INTERACTION WITH THE SMART INTERACTIVE MINI TABLES

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Abstract

This research aimed to provide the Smart Interactive Mini Tables with a use in healthcare. The target group is defined as older adults, living and eating alone, possibly less mobile. This group in society can experience feelings of loneliness and gloom, due to lack of (social) interaction and engagement. Interactions with the Smart Interactive Mini Tables have been designed and redefined, based on literature, expert interviews and the feedback of older adults, through the means of co-creation sessions, to enhance the social interaction and engagement during the day. A simple multiplayer game, designed to keep the brain active, incorporating music, was created in Unity. In addition to the multiplayer game, the table also provides interaction through the options of lighting up the place where something is placed, or displaying a colour on the border of the table, depending on time. To manage the settings and to provide a connection with friends and family, an app was also designed. These three options for the SIMT and the app were evaluated with three older adults. It showed promising results indicating the possibility of increased interaction and engagement if some aspects of the game are updated. The app was received well and considered usable for the target group. With further development of the SIMT, older adults could benefit from this and live at home more comfortably.

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1. Introduction

Eating moments, such as lunch and dinner, are structured parts of most people's lives. To study eating behaviour, the Sensory Interactive Table (SIT) was made [1]. The SIT has a tabletop covered in LEDs and load cells, which allow for patterns to be lit up on the table based on the placement of eating utensils. With this table, researchers are able to observe the eating behaviour of individuals within a social setting [1].

After the creation of the SIT, the idea for a smaller version of the table was developed by the Biomedical Signals and Systems (BSS) and the Human Media Interaction (HMI) groups. This smaller version would be almost identical to the big table, but as an additional feature, it would be connected to a second table. This allows people to use the interconnected tables from a distance. However, these Smart Interactive Mini Tables (SIMT) do not have a defined purpose yet, besides the wish to be of added value within the health sector, and possibly as a support for research. In addition to this, several other requirements were set that would ensure the goal of the SIMT is met. The project requirements are as follows:

1. The table needs to be connected with another table. The possibility to substitute one table with another interactive device, such as a smartphone, exists, but preferably two tables would be connected.
2. It should preferably add something to the research being done by one of the people at the BSS faculty at the University of Twente.
3. The use of the tables should not provide any medical claims or intent to be used as medical support for illnesses or disabilities.
4. The features of the table (the LEDs and the load sensors) should be used; otherwise the purpose of creating the table is discarded.

To meet these requirements, the goal of this research is to find a good and useful purpose for the SIMT. This will be done on the basis of the main research question:

How can the Smart Interactive Mini Tables be put to use in healthcare?

By providing an answer to the following four sub-questions, this main question will be answered:

- ***What interactions do people have with interactive tables that already exist?***

This question will provide an overview of the current state of interactive tables and the interactions people have with them. This can provide a base for the SIMT.

- ***Within what field of healthcare does the SIMT add to the existing technology that is being used to aid the patient group?***

  Though answering this question, the target group is defined and the technologies that already exist to support this group are made clear. This can be related to the SIMT and how the design of the SIMT can be influenced by this.

- ***Of what added benefit are the remote interaction possibilities for that field of healthcare?***

  This will set out the reasons the added internet connection is of value for the SIMT and the target group.

- ***Which interactions need to be implemented in order to achieve the greatest benefit for the patient group?***

  After answering this question, a clear set of interactions will be defined, which can be implemented.

To answer the research question and the additional sub-questions, Background Research will be done through literature research and expert interviews with researchers from the BSS faculty and will be described in Chapter 2. After this chapter, the current state of interactive tables is clear, and the target group and the current technologies aiding them will be defined. The remote aspect of the SIMT is also discussed.

Afterwards, the Methods and Techniques will be described in Chapter 3, explaining the design process that will be followed in the coming chapters. This will start with the Ideation in Chapter 4. This chapter describes the process of generating ideas and the co-creation sessions done with the target group. These ideas are specified and made more concrete in the Specification in Chapter 5. This final idea is created, and the process of this is part of Chapter 6, the Realisation. The final prototype that is made is then evaluated by the target group, and the results are described in the Evaluation in Chapter 7. These results will be discussed in Chapter 8, in addition to any limitations and future prospects. It will all wrap up in the Conclusion.

2. Background research

A literature review was conducted, in addition to expert interviews, to answer some of the sub-questions formulated in the Introduction. The current state of interactive tables will be discussed after the approach, providing insight into the categories and uses of interactive tables. Afterwards, the target group is defined with the help of expert interviews, supported by literature. As mentioned in Chapter 1, the SIMT should preferably add to research within the BSS faculty, and therefore researchers from BSS were interviewed as experts. To support the final choice of the target group, a clinical geriatrician was also interviewed as an expert. After the specification of the target group, current technologies that aid this group are described and related to the design of the SIMT. Lastly, the added value of the remote aspect of the SIMT is explained.

2.1 Approach

In order to find relevant and scientific papers about the current state of interactive technology and the use of it in healthcare and research, a search was conducted on Scopus. More information about the search strategy can be found in Appendix 1.

To find relevant use cases, including a target group and possible requirements for the SIMT, expert interviews were conducted. The expert interviews followed the same structure. The expert interviews with the researchers from the BSS faculty were done together with a fellow Bachelor student, Janine Ruumpol. Janine works on the technical implementation of the SIMT and the communication between the SIMT and other devices. As she also needed the requirements for the SIMT, these interviews were done at the same time to save the experts' time. The interviews were carefully planned beforehand following the format of a semi-structured interview. This format allowed additional questions to be asked during the interview if an unforeseen topic came up, or to get more clarification about the target group or the requirements, while also ensuring a prepared list of questions was available to make sure all the information needed was gathered. The prepared questionnaire for the semi-structured interview can be found in Appendix 2. Before the interview the experts were given an informed consent form, which can be found in Appendix 3. Ethical approval for the expert interviews was obtained from the Ethics committee of the University of Twente.

2.2 Interactive tables

In this section, an overview of the state of existing interactive tables is provided. First, different types of interactive tables will be discussed, and the category the SIMT fits best in is determined. This will be followed by an examination of the interactions the users have with those tables and the implications for the design of the SIMT. This sub-chapter was initially written as part of the Academic Writing course; however, significant changes have been made since then.

2.2.1 Types of interactive tables

Tables are commonly used in the daily human routine for working, eating, social interactions, and more. As technology progresses, tables also get upgraded with new types of interactions and technologies [9]. Since the SIMT would be considered one of these, it is important to get an understanding of what is already out there.

Hendriks [9] divides interactive tables into three categories: digital, tangible and actuated tabletops, which can be seen in Figure 1 below. Digital tabletops have a graphical user interface as the tabletop. Through a projector combined with a tracking depth-camera or multi-touch displays, these interfaces allow users to interact with the tabletops. This means the interactions users have with digital tabletops are similar to those with a tablet, namely through finger touch and gestures. Tangible tabletops have tangibles included, which are used as input for the tabletop. These tangibles can be moved around by the users, and the movement of these tangibles is tracked with cameras. The table can then react according to the movements. Actuated tabletops can change the shape of the tabletop through an interactive system. This means that these tables can adapt their appearance to differences in input, users, or the environment.

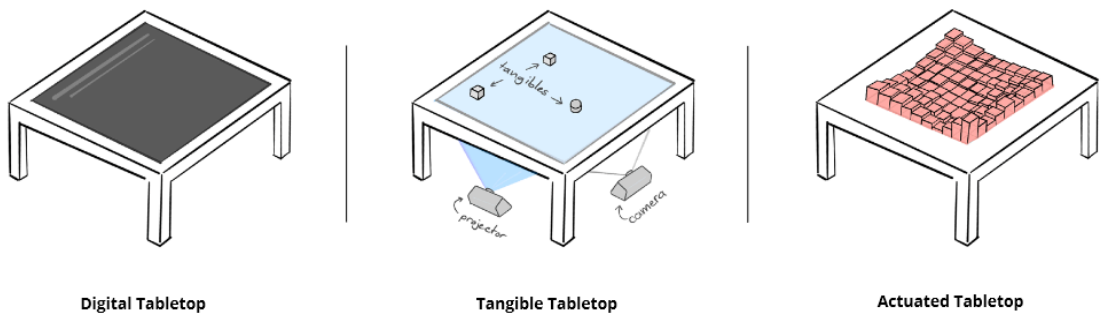


Figure 1: Overview of categories of interactive tables [9].

"Willy's pond" [3], shown in Figure 2 below, is an example of a digital tabletop. It is an Interactive Coffee Table with a small virtual fish swimming around in a pond. The pond expands, and the fish grows, as the number of people around the table increases [3]. The goal of this table was to create a more enjoyable lunch experience for students. A digital tabletop can also have an added remote aspect, like the multitouch system developed by SynergyNet, shown in Figure 3. They connected two multitouch tables via the Internet, allowing long-distance interaction, specifically aimed at exploring the possibilities of solving a problem with others who are at an external location [4]. Interactive projections are also included into the digital tabletop category. An example of this is the interactive projection tabletop system, designed to assist older adults, shown in Figure 4. This system projects an interface on the dining table, and users can easily interact with it whilst receiving audio feedback through several speakers [8].

Figure 2: Willy's pond [3]

Figure 3: SynergyNet system[4]

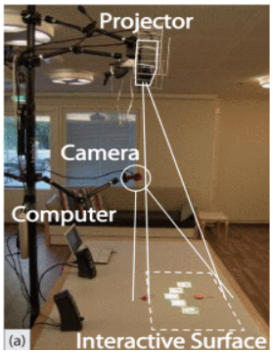


Figure 4: Tabletop system [8].

One example of a tangible tabletop is the "reacTable", shown in Figure 5. The reacTable is a musical tabletop with tangibles that users can move around to create music or sound effects. Moving the tangibles will influence the sound through audio filters, audio generators, and more [2]. This tabletop allows users to express their creativity and musical preferences in a natural and easy way.

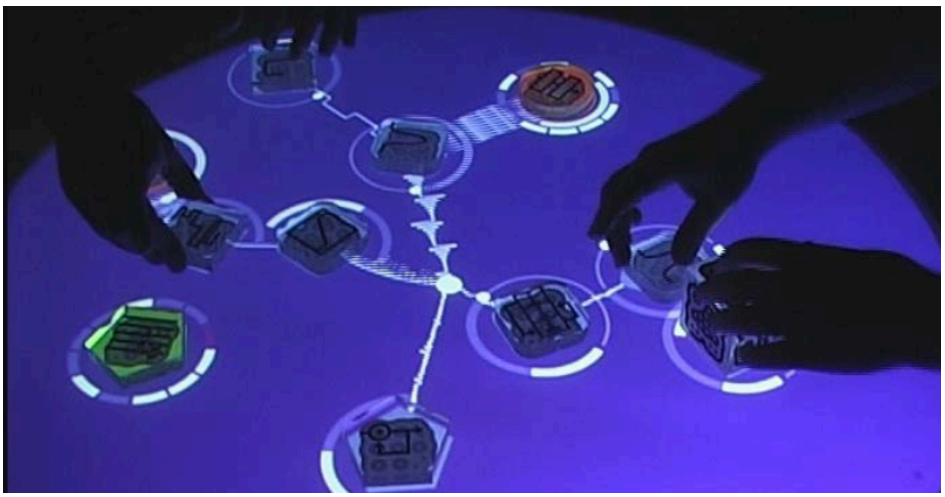


Figure 5: The reacTable [2].

“inFORM” is an actuated table. InFORM is a shape-changing UI (User Interface) made of small square motorised sticks that can move up and down, and can be seen in Figure 6 below. The 900 sticks create a large moving surface, allowing objects to be guided over the surface by creating a path for them with the sticks. Other uses for the table include using it as an interface or to create a tablet stand. On top of the table is a projector detecting user interaction and objects [5]. The concept of this table was to show the possibilities of shape manipulation. “KEEP-UP-WITH-ME” is more of a motorised table than an actuated table. It lifts or lowers people's plates, aiming to adjust the eating speeds to match each other, as seen in Figure 7. Through the weight sensors in the platforms, the weight of the plates is measured. If, due to a different eating speed, a difference between the plates is detected, the platforms lower or raise accordingly. The plate of the slower eater gets raised, and the plate of the faster eater is lowered [7]. In doing so, diners are made aware of their relative eating speed and are encouraged to maintain the same eating tempo as their fellow diner. A different type of a shape-changing construction can be seen in Figure 8, which is the “table-non-table”. This construction consists of a motorised aluminium base with a thousand pieces of paper stacked onto it. People can take paper from the pile, making it smaller over time. If the table-non-table is plugged in an outlet, it will move slowly one or two times a day for a duration of less than ten seconds. During movement, the motor makes a muffled sound [6]. This table-non-table was made to help with the process of design thinking. However, this does not fall under the term actuated table, as it acquires a user to change its shape and does not initiate the shape change through an interactive system.

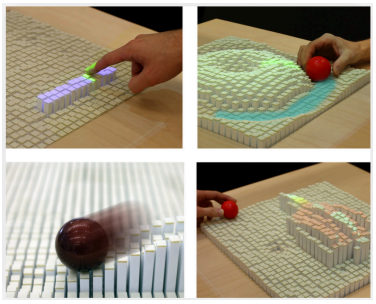


Figure 6: inFORM [5]

Figure 7: Kinetic table[7]

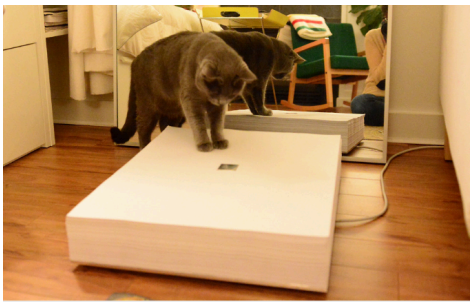


Figure 8: table-non-table [6]

It can be concluded that there are several different interactive tables, but not all interactive tables can be defined as digital, tangible, or actuated. The rapid development of new technologies and interventions makes it difficult to keep the categories all-inclusive. This is also the case for the SIMT, as it would mostly fall under the category of tangible tabletops, as you can interact with the table through putting objects on it. However, these objects do not have to be predetermined tangibles, but can be anything with weight, even including your finger or hand. It also measures the placement of the objects through load cells instead of using projectors and cameras.

