsellor using Figma. The prototype will be based on the information gathered in Chapter 4 and the asset selected in Chapter 4.6. The primary goal of this prototype is to provide a clear and interactive representation of the virtual genetic counsellor's functionalities, which will be used for user evaluation in Chapter 6.

The following subsections will clarify why certain design decisions have been made and how the requirements have been implemented in the prototype.

The full prototype can be found in Appendix G – Prototype screens.

5.5.1 Reduced screens in the prototype

To ensure manageability and a better user experience, the prototype will focus on a single information topic, unlike the 'real' eCG platform, where users navigate through multiple topics. This reduction allows users to explore the virtual genetic counsellor's key features without being overwhelmed with excessive information.

5.5.2 Utilizing Existing Screens and States

The prototype's foundation is built upon the existing screens available in the eCG platform, ensuring consistency and alignment with the real eCG platform. These screens serve as the starting point for the prototype's development. Figure 18 shows the design of the eCG platform created by UMC Utrecht, and Figure 19 shows the adaption of the prototype. As can be seen, the main layout has been kept the same, but the prototype has additional buttons to open the virtual genetic counsellor.

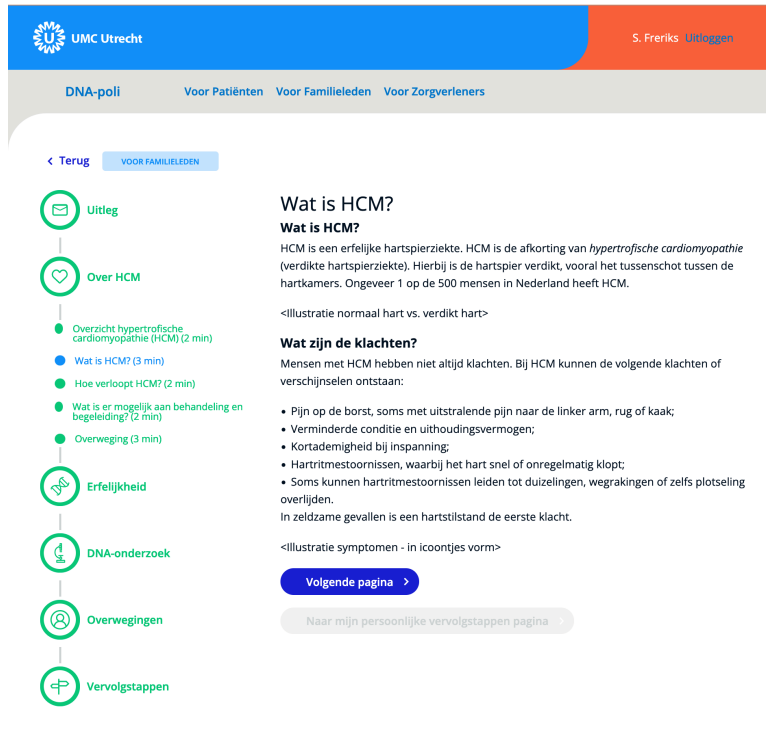


Figure 18 Original design

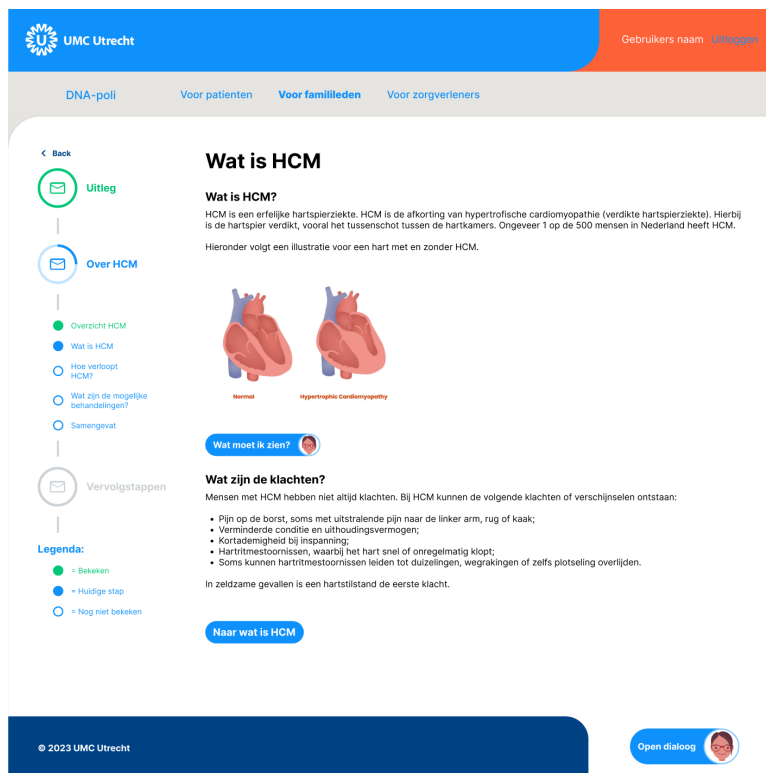


Figure 19 Adapted design

5.5.3 Interactive Figma Prototype

The prototype's screens and states will be interconnected in Figma, creating an interactive experience for users. By enabling seamless transitions between screens, users can navigate through the virtual genetic counsellor's functionalities with ease. Figure 20 shows a small part of how the buttons and interactions are linked to each other.

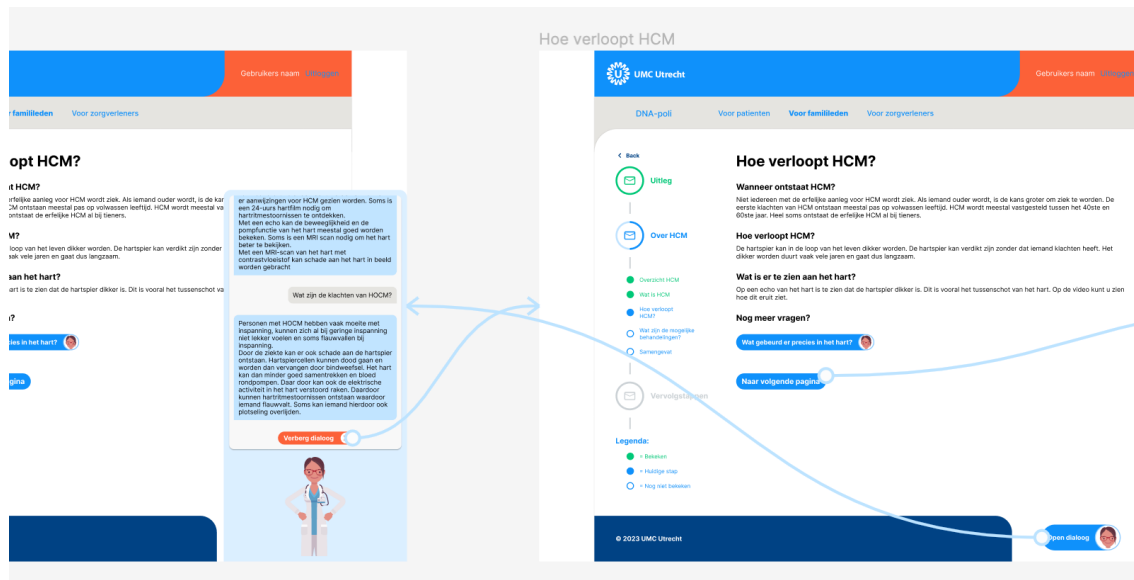


Figure 20 Example flow of buttons

5.5.4 Reduced information to focus on the virtual counsellor

To focus on the experience on the virtual genetic counsellor's core features, the amount of medical information is reduced compared to the real eCG platform. Figure 21 shows an example of how the prototype would look like with the original information, and Figure 22 shows the prototype with reduced information.

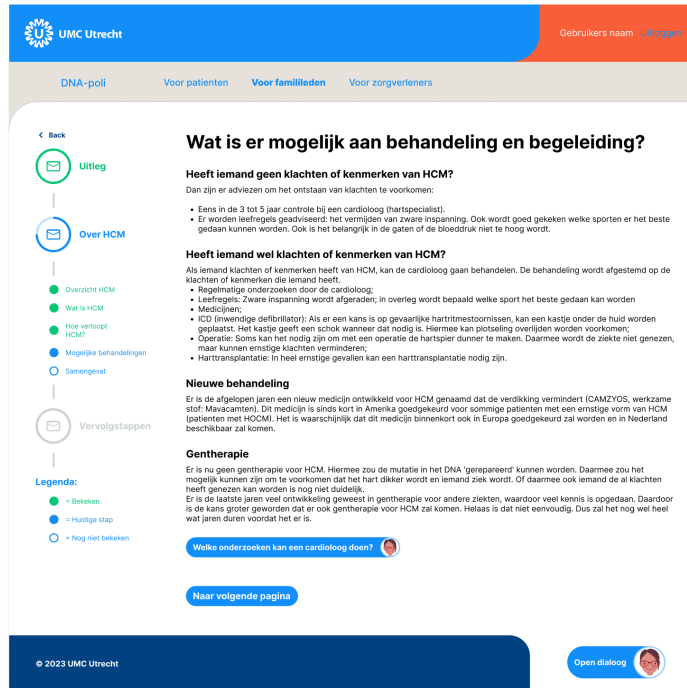


Figure 21 Screenshot of prototype with full information

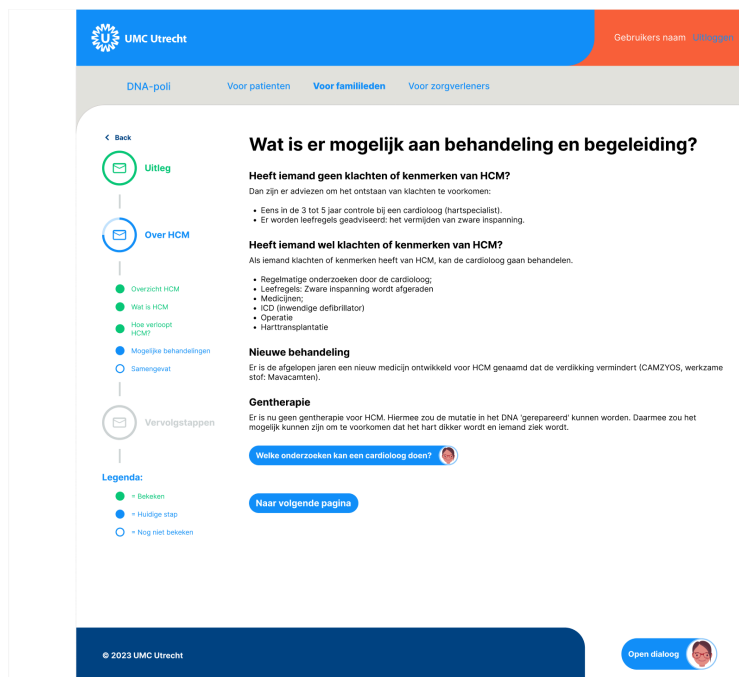


Figure 22 Screenshot of prototype with reduced information

5.5.5 Requirements implemented in the Prototype

The following describes which elements have been added to meet the requirements of the prototype.

Clear Introduction:

The prototype will begin with a clear and engaging introduction to provide users with context and set the tone for the genetic counselling session. Users will be introduced to the virtual assistant and understand its role in guiding them through the process. Figure 23 shows a part of the introduction of the virtual assistant. As can be seen, in the introduction the virtual assistant explains her purpose and how to use the assistant.

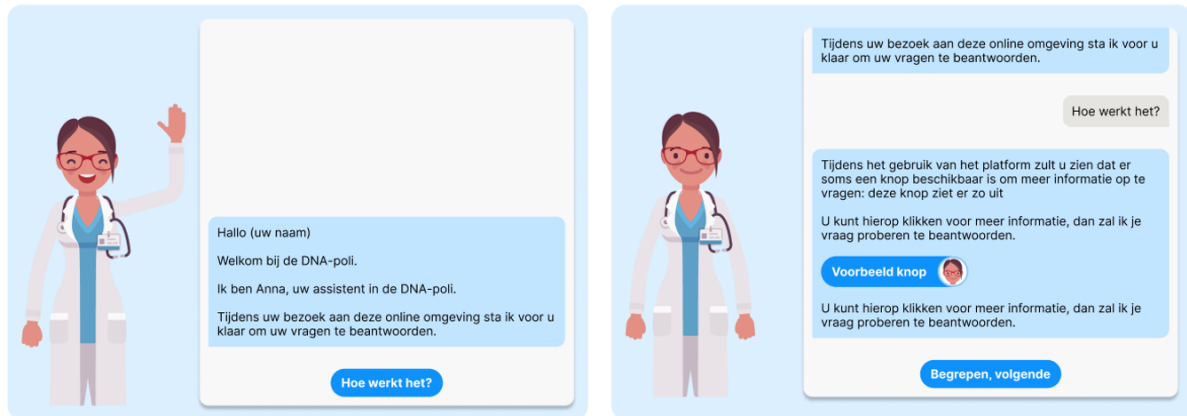


Figure 23 Virtual assistant introducing itself

Professional Appearance:

The virtual genetic counsellor's interface in the prototype will maintain a professional and clean appearance. As can be seen in Figure 24, the embodiment represents a doctor in professional clothes displaying a trustworthy assistant.

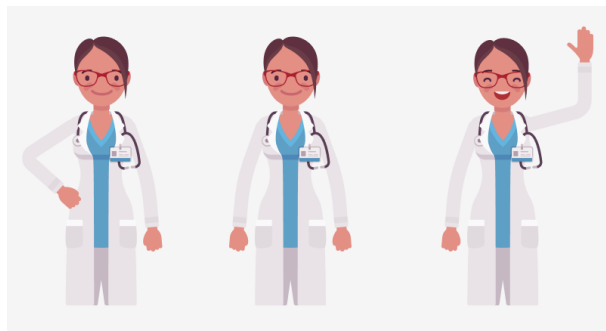


Figure 24 Visual appearance of embodiment

Easy Accessibility to the Virtual Assistant:

In the prototype, the virtual assistant will always be easily accessible. Users can interact with it with just one click at any point in time, which enhances user engagement and allows for seamless communication. To achieve this, a button has been added to the bottom right of the screen in the prototype. Once clicked, the dialogue with the virtual assistant will always reappear. Figure 25 provides an example of this button.



Figure 25 Open dialogue button

Highlighting Important Information:

The prototype effectively highlights crucial information to draw the user's attention. This makes it easy for users to identify essential details and understand the significance of specific information. Figure 26 demonstrates how highlighting is implemented in the platform. The main screen is darkened except for the chat and the part of the screen that requires attention, allowing users to focus on the highlighted information.

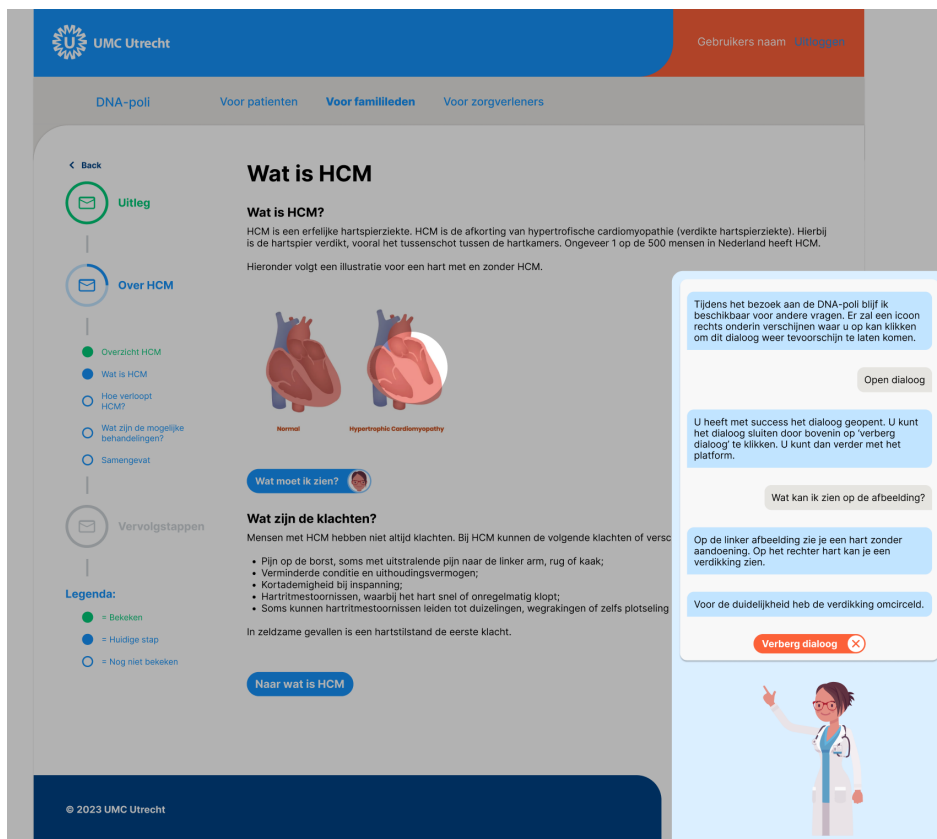


Figure 26 Highlighting information

Dynamic Embodiment:

In the prototype, the VGC won't stand still. Instead, it will move around and change positions to make the user's experience more interactive and interesting. Figure 27 displays a variety of positions the VGC can take. These different poses are utilized based on the conversation's context to create a subtle yet engaging experience.