2.2.2 Interactions

A wide variety of interactive tables also means that there are different types of interactions that people can have with them. In developing these interactions, User Centred Design (UCD) plays an important role. Through user research, information about the target group and possible input from the target group is gathered [14]. Gathering this information ensures that the target audience has an optimal experience during their interaction with the interactive tables.

The (connected) digital tabletops previously discussed, such as the remote multitouch system [4] and the interactive projection for older adults [8], have similar ways of interacting. The user moves their hand over the interface, causing a change in the display. These movements are similar to interactions one has with a tablet or smartphone and are 2D movements. However, even with similar interactions, the experiences themselves can be quite different. The remote multitouch system [4] was tested with children, and the movements are familiar and somewhat intuitive to them, as children today are generally exposed to tablets and smartphones early on. This led to the addition of the “flick” gesture to create something extra and interesting. While the flick gesture took a bit of time for the children to learn, once they figured it out, it resulted in excitement. The interactive projection

[8] however, is aimed at and made for older adults, keeping everything as simple as possible. Only basic movements are needed from the users, and actions need to be confirmed before completion to prevent possible mistakes. Additional audio feedback is provided to support the older adults, letting them know what is happening. This audio feedback is also useful for users whose sight is declining. In both situations, a multisensory experience was created, but while the children added to each other's experiences, the older adults interacted with a pre-recorded voice providing them support in their daily lives. “Willy’s pond” [3] takes a different approach by focusing on people being present. Simply being present around the table impacts the size of the pond Willy the fish is swimming in. With five people present, the option to drag and drop fish food into the pond is unlocked, helping Willy grow in size and improve his mood. Before the feeding option is available, there is no active interaction between the users and the table, creating a different kind of interaction with a digital tabletop. In this case, people also add to the experiences of others, but the design influences the experiences. Gondal et al. [3] describe that students were curious about the table, wondering what it is and what it does. Additionally, the collaboration needed to make Willy happy was playful, and the lack of a clear narrative allowed users to give their own meaning to the interaction [3]. This creates a personal experience for all users, as the level of interaction is left up to them. It is not meant to have a big impact on their lives, but rather to provoke a group setting and provide a bit of engagement during lunch breaks.

The tangible tabletop “reacTable” [2] also depends on the user for interaction and is very user-friendly. The tangibles on the table are inviting to move around and provide immediate feedback, even if a user does not initially know what the table is about. The immediate feedback, through sounds and music, encourages people to move the tangibles more, and through interacting with the table, they can learn to understand what the table does. However, if users do not have much prior knowledge about how music is built up, they might not understand how to use the table in the most rewarding way, which can lead to frustration or loss of interest. But if someone understands how to create music to their liking, it can lead to more interactions and a feeling of accomplishment. Therefore, the experience users have with this table will vary greatly, as it depends on the individual whether they are initially interested enough to continue interacting with the table, even if they do not fully understand what is happening. This means that this tangible table creates a more diverse range of experiences than the previously described digital tabletops.

The actuated tabletop “inFORM” [5] reacts to the 3D movements of users’ hands. By moving their hand up, down, left and right, and making different handshapes, the display of inFORM changes. This expands the possible interactions users can have with the table. Additionally, it can be used as a remote application, with the user in one room while the table is in the other room. This allows for users to feel present in a room while physically being somewhere else. It also creates a more interactive and immersive experience, as users can actually see their movements translated into the table and feel the power of being able to change its shape. The “table-non-table” [6] does not actively react to users but tries to catch their attention every now and then for less than ten seconds by moving slowly. However, this movement is random and not based on the presence of people around, as was the case with Willy’s pond. Users are welcome to take a piece of paper from table-non-table and use it for their personal preferences, or even draw or write directly on the table-non-table. Aside from being taken slowly apart, it can also be used as a “normal” coffee table, a foot stool, a nice bed for the cat, etcetera, making the table-non-table multifunctional and useful in many situations. This means that the experiences users have will also be diverse and different in each situation. In addition to this, the table-non-table was not designed for a specific target audience or goal as some of the earlier described tables, allowing everybody to have their own personal chosen experience.

This shows that the design of the table influences the interactions people have with it. These interactions can be similar between tables, but different experiences can occur depending on who the table was designed for. Even with one table, different users can have different experiences, as humans are all different. This should also be taken into account during the design of the interactions with the SIMT, to ensure that the target group has a positive relationship with the SIMT.

2.3 Target group

To get a clear goal for the design of the interactions, a target group was determined. To find the right target group, several people from the BSS faculty were interviewed, as one of the requirements for the project stated in the introduction that the SIMT preferably adds something to research within a part of the BSS faculty. These people are doing their own research projects within their own field at the BSS faculty. The research fields include E-Health and data processing, and offer lots of possible use cases. Besides the researchers from the BSS faculty, a clinical geriatrician was interviewed. As a geriatrician, she has a lot

of experience with the decided target population and was therefore able to provide a lot of information about the target group and their possible use of the SIMT.

First, the specification of the target group will be discussed, which will end with a description of the target group. Afterwards, technologies that currently aid the target group will be explained, and what this means for the design of the SIMT.

2.3.1 Specification of target group

During the expert interviews, a variety of possible target groups were identified, including ways the SIMT could be used with that target group. These use cases were all quite interesting, but only one target group can be further explored within this research. To ensure that the options for the possible target groups and use cases were fitting for this project, the possible use cases were written out within different categories: 1) Target group, 2) Interaction with the table, 3) Where would the table be, 4) What could be used within research? 5) Additional remarks, 6) Are the requirements met?. The requirements in the final category are the basic requirements that the project itself has, as stated in Chapter 1. By writing it out in these categories, a clear overview of the possible options and how well they fit within the project is made. The overview of all the use cases can be found in Appendix 4. After assessing the possible use cases provided in the expert interviews, two possible target groups met the requirements: Obesity patients and older adults, possibly with malnutrition. These parts of the overview from Appendix 4 can be seen in Figure 9 below. For both target groups, the use case was a bit of a combination of 2 ideas, hence why it looks like 2 different use cases.

TARGET GROUP	INTERACTION WITH THE TABLE	WHERE IS THE TABLE	WHAT WOULD BE USED FOR RESEARCH	ADDITIONAL REMARKS	REQUIREMENTS 1. TABLE IS CONNECTED TO TABLE/ OTHER DEVICES 2. BENEFICIAL TO RESEARCH 3. NO MEDICAL CLAIMS 4. USING THE LEDS 5. USING THE WEIGHTSENSORS
3) Older adults (with malnutrition)	Stimulation to eat more, for themselves and the other person at the other table in their homes Additional interaction with grandchildren	Hospital / home	• The speed that people eat. • How to enrich experience. • Eating behaviours	Keep the cognitive functions ans sensory impairments in mind. Could be connected with other devices as well.	+,+,+,+,+ +,?,+,+,+
3) Older adults (with malnutricion)	Fun interaction to stimulate them to join others in the dining room.	Home	• The speed that people eat. • How to enrich experience • Eating behaviour		+,+,+,+,+
2) Obesity patients	Using the table, having their arms on the table.	Home	Measure weight in unobtrusive manner	Weight is a sensitive topic for obesity patients. Focus on food may be unhealty	-,+,+,?,+
2) Obesity patients	Share eating details with other obesity patients	Home	Food intake (grams), notifications?	Weight is a sensitive topic for obesity patients. Focus on food may be unhealty	+,+,+,+,+

Figure 9: Overview of the possible target groups.

In the case of the obesity patients, the table would be used for sharing their eating habits with other obesity patients, and their food intake would be measured by the table. The weight of their arms can also be measured and compared with other measurements over time. They would receive notifications about their eating habits and weight. However, during the interview, while providing the possible use case for obesity patients, the disclaimer was given that it might not be as helpful for the obesity patients, as it is then another thing that focuses on their weight and eating habits, and it might result in more eating problems. This is supported by Balantekin [10], who states that focus on dieting and weight for many people resulted in a negative impact on the relationship obesity patients have with food and their body. Additionally, it raised concern about causing eating disorders.

For the older adults, it was mentioned in the interview to target those with malnutrition. The SIMT could provide stimulation for them to eat, whilst adding a social element to their lives. The SIMT would not claim to solve their malnutrition or provide

healthy eating habits. It would aim to enrich their eating experience, which could stimulate the older adults to eat. Therefore, the SIMT could be of the biggest benefit, targeting older adults with malnutrition or lower food intake. A reason for lower food intake provided during the interview was that some older adults do not feel like they have a reason to eat (enough). Choi [11] connects this with loneliness. It is explained that older adults living alone, possibly also due to loss of a spouse, can lack motivation to prepare their meals, which can result in skipping meals. During the study they also gathered the participants' reasoning:

"*Why bother to eat if I am eating alone and not with anybody else? I eat something to take my medications. If it is not for my medications, I do not need to eat at all.*" (68-year-old female) and:

"*I just eat because I have to sustain myself. There are times when I just eat one spoonful for lunch. There are times when I don't eat at all just because I don't feel like eating. I eat just to not die.*" (83-year-old female) [11, p.5].

Another study found that older adults eating alone are at higher risk of suffering from depressive symptoms. Eating alone is also linked to meal skipping. Contrasting to this, eating with others was likely to improve their happiness levels [12]. Ha et al. [13] links depression to a lower quality of life and poor health conditions. They also state that living alone can cause older adults to suffer from social isolation. However, social support can alleviate the depressive symptoms experienced by older adults. The literature suggests that providing older adults with a more social eating experience, or a reason to eat, might enrich their eating experience, which could improve their food intake.

During the expert interview with the clinical geriatrician, this was discussed, and she confirmed this, explaining that older adults long for company and a more inviting eating environment. She mentioned, however, they also want, and are expected, to stay home as long as possible, maintaining their autonomy and not be classified as one of those "needy old people". But as a result, they start to eat worse and do not put the effort into cooking for themselves. But even if people have the opportunity to eat in a common dining hall in a retirement home, they can still choose to eat in their own apartment. She mentioned reasons such as: not wanting to be confronted with others' (gross) eating habits, such as chewing loudly etc., trouble interacting with others and that having to eat with those they do not know is uninviting. The SIMT can provide interactions without having to listen to others eating, or having to maintain a conversation with those they do or do not know. Additionally, if they live in their own home instead of a retirement home, they can still have

interactions with others. She did note that fun games and the lights could be distracting to have during meal times and that some older adults could get overstimulated by all the different things they have to do. Focussing on one thing at a time could make it more manageable.

The SIMT could also come in handy as it is not as big as a full-size dining table. This is helpful, as the geriatrician mentioned that older adults tend to live smaller, and the SIMT would not take up that big of a space. This additionally means that, if they have to position it in their own house, they would otherwise have to throw something else out to be able to get the SIMT. If they also walk with a walker or sit in a wheelchair, it is nice to have some space to walk or ride around. The SIMT could be on an adjustable stand, allowing users to pull it over their chair or to move it out of the way. As the older adults are living alone, the table does not need to provide a lot of space to eat from. It can also be used outside of eating moments. During the interview, it was also brought up that certain older adults do not have much to do during the day and can lack certain structure. This depends on their mobility and attitude towards life, but it still happens. The SIMT could possibly provide interaction, structure, and engagement besides the eating moments.

Based on these reasons, it was decided to further develop the idea of using the table to enrich eating experiences for older adults that live and eat alone. Aiming it to provide a better eating experience for the older adults who have lower food intake. It can additionally provide some extra interactions during the day to fill the time besides the eating moments. With this, the research being conducted for the E-Health department is aided.

2.3.2 Current technologies for the target group

There have been several reviews discussing technologies for older adults, and their acceptance towards them. Technologies that aid older adults can be considered Assistive Technology (AT), if they help maintain autonomy and improve the quality of life, in addition to compensation, mitigation or prevention of a disability, disadvantage, or functional impairment [15]. These technologies can vary in their shapes, sizes, and functionality. In this chapter, these will be discussed, after a brief discussion about the acceptance of technologies.

The existence of (assistive) technologies is great, but it should be noted that they should be designed with the target group in mind, as older adults can have difficulty using the technologies, which can lead to anxiety and frustration [15][16]. Therefore, it is important

to get an understanding of how older adults view technology and what should be kept in mind during the design of the SIMT. For some older adults, technology, such as a phone or laptop, is commonly used within the house. The general usage of a laptop or computer is mastered, and assistance from others is only occasionally needed [16]. But, especially for older adults with a higher age, this common use of technologies declines [17]. This can be due to several reasons, such as declining or impaired eyesight, trouble with dexterity, and literacy issues [18]. Other reasons for a lower technology acceptance include: a negative attitude towards technology, a lack of knowledge about the potential benefits, or a lower educational level, worries about their privacy, and a restricted accessibility of technology [19]. When asked about the possible addition of an assistive robot in their lives, however, there was a more positive reaction [16]. This can also be due to the fact that the robot could provide more social support by itself and presents capabilities of helping them. Based on the view of older adults on technology, introducing a (new) technology to older adults has a few requirements:

1. It should be easy to learn and use, as it can be challenging to learn new things as people get older and unfamiliarity and insecurity can heighten the threshold to learn [19].
2. It should be intuitive in usage.
3. It should keep the privacy of the people safe.
4. It should be safe in use.
5. It should keep the deficiencies older adults can get over the years in mind.

But there is also a promising prospect of older adults showing interest in technology that is health related, and allows them to maintain their autonomy, provides support in their daily life and gives them opportunities to socialise [19], which are technologies that are part of AT. A part of AT is within the field of robotics. After a literature review, Shishehgar [20] found nine categories of robotic technologies that aid older adults. Robots addressing loneliness and social isolation are considered *companion robots* and *telepresence robots*. For assistance in daily activities, mobility and dependent living, *rehabilitation robots, domestic robots, fall prevention or detection robots* and *manipulator service robots* are made. *Health monitoring robots* and *reminder robots* maintain the health status up-to-date and help with medication management. Lastly, entertainment is provided with *entertainment robots*. These robots provide different assistive qualities within each category. Within the companion, entertainment, and reminder robot categories there are several interesting

robots in relation to the SIMT, as they provide entertainment, structure and social interaction to older adults, which was also discussed in Chapter 2.3.1.

Kachouie et al. [21] did a literature review of companion robots or Socially Assistive Robots (SAR), as they call these robots. The outcomes show that these types of robots have positive effects on older adults for their emotional state, social interactions and engagement. Limitations mentioned were that these robots were not tested in the homes of the older adults, and that the researchers did not personalise the target group enough. The personal information of the older adults and their experiences and perceptions were not taken into account enough. This should, however, be done to ensure an appropriate design.

To remind older adults, and assist them with their medicine intake, a robotic medication assistant was developed [22]. This robot has a screen that displays a task or instruction, a tray for medication, and is able to drive around. The user evaluation of this robot showed that the older adults found it easy to learn and use the robot, but also that they would like to be reminded for refill appointments, and they would like their family member or caregiver to be informed about their medication intake. This shows that a simple design and user interactions are appreciated by older adults. Additionally, they are open to receiving reminders and sharing intake with familiar individuals.

Engaging older adults and introducing learning therapy, has been addressed with the YORISOI Ifbot, equipped with the Robot Assisted Activity (RAA) program [23]. This robot shortly introduces different lessons to participants, engaging them in various activities, such as singing, maths, and riddles and tongue twisters. The results after testing with older adults show that the older adults enjoyed singing, but the tongue twisters were not received positively. As the robot was difficult to understand for the older adults, it negatively impacted their ability to participate. Additionally, the robot needed an assistant to be present to help the interaction with the older adults. The robot itself was considered “cute” and “therapeutic” [23, p.9]. This shows that the audible feedback should be adjusted to older adults, and a simple design would allow the older adults to use the robot by themselves. The addition of music and singing is however appreciated by older adults.

Other technologies, such as Mixed Reality, can be used to improve food intake in older adults. Korsgaard et al. [24] created a Mixed Reality environment, where older adults see their real food through a headset, while being placed into a different environment. They could choose between a modern kitchen or a park to eat their meal. The goal of this was to make the eating experience more enjoyable, as a positive environment and experience

could increase food intake. As this has quite some overlap with the intended use of the SIMT, this study will be discussed into more detail. The results of the study Korsgaard et al. [24] conducted show several interesting things. The eating environment has a significant impact on the eating behaviour. Participants mentioned that a nice view and a well set table improve the eating environment, whereas a more clean and cold looking environment, such as the modern kitchen, was not appreciated. It is stated that: “The environments lacked novelty and the ability to stimulate the elder's curiosity.” [24, p.7]. The ideal eating environment was an eating environment that could be perceived as cosy.

Another thing mentioned by the participants was that the colours should look more natural when shown in a natural environment. The unnatural colours that were shown in the park created a slight disconnection between the older adults and the environment. When provided with different options of places to eat their food, their kitchen and a terrace were chosen most, and exotic places were deemed unfit for the meal. This was, as explained by participants, due to the fact that these environments would not leave enough mental energy to focus on their meal, as their attention would go mainly to the environment [24, p.6]. When asked if they would see themselves use this Mixed Reality system in their own lives, the responses were mostly negative, due to, among others, the unnatural feeling of the environment and viewing a TV as a safer option [24, p.7]. However, the overall experience of trying the Mixed Reality was found to be pleasant.

It can be concluded that there are several technologies for older adults available on the market and under development. These technologies are all addressing different aspects of the lives of older adults. The overall effects of these ATs are considered positive, but there are several considerations that also need to be addressed during the design of the SIMT. During the design of the interactions with the SIMT, it is important to keep the target group in mind, and to gather information from the older adults themselves. A questionnaire can gather a lot of useful information, and the design process could make use of input from older adults in a form of co-creation. Reminders could be an interesting addition to the SIMT, but the type of reminders should be investigated further, due to the SIMT not being a medical device. The possibility of measuring eating speed with the table, and sharing it with family or caregivers, might be something that older adults are open for, but should also be determined through actual information from the target group themselves. If sounds are to be incorporated into the SIMT, they should be adjustable and tailored to the needs of older adults. This will ensure that they can hear and understand what audio is played. It can also

be interesting to examine the possibilities of incorporating music. The SIMT should aim to stimulate the mind of the older adults, without overwhelming them and draining their energy. The right use of colours can help with this, in addition to creating a “homey” feeling, as opposed to having the table stand too far apart from other furniture with looks and interactions.

2.4 Remote possibilities

One of the aspects, planned to be included in the SIMT, is that it can be connected to another SIMT through the Internet, or even other devices such as a smartphone. In the following section the added value of this will be discussed.

In the expert interviews, a few points of value were mentioned. The first point being that it allows for monitoring from a distance. This does not only have to be a health professional; for example, if a family member is on the other side of the connection, they receive frequent updates about the older adults through their interaction with the table, and possibly also about their eating habits. This can make the family more at ease about the wellbeing of the older adult, while the older adults have more interactions during the day. Another point mentioned was that it allows for more contact interaction possibilities. The table provides an easy connection with somebody else, without the pressure of having to keep a conversation up, or listen to others eating, which were points of difficulty for some older adults, mentioned during the specification of the target group in Chapter 2.3.1. And there is the option to connect the table with people who are also lonely, or cannot do a lot during the day, such as lonely youth or asylum seekers. The clinical geriatrician mentioned that this can allow for the older adults to get a sense of purpose, as through interacting with the table, they are helping others. One of the researchers at BSS also commented on this, saying that older adults can be motivated to eat, if they feel they are eating for others instead of just eating to eat, as discussed in Chapter 2.3.1. Therefore, the connection and interaction with others remotely can create a more inviting eating environment for older adults.

The remote connected table can also provide structure in eating habits, if older adults have the opportunity to eat with somebody else. As some older adults have trouble getting out of the house, or do not have close social relationships [11], the table can also provide easy interaction with other people. If this interaction is structured around meal times, it can stimulate older adults to eat at structured times, as they can eat with others.

This structure is important, as having frequent meals is associated with healthy nutritional intake [25].

The incorporation of an internet connection has appeared to be a valuable addition to the SIMT, but can make people concerned about privacy issues. In the previous chapter privacy was briefly mentioned as one of the reasons for a lower technology acceptance [19]. Keeping the privacy of users safe is one of the aspects that has priority during the development of the SIMT, but to ensure the older adults are comfortable in using the SIMT, it should have visible precautions taken to show the older adults that their privacy is kept. This can ease their worries and lower the threshold to use the SIMT.

3. Methods and Techniques

For this graduation project, the design method for Creative Technology was followed from Mader [26]. This design method is shown in Figure 10 below. The design method provides a clear overview of the different stages, and at which points what results should be gathered. The different stages are: Ideation, Specification, Realisation and Evaluation.

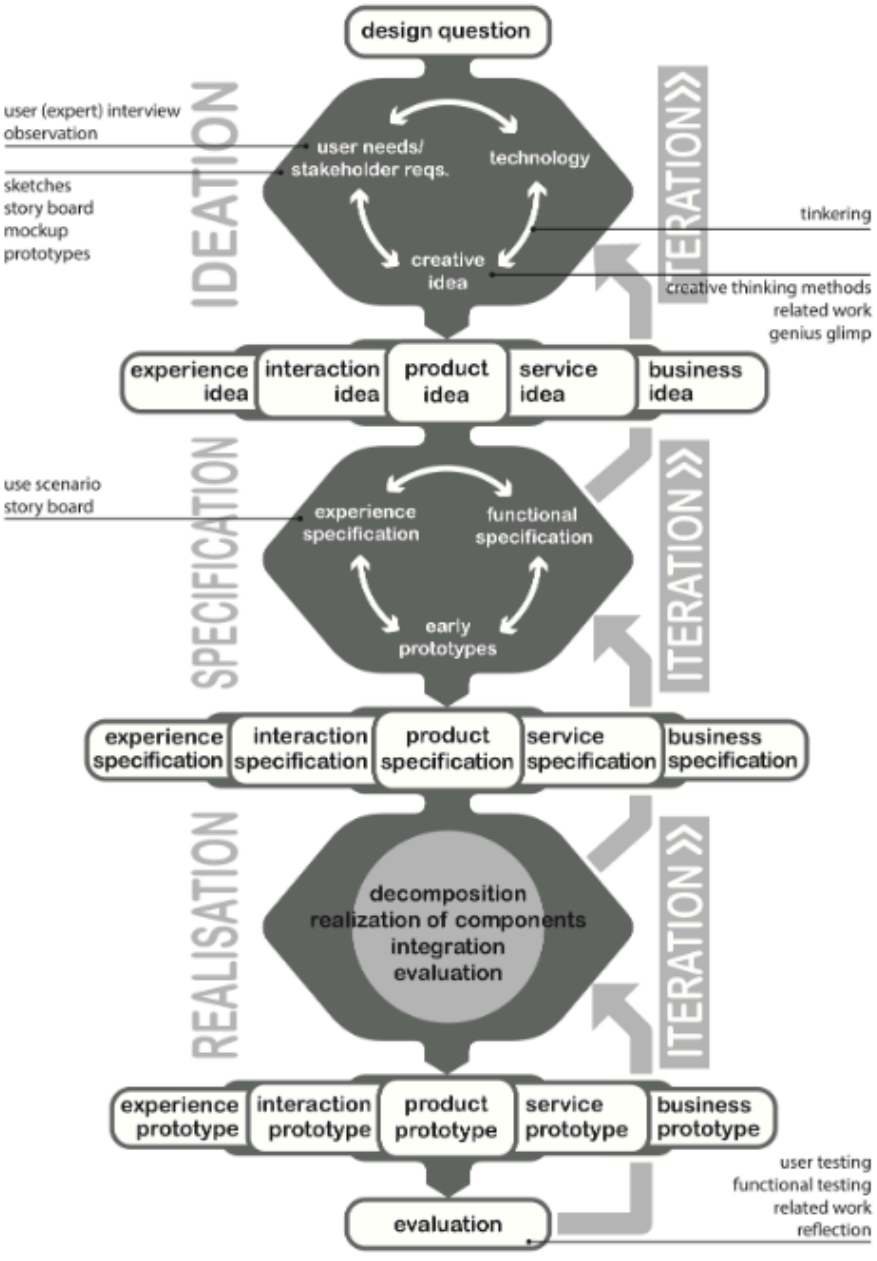


Figure 10: Design process for Creative Technology [26]

During the Ideation phase the goal is to get the problem clear and to think of basic ideas. To achieve a clear problem statement, a literature review was done in addition to expert interviews, as described in the previous chapter. This process helped to gather relevant information as a foundation for the project. The idea will be developed further and the basic requirements for the SIMT will be established. Following this, basic mockups will be made to figure out the right elements for the SIMT and presented to the target group during co-creation sessions. This will allow for a more clear understanding of what they actually want, and if the ideas for the SIMT are corresponding with that. If needed, the ideas can be adjusted and the ideas from the target group included. This will lead to the next stage in the design process, which is the Specification. During the Specification phase, the final idea for the prototype is shown to the target audience, through some prototypes and their feedback is gathered. The feedback will be worked out, and the final concept will be presented. This final concept will be created, and the process of this will be described in the Realisation. The final prototype will then be presented to the target group, and evaluated by them. The set-up for the evaluation and the results will be part of the Evaluation. These results and its relation to the whole project will be discussed afterwards in the Discussion.

4. Ideation

During the background research, a lot of information was gathered, from which useful requirements for this project can be extracted. An overview of these requirements will be provided first, in addition to the requirements that were identified during brainstorming. The requirements will act as the foundation of the design process, which will be described later in this chapter. During this design process, ideas were generated and assessed based on the requirements. Suitable ideas were developed further, and through the process of co-creation with older adults, ideas for the final prototype were selected, and are presented at the end of this chapter. The creation of the final prototype and the user testing conducted, will be described in later chapters.

4.1 Requirements

The requirements extracted from Chapter 2, and some additional requirements that were identified during the brainstorming, are organised based on the MoSCoW method. This divides the requirements in categories the project Must have, Should have, Could have and Would have, to determine the level of importance of the requirements for the project. The goal is to have the Must have requirements met at the end of this project. The result of this can be seen in Figure 11 below. Each requirement has their own added code, such as A1 or B1, to distinguish them and facilitate easy reference. The numbers in brackets refer to the chapter this requirement was found and the ones with the B or EI, were identified during brainstorming and expert interviews.

The requirement of the table being sturdy has been placed into the “could” category, as this project is mainly focussed on the interaction with the table. If possible, this can be included in the design, depending on the time.