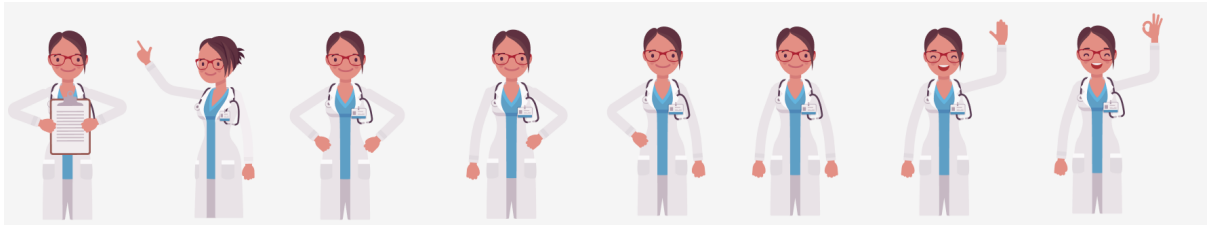


Figure 27 Range of poses

Requesting Additional Information:

If users need more information or want to learn more about a specific topic, they can ask the virtual assistant for help. In the prototype, there are two ways to request additional information. Firstly, a button with a predefined question is added after a main piece of information, letting users know that the virtual genetic counsellor can provide more information. An example can be seen in Figure 28. Secondly, during the chat, users can select from a set of predefined questions presented as blue buttons at the bottom of the chat interface to ask for more information. This is shown in Figure 29.

Nog meer vragen?

Wat gebeurt er precies in het hart? 

Figure 28 Additional information questions



Figure 29 In chat questions

Information Delivery via Images

The virtual assistant prototype will have the ability to share information using images in the chat interface. This feature improves the explanation of difficult concepts and helps users to better comprehend them. The image presentation is illustrated in Figure 30.

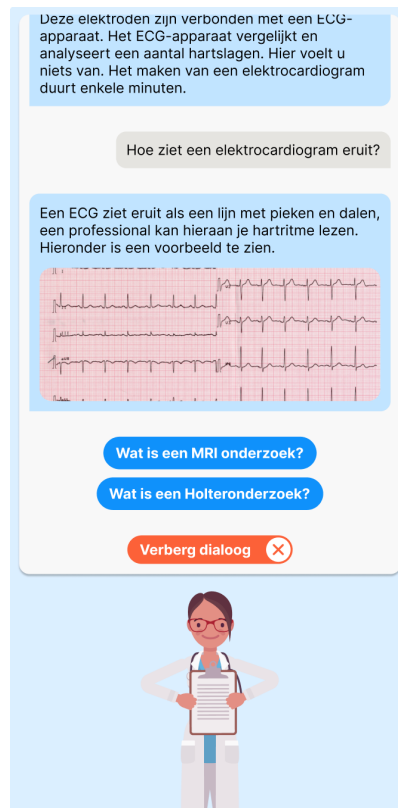


Figure 30 Providing information through images in the chat

5.6 CONCLUSION

In this chapter, we have successfully created the prototype for the virtual genetic counsellor, which will play a critical role in evaluating user experience in the upcoming chapter. We have ensured that all the necessary features were incorporated during the development process to accurately represent the virtual genetic counsellor's core functions. The prototype fully meets the adjusted requirements and will serve as a solid foundation for user evaluation in the next chapter. In the upcoming chapter, we will confidently determine the prototype's suitability for users.

6 USER EVALUATION

This chapter aims to gather and analyse data from the general population concerning their experience with the virtual genetic counsellor prototype. The primary sub-question addressed in this study is as follows:

“Do the identified requirements obtained during the co-creation session, align with the feedback of users during the prototype evaluation?”

This chapter will begin by presenting the methods used for this study, followed by the results of the thematic analysis and the survey, a discussion, and a conclusion in which an answer to the research question will be given.

6.1 METHODS

To assess the prototype of the virtual genetic counsellor, participants engaged with the prototype and performed a variety of tasks designed to activate all planned interactions/features of the prototype. This methodology ensured that participants fully interacted with every aspect of the prototype. The participants were asked to ‘think aloud’ during the tasks, to gather as many insights as possible. Following these task-oriented interactions, we conducted semi-structured interviews to delve into participants' experiences regarding specific facets of the platform. The evaluation process concluded with participants completing the System Usability Scale (SUS) survey [30].

The data acquired was used in a thematic analysis [31], representing a hybrid approach that incorporates elements of both inductive and deductive methods. Given that the prototype is grounded in previously gathered data, we leveraged this information for the deductive component of the thematic analysis. However, inductive thematic analysis was used to find new codes and fresh perspectives.

6.1.1 Participants

The target group for the evaluation was the general population, aligning with the target group of the eCG project. Participants were selected without specific restrictions on backgrounds or regions, as genetic diseases can affect anyone. The only requirement was the ability to read and write in English or Dutch. The sampling approach was mostly non-random, considering participants' availability. The focus was on gathering individuals from various educational backgrounds and age groups to create a representative sample of the general population. Section 0 will delve more deeply into these specifics.

6.1.2 Measurements

During the evaluation sessions, the following data were collected:

- **Audio Recordings:** Participants' thoughts and feedback were captured through think-aloud task-based evaluations. These audio recordings provided valuable insights into their interactions with the prototype.
- **Semi-Structured Interviews:** Detailed insights into participants' experiences and opinions were obtained through semi-structured interviews. This allowed for a deeper understanding of user perceptions.

- **System Usability Scale (SUS) Survey:** The SUS survey, a standardized measure of usability and user satisfaction, was used to assess participants' overall experience with the virtual genetic counsellor prototype.

6.1.3 Materials

The following materials were prepared for the evaluation:

Information letter and consent form

Participants were provided with an information letter detailing their rights and explaining the evaluation process. A consent form accompanied the letter, ensuring participants' agreement to take part in the evaluation. The consent form can be found in Appendix H – Evaluation consent form and the information letter can be found in Appendix I – Evaluation information letter.

Presentation

A concise PowerPoint presentation was created to briefly introduce participants to the eCG project and provide them with an overview of what to expect from the prototype, ensuring a smoother evaluation process without revealing any of its features. The presentation can be found in Appendix J – Evaluation presentation.

Tasks list

Participants were given a task list outlining specific actions to be performed on the prototype. The tasks were designed to cover different aspects of the platform and included clear reasons for each task. The task list for the participants did not contain the reasoning for each task. The full task list with instructions for the participants can be found in Appendix K – Evaluation task list.

The task list contained the following tasks followed by the reason for the task:

- 1. Read the introductory information and continue to the next pages on the screen until you see the virtual genetic counsellor.**
 - a. This task aims to help users become familiar with the platform's interface, allowing them to get comfortable with its appearance and interactions.
- 2. Finish the conversation with the virtual genetic counsellor, follow her instructions, and close the conversational dialogue.**
 - a. In this task, users are introduced to the concept of embodiment, experiencing interaction with the virtual genetic counsellor for the first time.
 - b. This task allows users to open and close the dialogue, conducting their initial interaction with the virtual genetic counsellor.
- 3. You want to know more about HCM, open the information page about HCM.**
 - a. This task empowers users to access specific information about HCM, promoting targeted information retrieval.
- 4. Ask the virtual genetic counsellor for more information about the illustration on the page.**
 - a. In this task, users engage with the virtual genetic counsellor by seeking additional information, enhancing their interaction with the platform.
 - b. The virtual genetic counsellor will offer guidance on the screen, highlighting relevant information.
- 5. Go to the page about the process of HCM.**
 - a. This task directs users to the next page in the prototype.
- 6. Gather all available information about HCM and then close the conversation.**
 - a. Users can use this task to ask multiple questions about HCM, engaging with the chat interface to collect comprehensive information.

- b. This task also enables users to conclude their interaction with the virtual genetic counsellor.
- 7. **Go to the page about possible treatments.**
 - a. This task directs users to the next page in the prototype.
- 8. **Ask the virtual assistant for all available information about Elektrodiagrams and then close the conversation.**
 - a. In this task, users receive additional information in the form of images from the virtual genetic counsellor, enhancing their understanding of Elektrodiagrams.
 - b. Users can conclude their interaction after obtaining the desired information.
- 9. **Go to the summary page.**
 - a. This task directs users to the next page in the prototype.
- 10. **Task 10: Finish.**

Semi-structured interview

A set of interview questions was prepared to gather relevant information from participants. The questions covered various aspects of their experience with the virtual genetic counsellor, along with the corresponding prototype screens.

- What did you think about the introduction?
 - What did you think about the way the virtual assistant introduced itself?
- What did you think about the styling of the virtual assistant?
- What do you think about the way you can access the virtual assistant?
 - If not, what could be improved?
 - If yes, why?
- What did you think about the way the virtual assistant provided information?
- What do you think about the way the virtual genetic counsellor is integrated into the platform?
- Did you notice the different positions of the virtual genetic counsellor?
 - What did you think about the different poses?
- Do you think the virtual assistant is of additional value?

The SUS Survey

The survey utilized in this study is a standard usability survey known as the System Usability Scale (SUS) [30]. It consists of ten questions, each rated on a 5-point Likert scale, ranging from "strongly disagree" to "strongly agree.". The questions have been adapted to refer to the virtual genetic counsellor instead of the default subject 'the system'. The survey given to the participants can be found in Appendix M – Evaluation survey.

The SUS score is calculated using a specific method as follows. Each item's score contribution will fall within the range of 0 to 4. For items 1, 3, 5, 7, and 9, the score contribution is derived by subtracting 1 from the scale position. For items 2, 4, 6, 8, and 10, the contribution is calculated as 5 minus the scale position.

Once the sum of the scores is obtained, it must be multiplied by 2.5 to determine the overall SUS value. SUS scores have a potential range of 0 to 100, with a score above 68 considered above average.

By employing the SUS, we can effectively measure the usability of the virtual assistant. The calculated SUS score provides a clear and standardized metric to evaluate the virtual assistant's

usability. The results of the SUS survey do not say anything qualitatively but give a simple insight into the usability.

6.1.4 Procedure

The evaluation session followed a structured procedure (see Figure 31), and the entire process was audio-recorded for documentation purposes.

- **Introduction and Project Information:** The session began with an introduction to the eCG project and an overview of the evaluation process.
- **Task Explanation:** Participants were given the task list which explained the objectives of each task.
- **Task Performance:** Participants proceeded to interact with the prototype and complete the assigned tasks.
- **Semi-Structured Interview:** Following task completion, participants engaged in a semi-structured interview to share their thoughts and experiences.
- **System Usability Scale (SUS) Survey:** After the interview, participants filled out the SUS survey, providing a standardized measure of usability and satisfaction.

On average, the entire session was completed in about 30 minutes.

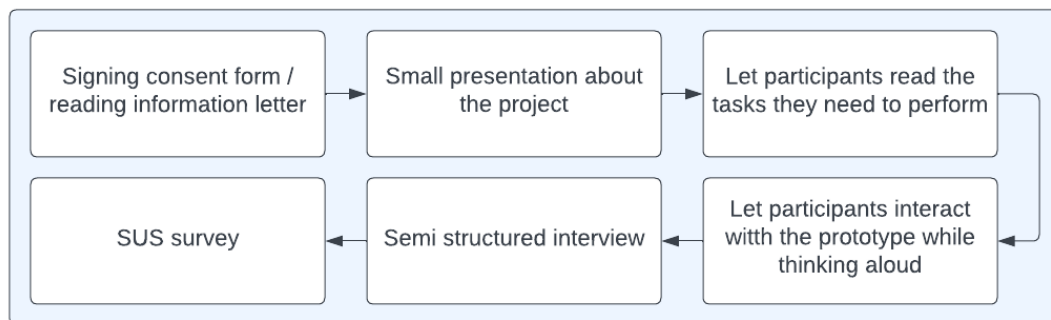


Figure 31 Outline evaluation session

6.1.5 Data analysis

The data analysis process of this section involved a thematic analysis of the transcripts of the evaluation session and calculating an average score for the SUS rating.

The thematic analysis involved coding the data and identifying recurring themes. To begin the thematic analysis, all recordings were transcribed to make the data easier to work with.

Several points of interest were defined as a starting point for the deductive part of the thematic analysis. These points of interest were the deductive part of the thematic analysis. The points of interest originated from the results of the thematic analysis from chapter 4.

Next, the transcriptions were read thoroughly to comprehensively understand the information. Based on this reading, several codes were created to capture the key ideas and concepts that emerged during the evaluation sessions. Iteratively these codes were developed with additional codes being created and merged until a comprehensive set of codes was developed.

After the codes were finalised, they were organised into themes based on their similarity and relevance. These themes were identified as the recurring topics that emerged during the focus

groups. The themes guided the data interpretation and developed meaningful conclusions that addressed the research questions.

The main tool used during the thematic analysis was Atlas TI [27]. Atlas TI was used to organise the codes, quotations, and themes.

6.2 RESULTS – DEMOGRAPHICS

In this section, an overview of the demographics of the participants is provided. This section aims to outline the characteristics and backgrounds of the individual participants involved in the research. Examining the demographics makes it easier to understand the diversity and representation of the global population in the co-creation sessions.

The evaluation sessions involved 11 participants. Of the 11 participants, six participants were female and five were male.

The average age of the participants was 30.8, with a median of 25 and a standard deviation of 14.28. The age range varied from a minimum of 22 to a maximum of 63. Figure 32 below illustrates the age distribution, ordered from left to right in the same sequence as the conducted sessions. As can be seen from the figure, two participants stand out in age which can affect the overall conclusion but is needed nonetheless as the platform should be accessible for every age group.

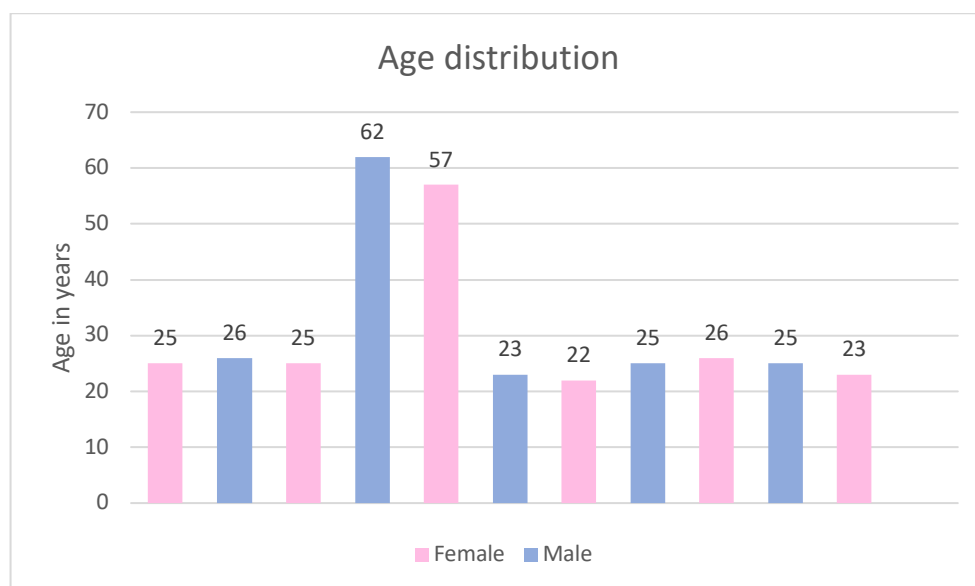


Figure 32 – Demographic distribution of evaluation session participants, with each bar representing an individual participant.