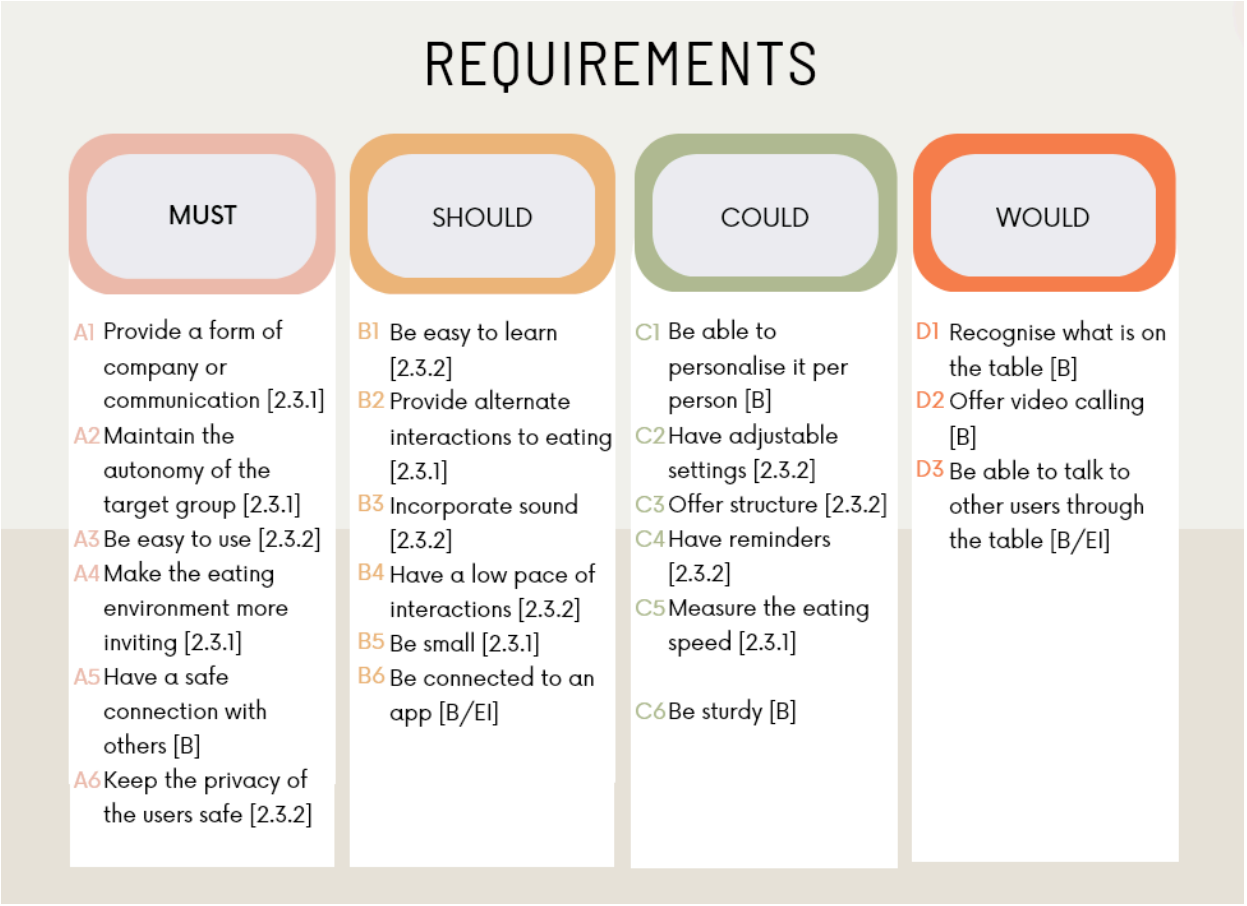


Figure 11 : Overview of the requirements

4.2 Overview of ideas

Through brainstorming, several ideas for the SIMT were generated. The brainstorming session is described first, with a short overview of the outcome of the session. The ideas that were generated, were assessed based on the requirements above, and those that sufficed are explained in more detail after the brainstorming description. The ideas are divided into: 1) Ideas for interaction and 2) Ideas for the table. The second category is about the physical appearance of the table. This is not necessarily what this project focuses on but was still deemed important to mention, as the appearance of the table does influence the use of the table.

4.2.1 Generation of ideas

A brainstorming session with some sisters was done to generate ideas and find additional requirements for the tables. The addition of the sisters to the brainstorming session is

based on Brainstorming Tip #16*: Find a Partner* from Schell [27, p.92]. Schell highlights the importance of a small group to brainstorm with, as this can have tremendous benefits for the generation of ideas. As they did not have the same vision on the project as the researcher, they brought in new views and ideas. In addition to this, all sisters included, have worked or are currently working in a retirement home, having frequent contact with older adults. This session was very open, and all ideas were welcome. During the session other brainstorming tips from Schell, such as: *#2: Write or Type?, #3: Sketch, #7: Crack Jokes,* and *#11: Write Everything,* were also included [27, p.86-89]. To give some structure a few categories were established beforehand.

- What requirements does the table have?
- Who is the table connected to?
- What interactions do the older adults have with the table?
- What will be displayed on the table
- What additions could be done to the table?

The requirements found are added into the overview in Figure 11 in chapter 4.1. A short overview of other ideas generated can be seen below in Figure 12.

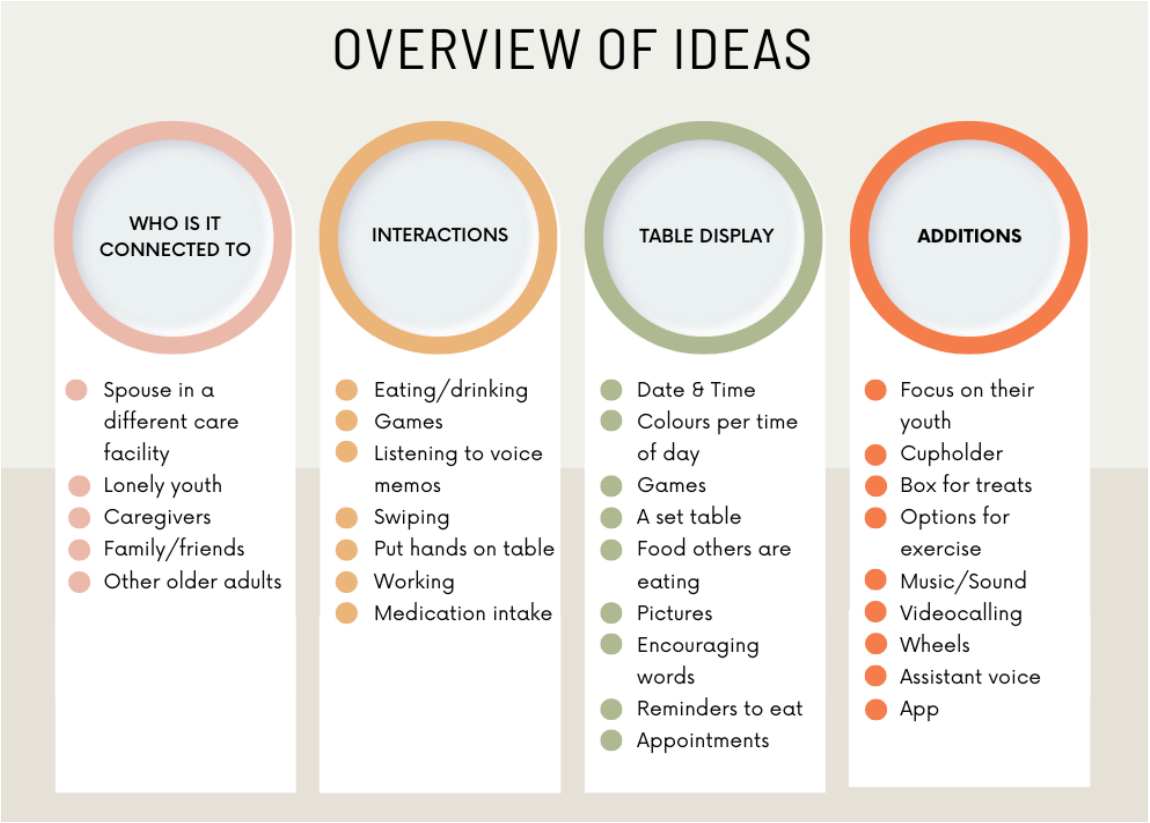


Figure 12: Overview of outcomes brainstorming.

During the expert interviews, some ideas they had for the SIMT were also mentioned, and an overview of these ideas can be seen below in Figure 13.

Figure 13: Overview of ideas from the expert interviews

4.2.2 Ideas for the interaction

Several ideas and functionalities to implement were generated, keeping the feasibility and requirements in mind. These ideas will be discussed in more detail below and will be discussed during the co-creation with older adults to get their feedback on the ideas and to see if this is actually something they would like and use. Several of these ideas can be combined into one big idea, as these options can be added simultaneously .

1. Connect the table with a table that is placed with lonely youth or asylum seekers. This gives everybody a chance of interaction, and there is no language barrier as it is visuals on the table. This can also provide older adults with a sense of purpose.
2. Connect the table to other older adults. This allows more people within the target group with the possibility to use the SIMT, as it would then only be used within the target group.
3. Connect the table to an app. In this app, the connection of the table can be regulated and optional personal preferences can be set. As the table does not have

a lot of pixels, displaying a lot of text on the table is not possible. Therefore, it will be clearer to change the settings in the app. The app could also provide a chance for family members to interact with the table, even if they do not have a SIMT themselves. They can, for example, have the possibility to make a small smiley pop up on the table, to let the older adults know they are thinking about them, or draw a figure on the table. If the eating habits are tracked, this can also be displayed here.

4. Implement simple multiplayer games that provide older adults with a fun activity during the day. As explained in Chapter 2, this engages users who otherwise would lack entertainment. The type of multiplayer games would have to be determined by the target group. If necessary a new game can be designed.
5. Display colours on the table which correspond with the time of day. This provides a bit of structure during the day, as it gets very easy to "read the time", especially if people have trouble with seeing the clock.
6. Provide visuals and input from the other table on the table during meal times, to provide the older adults with some distraction and fun. These visuals can provide information about where the other person's eating utensils are, or if they are almost done eating. And in addition, some visuals when they move their glass around.

   It could also be a very low key game for example: Some flowers pop up every now and then, and they have to press the flowers before the other person does. Or if they lift up their glass, they cannot put it back on the same spot, or the spot the other user has their glass.

   It should, however, always be kept in mind that it does not start overstimulating them or become too distracting. Additionally, if the eating is compared to the other user's eating, it can also de-motivate if the other is a naturally fast eater, or there is a difference in portion size, giving inaccurate sense of eating speed.
7. Light up the places that the eating utensils are laying and the drinking glass is located. This can help older adults with a declining eyesight to locate their eating utensils more easily.

   The table is already quite small, so there are not a lot of places for the utensils to be. This might, therefore, be more of interest with a bigger table.
8. Provide the option for music and sound effects, such as nature sounds. In Chapter 2, it was found that the older adults enjoyed singing, and adding music to the table could improve their mood. The sound effects could be used to get the outside world

more inside, which would especially be useful for those who have decreased mobility. This could also change the eating environment for the older adults in a positive way.

4.2.3 Ideas for the table

Besides ideas for the interaction with the SIMT, there are additionally several ideas for the design of the table itself. These ideas will probably not be worked out in detail during the design phase, due to lack of time, but can be considered for future work on the SIMT. Additionally, the position of the table can influence the use of the table, and therefore it is still relevant to discuss these ideas.

1. A smaller table that you can either pull over your chair (like pull-out lamps) or pull out a bit higher, so you can stand at the table while interacting with it.
2. If the table is on the floor, an addition of wheels. This allows older adults to easily move the table out the way, and simplifies transport of the table.
3. Changing the shape of the table, and creating a more rectangular shape. Depending on the interactions with the table, this can be interesting to look into.
   This does add more corners older adults can hurt themselves on.
4. Create a design that blends in with the furniture that older adults already have. This ensures the table does not stand out from the rest of the furniture as much, which is sometimes the case with health-supportive devices.

4.3 Co-creation target group

As found in Chapter 2, it is important to have accurate information from the target group during the design process. That is why it was decided to do a series of co-creation sessions with the target group, in addition to providing them with a questionnaire. During these sessions, more information of the target group can be gathered, and the target group can give their input already in the early stages of the design process to ensure that their needs are met. The realisation of the different sessions, the sessions themselves, and their outcomes will be described below.

4.3.1 Gathering participants

Participants are essential for the co-creation sessions. The participants should all be within age range of the target group and have the mental capacity for the sessions, and therefore be: 1) 60+ of age, 2) Living alone, 3) Eating alone, 4) Capable of giving consent, 5) Free of a presence of a mental illness that impacts the ability to understand the study and provide consent, such as dementia. To find people that fall within these criteria, several retirement homes were contacted through phone and email. Additionally, a 50+ group, and a 55+ activity association were contacted via email, and their meeting place was visited. The retirement homes did initially respond to the emails, but stopped responding before giving their consent to participate in the study. Therefore, all the older adults living in those retirement homes were not personally contacted, or asked to fill in the questionnaire. Through the 50+ group and the 55+ activity association however, 5 participants were found for the co-creation sessions and 12 people filled in the questionnaire. The questionnaire and the co-creation sessions were both in Dutch, as that is the mother language of the participants. This ensured that the participants could freely express their thoughts and ideas, without having to translate it first.

Older adults were presented with a choice of whether they would like to only fill in the questionnaire , which can be found in Appendix 5, or if they would also like to join one or more of the co-creation sessions. The people who participated in the co-creation sessions were all provided with an informed consent form, which can be found in Appendix 6. After signing, the consent forms were collected, in addition to the filled in questionnaires. Participants were made aware of their right to withdraw from the study at any time. Any questions participants had before the session were answered, to ensure they understood what was going to happen during the session.

The people who filled in the questionnaires and participated in the co-creation were all more active older adults, who would not necessarily need the table themselves. This means that some of the questions in the questionnaire were not as relevant for them, as it would have been for less active older adults, who have more difficulty with social contact, or have lower mobility. For the co-sessions, the participants tried to keep in mind what they would like if they were a bit older, or what might be interesting for the people they know, that do not get out of the house as often.

4.3.2 The questionnaire

The questionnaire was filled in by a number of people from a 55+ club in Enschede. Several printed versions of the questionnaire were left at their meeting place, and picked up again the next day, due to activities happening at the time. This meant that the questionnaire could not be fully explained to the target group, which led to some participants misunderstanding the questionnaire, or leaving out the necessary questions that had to be answered. For this reason, these filled in questionnaires were left out of the research. All included answers provided consent and were (partially) part of the target group. Afterwards, during the co-creation sessions, participants were also asked to fill in the questionnaire before the session. This allowed for more responses to the questions and a nice way to ease into the co-creation session.

The questionnaire was eventually filled in by twelve people, aged 60 - 90. Ten out of those live alone and the majority eat all or most of their meals alone. The average grade they would give their current life is 7,7. As most of the participants were still quite active with things such as volunteering, walking, sports, social activities and working in the garden, seven people did not feel the need for more interaction during the day, and two people were unsure. If they could add more interaction, social contact is preferred. A preference for social interactions is also shown in the answers to the question: What makes you happy? The outcome of this can be seen in Figure 14 below. It shows that almost all participants enjoy visits from family or friends and social contacts in general. Watching TV or social media, however, both score very low. Games attract about half of the participants.

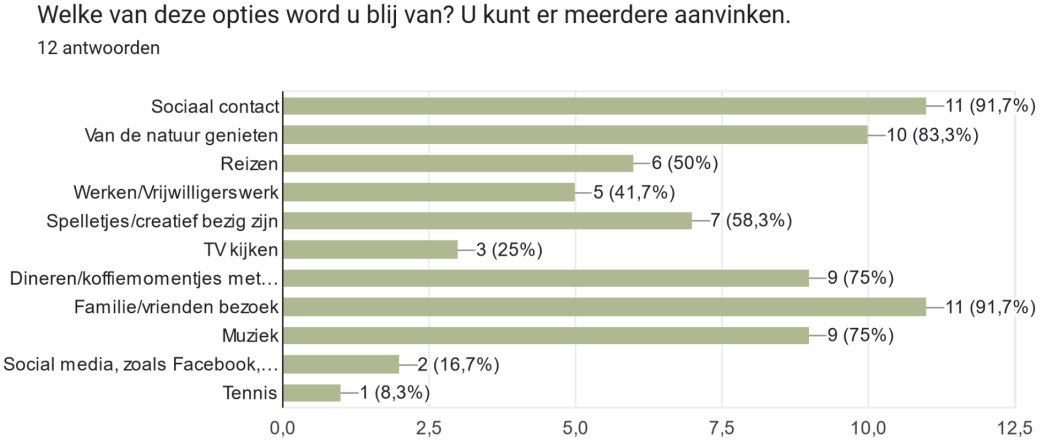


Figure 14: Outcome of the question: What makes you happy?

When it comes to eating habits, eleven out of twelve participants eat three meals a day, with some people missing a meal sporadically. A reason given for missing a meal was lack

of time. Most of them just eat, whereas sometimes a newspaper/ phone/ TV/ tablet is added to the mealtime. Eight participants then also did not feel the need for more interaction during the meal, with only one person wishing for more interaction. Something that could be added to the mealtime would then be more social contacts or music or calming sounds.

The answers to the questionnaire do not overlap much with the target group that was found in Chapter 2. Most of the people who filled in the questionnaire did eat alone but did not feel a need for more interaction during meal times. They also did eat their three meals a day, or only sporadically missing a meal. This does mean that the target population described in Chapter 2, was not included in this sample. This was already established before, when stating that the participants are more active older adults. It does mean that there has not been a lot of useful information collected about the eating habits of lonely older adults, which is necessary to design an interaction to enrich their eating experience. However, with the information obtained, it is possible to focus more on a game like interaction, to provide more interaction during the day. In Chapter 2.3.1 it was also described that lonely older adults can also benefit from more (social) interaction during the day, and especially if their mobility has declined, the SIMT can then still be a source of engagement during the day.

4.3.3 The co-creation sessions

The goal of these co-creation sessions was to speak with the people from the target group individually and get their ideas and opinions for the SIMT. This ensures that the designer can empathise better with the target group and get a clearer understanding of what could be useful to add in the design. In addition to this, the participants were asked if they had some ideas they would like incorporated into the SIMT, and the previously described ideas were presented to the participants, and their opinions were asked about them. As stated before, the participants were more active older adults, but they did try to think about the SIMT in a way of what they would like to have when they were older. Five women participated in the co-creations sessions, with each session lasting between 45 and 75 minutes.

Before the session, participants were asked to sign the informed consent forms, which can be found in Appendix 6. The session started with an introduction about the project, and the layout of the session was explained. Any questions the participants had

were answered, and those who had not filled in the questionnaire yet, got a chance to do so. Afterwards, the different categories were introduced and explained. The categories being: 1) Who is at the other table? 2) What interactions can be done with the table? 3) What is visualised on the table? 4) What can be added to the table?. Each of these categories had their own colour, and participants could write their ideas on corresponding coloured pieces of paper, or the researcher wrote down the ideas during the conversation. After the brainstorming part, the different ideas explained in 4.2.2 were introduced and handed out to the participants, so they could write their opinions down during the discussion of the ideas. The final outcome of a session is shown in Figure 15.

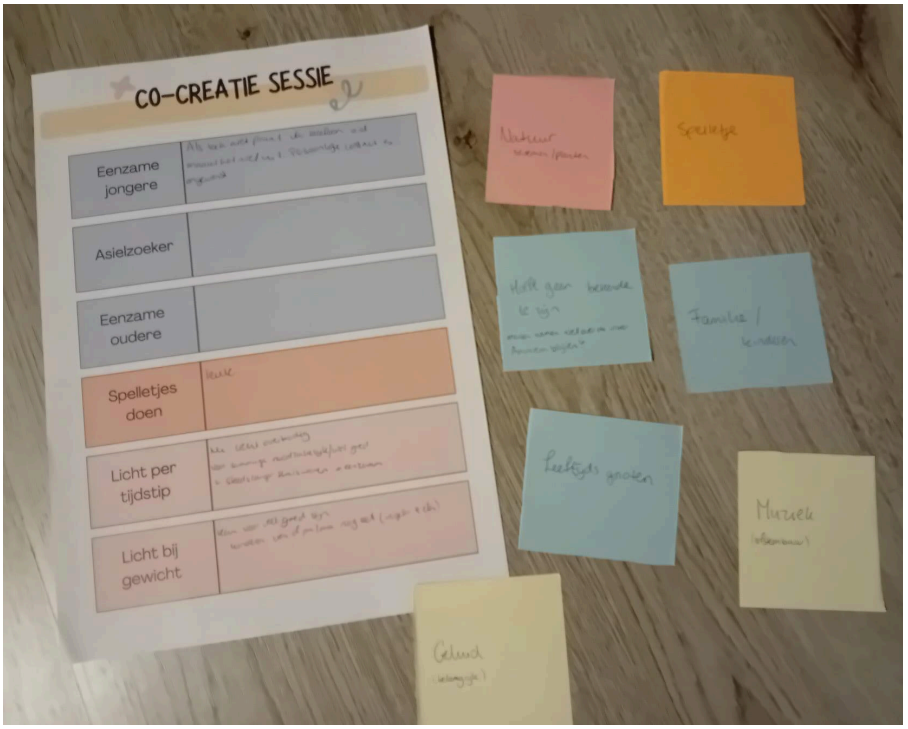


Figure 15: Outcome of a co-creation session

After finishing up the co-creation sessions with the participants, all ideas were organised within their category, and the outcomes will be discussed below. The discussion about the ideas already present, will be analysed in Chapter 5.

Who is at the other table?

Below, in Figure 16, the answers participants gave to this question are shown. Family and friends or acquaintances were mentioned by all participants. There were mixed opinions about having strangers at the other table. Some did not mind and would even like to talk to others, whereas some others felt like it was not desirable. There was, however, the side

note that if they did not have to talk to the other person and their location was safe, it was okay. Some other interesting groups that were mentioned are: youths with a disability and deaf people. The disability could be a physical disability, meaning they get out of the house less often, or a developmental disability such as autism, which could make it more difficult to communicate with others, including through words. Difficulty with the spoken language can also be the case for the deaf people. If the SIMT would not require them to talk or listen to others, they could benefit from using the table.

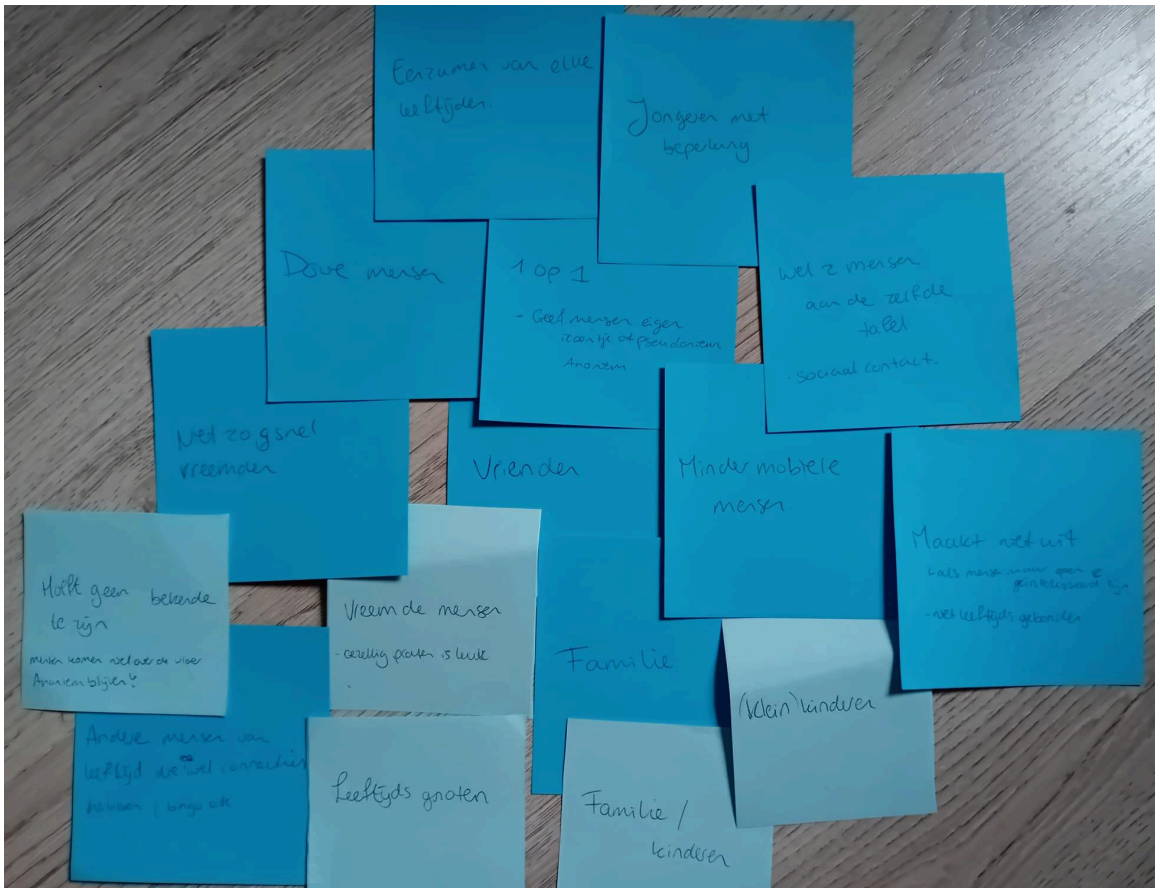


Figure 16: Answers to: Who is at the other table?

What interactions can be done with the table?

Within this category, games were mentioned quite a lot, as can be seen in Figure 17 below. Some even gave examples of games, such as Pictionary, guessing the object on the table, a game of ‘tag’ where players move objects over the table and the other one tries to tag it, or make drawings together. There was also a new game mentioned where players try to get a specific coloured shape on the table, by putting that shape with a certain weight on the table. The darker the colour, the heavier the object should be. This could help to keep the mind a bit more active, as players have to think quickly.

Some participants would also enjoy talking to others through the table. It would be preferred with friends, family, or a person of choice, and it should be one-on-one conversations. Of importance was that it should be enjoyable conversations, keeping it friendly and ideally with a set of rules. It was, however, realised that regulating the conversations, especially if it is with strangers, is almost impossible. A screening process, to ensure that those who get the table, are actually trusted people, could be done, to try to keep the environment more safe for the older adults.

Another participant mentioned that she would like the table to look good, even when it is not in use, so she could also enjoy just looking at it. It could also show beautiful figures and colours during mealtimes. In this case, the SIMT would then turn into a form of an art piece, providing a conversation starter, but also some satisfaction by looking at it.