6.3 RESULTS – SUS SURVEY

In this section, we will read into the findings of the SUS (System Usability Scale) survey. The SUS survey provides a holistic perspective on the overall usability of the system. While the SUS survey yields a singular numerical score, it primarily offers a quantitative assessment, lacking in-depth qualitative data. Nonetheless, this score can provide valuable high-level insights into system usability. Table 20 below displays the score per question per participant, the scores in this table are already normalised according to the rules of the SUS survey, thus making the scores range from 0 to 4.

Table 20 - SUS results normalised ranging from 0 to 4

Question	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11
I think that I would use the virtual assistant frequently.	4	3	4	4	2	3	3	4	3	3	3
I found the virtual assistant unnecessarily complex.	4	4	1	4	1	4	4	4	3	4	4
I thought the virtual assistant was easy to use.	4	4	4	4	3	3	4	4	4	4	4
I think that I would need the support of a technical person to be able to use the virtual assistant.	4	4	4	4	3	4	4	4	4	4	4
I found the various functions in the virtual assistant were well integrated.	3	4	3	2	2	4	4	3	4	4	3
I thought there was too much inconsistency in the virtual assistant.	4	4	3	2	4	4	4	3	4	4	4
I would imagine that most people would learn to use the virtual assistant very quickly.	4	4	2	4	3	4	4	4	3	4	4
I found the virtual assistant very cumbersome to use.	4	4	4	1	3	4	4	4	3	4	4
I felt very confident using the virtual assistant.	4	4	3	3	2	3	4	1	3	3	4
I needed to learn a lot of things before I could get going with the virtual assistant.	4	3	4	1	3	4	4	4	3	4	4

The SUS survey averaged a score of 87.5. According to the SUS survey's criteria [32], an average score of 68 or higher is considered above average in terms of usability. With a median score of 92.5, a minimum of 65, a maximum of 97.5, and a standard deviation of 10.9, the data suggests a high level of usability. It's worth noting that only one individual score fell below 68, reinforcing the conclusion that, based on the SUS survey, the prototype is above average in terms of usability.

Figure 33 presents the SUS scores for each participant. Examining the scores on a per-participant basis, it's evident that participants 4 and 5 provided the lowest scores. Notably, these participants were also identified as outliers in the age distribution, which could suggest that the system might be less usable for "elderly" users.

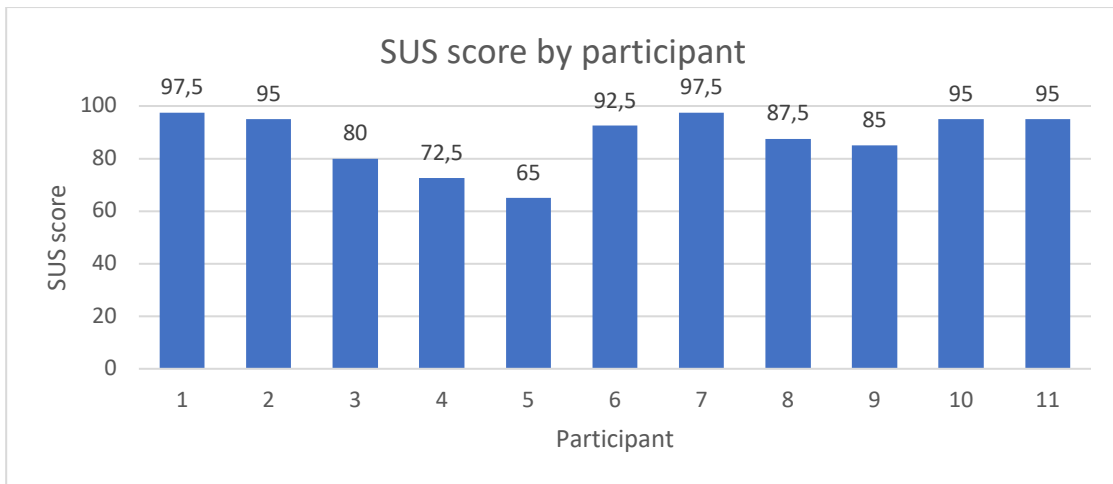


Figure 33 - SUS score per participant

Figure 34 display the SUS score per question. As can be seen for question 9, the questions about using the system with confidence, scores the lowest on average, but still with a score of 77, which is still 'good'.

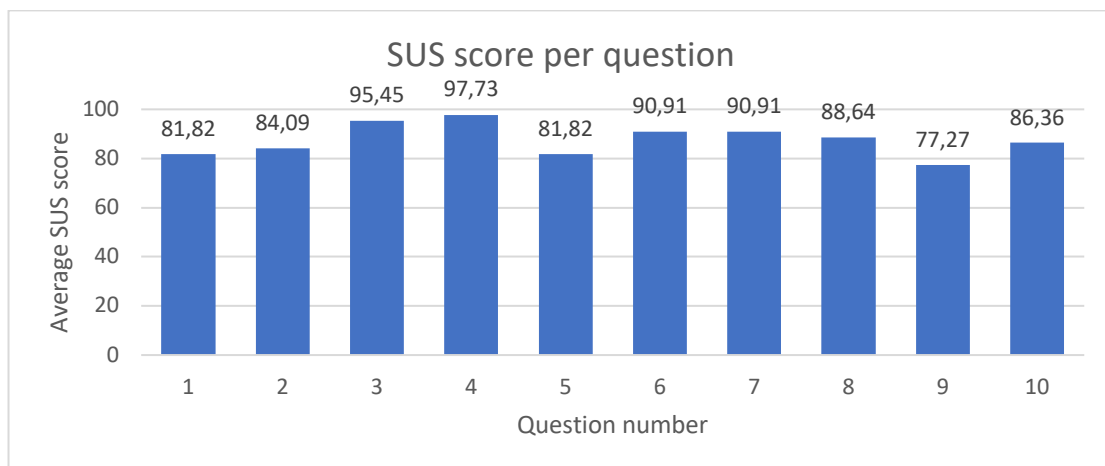


Figure 34 - SUS score per question

To provide a more straightforward interpretation of the SUS score, Figure 35 provides a visual representation of score categories. Within the figure, it's clear that a score of around 72 is considered 'good.' Our system's average score of 87.5 places it comfortably within the 'excellent' range, as depicted in the figure.

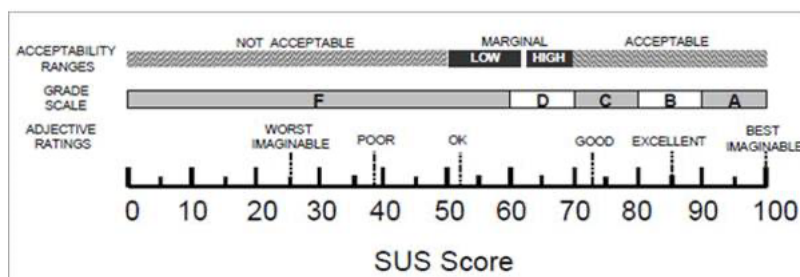


Figure 35 - Interpretation SUS scores [33]

6.4 RESULTS – THEMATIC ANALYSIS THEME DEVELOPMENT

The thematic analysis approach was used to identify and analyse the recurring themes that emerged from the evaluation sessions. This involved reading through the transcriptions thoroughly and creating codes to capture the key ideas and concepts that were mentioned by the participants. The transcripts can be found in Appendix N – Evaluation transcripts.

6.4.1 Key Areas of Interest (deductive)

Before the evaluation sessions were conducted, specific aspects of the prototype were identified for in-depth exploration. These areas of interest were informed by both recurring themes of the focus groups and the requirements of the prototype.

The following key areas of interest guided the inquiry:

Movements of the assistant: How do participants perceive and react to the movements integrated into the prototype?

Connection with Embodiment: To what extent do users feel connected with the embodiment within the system?

Maintaining Information Focus: Can users effectively concentrate on the information provided while interacting with the assistant?

Assistance with Information Processing: Does the assistant assist users in processing and understanding the information effectively?

Overall Satisfaction with Embodiment: Does the embodiment of the assistant meet users' expectations and needs?

Professionalism: Do participants consider the behaviour and interactions of the assistant to be professional enough?

Distraction: Is the assistant not too distracting?

These key areas of interest formed the basis of our discussions and analyses during the evaluation sessions, helping us gain a deeper understanding of our prototype's performance and how users perceived it.

6.4.2 Initial observations

During the evaluation sessions, there were a few observations that stood out. In this section, these observations will briefly be described before going into the thematic analysis in the next section.

The first observation is the fact that individuals often do not give their full attention to the embodiment when their primary focus is on the textual content. Focussing more on the chat and the content rather than the visuals of the embodiment.

The second observation reveals that only half of the participants noticed that the embodiments occasionally moved into different positions during the sessions.

When questioned, all participants expressed a preference for having an assistant present, even when they had not particularly noticed its presence throughout the session.

6.4.3 Final themes and code

After approximately four phases of reordering, combining, and generating new themes, a definitive set of themes and codes was created. This process followed a structured procedure, as outlined below:

At first, the transcriptions were subjected to universal and descriptive coding. This process involved the assignment of labels or codes to segments of the data, aiming to capture the core concepts and ideas expressed in the text. This initial categorization helped lay the foundation for the subsequent analysis.

Once all the transcriptions were coded, the codes created were consolidated into themes. During the creation of these themes, it became apparent that multiple codes had been generated that essentially represented the same underlying aspects but were articulated differently. These codes were subsequently refined to establish a more coherent and comprehensive set.

Following the refinement of the codes, the themes were revisited. This new grouping process aimed to bring together codes that pertained to the same overarching themes or concepts, even if they were initially scattered throughout the data. By clustering related codes, emerging patterns and relationships within the data started to become apparent.

With the codes now organized into themes, the next step involved revisiting these newly structured code themes. During this revisitation, the focus shifted to a broader perspective, seeking to understand how these codes related to one another within a more comprehensive context. This allows for codes to switch to different themes, and for the themes to be better named and specified.

As a result of this, new themes began to surface. These themes represented higher-level concepts or patterns that were not immediately evident during the initial coding process. Essentially, they served as overarching and unifying concepts that tied together the codes within each thematic group. These emergent themes provided a more profound and coherent structure for interpreting the data.

This sub-chapter provides information about these final themes, which are now referred to as the themes.

In total, five different themes were created during the thematic analysis. Table 21 gives a global overview of the various themes that were found. The quotes are not mutually exclusive, and a single quote may belong to multiple codes and/or themes. In the following sub-chapter, the codes of the themes are discussed, and quotations of the codes are provided to provide a body to the subject. The themes are ordered in alphabetical order. As some of the evaluation sessions were conducted in Dutch, some of the quotations were translated into English to fit this report, this is mentioned beside the quote. The next chapter covers every theme in more detail.

Table 21 Global evaluation themes

Theme name	Number of codes	Number of quotes
Embodiment and realism	5	70
Information clarity and focus	5	68
Interaction with the virtual genetic counsellor	5	117
Technical and practical aspects	2	18
User experience and engagement	4	39
Total	21	312

6.5 RESULTS AND FINDINGS – THEMATIC ANALYSIS THEMES AND CODES

This section will go in-depth into the five different themes found in the thematic analysis. Per theme the codes are displayed and explained with the use of quotations.

6.5.1 Theme 1: Embodiment and Realism

The first theme is the theme of “Embodiment and realism”. Embodiment and Realism explores the visual aspects of the virtual genetic counsellor, specifically focusing on how it impacts the realism perceived by participants in a genetic counselling context.

Table 22 displays the theme and its codes, along with the number of quotes per code.

Table 22 Theme 1: Embodiment and realism

Theme 1: Embodiment and realism	
Code	# of mentions
Appearance of the virtual counsellor	29
Distractions by the virtual counsellor	25
Movements of the virtual counsellor	8
Professionalism of the virtual counsellor	16
Visibility of the virtual counsellor	5
Total	83

Code: Appearance of the virtual counsellor

The code “Appearance of the virtual counsellor” is about the general visuals of the virtual counsellor.

Participants noted that the visuals of the virtual counsellor are simple yet efficient. Having the embodiment represent a doctor fits the topic well as this conversation is generally also done with a healthcare professional.

“It's not too fussy [The appearance of the virtual counsellor]. It's just simple. Judging by the clothing, you naturally think of a doctor. You would probably have this conversation with a doctor, I think. So that's fine.”
 - (translated) Participant 1

It is noted that the balance between details and simplicity of appearance helps in terms of distractions, which are kept to a minimum.

“Simple enough, but also detailed enough, so to speak. It doesn't distract you too much.” - (translated) Participant 1

A participant mentioned that the virtual genetic counsellor does not have to be realistic, but just needs to be clear to the patient that the virtual genetic counsellor is someone who has knowledge and expertise on the subject.

“The styling [of the virtual counsellor], I think it's fine. A good generic one in that sense. It doesn't really have to be anything special for me. It just needs to at least reflect a person who is involved with the subject you're dealing with. Without immediately giving the impression that it has to be hyper-realistic. I think the whole idea kind of undermines what you want with such an embodiment. Simple, but clear for the patient. This is

someone who has knowledge and expertise in it.”
- (translated) Participant 11

The same participant pointed out that the virtual counsellor's appearance was perceived as 'cartoony'. However, they also noted that the purpose of the virtual counsellor as a medical specialist was still apparent. This suggests that the cartoonish style is effective in conveying a professional image.

“It's a bit cartoony [The appearance of the virtual counsellor], but it still serves a purpose, carries its purpose. It's clearly a medical specialist you're conversing with.”
- (translated) Participant 11

One of the participants expressed that if the styling of the icon becomes too realistic, people might have diverse opinions about it. Therefore, keeping it simple will make it clear and understandable. The participant stated;

“No, this is just right as it is. If you move towards more realism, then you'll have people forming opinions about it. Right now, it's just clear that it's an icon of a doctor or an assistant.”
- (translated) Participant 8

There was one specific mention regarding the 'happiness' of the VGC, as the appearance might be too happy for the context.

“The little figure is indeed very cheerful. A bit too cheerful. Still a nice figurine.”
- (translated) Participant 5

Based on the quotations, it can be concluded that the embodiment of the medical specialist is simple yet efficient. It is important to ensure that the embodiment is recognizable as a medical specialist but not overloaded with too many details. This is because users may form a biased opinion about the appearance if too many details are added. In addition, the emotions conveyed through the embodiment should not be overly cheerful as they may not align with the context of the platform.

Code: Distractions by the virtual counsellor

In the code “distraction” the focus is on how the virtual genetic counsellor distracts the participants from their main task, gaining information.

All participants noted that the virtual genetic counsellor was not distracting the users from focusing on the information. Participants noted that they did not focus on the virtual genetic counsellor too much.

“No, that's not distracting [The movements of the virtual counsellor]. No, no, definitely not.”
- (translated) Participant 4

One participant stated that only the 'pointing' of the VGC caught the attention of the participant, but not to the point of distraction.

“I mean it didn't distract me to the point where I wondered what kind of crazy dance she was doing. And on the other hand, it's not like I missed anything. So, that pointing, that did catch my attention. As for the rest, as I scroll through it now, I see that her arms are moving a bit. And that's nice for adding some dynamics for those who do notice it. But yeah, no, I don't think it's unnecessary movement, it just didn't stand out to me. So, in my opinion, that's also a good thing because it didn't distract

me.”
- (translated) Participant 1

Given the feedback from the participants, it is safe to say that the VGC did not distract the users from the main content, the genetic information.

Code: Movements of the virtual counsellor

The code animation refers to the movements of the virtual counsellor, like arm and hand movements.

It is noted that most participants did not actively notice the movements of the virtual counsellor as they were more focused on the information, as depicted by the following two quotations.

“I only noticed it [the movements of the virtual counsellor] halfway through, and by that time I was too late to see what she did exactly”
- (translated) Participant 2

“I was very much focused on the text and what was on the pictures. So I was more focused on that [the text and pictures] actually and choosing the questions. So I noticed of course that she is there, but it's not that I noticed that she stands differently or that she moves now.”
- Participant 10

There were also several participants that did notice the movements of the VGC, and, in general, the those who did found it a positive experience.

“The little figure keeps changing, and I find that funny.”
- (translated) Participant 5

“She does look nice, and I also find it funny that she's in a different position on every page.”
- (translated) Participant 9

One participant didn't notice the movements at all but did find it positive when they were shown afterward.

“I actually didn't notice that [the movements], but now that you mention it, it is nice.”
- (translated) Participant 7

Another participant found that the movements made the virtual genetic counsellor more cheerful and playful.

“It's not super conspicuous [The movements], so that's good, I think. But it does make it cheerier, a bit more playful than very plain, you know. So that's nice. And it's [The appearance of the embodiment] also just beautiful.”
- (translated) Participant 2

In summary, not all participants initially observed the "movements of the embodiment" as they were primarily focused on the information. However, when questioned, participants found these movements to be beneficial, enhancing the platform's dynamism and playfulness. Based on this, we can conclude that the movements add value to the VGC without any apparent negative side effects.

Code: Professionalism of the virtual counsellor

The code of professionalism refers to the professionalism of the appearance of the virtual counsellor.

One participant expressed the view that it's only logical for the virtual genetic counsellor to resemble a doctor, as the conversation would typically take place with a healthcare professional in real life. The participant specifically noted that it would feel odd if the VGC represented a "generic person".

"You would have had this conversation with a doctor if this wasn't here. So, it actually feels comforting. Yes, and it just feels more logical that you discuss this with a doctor, that a doctor provides you with this information. If it had just been a completely random person in a sports outfit, it would have felt a bit strange to me. So, it also feels more serious"

- (translated) Participant 1

Despite the virtual genetic counsellor being "animated", participants still perceived the VGC as professional. Participant 9 expressed this by saying:

"She looks like a real professional doctor, even though it's animated."

- (translated) Participant 9

The "professionalism of the embodiment" is conveyed through the appearance of a medical expert. Participants recognized that the virtual genetic counsellor effectively displayed professionalism, and they preferred the portrayal of a medical expert over that of a 'general person'. Consequently, the current VGC is deemed sufficiently professional by the participants.

Code: Visibility of the virtual counsellor

The "Visibility" code was established in response to opinions regarding what should be visible for the virtual genetic counsellor.

One participant suggested the idea of displaying only the head of the embodiment, but they also noted that this might lead to the removal of the lab coat and potentially the professionalism associated with it.

"Maybe just a head is enough. I mean, the head and the eyes. The coat suggests that you're talking to a doctor. But that's not the case, of course. Maybe that creates confidence in people. It could. But just a head is already sufficient."

- (translated) Participant 4

Another participant suggested that if only a smaller part of the embodiment were visible, it could be depicted slightly larger, which might be beneficial for individuals with poor eyesight.

"It can be slightly smaller, depict the character a bit larger, but you can remove the legs, for example. You could go up to the waist, not to the knee but up to the waist. And depict it slightly larger, as people who are ill might have some difficulty seeing."

- (translated) Participant 5

Another participant also mentioned that the embodiment is a bit long and not quite proportional.

"Her torso is a bit long, and then this part [Lower part of lab coat], I don't know. It's like this whole section is her torso, and then her legs

start here.”
 - (translated) Participant 9

In summary, "Visibility of the embodiment" relates to which parts of the embodiment are visible to users. Participants agreed that showing only the torso is a good practice. However, they also suggested that by removing a portion of the lab coat, the virtual genetic counsellor could be scaled slightly larger, potentially helping users with poor eyesight. Therefore, a potential improvement could involve 'trimming' the lower part of the lab coat to depict the embodiment as slightly larger, while also maintaining a proportionate appearance for the VGC.

6.5.2 Theme 2: Information clarity and focus

The second thematic analysis theme is "Information Clarity and Focus." This theme is centred on the clarity and focus of the information provided, whether it's by the virtual genetic counsellor or the platform. It includes several codes that illuminate how participants perceive and engage with the information.

Table 23 displays the theme and its codes, along with the number of quotes per code.

Table 23 Theme 2: Information clarity and focus

Theme 2: Information clarity and focus	
Code	# of mentions
Beyond the essential information	16
Digesting the information	15
Highlighting the information	11
Keeping it simple	19
Much information	20
Total	81

Code: Beyond the essential information:

The "beyond the essential information" code originates from comments indicating that the information provided by the virtual genetic counsellor is considered supplementary to the essential information already presented by the platform. This allows participants to gain more in-depth knowledge on specific topics.

Participants noted that the buttons with questions in the platform, which open up additional information, are valuable and helpful.

“Usually, you scan through it first, and then suddenly you see the button. It's always great to have more explanation for that.”
 - (translated) Participant 2

“Yes, I find it convenient [the more information buttons]. I think that if it's not clear, you can click on it for additional explanation. And it also clearly states the question of what I should see. I find it convenient.”
 - (translated) Participant 7

Participants believe that "hiding" non-essential information behind the virtual genetic counsellor is a sensible approach, as it helps reduce the information overload for individuals who may not be interested in it.

"I think it's unwise to fill a page with Wikipedia-like text. And there are still people who do not have enough information from what is on that page. So, to hide it behind the assistant seems like a good choice to me."
- (translated) Participant 8

Participants generally favour the notion of the platform presenting essential information while allowing those interested to access supplementary details through the virtual assistant. Therefore, it is reasonable to conclude that the current split between essential and additional should remain.

Code: Digesting information

The "digesting information" code pertains to the process of gaining knowledge while navigating the system.

Participants noted that the platform's structured approach with different steps is an effective way to comprehend all the information.

"I think that the way you walk through it step by step is quite clear. If you start with the letter, a point of recognition for a person. Naturally, the person who received the letter sees it again. They have questions about it. The most clear questions are answered first. I think that's the right approach if done well."
- (translated) Participant 8

One participant suggested that it would be easier to digest the knowledge if keywords in the text were highlighted, such as using bold or other indicators to emphasize important words. Additionally, they recommended having more space between the paragraphs to enhance readability.

"What helps me when reading such texts is if there are some words in bold or something indicating important words or such." "Maybe there could be a bit more space between the lines."
- (translated) Participant 9

The platform's step-by-step approach is considered an effective way to deliver information to users. However, there is room for improvement in terms of information styling. Participants suggest enhancing information comprehension by highlighting keywords in bold for easier identification. This proposed styling change could contribute to better understanding and digestion of the information.

Code: Highlighting the information

The "highlighting the information" code was introduced based on feedback related to the feature where the virtual genetic counsellor points to and highlights specific pieces of information.

Participants, overall, found the highlighting feature to be a valuable addition and appreciated its presence. The following shows several examples of participants indicating the clarity of the highlight.

"I found it [the circle around the heart] clear"
- (translated) Participant 6

"Yes clear, with the pointing towards it, fine"
- (translated) Participant 11

"I actually find it very good that you highlight that. Then I know exactly where to look. Yes, I think that's a very good feature. It darkens the rest a bit, but that's the point."
- (translated) Participant 4

However, as a point of improvement, a participant mentioned it might be even clearer if the virtual genetic counsellor would move towards the highlighted information instead of pointing towards it.

"Maybe for some, it's completely clear if the little figure will appear next to it [the information], but for me, this is clear as well. But it's nice that they immediately indicate where you can find it."
- (translated) Participant 11

Another area for improvement concerns the accuracy of the highlight feature. A participant mentioned that the entire heart was highlighted instead of a specific area of interest, indicating that the highlight could have been more precise.

"But the entire image is also circled. So you mean the central part. But the whole heart falls within it."
- (translated) Participant 3

The "Highlighting the information" code pertains to the virtual genetic counsellor's ability to point to and 'highlight' specific elements on the screen. Participants generally appreciated this feature as it made it easier to discern where to focus their attention on the screen, facilitating a stronger connection with the information and visual content. While the implementation of the highlight feature could be enhanced for precision, it is seen as a promising step in the right direction.

Code: Keeping it simple

The code "keeping it simple" refers to the remarks of the participants where they mention the information should be kept simple or that the platform is already simple.

Participants like that the information is general is not shown all at once.

"It is cool that it is not one wall of information"
- (translated) Participant 2

Besides the amount of information, the given information, by both the platform and the virtual genetic counsellor should be in easily readable language.

"It all needs to be a bit in simple language, this is way too doctor language."
- (translated) Participant 5

The multiple steps of the platform in combination with the additional information from the virtual genetic counsellor help to make the information more personal, and simpler to understand as a big piece of text.

"Yes, but I still find this, I find it more enjoyable or something. But also, perhaps more organized, and less like a wall of text. It comes across as more personal when it's done this way. Because you can have a whole information letter and a lot of information in a row without such a little figure or something. Yes, this makes it a bit nicer, user-friendly. I would be more likely to scan over a large block of text and not read anything than in this way."
- (translated) Participant 7

"Keeping it simple" in this context means that the information provided by the platform should be as straightforward as possible. This involves primarily using simple language instead of complex, difficult-to-read terms. Additionally, breaking the information into smaller, more manageable pieces enhances its readability and accessibility. Consequently, the inclusion of multiple steps in the

platform helps in reducing complexity and aids in making the information more accessible and understandable.

Code: Much information

The "much information" code is derived from comments related to the information density in both the platform and the virtual counsellor. Several participants found that there was an excessive amount of information, particularly on the platform, which they perceived as overwhelming. They also mentioned that if you don't focus properly, it can become too much to absorb.

"At first glance, it is a lot, and very chaotic [The information of the pages]"

- (translated) Participant 4

"It is quite a lot of text overall"

- (translated) Participant 5

"It's a lot of text [the text on the platform]. It's also a complex subject. Maybe it's logical that it requires a lot of text. But if you don't specifically sit down to read it, I think it's a lot of information all at once. I'm not sure if someone who only dips into it briefly will understand enough."

- (translated) Participant 8

Interestingly there was also a participant who found the information given by the platform not complex at all.

"I didn't find there anything that was too complex or so. I feel like every point was with sort of bullet points. It was done with the bullet points and it was just clear to read and not too much text."

- Participant 10

There was also a remark about the information density given by the virtual genetic counsellor itself. It was stated that the chat boxes should have more space between them.

"I found that they are a bit too close together. For me. Yes, and they shared a lot of information. It seemed a bit long to me. Not that they have to be very short, because of course, it's important information, but maybe it's a bit, how do you call it? That the key words or something like that are in bold, that it might be easier to read. For me."

- (translated) Participant 9

The "much information" code shares some similarities with "keeping it simple" but primarily addresses the length and volume of information. Participants emphasized that it's essential to keep the quantity of essential text to a minimum to maintain participants' focus. They appreciated how the virtual genetic counsellor already withholds some advanced information, preventing all information from being presented at once.

A potential improvement suggested by participants is to further break down the text into manageable segments to prevent participants from feeling overwhelmed. It's important to note that participants recognized the inherent complexity of the topic, which can justify the presence of a substantial amount of information.

6.5.3 Theme 3: Interaction with the virtual counsellor

The third thematic analysis theme delves into the interaction between users and the virtual genetic counsellor, as well as the platform. The explanation of the codes will make clear if the description is about the virtual genetic counsellor or the platform itself.

Table 24 displays the theme and the codes, along with the number of quotes per code.

Table 24 Theme 3: Interaction with the virtual genetic counsellor

Theme 3: Interaction with the virtual genetic counsellor	
Code	# of mentions
The chat interface	48
Having the power of choice	23
Interaction in the platform	31
Introduction with the virtual counsellor	28
The learning curve	10
Total	140

Code: The chat interface

The code of “the chat interface” refers to the mentions about the usage of the chat interface.

A notable feature of the chat interface is the ability to read back the conversation. Participants generally appreciate this feature, as it allows them to easily review and reference earlier parts of the conversation, enhancing their user experience.

“And I also like that I can scroll back to what was said in the beginning. And not that you have to click back. That's a bit of a hassle. But having all the information on one page, so to speak, I do like. Nothing to complain about.”

- (translated) Participant 1

Participants in general also liked the additional images that were presented inside the chat interface for additional information.

“Yes, it's nice that there's an image in the chat.”

- (translated) Participant 9

“An image added. A video clip. That's nice.”

- (translated) participant 8

The buttons in the platform to open the chat on specific questions created a sense among participants that the virtual genetic counsellor was readily available to assist and answer their questions. This feature was well-received, as it enhanced their perception of having immediate access to support.

“Yes, that's nice [The button to open the chat]. Because then you have the idea that she's available. So you have the sense that, well, if I have a question, at least I can... Then you get more information about her. Or at least. Yes, then you have a bit more input.”

- (translated) Participant 4

"And then he opens the same chat again. Okay, I hide that one then. Well, that was it. Very clear."

- (translated) participant 8

Participants have also pointed out that having information presented in a chat format provides them with the sensation that they can read at their own pace, creating a sense of calm and comfort. This feature is particularly valued, as it allows individuals to absorb information in a relaxed manner.

"I find it very nice [the chat interface]. Something different and indeed, especially for the people who, if I would be in the skin of someone getting such a letter or information, then I feel like this is nice and as well calm to just sit down and read it first yourself."

- (translated) Participant 10

The same participant also mentioned that the questions to choose from are a nice addition, as as a user, you do not have to come up with your own questions.

"There are a lot of questions that are already spoken about that it's hard to even come up with your extra questions. I feel like this gives a lot of information already that you don't sit here and what can I ask more or something"

However, several participants mentioned that, as the chat interface continues where it left off, it can be very confusing to distinguish where the old information ends and the new information begins.

"But when I opened it here, suddenly this came up. And I didn't realize it was something new."

- Translated Participant 9

"I'm starting to read this again now even though I've just read it, that's not necessary anymore."

- (translated) Participant 5

Regarding "the chat interface," participants generally appreciate the concept of having a chat conversation with the virtual genetic counsellor. They find it valuable, especially the ability to scroll back in the conversation to review the chat history. Additionally, the option to include images for additional information within the chat is seen as a positive feature.

The chat interface aligns with participants' preferences as it allows them to go through the information at their own pace, providing a sense of control and comfort during the interaction. However, there is room for improvement in terms of clarifying which information is new and where the chat history starts. Some participants have experienced confusion about distinguishing between new and old information, leading to the inadvertent rereading of old content, and this aspect could be enhanced for a smoother user experience.

Code: Having the power of choice

The "Having the power of choice" code was created due to participants' expressed desire for the ability to choose from available options when it comes to information and questions.

Many participants prefer the option to select a question from a set of questions in the chat, rather than being limited to a single predetermined question. They value this choice because it allows them to tailor their interaction based on their specific interests and needs.

"Well, all the questions have been answered one by one. But I would have liked to choose which question I wanted to answer and when. I wanted to have a choice in that. Because maybe I was already looking forward to the first question, and then I thought, oh yes, I probably know everything already. But at the end, there's still an explanation about the symptoms of HCM. And maybe I was already done and had clicked away, while I did want to know the symptoms. So maybe it's nice to know what questions can be asked."
- (translated) Participant 1

"I think that when you can choose from few questions, that's a little bit better because sometimes if I have one question in my mind, but I looked at the other ones online, okay, I didn't think about that and it's also good to ask. So I feel like the option of having few to choose from is better."
- Participant 10

Another participant even mentioned that it might be frustrating if the user could not choose their own questions in the chat.

"At one point, there came a moment where I could only ask one question. And then a large text would appear. And then I could only ask one question again. And then another large text would come up. Yes, if that's not the question I have, it's a bit frustrating, I think. Maybe some questions could come up a little earlier in the chat."
- Translated Participant 8

One participant expressed a viewpoint that showing multiple questions in the chat wouldn't be overwhelming, as they believe that more information is preferable.

"I don't find it too much choice. I think the more information, the better. But that's what I think."
- Translated Participant 7

Participants expressed a desire not only to control the narrative during their interaction with the virtual genetic counsellor but also to have more control over how they navigate and digest the information in general.

One participant appreciated the ability to open and close the conversation at any time, as it grants them control over their focus and allows them to decide what information they want to prioritize.