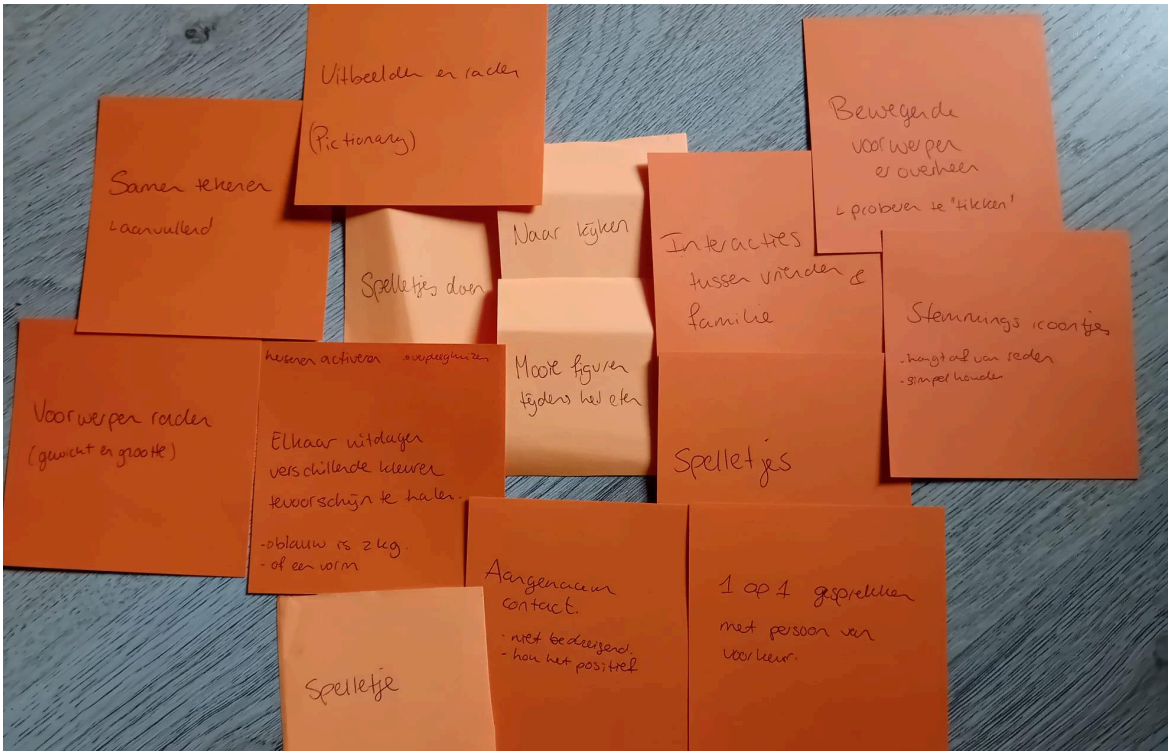


Figure 17: Answers to: What interactions can be done with the table?

What is shown on the table?

Besides the games mentioned in the category above, other ideas were mentioned, and can be seen in Figure 18 below. One of these ideas was to care for an animal or plant on the table. This could stimulate users to keep interacting with the table on a daily basis, as the animal or plant needs some caring. It did not have to be a specific animal, or a very clear

picture of said animal, as long as there is the feeling that the user can care for it. Of importance is that the animal or plant cannot die. This ensures that it would not feel like an obligation, and users will not have the feeling of “failing” the table or animal. If this were the case, users could start to associate negative feelings with the table, and that should be avoided. An additional idea was to have the table as one of those magnetic drawing boards for children. Users can draw simple figures, but with a simple movement the drawings are erased and new drawings can be made. This could be interesting for users to let their creativity run wild, and optionally they can also collaborate with drawings. Other than games, figures that move over the table, maybe in a playful way, were also desired by some. They felt it would be enjoyable to look at. On the other hand, some mentioned it would become overstimulating to see lights and colours all day. It would be of importance to let users choose what they want to see on the table, and regulate the amount of lights and activity themselves. This ensures that all users feel comfortable in their own way, whilst using the SIMT.

For the connection, one participant mentioned that it would be nice if only once you touch the table on a specific place, the table activates, and it can also activate the table it is connected to. This allows users to “contact” other users in a simple way. Optionally, the other user can decline the invitation for interaction, by not reacting on the table. The table can then deactivate again. This could all be personalised in the settings in the app. Other things that were mentioned were to show pictures or nature scenes on the table, but due to the amount of lights in the table, these would not be clearly recognisable images.

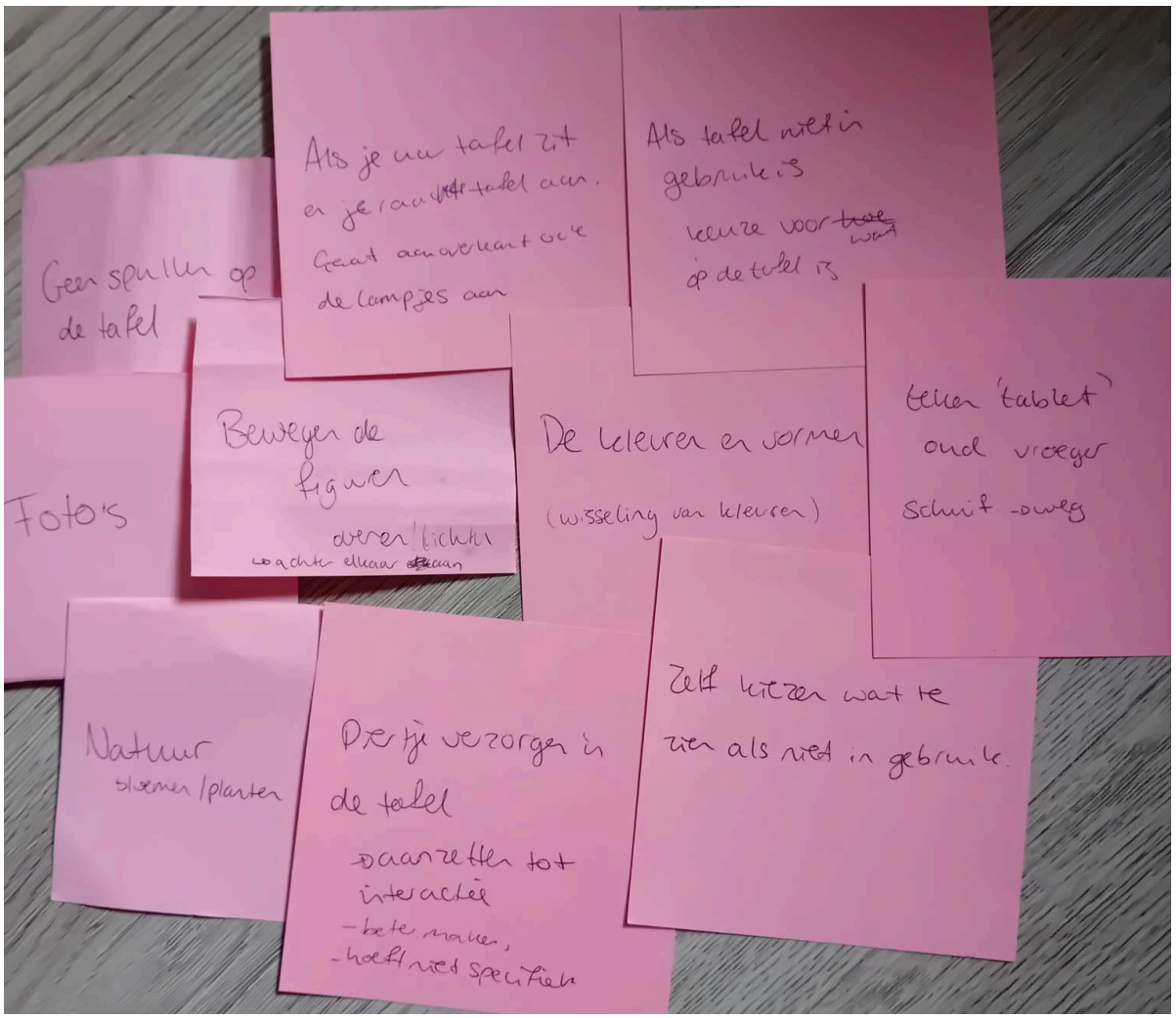


Figure 18: Answers to: What is shown on the table?

What would you like to add to the table?

A well mentioned addition was audio, as seen in Figure 19. Some wanted to talk to others, or have the table itself talk back to them. Music, albeit it music of their choice, or sound effects with movements or certain actions were also welcome. And one participant even mentioned a translation function to be added. This was discussed in the context of talking with asylum seekers, but also those who lived here for a long time, but due to dementia or other illnesses, fall back into their mother language. A translation function can enable other users to still communicate with these people. Besides audio, facial recognition was suggested, but the participant did not feel that it was very necessary, and it could make the table feel more intrusive. This is unwanted, as the users should be able to feel comfortable to use the table. Privacy is very important with this too, and was brought up by several people. They want to feel that their information is secure, but also that the people they connect with are trustworthy.

For the physical appearance of the table, there were also some options given. It should look friendly and fit into a home easily. It should have a scratch-free surface, to make users feel like they can use the table freely, and it will not break easily. It can have a raised edge, so that if something falls, it stays on the table, meaning users who are less mobile do not have to bend down to pick it up again. Additionally, the table top could be removable from the legs, and have a padded bottom. This can allow users to put the tabletop on their lap, allowing, for example, users in a wheelchair to easily access the table. The base of the table could also have some added lights, to make it more coherent and visible. This could however also have a counter-effect of it becoming overstimulating again.

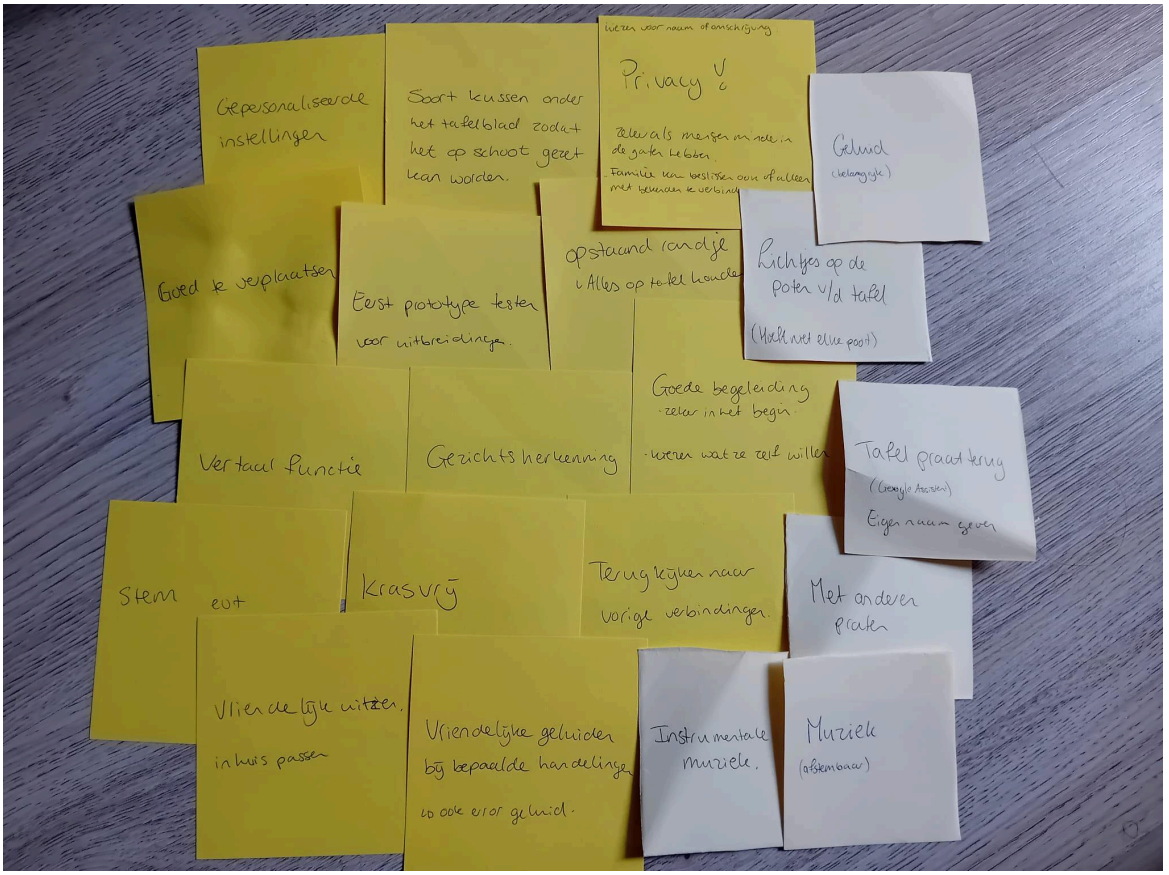


Figure 19: Answers to: What would you like to add to the table?

4.3.4 Outcomes

After reviewing the questionnaire and the co-creation sessions, the requirements stated in chapter 4.1 are revisited. Some requirements are confirmed through talking with the older adults, such as : *A3: Must be easy to use*, and *A6: privacy of users must be kept safe*. However, it became clear that the focus should not be as much on the eating environment as initially thought. Some people felt it would be too distracting, and others would not even

consider playing a game during the mealtime. It should be noted that the participants were more active older adults, and did not feel as lonely during the mealtimes, as the less active or mobile older adults might feel. However, the geriatrician also mentioned this during the interview. It could be distracting and possibly also overstimulating to have to focus on lights and games as well as their meal. Therefore, for this thesis, keeping the scope and possibilities in mind, it is decided to focus more on engagement during the day, and only provide optional engagement for the mealtimes. By shifting to general engagement during the day, the SIMT could still fit within the E-Health department, as it is their goal to also encourage people to live an engaging life. Older adults can choose themselves if they prefer to add more interaction during their mealtimes. As stated in Chapter 2.3.1, some older adults do not have much to do during the day, and can lack engagement and interaction. Older adults can therefore benefit greatly from more (social) interaction during the day, especially if they are less mobile. The requirement: *C1: It could be able to personalise it per person,* however, moved up in urgency, as this was very prominent during the discussions. Almost all participants mentioned this, and since each older adult is different, this customisation could ensure that everybody feels comfortable using the table. This option for customisation can be regulated in the connected app. Additionally, the interface and use of the table and the app, should be as simple as possible, allowing for easy understanding and minimal confusion. By managing the settings in the app, the buttons and options are a lot clearer, and the table itself will stay as simple as possible. Having the reminders show up on the table turned out to be less desired, as older adults already receive many reminders, and having them on the table could become anxiety inducing or reduce the positive association with the table. Moreover, it detracts from the uniqueness of the table, as highlighted during the co-creating sessions. The table should be a unique object and not merely a replacement for a phone or agenda. In the context of privacy, it could be better for users not to be able to talk to others, especially if it is not controlled who gets a table. Conversations cannot always be supervised, and older adults are sometimes more easily targeted by scammers or other unethical actions.