"Yeah, that's, that's also nice [The ability to open and close the information] because if the conversation would have to go all the time, that's of course not that handy. And I found it indeed nice that I can first read it myself and then if I need, then I can still go back to the dialogue, so to say. And yeah, that I don't have to focus only on the dialogue, but first I can take my time and read the information that I want to read. So that about the symptoms or this, yeah, the specific, specific parts over the disease or."
- Participant 10

"actually, thought it was very nice that you at least had more choice where you can really choose which information you actually need now. And indeed, bringing it up and taking it back down. Minimizing the assistant. To not

have it constantly on the screen. That was fine."
- Participant 10

Even though participants wanted the ability to choose, participants liked the idea that the questions were already available to choose from instead of coming up with the questions themselves, as this helps with answering topics the users does not yet understand.

"I think this is a good approach because it helps you without having to think about what questions you could ask. You get possible additional information offered to you, like in a very brief sentence, it's like, "Do you still not understand this?"

And if you've clicked on one, the assistant has read more about it and then indicates, "Yes, in this part of the text, there's also this aspect, which might be something you don't understand."

So if you have this question, you just have to click on it, and we'll explain it to you. So I find it very good that it's actually looking at what information you might not understand or what information you might struggle with.

And then it's just offered as a simple button, like if you don't understand this info yet, and this is the question in your mind, you just have to click on it, and we'll explain it to you. So I think that's very good."
- (translated) Participant 3

"Having the power of choice" refers to the concept that users should have control over their session with the virtual genetic counsellor. Participants emphasized their preference for choosing the questions they ask, rather than following a linear path. This choice is valued because participants want to focus on information that is personally relevant to them.

While participants desire control over their sessions, they also appreciate the idea of choosing from a set of questions. This approach allows them to explore topics and queries they might not have thought of on their own. The combination of control and choice contributes to a more tailored and informative user experience.

Code: Interactions with the platform

The code "interactions with the platform" refers to how the user can interact with the platform surrounding the virtual genetic counsellor.

Participants noted that the button at the bottom corner of the page to open the virtual genetic counsellor feels familiar and easy to understand. Also, the fact that the chat does not obscure the entire page is seen as nice.

"That it appears in the bottom right corner? Yes. I find that very nice. Because the way it pops up doesn't obstruct too much of the total page. And you can easily hide it. And the way it's still displayed, in the bottom right as a small [The button to open the assistant], is actually fine. It's not in the way, but it's clear enough that you can click on it. Because her face is also there. So it's nice that you can open a conversation with her. It's quite intuitive, in my opinion. So yeah, no, I find that a very nice, a nice way."
- (translated) Participant 1

"Interaction with the platform" is about the ways the participants can interact with the platform. Participants mostly had remarks about the way they can access the virtual genetic counsellor.

Participants found the button in the corner intuitive and easy to use. The fact that the user can hide the virtual genetic counsellor when needed was seen as a nice feature. For this we can conclude that the interaction to open and close the VGC meets the expectations of the participants and thus does not need to change.

Code: Introduction with the virtual counsellor

This code refers to the remarks of the participants regarding the introduction they had with the virtual counsellor.

Participants noted that the introduction with the virtual genetic counsellor is a nice way to introduce the counsellor. Several participants feel welcomed and have the feeling that they are in a conversation with someone who will help them along the way.

"Well, it gave a nice welcome [the introduction]. A bit of a general introduction. I'm introduced to the character. And in itself, that's nice. Then I can have a name with the face. Or I have a name with the face. Yes, it's a friendly opening. I'm fine with it."

- (translated) participant 1

"Short and clear, yes. Mostly that. And cheerful, you were greeted. What do you call it? I do feel welcomed or something like that."

- (translated) participant 2

"if that introduction wasn't there, it might be a bit more challenging. But even then, it would still be quite easy to find, actually. Perfectly inviting."

- (translated) participant 11

"Cute character. Cheerful greeting."

- (translated) Participant 2

"Yes, that is necessary. It's quite handy. Yes, the idea that someone guides you through so much text."

- (translated) Participant 4

Participants emphasized the importance of keeping the text in the introduction concise to maintain a smooth flow. They appreciated that the introduction isn't overly lengthy, ensuring that they don't spend an excessive amount of time reading just the introduction.

"Yeah, I find it, it's good that it's not too long because you don't want to spend the whole half of the day reading just introduction. It contains what it needs to contain, I would say. So it doesn't need anything else and it's nice that it's in the, I don't know if it makes any difference that I say it now, but that it's in the short chat. Okay. We move forward from the short intro."

- Participant 10

Additionally, some participants noted that while the introduction might not be entirely necessary, it doesn't hurt to have it, particularly for those who might benefit from a brief explanation, like the elderly. This suggests that the inclusion of an introduction can cater to a wider audience and ensure a more inclusive experience.

"I still think that it spoke for itself [the assistant button]. But an explanation doesn't hurt, I guess. For the elderly."

- (translated) Participant 3

A participant did mention that for some people the introduction might not be a good idea, as it shows the user their helpline will be a 'robot' and not a real person, making the comparison with a regular chatbot. This could give a feeling to the users, where they might feel 'not good enough' to be treated by a real human being. The participant noted that, from experience, that there will always be users that do not like getting 'default answers' and always want to talk to a real human being.

"I think it's good because I believe it's necessary. And I think it would be worse if it wasn't there. But it does resemble something like the bol.com assistant, for example.

And that's not necessarily a bad thing, but it gives everyone or, I can't say everyone, but it gives me the impression. And with that, it sends a bit of a signal that it's just another bot assistant.

And for some people, including myself sometimes, that can be quite frustrating because it feels like you're not worth a person's time, so to speak. Like, oh, I'm being passed off to this automated thing. And from my work experience, I know that people don't appreciate getting standard messages and responses because everyone wants a personal touch. I understand that it's not always possible, so to speak.

But there will always be people, I think, who see this as a, "But that's just the standard talk; I deserve more than that, or I'm better than that. Someone should just talk to me in person and explain." And not that it makes a significant difference in the knowledge they gain, but it's more about them feeling entitled for that reason.

So, I think in that regard, maybe the introduction of the assistant hits a nerve with people, making them question, "Why do you say, 'Oh, you're just a bot'?" And that's why they find a way to turn it into a negative point."
- (translated) Participant 9

Opinions on the introduction to the Virtual Genetic Counsellor (VGC) vary among users, but the majority agree that it provides a welcoming way to become familiar with the VGC. However, it's important to keep the introduction concise, as users should not have to spend an excessive amount of time getting acquainted with the digital assistant.

As noted by a participant, some users might not want to interact with a VGC at all. To address this, an improvement point could be to allow users to either skip the introduction or hide the VGC altogether. This would provide users with the flexibility to engage with the digital assistant according to their preferences.

Overall, the "introduction with the virtual genetic counsellor" is appreciated for its welcoming and personal approach, with participants finding the tutorial easy to understand. This ensures that the introduction remains accessible and user-friendly while accommodating diverse user preferences.

Code: Learning curve

The code "learning curve" refers to the effort participants needed to take to understand how to control the virtual genetic counsellor and the platform.

As for the platform itself, the learning curve was seen as easy, but there were times participants needed to use their concentration to understand what was happening. But with trial-and-error participants were able to understand what was going on.

*"Yes, I think with trial and error, you can easily navigate through it because you can just go back, so you don't really have any consequences."
- (translated) Participant 1*

Participants mentioned that the link between the question buttons and the virtual genetic counsellor was easily found.

*"I do like it because it helps you realize that she pops up, so to speak. And if you didn't notice that in the beginning, you still make that connection fairly quickly. So, no, I find it quite nice. It gives you an idea of what will happen when you click it, and you'll see her again with an explanation."
- Translated Participant 1*

As for the virtual genetic counsellor itself, participants mentioned that after the first few questions, everything was easy to find in the chat interface.

*"Well, I think with the first three questions, it was a bit tricky with the assistant. But after that, well... It was actually quite easy to find, I thought. Everything."
- (translated) participant 6*

The introduction helped the participants understand how to interact with the chatbot.

*"That introduction is sufficient, especially for people in my age group."
- (translated) Participant 11*

However, there was one participant, who mentioned that for a certain group of people it might still be too challenging. But the participant mentioned this is not due to the design of the platform and counsellor, but because some people might not want to learn in general.

*"I think there's a very large group of people who would still have a lot of difficulty with it. And in my opinion, that's not because of the virtual assistant. It's because many people are not willing to learn when it comes to technology. Especially the people who are not even willing to come to my appointment to get explanations about personal health. So..".
- (translated) Participant 3*

Based on participants' feedback, it can be concluded that the learning curve for both the virtual genetic counsellor and the platform is generally easy to navigate. Most users found that with a bit of trial and error and the help of the introduction, they were able to learn how to use the system effectively. Overall, there don't appear to be significant difficulties in controlling the virtual genetic counsellor or the platform.

6.5.4 Theme 4: Technical and practical aspects

The theme of "technical and practical aspects" revolves around comments related to these elements. This theme comprises just two smaller codes: accessibility and a user-friendly interface.

Table 25 displays the theme and its codes.

Table 25 Theme 4: Technical and practical aspects

Theme 4: Technical and practical aspects	
Code	# of mentions
Accessibility	12
Familiar interface	7
Total	19

Code: Accessibility

One of the practical aspects that was talked about was “Accessibility”.

A participant mentioned that the use of the virtual genetic counsellor would increase the accessibility in general, as this could make learning about a genetic condition less scary. The participant specifically mentions the younger audience who might already be familiar with ‘avatars’.

“If you're a young person or even older, this makes it more accessible to even look up information about it and not be so scared of it or anything. When you hear that you have a genetic condition, I can imagine that you'd also be overwhelmed, and this helps you go through it calmly or something. So that's cool. Especially for young children as well. It makes it a lot less intimidating, I guess. They are familiar with avatars and such. Cool, I would like to see this more often.”

- (translated) Participant 2

On the contrary, one participant mentioned that the use of a virtual genetic counsellor might not work well with the elderly they might not like the idea of being helped by a virtual assistant. However, this is only a contemplation.

“But I do think it gives away that your helpline is a bot. Which isn't necessarily a bad thing, but I also think it might not sit well with some people. And I'm almost talking about the older generation here. Those who might already be a bit technophobic or something along those lines. But yeah, I don't know. There will always be some like that. You can't always count on them, so to speak.”

- (translated) Participant 3

Regarding the platform itself, participants mention the use of colours, and the features that saves the process of the user increase the accessibility of the platform.

“And what was nice as well is that the action buttons are in one color, in blue. So that's actually quite nice that, especially for older people, I would say it's quite easy that you're like, okay, with the blue button, I can go forward, or I can go into the chat. So yeah”

- Participant 10

“It's saved to continue later, especially nice for older people, I think, who might sometimes find it a bit too much.”

- (translated) Participant 11

Another participant also specifically mentioned the idea that the user can continue at any time they want and mentioned it as a very convenient way of learning about genetic conditions.

"Yeah, I feel like it's a nice and convenient way of getting the information about when you are not sure about something, you can always go back to it anytime, either if it's on your phone or a computer. So you can do it at home, you can do it in the when you are on the walk or when you are not even at home. So you don't have to make a separate appointment to the doctor as well. So I feel like it's very convenient." - Participant 10

A feature that participants felt was missing in the prototype was the option for text-to-speech, which could benefit users with reading difficulties.

*"Maybe some spoken texts in."
- (translated) Participant 4*

*"Perhaps the only thing that could possibly be added to the prototype is the ability to have some texts possibly read aloud. If it were a kind of text-to-speech feature, it might be more comfortable for some people."
- (translated) Participant 11*

Participants found that the VGC improved the accessibility of the platform, particularly benefiting younger users familiar with avatars and chatbots. The addition of a virtual genetic counsellor was seen as a helpful feature for users. The feature of 'saving the progress' was seen as a key feature and very useful. To further enhance accessibility, there was a suggestion to add a text-to-speech feature. However, it was acknowledged that there might still be a segment of users who could struggle with the platform due to limited tech proficiency. We can conclude that the VGC in general is seen as accessible, with text to speech as an improvement point.

Code: Familiar interface:

The code "familiar interface" arrived from the several mentions that the chat interface looks quite like other chat applications.

Many participants noted that the chat interface feels familiar like application like WhatsApp. According to the participants this creates an atmosphere of 'just texting' and can relieve some stress about the topics.

*"It seems like a little bit of WhatsApp or messenger or whatsoever. We are used to it now, so it's quite nice to do it the same on the internet on such a platform. Then you don't, yeah, then you stay in the, of the atmosphere of just texting. So it's not that much stress. You don't feel like, oh, I sit with the doctor, so it's stressful. Yeah, I feel like that the layout is nice and as well with the virtual assistant, it looks nice and professional as well. It's not too much or too colorized or yeah.
Yeah."
- Participant 10*

The interface of texting also gives a feeling of 'personal contact' with the embodiment.

*"Yes, fine. As I mentioned earlier, it resembles actual mobile conversations. It's a familiar way for everyone, fun to do it that way. Indeed, if you just have some personal contact with the embodiment. Overall, nicely presented, I think. Loud and clear, whatever it is, how it's going to work."
- (translated) participant 11*

"It's actually designed, I believe, with the idea that everyone can understand it. Nowadays, everyone has a mobile phone and can engage in these short conversations via WhatsApp or other similar apps. It feels very

familiar.”
- (translated) Participant 11

The “familiar interface”, which can resemble a chat interface like WhatsApp, can help with reducing stress about the topic, as it is seen as ‘just texting’ by some participants. The texting interface also gives a feeling of ‘personal contact’ with an assistant. For these reasons we can conclude that the using a familiar interface in the chat is the right solution.

6.5.5 Theme 5: User experience and engagement

The theme of user experience and engagement are about several feelings the participants had when using the platform and the virtual genetic counsellor.

Table 26 displays the theme and its codes, along with the number of quotes per code.

Table 26 Theme 5: User experience and engagement

Theme 5: User experience and engagement	
Code	# of mentions
Confused	8
Connection with the embodiment	17
Fun	8
Progress	9
Total	42

Code: Confused

Several participants clicked on the example button in the introduction, confusing it with a ‘real’ button, which caused some confusion.

“Oh that is an example button”
- (translated) Participant 7

Also, the virtual genetic counsellor kept a history of the chat visible, which for some participants was seen as confusing as they did not know where the new information started, and the old information ended.

“Now that text is there again, that is a bit confusing. It might be clearer if you have less text”
- (translated) Participant 5

The “confused” code was a recurring issue throughout the evaluation, primarily related to the ‘example button’ and the chat history. Participants often didn’t immediately grasp that the ‘example button’ was meant for demonstration and didn’t perform any action when clicked. Regarding the chat history, participants found it confusing as it wasn’t clear where the current conversation started, and some started reading the older information inadvertently.

To address these concerns, in the next version of the platform, the ‘example button’ could still serve the purpose of illustrating button functionality. However, incorporating interactivity, like a modal

explaining that they pressed the 'example button,' might provide users with feedback rather than non-responsiveness.

For the issue of chat history, a potential solution could involve automatically scrolling 'old' content out of the chat viewport, ensuring that users can still access the history if needed but minimizing confusion about which content is currently relevant. This adjustment aims to streamline the user experience and reduce confusion.

Code: Connection with the embodiment

Participants expressed a range of feelings regarding the connection with the embodiment and the impact on their user experience.

One participant noted that they didn't necessarily feel a strong connection with the embodiment but imagined themselves going through the platform as if they were accompanied by a person.

*"I don't know the connection. But you can imagine yourself going through this with a person or something like that. That's what I think."
- (translated) Participant 1*

On the other hand, some participants found the embodiment to enhance the user experience by sparking their imagination and creating a sense of interaction with the platform.

*"I would add a little figure, yes. That seemed to spark a bit more imagination, that you really have an interaction."
- (translated) Participant 4*

The embodiment was also seen to increase accessibility, making conversations with the virtual assistant more approachable, as it gave the impression that the "little figure" understood them.

*"A conversation with a doctor, it becomes more accessible perhaps. Then you have the idea that the little figure understands you."
- (translated) Participant 5*

Furthermore, the presence of the chatbox and the embodiment created a feeling of talking to someone, making the platform seem more personal and enhancing the overall user experience.

*"Yeah, I think having this virtual assistant is nice. It's a nicer option, especially. Yeah, I feel like it's a nice reference point that you see the person you're like, okay, I'm going there because there's the chat box, let's say. And it makes it feel a bit more personal that you have the feeling that, okay, someone is there and you actually are talking with someone. So I feel like this is a nice addition."
- Participant 10*

In summary, participants had various perceptions about the connection with the embodiment, with some emphasizing the sense of collaboration while others highlighted the interactive and accessible nature it added to the platform. The embodiment and chatbot contributed to a more engaging and personal user experience. To enhance the connection even further with the embodiment, the content of the chat could be more personal, with personal responses and maybe calling the user by name might increase the connection with the embodiment.

Code: Fun

The virtual assistant was generally perceived as a "fun" addition to the platform, with participants highlighting its entertaining aspects. Many found it enjoyable when the embodiment moved, and

they appreciated receiving additional information through the virtual assistant instead of lengthy blocks of text.

"If you just want to read information by yourself, you can of course choose not to click on the little figure. But I actually found it quite enjoyable."

- (translated) Participant 2

"The little figure keeps changing, and I find that amusing."

- (translated) Participant 5

Several participants agreed that the embodiment added an element of "fun" to the application. Having a dynamic virtual genetic counselor with a visible presence made the information-gathering process more enjoyable, as participants could associate a "face" with the assistant, enhancing their overall engagement with the platform.

Code: Progress

Participants provided feedback regarding the progress indicators in the platform, and their comments were generally positive.

Many participants appreciated the feature that allowed them to track their progress in the platform. They liked being able to see how far they had come and how much more they needed to do. This feature gave them a sense of being "almost there" and helped them understand their location within the platform.

"I think that's nice, so people know when they're almost there. [Referring to the progress bar on the left] With the icon. Clear."

- (translated) Participant 11

"That you can see, let's say, where you are on the website, so you're not confused about your location, let's say, and which part of the website you're on."

- Participant 10

Overall, the "progress" feature, particularly the use of a progress bar, was highly regarded by participants, as it provided a valuable sense of progression and helped them stay oriented within the platform.

6.6 DISCUSSION

In section 4.6, we examined the user preferences and requirements for the design and interaction with the virtual genetic counsellor. These requirements contained various aspects of the embodiment, including personification, physical details, realism, language modality, facial display, and hand movements. The findings from Chapter 6, based on the thematic analysis, provide valuable insights that can be aligned with the created requirements. In the following, the requirements will be compared with the findings of this chapter to identify which requirements were validated and how they impact the design of the virtual genetic counsellor.

Aspect Personification:

The aspect of personification for the virtual genetic counsellor. User preferences indicated a strong inclination toward human personification, as a majority of participants favoured the representation of a human being. This preference was primarily driven by the desire for a face-to-face connection and trust-building. The findings of the evaluation align with this requirement by emphasizing that the embodiment should be simple and efficient. Participants suggested that the embodiment should be recognizably a medical specialist. Overly detailed appearances were noted to potentially lead to prejudice. Moreover, maintaining professionalism and avoiding excessive cheerfulness was preferred. These findings align well with the preference for a human being as the embodiment in section 4.6, reinforcing the design choice for a human personification. The alignment of these chapters solidifies the importance of a medical specialist's appearance in fostering trust and reliability in the virtual genetic counsellor.

Aspect Physical Details:

Section 4.6 highlighted the importance of choosing the appropriate physical details for the virtual genetic counsellor. The user preferences leaned toward displaying the torso, as it struck a balance between being intimidating (only displaying the head) and being overly distant or distracting (full body visible). The findings of the evaluation sessions are consistent with this preference and further elaborate on the benefits of displaying only the torso. Participants noted that displaying only the torso is a sound practice and suggested that slight modifications, such as removing a part of the lab coat, could enhance visibility for users with poor eyesight. This alignment solidifies the choice of the torso as the optimal physical detail for the embodiment.

Aspect Realism:

Section 4.6 emphasized the importance of striking a balance between realism and stylistic design for the virtual genetic counsellor's appearance. User preferences ranged from very realistic to very stylistic, with a majority favouring a balance between the two. Chapter 6 findings provide support for this preference, suggesting that the embodiment should be simple yet efficient, with stylistic elements but with limited details. This alignment reinforces the choice of a more stylistic appearance with subtle details. It underscores the importance of balancing realism and stylistic design to create an embodiment that is both relatable and not distracting for users. The findings emphasize that achieving the right level of realism is crucial in maintaining user engagement.

Aspect Language Modality:

In section 4.6, user preferences were clear when it came to language modality. Participants strongly favoured a combination of verbal and textual information. They expressed the importance of the voice sounding like a real human to create a sense of connection. Even when the prototype only contained textual information, participants suggested voice could be added to increase accessibility. This alignment reinforces the choice of a verbal and textual language modality.

Aspect Facial Display:

Section 4.6 highlighted a preference for a moderate level of facial movements to avoid distractions and misinterpretations. The findings of the evaluation corroborate this preference, suggesting that the embodiment should show some emotions while keeping them minimal to prevent interpretation errors and distractions. This alignment solidifies the choice of a professional but moderately expressive facial display. It reinforces the importance of maintaining a professional yet engaging facial expression, which is vital for user interaction and trust-building. It highlights the need to strike a balance between a static appearance and excessive expressiveness, as too many emotions might not be suited for the topic.

Aspect Hand Movements:

Section 4.6 identified a preference for limited hand movements, as excessive movements, particularly those used to point at specific places on the dashboard, could be distracting. The findings of the evaluation validate this preference. Participants liked how the objects were 'pointed to' using highlights, which were seen as very intuitive. This alignment confirms the choice of limited hand movements, further emphasizing the importance of preventing excessive distractions. It highlights the need to use hand movements judiciously, ensuring that they enhance the user experience rather than detract from it.

Theme Accessibility:

Section 4.6 highlighted the significance of accessibility considerations in the design and interaction with the virtual genetic counsellor. Participants emphasized the importance of making the embodiment and platform accessible to all users. This included considerations such as device compatibility, options for those with hearing or reading difficulties, and ensuring user-friendliness for older individuals.

The findings of the evaluation session reiterated the importance of accessibility, but the participants mentioned different aspects of accessibility. Participants noted that the virtual genetic counsellor should be simple yet efficient, with recognition as a medical specialist. It is important to avoid excessive details, which could lead to prejudice. The embodiment should not be overly cheerful, as it may not align with the serious subject matter.

Theme Building a connection with the user:

Section 4.6 emphasized the significance of building a connection with the user to establish trust and encourage engagement. User preferences included the importance of the embodiment introducing itself. Introducing a human-like presence in the online patient room was seen as crucial for creating a sense of comfort and ease.

The findings of the evaluation session align with these requirements, indicating that participants did not necessarily have a 'connection with the embodiment' but felt they were walking through the platform together. The virtual genetic counsellor helped make the platform feel interactive and more accessible. This supports the choice of introducing a human-like presence to enhance user engagement and create a feeling of interaction.

Theme Gaining information from the session

In Section 4.6, user preferences revolved around the theme of "gaining information from the session." Participants stressed the need for capturing attention quickly, clarifying the platform's purpose, and promoting proactive learning. The importance of presenting information in a straightforward manner and offering options for both reading and hearing information was emphasized.

The findings of the evaluation session support these requirements, noting that participants liked the idea of having a chat conversation with the virtual genetic counsellor and the possibility of having images for additional information in the chat. The chat interface was seen as preferable as users could go through the information at their own pace. However, participants explicitly mentioned that the information in the chat should scroll in a way that only the new information is visible, to prevent the user from reading information twice. Additionally, participants appreciated the use of a progress bar in the platform, as it gave them a sense of advancement. There were also a few additions mentioned by the participants, like better use of spacing and highlighting important words in the text.

Theme Giving control to the user

Section 4.6 mentioned giving control to the user, as a way that participants should not have too much choice, as they should not be able to choose an embodiment.

The findings from the evaluation do not necessarily support this claim, as no participant noted anything about the ability to choose their own virtual genetic counsellor. However, there are some additional topics to the theme of giving control to the user. Participants noted that they prefer to choose their questions themselves. The idea of linear questioning was seen as less favourable, as participants wanted information on topics that were relevant to them. The participants also liked the ability in which they could choose if they want to virtual counsellor open or not, as participants had the feeling this gave a sense of control.

Theme: Nonverbal communication

In Section 4.6, participants expressed varying preferences regarding non-verbal communication, such as body movements, facial expressions, hand movements, and emotional portrayal. The findings indicated that non-verbal cues should be balanced and not distract from the content.

The findings of the evaluation sessions align with these requirements, emphasizing the importance of maintaining a natural and engaging posture, incorporating subtle facial expressions and hand movements, and conveying emotions in a balanced manner. The findings underscore the significance of avoiding excessive or overwhelming non-verbal cues to ensure effective interaction with the embodiment. It is noted that many of the participants did not see the nonverbal communication in the first place, at least not enough to give it much thought. However, when asked, all participants liked that the virtual counsellor did move.

Theme Appearance

Section 4.6 explored preferences related to the visual appearance of the virtual genetic counsellor, including topics such as representing animals, animations, distractions, gender preferences, physical details, professional appearance, and stylization.

The findings of the evaluation align with these preferences, emphasizing the significance of a visually straightforward and simple look with a stylized or cartoonish touch. The findings also support the preference for concentrating on the torso and up while avoiding excessive movements or distractions. The prototype itself contained a full lab coat, visually showing the embodiment a bit longer as only to the waist, participants noted that the virtual counsellor should be cut off at the waist to display the virtual counsellor a bit bigger.

6.7 CONCLUSION

In this chapter, we set out to answer the primary research question: "Do the identified requirements obtained during the co-creation session align with the feedback of users during the prototype evaluation?"

Given the findings and the discussion this question can be answered with, yes mostly. Most of the requirements which were set in Chapter 4 align with the references found during the user evaluation.

The findings from the prototype evaluation solidify the alignment with the user requirements identified during the co-creation session. This alignment substantiates the design choices made in developing the virtual genetic counsellor.

7 DISCUSSION

This thesis is in collaboration with the Electronic Cardiovascular Genetic family clinic project, also called the eCG project. The core of the eCG project is to provide information about inherited heart diseases to at-risk relatives. The eCG project is building a digital platform which will inform at-risk relatives about the potential genetic condition. A part of this platform is the Virtual Genetic Counsellor, which is the topic of this thesis. The central aim of this thesis was to determine the optimal levels of embodiment for a virtual genetic counsellor.

To find these levels of embodiment, focus groups were conducted, followed by the creation of a prototype and evaluation sessions. To mimic a real world scenario, the prototype of the virtual genetic counsellor was integrated into the eCG platform, replicating its interface and functionalities. This integration was intended to capture participants' thoughts and perspectives in a context that closely resembles actual use scenarios. This methodology was used to find an answer to the following research question:

“Which different levels of the aspects of embodiment should be used in the visual design of a virtual genetic counsellor, according to the preferences of the general population?”

To answer the above research question, the following three sub-questions were defined:

- *What are the different aspects of embodiment and into which levels can these aspects be divided?*
- *Which levels of the aspects of embodiment are preferred by the general population in the context of virtual genetic counselling?*
- *How do the identified requirements of the virtual genetic counsellor, obtained during the co-creation session, align with the preferences and feedback of users during the prototype evaluation?*

The following will in a high overview answer the three sub-questions by going through the methodology and the key findings. This is followed by the interpretations of the results, the practical implications, the strengths and limitations, recommendations for future work and some notes regarding the learning process of this thesis.

7.1.1 Key findings

The first sub-question was: “What are the different aspects of embodiment and into which levels can these aspects be divided?”.

Literature research was conducted to find the different aspects of embodiment. As can be read in Chapter 3.2, the aspects of embodiment can be divided into two different categories: the ‘look’ and ‘communication’. The category of look consists of personification, physical details, realism, dimensions, and general deformability. The category of communication consists of: language, language modality, facial display, hands, body and modality coordination and motion generation. The level of each aspect can be either based on a scale or based on several options to choose from. Chapter 3.3 explains per aspect of embodiment which levels or options are available.

The second sub-question was: “Which levels of the aspects of embodiment are preferred by the general population in the context of virtual genetic counselling”.

To answer the second sub-question, two focus groups were organized in which participants were asked for their preferences regarding the aspects of embodiment. The focus groups consisted of a quantitative survey, which was answered individually, and a qualitative co-creation session in which participants could discuss their preferences with each other. As can be read in Chapter 4.4, the transcriptions of the co-creation sessions were thematically analysed to find the recurring themes during the discussions. Regarding the preferred levels of the aspects of embodiment, Chapter 4.6 defines the preferred aspects of embodiment, in which the following choices have been made. Firstly, the personification should consist of a human being. Secondly, the physical details should be of the option torso. The realism should be mostly stylistic but with slight details. The language output modality should preferably be verbal and textual, but on the condition that the verbal audio is very human-like. The facial display should show some emotions but this should be kept to a minimum to prevent distractions. Lastly, the hand movements should be used to a limited extent. The different themes that occurred during the thematic analysis, provided additional requirements for the embodiment, which can be seen in Chapter 4.6.2.

The third sub-question is: “How do the identified requirements of the virtual genetic counsellor, obtained during the co-creation session, align with the preferences and feedback of users during the prototype evaluation?”

To answer the above sub-question, a prototype was created to perform evaluation. The creation of this prototype is covered separately in Chapter 5. As discussed in Chapter 5.2, the primary objective of the prototype was to facilitate user evaluation. To create a prototype, the original requirements for the embodiment, as created in Chapter 4, were slightly adjusted to better fit the scope of the prototype, as can be seen in Chapter 5.3. The final prototype consisted of a clickable Figma project, with a static user journey.

The prototype created in Chapter 5 was utilized for user evaluation. As described in Chapter 6, user evaluation consisted of eleven individual evaluation sessions. The evaluation sessions were recorded, transcribed, and thematically analysed. The themes that occurred during the thematic analysis are, embodiment and realism, information clarity and focus, interaction with the virtual genetic counsellor, technical and practical aspects, and user experience and engagement. Chapter 6.4 describes the different themes that occurred during the thematic analysis, and Chapter 6.5 explains the sub codes per theme. These findings, detailed in Chapter 6.4, underscored the alignment with the preferences and requirements identified during the co-creation sessions described in Chapter 4.6. Specifically, the evaluation session confirmed that the user preferences for aspects like personification, physical details, and language modality resonated strongly with the prototype design choices, reinforcing the significance of these considerations in the development of the virtual genetic counsellor, in short, the results from the evaluation session do align with the preferences created found in the co-creation sessions.

With the answer to the sub-questions, we can answer the main research question of this thesis:

“Which different levels of the aspects of embodiment should be used in the visual design of a virtual genetic counsellor, according to the preferences of the general population?”

The full answer to this question consists of the requirements created in Chapter 4.6.1, the findings suggest that users prefer an embodiment that projects professionalism in the healthcare field. The embodiment should avoid excessive distraction, minimizing body and facial movements. It must portray a professional image, detailed enough to be recognizable as a professional, but not too detailed that it would become a distraction.

7.1.2 Interpretations of the results

The results from Chapter 3 defined the different aspects of embodiment, which are personification physical details, dimensions, general deformability, language, language modality, facial display, hands, body and modality coordination and motion generation.

Some aspects of embodiment were excluded from this thesis due to the scope of the project. The aspects that were deemed out of scope are dimensions, general deformability, language, body and modality coordination and motion generation. These aspects were marked as out of scope for this project because they do not directly relate to the general appearance of the virtual genetic counsellor, which is the focus of this research. Chapter 3.3.12 explains per aspects why this decision was made.

As the aspects of embodiment are the main goal of this thesis, the interpretations of the results will be discussed per aspect. The following will discuss five different aspects of embodiment that were in scope for the prototype.