With these conclusions in mind, the list of requirements, made at the beginning of this chapter, is updated, based on the new urgency of the requirements. Requirements mentioned in the co-creation sessions are now marked with a C. The requirements are split up into two categories to enhance specificity and ensure a clear overview of their fulfilment in the final stages of this research. The two categories are functional requirements (Figure

20), incorporating all requirements for the table and its system, and non-functional requirements (Figure 21), incorporating requirements for the interaction between the users and the table. The functional requirements will not all be met within the scope of this thesis, as this thesis is more about the interaction between the SIMT and the target group. However, they are still mentioned and discussed here, as they are still crucial for the interaction with the table. The non-functional requirements will however be the main focus.

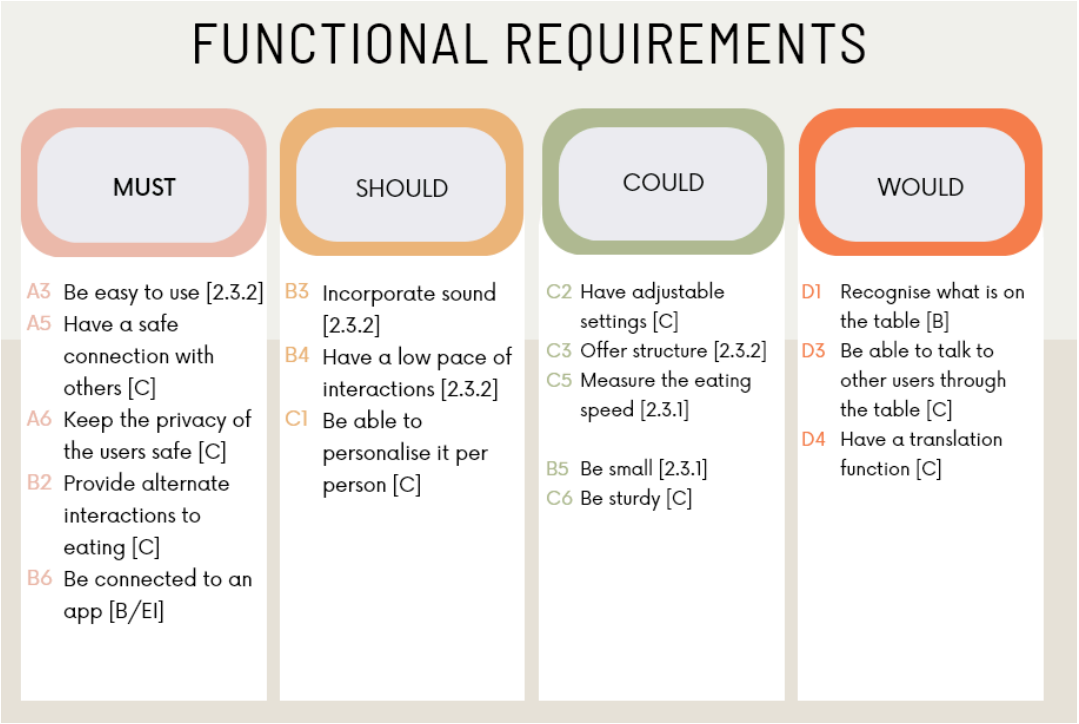


Figure 20: Functional requirements

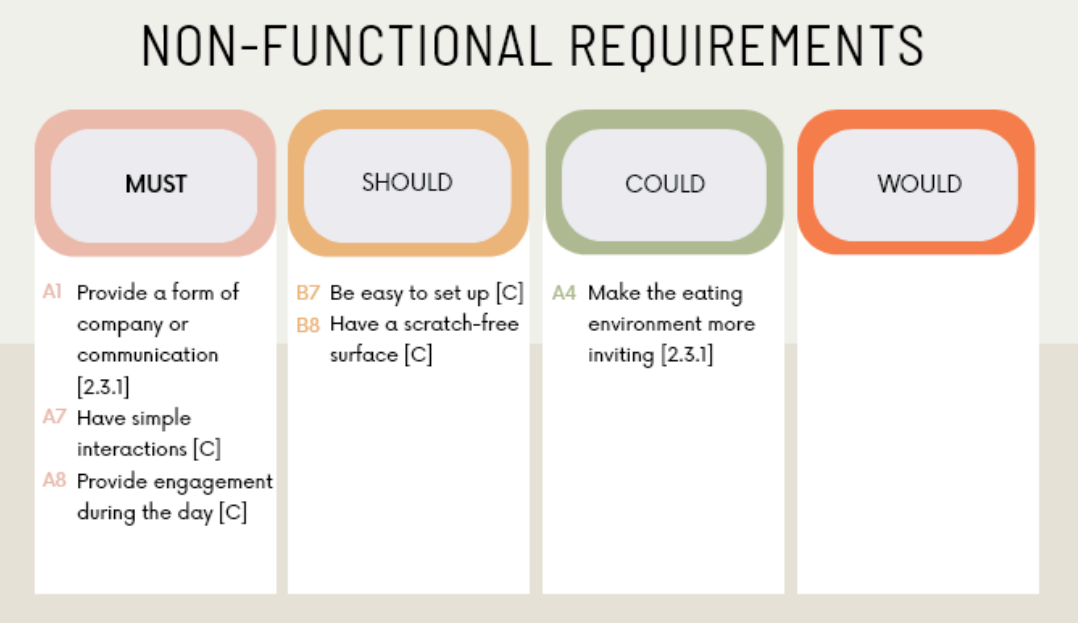


Figure 21: Non-functional requirements

5. Specification

In this chapter, the previous ideas are synthesised to create a prototype version of the app, and the final ideas are discussed with the target group. The process of developing a prototype version of the app will be described, as well as the storyboard for an explanatory video. During the co-creation sessions, participants evaluated the ideas outlined in Chapter 4, a prototype of the app and the storyboard for an explanation video. This evaluation will be described afterwards. Finally, the resulting changes in the design of the SIMT will be discussed. This chapter will conclude with a more specific concept for the table and the app.

5.1 Making of prototypes

Two different prototypes were developed for the different components. A mockup version of the app was created in Figma, based on requirement B6, which was mentioned both in the brainstorming sessions and the expert interviews. Additionally, a storyboard was created for an explanatory video aimed at first time users, which explains the concept and aids in fulfilling requirements A3 and B7 concerning easy usability and setup of the SIMT. The creation of these prototypes will be elaborated upon in the following sections.

5.1.1 Figma App

As per requirement B6, which states that the table must be connected to an app, an initial version was created using Figma. The purpose of the app is to manage the table's settings and handle connections with other devices, as it is difficult to display these options on the table itself with the limited amount of pixels. An optional feature is the ability to connect with family and friends. The basic user interface was made of the app, so users could understand the use of the app, and test it out.

The prototype is illustrated in Figure 22. It starts with a lock screen (left side) to secure the user information and prevent unwanted or unauthorised access to table settings. Upon unlocking, users are presented with a home screen. They can navigate to app settings, table settings, manage table connections, or access the family/friends option. Both setting options allow users to adjust the settings for the app or the table with basic sliders to their preferences. The connection tab displays the current connection and offers

the option of changing the connection. The family/friends tab is meant for family or friends of a person that has a table. In their version of the app they would only see the family/friends tab and not the settings of the table, unless they are granted permission by the user of the table. Through the app they could send an emoji to the user to let them know they are thinking about them. A colour scheme with earthtones was selected by the designer, chosen for its soothing feel compared to brighter, more overwhelming colours.

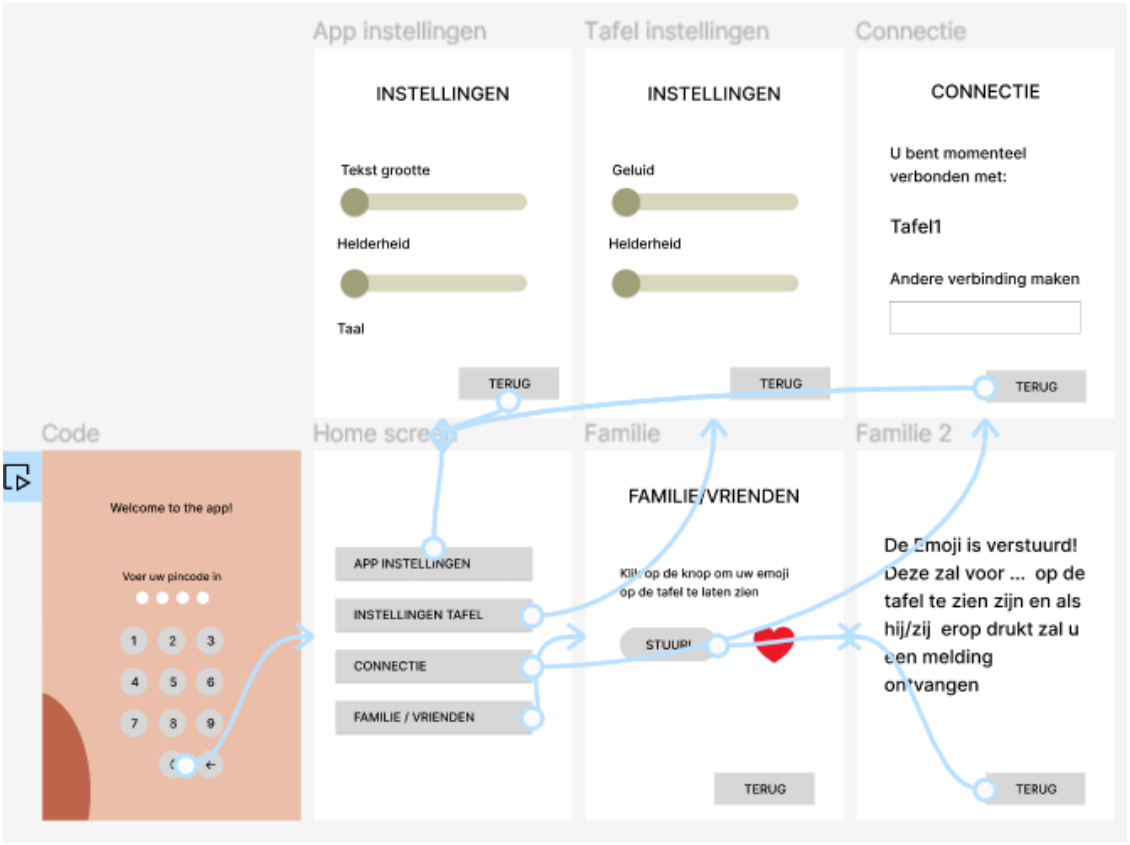
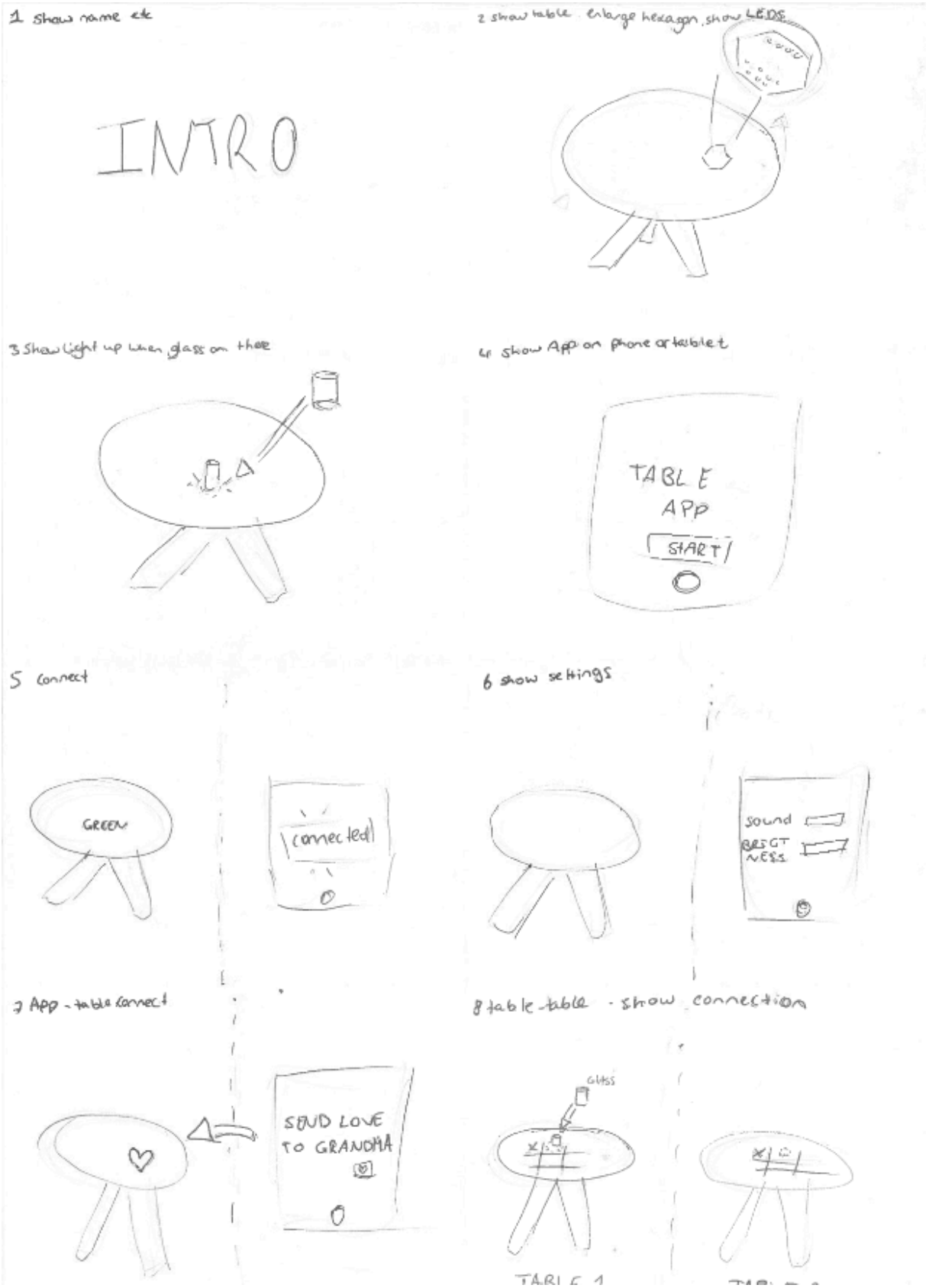


Figure 22: Figma app design.