Initially, there is the aspect of personification. The data from Chapter 4, the two focus groups, suggested that the preferred personification is a human being. During the focus groups participants stated that a human being would be able to build trust with the user and would allow to make the embodiment look like a healthcare professional. This conclusion was reinforced by the evaluation sessions from Chapter 6. Participants found the embodiment of the prototype, a human healthcare professional, comforting and appreciated the idea of interacting with a healthcare professional. Other forms of personification, like non-human living creatures or objects, which were the other options of personification, would have made it more difficult to associate the embodiment with a healthcare professional. The finding of the preference for a human being is supported by the state-of-the-art solutions discussed in Chapter 2.2, where out of seven solutions that provided an embodiment, five depicted a human being while only two solutions showed a robot-like icon. Three of the seven embodiments contained just an icon of either a robot or a human being. The four other solutions, AI [7], VICKY [11], APA [12], and Virtual Nurse [14], all depict a human being, where all the solutions display some form of a medical healthcare professional. Notably is that different choices were made regarding which kind of healthcare professional, the Virtual Nurse displays a nurse in a hospital, the VIKCY displays a counsellor in an office setting, whereas the APA displays a counsellor in a more casual setting, while the AI only offers a static image with a very simplistic clothing of a nurse. The data of the focus groups of Chapter 4 suggest that participants wanted to see a healthcare professional specifically dressed as a nurse or doctor, which is not always seen in the state-of-the-art solutions. One of the thematical codes that was brought up during the focus groups was the code of 'importance of information' Chapter 4.4.6, in which participants stated that the information in the platform is seen as very serious, this could have contributed to the preference of seeing a more 'typical' healthcare professional like a doctor or nurse.

For the second aspect, the physical details, the focus groups of Chapter 4 concluded that the general preference was a 'torso'. The evaluation sessions of Chapter 6 confirmed this preference, although suggesting that the lab coat should be cut off at the torso to avoid making the embodiment too long and having more space left for the overall expressions. This is in line with the state-of-the-art solutions, where all solutions with an embodiment beyond an icon, displayed a torso or more, only the virtual nurse [14] showed more than just a torso, as it also displays parts of the upper legs. The results from the focus groups, the user evaluation and the state-of-the-art provide a solid understanding that displaying the torso of the embodiment is probably the best-suited way to display the embodiment. Given the presence of various other UI elements on the eCG platform, such

as navigation bars and information panels, optimising screen space is important. A full-body representation in the same screen space would result in smaller body parts, potentially compromising visibility, while a close-up of the head would limit the ability for hand movements and other expressions. The torso allows for a balance between how much is visible, and how big certain aspects can be represented.

The third aspect, the aspect of realism determines the choice between a realistic or cartoonish virtual genetic counsellor. The data from the focus groups of Chapter 4 suggest that a cartoonish appearance was favoured over a realistic appearance. However, some participants were divided on this aspect, preferring either a cartoonish or very realistic look. During these focus groups concerns were raised that a realistic approach, if not well-executed, might result in an uncanny valley effect, in which the face of the embodiment might look strange or give an uncomfortable feeling. Some participants noted that a too realistic embodiment might bring the risk of the embodiment looking like someone they knew, which was not preferable. Other participants mentioned that a realistically looking embodiment might also impress that the embodiment would also be as intelligent as a real human doctor. Regarding the realism, most state-of-the-art solutions offer a somewhat cartoonish embodiment, with only the adaptive pedagogical agent [12] attempting a somewhat realistic appearance using a 3D model. In the context of the eCG project, where the VGC is a component of the entire system, a cartoonish embodiment remains the preferable option as it this will not distract the users too much and can still provide a professional appearance. An alternative solution, to provide a more realistic look could be to use pre-recorded videos that provide additional information instead of a virtual counsellor. While this would limit the amount of interaction possible, it could be the better solution for certain target audiences that do not like interacting with the VGC.

Facial display determines the level of expression on the embodiment's face. Minimal facial movement was preferred during the focus groups of Chapter 4. The reason for this was to avoid distraction, a finding supported by evaluation sessions of Chapter 6. However, it is important to note that some participants during both the evaluation sessions and the focus groups emphasized the professional representation of the embodiment, so overly happy or emotional faces are inappropriate for this context. If we look at the state-of-the-art technologies, we can see that one particular solution uses a lot of facial expressions, which is the "AI" [7], this particular embodiment uses a lot of facial expression, even going towards using 'heart eyes' and floating question marks to show emotions. Given the results of our co-creation sessions and evaluation session this would not be the appropriate approach in a medical setting, and are more in line with solutions like the VICKY [11], Adaptive pedagogical agent [12] and virtual nurse [14], which all include some facial movements, but are more 'professional'. Given that the eCG project is in a medical context, where potentially very serious conditions are discussed, the embodiment should not show overly positive or negative emotions while discussing serious matter.

Hand movements elicited mixed responses in the co-creation session of Chapter 4, with preferences ranging from no hand movements to significant hand movements. Some participants thought they would be distracting, while others felt they were necessary for a welcoming feeling. The prototype of Chapter 5 included some hand movements, like pointing at objects and standing in different positions. The movements in the prototype were not found distracting during evaluations in Chapter 6. Most participants found the embodiment non-distracting at all. Slight hand movements can be beneficial for clarity without causing distraction. Looking at the theory, several state-of-the-art solutions allow hand movements typically use them to point at objects. For example, the adaptive pedagogical agent [12] and the virtual nurse [14], support the approach of using hands as a tool to

make information more clear. Given the context of the eCG platform, where there is a lot of information, hand movements should be supported by highlighting important text instead of letting the embodiment point towards the information, this allows more accurate pointing, while the embodiment can be used for more human contact.

7.1.3 Practical implications

This thesis established a set of requirements for creating the embodiment of a virtual genetic counsellor in the context of the eCG project. These requirements are also applicable in the development of other virtual assistants within the realm of medical information and digital platforms. Their significance lies in the fact that without a carefully thought-out design for the embodiment, users might feel reluctant to engage with the assistant, therefore the assistant must appear trustworthy and professional. Considering the common concerns about distractions, a slightly less realistic and more subdued embodiment is recommended over an overly realistic and extroverted one, which could lead to user distraction. It is essential to find a balance between assisting and not diverting attention from the main content, particularly when participants could be emotionally affected by the possibility of having a genetic condition. Considering the concerns about the uncanny valley, a balanced approach to realism in design is advocated. This involves creating a slightly less realistic yet still engaging embodiment, this means no overly detailed or exaggerated representations that might divert attention from the primary content. The established set of requirements are supported by some of the state of the art solutions discussed in Chapter 2.2, as example, VICKY [11] and Virtual Nurse [14] are both equipped with facial details, but keep the styling cartoonish without too much details, which align to the requirement of a balanced approach of realism.

Expanding on the requirements, it is important to consider the evolving landscape of chatbot technologies and their implications in healthcare. Recent advancements in natural language processing and AI, such as the natural language model ChaptGPT [34], enable chatbots to offer more personalized, context-aware interactions, making them not just informative but also empathetic and responsive to individual user needs. Incorporating these technologies into virtual assistants can enhance the user experience, making interactions more natural and relatable. However, this also brings to the forefront new challenges in maintaining the balance between technological sophistication and user comfort, especially in scenarios dealing with complex and sensitive health information. As technology cannot feel emotions and only mimics the responses a human would expect, the technology may not respond appropriately in certain scenarios, which can make the user uncomfortable or give any other bad feeling. In light of these new technologies, the challenge becomes how to effectively integrate advanced AI capabilities while carefully managing the emotional dimensions of these interactions. Ensuring that the virtual assistant's emotional responses are appropriate and sensitive to the context is crucial, as inappropriate emotional responses could undermine the assistant's credibility and effectiveness in a healthcare setting. Therefore, while leveraging these technological advancements offers significant benefits, a cautious approach is essential. Minimizing the emotional expressiveness in a medical virtual assistant might be a prudent strategy, ensuring that the technology is robust, reliable, and fitting for the sensitive nature of healthcare interactions.

The requirements from this thesis can help guide the development of virtual assistants, not only in healthcare but in any field requiring subtle and sensitive interaction with users. As chatbot technologies continue to evolve, they present opportunities to improve and support the way

information is communicated and processed in digital platforms, making them more accessible, intuitive, and effective in meeting the diverse needs of users.

7.1.4 Strengths and limitations

The primary strength of this thesis lies in its extensive qualitative data collection and analysis. Conducting two studies allowed for the accumulation, processing, and summarization of a substantial amount of data. This approach yielded two comprehensive sets of themes and codes that encapsulate a diverse array of opinions, preferences, requirements, and underlying thoughts from the participants. This allows me to look at the topic from a wide range of opinions and find as many points of interest as possible. However, it also needs to be noted that due to the qualitative nature of the data, it might be possible that another researcher would have chosen different examples from the data or would have seen other pieces of data as relevant.

Another strength of this thesis is that it captures the entire process from theory to requirements, and from prototyping to evaluation. This results in a complete overview of the process as the chapters build on top of each other, where the theory around the preferences is tested during the evaluation.

One significant limitation of this study lies in the demographic composition of its participant pool. While theoretically, anyone could receive an information letter indicating a potential genetic condition, the predominantly younger adult demographic in the study may have led to missing insights from a more diverse demographic. Although the inclusion of younger adults provides valuable perspectives, a broader representation across different age groups and backgrounds could offer a more comprehensive understanding of the topic. This demographic bias potentially skews perspectives towards a technology-friendly viewpoint, which may not accurately reflect the views of older adults or actual patients. Despite efforts to include some older participants, the dominance of younger adults restricts the diversity of perspectives, potentially influencing the feedback towards a more technology-oriented bias. Future research efforts could focus on recruiting participants from a wider demographic spectrum to address this limitation and enhance the generalizability of the findings.

One notable limitation of this study extends beyond the demographic composition to the absence of interviews with individuals who have undergone the actual process of dealing with a genetic condition. Engaging with these real clients could have provided insights, grounding the research in practical, real-world contexts, and diversifying perspectives beyond what 'regular' participants can offer. This new set of participants is important, as interactions with individuals who have firsthand experience with genetic conditions might have revealed unique challenges, preferences, and viewpoints not captured through the current participant pool. Future research could prioritize including interviews with individuals who have undergone the actual process of dealing with genetic conditions to enrich the understanding of their experiences and perspectives.

The last limitation we will discuss are the limitations provided by the prototype. As the prototype was essentially a clickable wireframe, the prototype could not provide information that was of interest to the user, and all users followed a pre-determined path. Having a more dynamic prototype could change the perception of the participants towards the embodiment, giving different pieces of feedback.

7.1.5 Recommendations for future work

To address the absence of firsthand experiences with genetic conditions in this thesis, future research should involve patients' family members or those who have received genetic counseling. This approach can provide valuable insights and broaden perspectives beyond what typical participants offer. Engaging directly with patients and their families will ground the research in real-life situations, capturing a diverse range of experiences and needs, especially those specific to patients. By following this recommendation, future studies can become more relevant and contribute to a deeper understanding of the needs and experiences of individuals affected by genetic conditions.

Considering the limitation of relying on a single, static prototype, future studies should pivot to iterative prototype development. It is essential to integrate feedback from evaluation sessions. This will help overcome the previously noted limitation of a less defined conclusion and scope, a consequence of covering a broad process in your thesis. By refining the prototype in response to specific user feedback, the research can produce more focused and practical insights.

In considering potential advancements for the prototype, it is apparent that prioritizing accessibility, particularly through the incorporation of features such as audio functionality, holds substantial promise in enhancing the virtual genetic counsellor's utility and inclusivity. By integrating elements like screen readers and voice commands, we can accommodate individuals with visual impairments and those who prefer auditory information, aligning with principles of universal design. Rigorous testing, including methodologies like A/B testing, will be imperative to ensure the seamless integration of these features while maintaining usability standards. Ultimately, our goal is to develop a prototype that not only showcases technological sophistication but also prioritizes accessibility for all users.

Furthermore, it is important to recognize that individuals within the general population have diverse needs and opinions. In this thesis, this diversity is left behind with the focus being broadly on the 'general population.' To address this, future research should focus on specific target groups. By doing so, it becomes possible to uncover the unique preferences, requirements, and concerns of these distinct groups. This targeted approach will enable the development of more tailored and effective virtual counselling solutions that resonate with the specific needs and expectations of different user segments. This strategy will not only enhance user satisfaction and engagement but also ensure that the virtual counsellor is more inclusive and representative of the varied demographic it aims to serve.

Moreover, a more extensive study could explore users' experiences over a prolonged duration. Given the likelihood that users may engage with the eCG process across multiple sessions, spanning days or weeks, it could be insightful to examine the users' perspectives at different stages: the beginning, midpoint, and after ending the platform. This could involve gathering feedback from real users through interviews or surveys conducted during their sessions. Such insights would provide a comprehensive understanding of users' experiences with the Virtual Genetic Counsellor (VGC) over an extended period, potentially involving multiple sessions, which would be an improvement over getting insights after just a single sitting.

7.1.6 Learnings from the process

The main goal of this thesis was to identify the ideal levels of embodiment for a virtual genetic counsellor. To achieve this, a prototype was developed through co-creation sessions. The strategy

was to simulate an authentic environment, so the prototype was integrated into the eCG platform, aiming to gather participants' views in a setting like actual usage.

This strategy, however, introduced an unexpected challenge. The prototype's close resemblance to real-life scenarios led participants to focus more on the genetic information provided by the platform than on the virtual genetic counsellor itself. Although this mirrors a realistic situation where the counsellor plays a supportive role, it resulted in a less concentrated evaluation of the counsellor's embodiment. Had participants interacted with the counsellor in isolation, their feedback might have been different and possibly more detailed.

Despite this issue, evaluating the virtual genetic counsellor within the eCG platform was a sound decision. In real-life applications, the counsellor would operate as part of a larger system, not in isolation. Thus, the evaluation conducted remains pertinent, providing insights into its integration and functioning in a realistic environment. Future studies, however, could benefit from an isolated assessment if the focus is on the counsellor's embodiment in more detail. Such studies might provide a deeper understanding of the counsellor's design and functionality.

A significant challenge during the evaluation was effectively communicating the prototype's nature to participants. Despite efforts, it was sometimes challenging to convey that the prototype was still under development and that the primary focus was on evaluating the virtual genetic counsellor, not the eCG platform's overall design or layout. Participants occasionally commented on elements like the platform's colour scheme and button layout, which, while useful, diverted from the session's main objective. Redirecting their focus was sometimes necessary, a consequence of the evaluation method chosen. Providing more comprehensive explanations about the session's goals could have been a solution, but this risked directing participants' thoughts and responses, potentially skewing the feedback.

8 CONCLUSION

This thesis intended to answer the research question: “Which different levels of the aspects of embodiment should be used in the visual design of a virtual genetic counsellor, according to the preferences of the general population?”

Through qualitative and quantitative research, including focus groups, thematic analysis, and prototype evaluations, this study has concluded that the optimal embodiment for a virtual genetic counsellor combines human-like professionalism with a simplistic, cartoonish aesthetic. This design choice aligns with the general population's preference for an embodiment that is relatable yet non-threatening, approachable yet professional.

The research emphasized the importance of minimal yet meaningful movements in the virtual counsellor's design. Limited movements were found to enhance engagement without causing distractions. Furthermore, the embodiment's professional appearance, characterized by minimal facial expressions/emotions and gestures, were a crucial element. The minimal emotions are particularly relevant in the sensitive context of genetic counselling, where the virtual counsellor's role is primarily informational and supportive, rather than emotive.

A significant finding of this thesis is the preference for a cartoonish style over a hyper-realistic rendering. This choice effectively circumvents the "uncanny valley" effect, wherein too-realistic representations can evoke discomfort or unease in users. The cartoonish style, therefore, ensures that the virtual counsellor is perceived as friendly and accessible, without compromising on the seriousness and professionalism required in a medical setting.

In conclusion, the ideal virtual genetic counsellor, as determined by this study, strikes a balance between professionalism and approachability. Its design is guided by the principles of clear communication, minimal yet effective movements, and an aesthetically pleasing yet professional appearance. This embodiment serves as an informative guide, aiding users in navigating complex genetic information without overwhelming or distracting them. As such, this thesis provides a list of requirements for designing virtual counsellors in healthcare, one that is built with user preferences and professional medical communication. With these insights, we pave the way for the future, where virtual genetic counsellors can effectively support individuals in the comfort of their homes, offering personalized, accessible, and reliable guidance on complex health matters.

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APPENDICES

APPENDIX A – CO-CREATION SHEET

Full version together with filled in forms available in annex 1.

Co-creation participant sheet

your age (optionally): _____ your gender (optionally): _____

Thank you for participating. There are no right or wrong answers during this session.

Part 1 – Look

1. The personification – preference
The personification determines how the virtual agent is embodied.
Which personification would you prefer if you needed to interact with a virtual genetic counsellor?
Please circle your choice:

A. Human being For example: <ul style="list-style-type: none">• A doctor• A patient• Male• Female	B. Living creature For example: <ul style="list-style-type: none">• A dog• A bird	C. Non-living object For example: <ul style="list-style-type: none">• A paperclip• Amazon Alexa
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2. The personification – Importance
How important is this aspect for you? *Please circle your choice*

Not important	1	2	3	4	5	6	7	Very important
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3. The personification – description
Please write or draw how you would like the virtual genetic counsellor to look. Think about clothing, objects, colours, and general appearance. Everything is correct.
You can write or draw in the grey area below:

Figure 36 First page co-creation sheet

APPENDIX B – CO-CREATION PRESENTATION

Full version available in annex 2.



Figure 37 - First slides co-creation presentation

APPENDIX C – CO-CREATION CONSENT FORM

Consent form together with filled in consent forms available in annex 3.

APPENDIX D – CO-CREATION INFORMATION LETTER

Full version available in annex 4.

ECG VIRTUAL GENETIC COUNSELLOR EMBODIMENT CO-CREATION SESSION

I invite you to participate in a research study for the master thesis about embodiment in virtual genetic counsellors. Before you decide, you need to understand why the research is being done and what it would involve for you. Please take time to read the following information carefully. Ask questions if anything you read needs clarification or if you want more information. Take time to decide whether to take part.

WHO I AM AND WHAT THIS STUDY IS ABOUT

My name is Sam Freriks, and I am conducting this study as a part of my master's thesis about embodiment in virtual genetic counsellors. This study aims to find if there are any specific preferences for the embodiment of virtual genetic counsellors. The results will help in the design and creation process of a virtual genetic counsellor, especially in the visual design of such a counsellor.

WHAT WILL TAKING PART INVOLVE?

Taking part in this study involves participating in a co-creation session. In the co-creation session, we will discuss the various aspects of embodiment in virtual genetic counsellors and discuss personal preferences for the aspects of embodiment.

The brainstorming will be done using a brainstorming sheet; on this brainstorming sheet, you can fill in your preferences and thoughts about the embodiments.

The session will be audio recorded and later transcribed and anonymised.

WHY HAVE YOU BEEN INVITED TO TAKE PART?

You have been invited to participate because you meet the acceptance criteria, which are the ability to speak, read, and write in English or Dutch.

DO YOU HAVE TO TAKE PART?

Participation is entirely voluntary, and you have the right to refuse participation, reject any question, and withdraw at any time without any consequences.

WHAT ARE THE POSSIBLE RISKS AND BENEFITS OF TAKING PART?

To cover the basic information of this research, the topic of inherited heart conditions will briefly be explained. As you may already know, inherited heart conditions can be a sensitive topic for some individuals. We understand that some individuals may be uncomfortable with the thoughts of inherited heart conditions. We assure you that it is entirely up to you whether you participate in this study. If you feel this topic is not for you, please feel free to join this session.

Figure 38 - Preview information letter

APPENDIX E – CO-CREATION TRANSCRIPTS

Transcripts available in annex 5.

APPENDIX F – CO-CREATION DATA

All data available in annex 6.




1 - Preference	Q2	Q3 - Description	Q3 - Image	Physical details	Q4 - Preference	Q5	Q6 - Description
Human being		Met een mens kun je makkelijk identificeren Schept vertrouwen			Torso		De handen zijn in beeld, dit kan belangrijk zijn bij de communicatie. Non-verbale lichaamstaal geeft een toegevoegde waarde
Human being		Als een medisch expert. - dokter - witte jas Het moet direct duidelijk zijn dat eht gaat om medisch advies/info			Head and neck / Torso		Het moet duidelijk zijn dat het gaat om belangrijke informatie over een mogelijke afwijking van een persoon. - Neutrale houding - Mogelijke gebaren met handen en gezichtsuitdrukkingen om de gebruiker a
Non-living object		Voor mij heeft een counsellor niet echt meeswaarde Ik denk zelf dat qua vormgeving van dit soort apps waarbij gezondheidszorg centraal staat, het beter is om een zakelijkere uitstraling te geven ipv een counsellor.			Head and neck / Torso		Ik denk dat het meer conventioneel is om alleen het hoofd en de schouers af 1 Maar persoonlijk maakt dat voor mij geen verschil
Non-living object		Ik zou gaan voor simplicitet, iets zonder details die ergens of afleiding bieden, maar wel te maken heeft met het doel van de app. 4 Bijvoorbeeld een hart met een gezichtje.			Niet van toepassing op 'hartje'		Simplicitet en duidelijkheid is key! 3 De app draait om de info!
Human being		Ik zou de virtual genetic counsellor graag willen zien als een mens. Het betreft een enorm seriosus onderwerp waarbij ik een verbandis met de counsellor erg belangrijk vind. Daze zou ik zelf niet terugzien in een level/ niet levend wezen			Torso		Door gebruik te maken van een Torso zou de patient zichzelf misschien bete identificeren / spiegelen met de counsellor. 5 Misschien ook voor de visualisatie om dingen aan te wijzen
Human being		1. Een soort 3D gezichte die meebeweegt met de te geven antwoorden. 5 2. Een 3D human being (Realistisch)			Torso		5 Met terso geeft meer vertrouwen
Human being		I believe that for this kind of interactions it would be nice to have a semi realistic doctor that can explain what your conditions are. Maybe even better to have a nurse giving you the intro information at the beginning and later a doctor that can talk about medical conditions. I think that more realistic it is the better, cause it does not give the impression it could be a gaming character, 6 since it is a medical consult.			Full body		It gives the impression you are actually being assisted by a real professional, more realistic feeling. 3 Maybe switch from full body to torso when maybe showing a graph or a pap
Living creature		I would like it to look colorful so that it kinda pops out. Not too much of 'human' clothing like a snite because that would look out of place Just very simple clothing, or maybe not even clothes 6 but just an item like a stropdas.			Full body		I think that an animal would look better with a full body since everything else my opinion. 4 Also a full body could be more engaging en minder statisch

Figure 39 - Preview of co-creation data sheet

APPENDIX G – PROTOTYPE SCREENS

Full version available in annex 7 and on <https://www.figma.com/file/Uyuqw9OPNTHAXyTBJ3RQQq/Prototype-1?type=design&node-id=0%3A1&mode=design&t=5OHsvxHbcNWEe4bJ-1>.

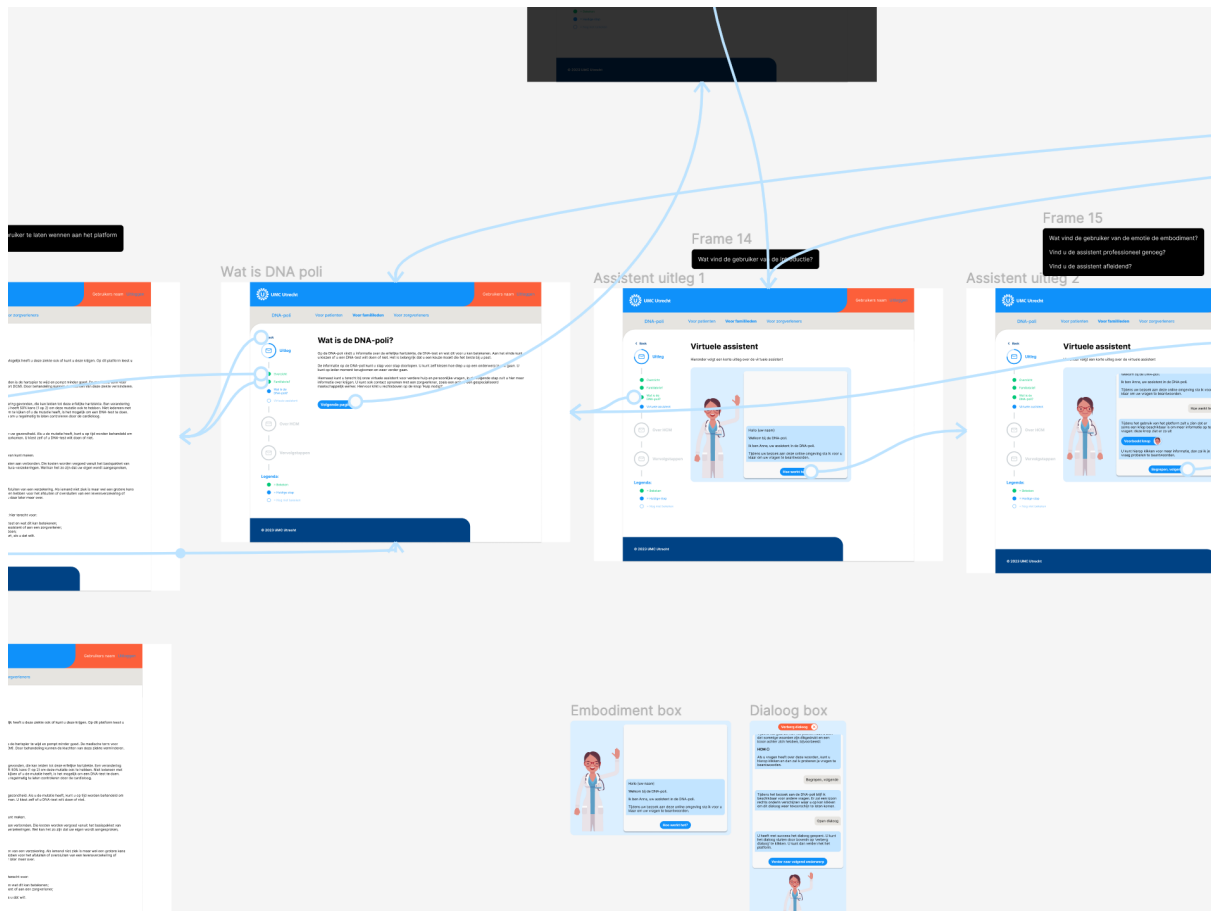


Figure 40 - Preview of prototype

APPENDIX H – EVALUATION CONSENT FORM

Consent form together with filled in consent forms available in annex 8.

APPENDIX I – EVALUATION INFORMATION LETTER

Full version available in annex 9.

**ECG VIRTUAL GENETIC COUNSELLOR EMBODIMENT PROTOTYPE
EVALUATION AND INTERVIEW – ENGLISH**

I invite you to participate in a research study for the master thesis about embodiment in virtual genetic counsellors. Before you decide, you need to understand why the research is being done and what it would involve for you. Please take time to read the following information carefully. Ask questions if anything you read needs clarification or if you want more information. Take time to decide whether to take part.

WHO I AM AND WHAT THIS STUDY IS ABOUT

My name is Sam Freriks, and I am conducting this study as a part of my master's thesis about embodiment in virtual genetic counsellors. This study aims to evaluate the prototype of a virtual genetic counsellor in an online platform. The results will identify areas for improvement as well as areas that are already performing well.

WHAT WILL TAKING PART INVOLVE?

To participate in this study, you will need to follow the task-based instructions provided when interacting with the prototype. Afterwards, you will have a semi-structured interview where you will be asked several questions about your experience. The interview will be audio recorded and transcribed later, with all personal information removed for anonymity.

WHY HAVE YOU BEEN INVITED TO TAKE PART?

You have been invited to participate because you meet the acceptance criteria, which are the ability to speak, read, and write in English or Dutch.

DO YOU HAVE TO TAKE PART?

Participation is entirely voluntary, and you have the right to refuse participation, reject any question, and withdraw at any time without any consequences.

WHAT ARE THE POSSIBLE RISKS AND BENEFITS OF TAKING PART?

When interacting with the prototype you will receive some basic information about an inherited heart condition named HCM (Hypertrophic cardiomyopathy). This information is generic medical information and is not related to your personal health in any way. As you may already know

Figure 41 - Preview of evaluation information letter

APPENDIX J – EVALUATION PRESENTATION

Full version available in annex 10.



Figure 42 - Evaluation presentation preview

APPENDIX K – EVALUATION TASK LIST

Also available in annex 11.

PROTOTYPING – TASK BASED EVALUATION

Welcome and thanks for joining the evaluation sessions.

Please remember to think aloud during the session.

INSTRUCTIONS

Imagine that you have just received information suggesting that you might have a genetic condition and you're seeking information from the system to better understand your situation. Your goal is to navigate the prototype to gather relevant information.

Please perform the following tasks in the prototype. You can a message on the screen indicating a task has been completed.

1. Read the introductory information and continue to the next pages on the screen and continue until you see the virtual genetic counsellor.
2. Finished the conversation with the virtual genetic counsellor, follow her instructions and close the conversational dialogue
3. You want to know more about HCM, open the information page about HCM.
4. Ask the virtual genetic counsellor about more information about the illustration on the page.
5. Go to the page about the process of HCM
6. Gather all the information about HCM, and close the conversation.
7. Go to the page about possible treatments.
8. Ask the virtual assistant all the information about Elektrodiagrams and close the conversation.
9. Go the the summary page
10. Finished

Figure 43 - Evaluation task list

APPENDIX L – EVALUATION INTERVIEW QUESTIONS

Also available in annex 12.

PROTOTYPING – INTERVIEW QUESTIONS

- What did you think about the introduction?
 - What did you think about the way the virtual assistant introduced itself?
- What did you think about the styling of the virtual assistant?
- Do you think about the way you can access the virtual assistant?
 - If not, what could be improved?
 - If yes, why?
- What did you think about the way the virtual assistant provided information?
- What do you think about the way the virtual genetic counsellor is integrated in the platform?
- Did you notice the different positions of the virtual genetic counsellor?
 - What did you think about the different poses?
- Do you think the virtual assistant is of additional value?

Figure 44 - Evaluation interview questions

APPENDIX M – EVALUATION SURVEY

Survey and survey results are available in annex 13.

EVALUATION SURVEY

your age (optionally): _____ your gender (optionally): _____

Thank you for participating. Please answer the following questions.

Question	Strongly disagree (1)	2	3	4	Strongly Agree (5)
I think that I would use the virtual assistant frequently.					
I found the virtual assistant unnecessarily complex					
I thought the virtual assistant was easy to use.					
I think that I would need the support of a technical person to be able to use the virtual assistant.					
I found the various functions in the virtual assistant were well integrated.					
I thought there was too much inconsistency in the virtual assistant					
I would imagine that most people would learn to use the virtual assistant very quickly					
I found the virtual assistant very cumbersome to use					
I felt very confident using the virtual assistant					
I needed to learn a lot of things before I could get going with the virtual assistant					

Figure 45 - Evaluation survey

ANNEXES

Annex number	Annex name	File name
1	Co-creation sheet	1.1-co_creation_sheet.pdf 1.2-co_creation_sheets_filled.zip
2	Co-creation presentation	2-co_creation_presentation.pdf
3	Co-creation consent form	3.1-co_creation_consent_form.pdf 3.2-co_creation_consent_forms_filled.zip
4	Co-creation information letter	4-co_creation_information_letter.pdf
5	Co-creation transcripts	5.1-co_creation_transcript_group_1.pdf 5.2-co_creation_transcript_group_2.pdf 5.3-co_creation_transcript_group_3.pdf
6	Co-creation data	6-co_creation_sheet_data.xlsx
7	Interactive prototype screens	7-prototype.pdf
8	Evaluation consent form	8.1-evaluation_consent_form.pdf 8.2-evaluation_consent_forms_filled.zip
9	Evaluation information letter	9-evaluation_information_letter.pdf
10	Evaluation presentation	10-evaluation-presentation.pdf
11	Evaluation task list	11-evaluation-task-list.pdf
12	Evaluation interview questions	12-evaluation-interview-questions.pdf
13	Evaluation survey	13.1-evaluation-survey.pdf 13.2-evaluation-survey-results.zip
14	Evaluation transcripts	14-evaluation-transcripts.zip
15	Evaluation survey data	15-evaluation-data.xlsx