5.1.2 Video

To effectively communicate the functionality of the table and its supporting app, a video was deemed most appropriate. A first time user can easily see how the SIMT works and afterwards only need to repeat the steps. Explanation through video also lowers the need for extensive in-person explanations to the target group. Furthermore, the video could be shown to organisations or nursing homes, explaining the concept of the SIMT in a simple way. In doing so, the video could aid in meeting requirements A3 and B7 concerning easy usability and setup of the SIMT. As the concept would be explained clearly, the threshold to use the SIMT lowers for first-time users.

For this video a storyboard was developed, providing a clear overview of what would be put into the video, and show the narrative of the story of the video. The storyboard is depicted in Figure 23 below.



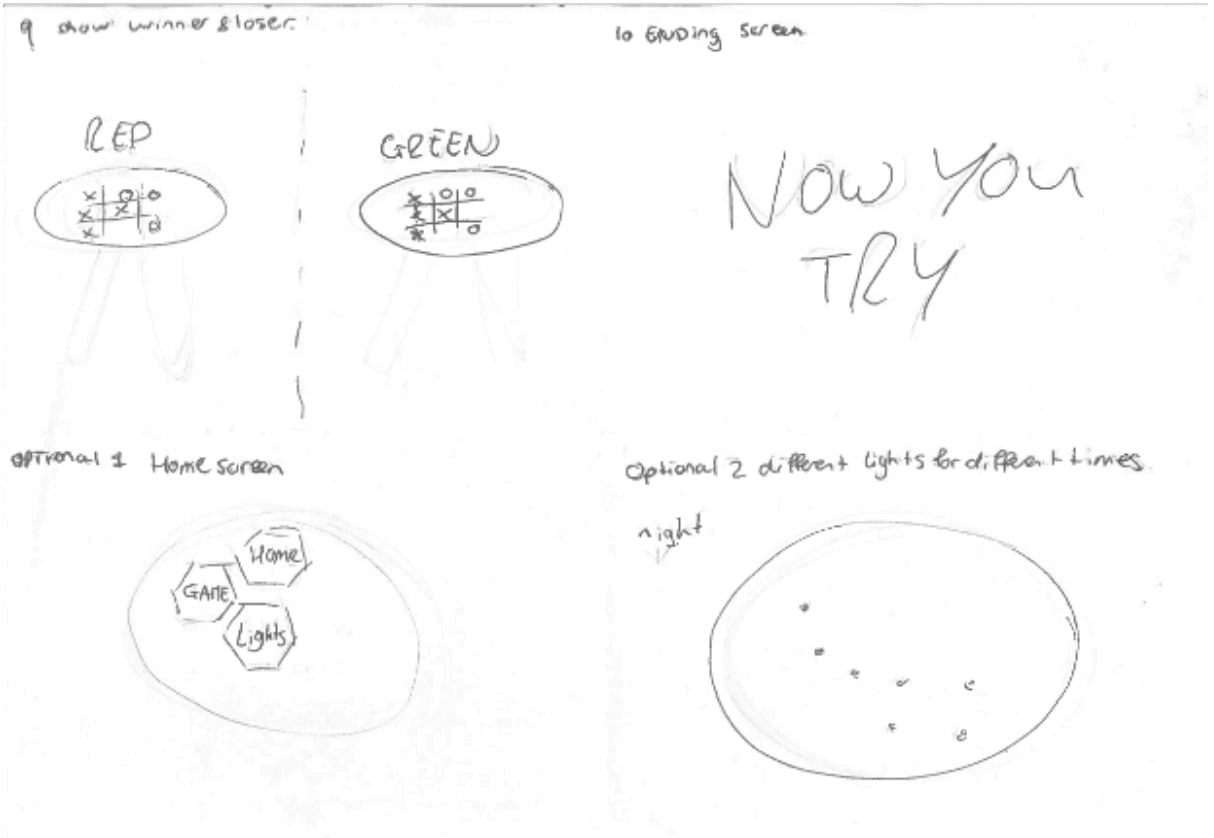


Figure 23: Storyboard

The storyboard begins by introducing the table, by showing the functionalities of the table. Following this, the app is presented, showing real-time effects of interactions in the app affecting the table, thereby clearly explaining the integration between the table and the app. Lastly, the connection between two tables is shown and explained with a simple game of tic-tac-toe. With this game, the multiplayer part is clearly visible, and the input from other users is shown. In the end there are two optional shots, showing the home screen and the option for showing different colours depending on the time.

5.2 Testing

The prototypes described earlier were evaluated with older adults during the co-creation sessions. Participants were shown and explained the prototypes, and their feedback on the prototypes was asked regarding possible improvements. In addition to this, the ideas for the table from Chapter 4 were discussed, to get a better understanding of what participants would prefer the table to do. During these sessions, participants provided insights into their preferred interactions with the SIMT and the app.

5.2.1 The goal

The goal of the co-creation sessions is to ensure that the set requirements are being met and that the last sub research question: *Which interactions need to be implemented in order to achieve the greatest benefit for the patient group?* can be answered to satisfaction. The requirements tested with the mockups and ideas are:

- Functional: A3: Must be easy to use
- Functional: B6: Must be connected to an app
- Functional: B3: Should incorporate sound
- Non-Functional: A1: Must provide a form of company or communication
- Non-Functional: A8: Must provide engagement during the day

Through discussing the ideas from Chapter 4, requirements A1, A8, and B3 are evaluated. By testing the Figma design of the app, requirement B6 is fulfilled, but A3 will be evaluated for the app too.

5.2.2 Previous ideas

The ideas from Chapter 4.2.2 were discussed with participants during the co-creation sessions. Regarding who would be on the other table, participants expressed uniform answers: if there was no talking involved, there was no specific preference who would be on the other side. The games could speak for themselves. However, for those interested in talking to others, it was important that the contact would be safe and secure, and friendly language is used during the conversation.

Playing games on the table, either with others or alone, was well-received by the participants. When asked if it should be games from their youth, a participant remarked that that was not necessary. They could play those games in real life, and the table could be used for new games. Games requiring mental engagement were preferred to keep the brain active. This was also mentioned during the brainstorming part of the co-creation sessions. A game of exploring a little island or a similar exploring game was unanimously liked, with an optional competition element. Taking care of something received mixed reactions. While some participants would enjoy this, others did not see the point unless it was optional and that whatever they would care for, could not die.

Regarding the lights and sounds on the table, all participants emphasised the importance of allowing users to choose their preferences. Concerning the use of different coloured lights to denote time periods, participants raised concerns about memorization

and suggested using symbols or actual time displays instead. There was also interest in exploring how different colours could affect mood, with a suggestion to use star constellations for nighttime.

Activating and deactivating the table was deemed essential for most participants, to prevent accidental actions on the table if interaction with the SIMT was not desired. When the table is inactive, it is suggested to play sounds of nature. This was not deemed necessary during games or other interactions. One participant mentioned that it might be confusing to hear spring sounds, when it is winter outside, which is something to keep in mind. While music could be enjoyed, all participants had their own preference music, with one participant feeling it would take away from the table, stating that there are many other ways to play music and it was not a needed aspect for the table.

5.2.3 Figma App

The prototype version of the app was presented and explained to the older adults, who received the usage of an app well. However, they stressed that the app should be as simple as possible, preferably feeling familiar or reliable to users. Although the current design does not have too many options, this should be kept in mind during future designs of the app. The use of a personal code was approved, and including different languages, optionally including dialects was a nice addition. The family/friends tab received mixed reactions. One participant appreciated the addition, whereas another felt it encouraged family members to only do the minimal effort, suggesting they should show more initiative with a card or a call instead. There was also a concert that the feature could make the users wait around for a new pop-up for some attention, or get a bit scared by random pop-ups on the table. To avoid this, it should be clearly explained beforehand to users what these pop-up mean. The colours selected by the designer were liked, however, participants noted that they might not provide enough contrast. If the app is to be used by older adults themselves, brighter colours could improve recognisability and usability.

5.2.4 Video

The storyboard for the explanation video was well received by the participants. They felt that it effectively conveyed the basic concept of the table and its functions. However, they emphasised that the video should maintain simple explanations and avoid delving into too

much detail. This approach would help ensure that potential users do not feel overwhelmed by the information.

5.2.5 Discussion of results

During the co-creation sessions, the prototypes and ideas for the final design were discussed with participants. The goal was to assess how well the proposed solutions met the requirements set and to identify any necessary adjustments to better align with the needs and preferences of older adults.

The connection between two different tables ensures that the older adults have the possibility to communicate with others, be it through games. As explained in Chapter 4, talking to other users is not recommended and will therefore not be implemented in the design. However, through multiplayer games, users can still feel company, thus meeting requirement A1: *Must provide a form of company or communication*. With these games, in addition to other options for the table, engagement is provided, ensuring that A8: *Must provide engagement during the day* is also met. B3: *Should incorporate sound* can be fulfilled if the sound effects of the table can be set to each user's preference. As some users would enjoy listening to sounds and others not as much, providing the option of sound, while being able to turn it off too, can be a satisfying way to ensure B3 is met.

The table-app connection is created, ensuring that B6: *Must be connected to an app* is met. The app was received well, with only minor improvements needed. It showed to be easy to use, thus fulfilling requirement A3: *Must be easy to use*, for the app.

5.3 Final design

Within Chapter 2, it was established that a more enjoyable meal time would help older adults eat more. However, the answers from the questionnaire did not indicate that this was needed. The respondents to the questionnaire were however more active older adults who did not feel very lonely during meal times, as they had a lot more social interactions during the rest of the day. But as it has turned out to be out of the researchers hands to reach the more lonely older adults, it was decided to test a more game-like interaction. This can also be evaluated by more active older adults, and still improve the interaction and fun throughout the day for more lonely older adults. In addition to this, the size of the SIMT has turned out to be quite small to be used as a dining table in combination with playing games at the same time. Therefore with the feedback from the older adults, a more final idea of the

final prototype will be presented. Below, this will be described for both the table and the app. Due to time constraints, the video will not be developed further.

5.3.1 Table

The main interaction that will be created for the table is a game. Due to reasons previously described in Chapter 4, it will not be focussed around mealtimes, but instead provide more engagement during the day. If users are less mobile and their options of interaction are limited, the SIMT can then provide easy (social) interaction and engagement for them, as stated in requirement B2 and A8. A game was something that all participants of the co-creation sessions wanted and was also opted by the geriatrician as a way to provide engagement during the day, and therefore it will be the focus of this design. The interaction will be simple, and it would preferably keep the brain a bit more active. Depending on the time, other options and possibilities can be created and tested, such as a small animal to care for or a drawing feature. Another thing that will be incorporated into the design will be an activation and deactivation button or spot, allowing users to choose their interaction moments with the table. This was also mentioned a lot in the co-creation sessions.

To provide the older adults with engagement during the day, a musical game was designed for the SIMT. Through the simple musical interactions with the SIMT, older adults, including those with declined mobility, can enjoy the music from the game and the sense of social interaction the game gives. As found in Chapter 2, providing engagement can be of great benefit for older adults living alone. In doing so, requirement A8: *Must provide engagement during the day* is also met. During the co-creation sessions options for games were mentioned, such as a game of tag on the table, and memory games. It was stressed that it did not need to be a game they already played in their youth or was a board game. Something that would keep the brain a bit active was preferred. It should also still be quite self-explanatory, as there will not be a lot of space on the table to explain the game. There is an option to add explanations via sound, but long explanations will just bore people or make it complicated. In addition to this, music was considered fun to have, even though people have their own music taste. It was mentioned that just playing music would not add to the table, but if it is incorporated into a game, this is different. When combining a game of tag and music, games such as Beat Saber in VR (Figure 24) or Piano Tiles (Figure 25) come up.

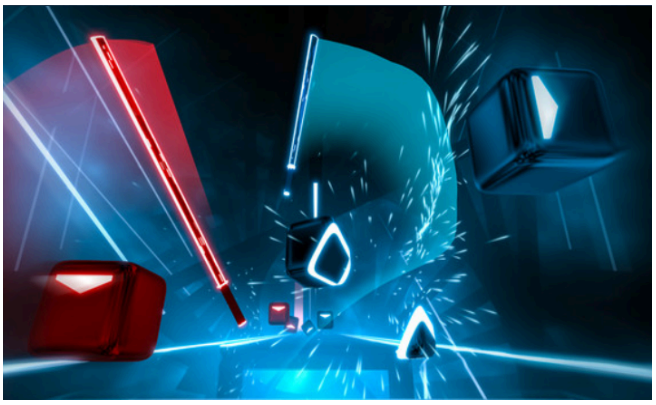


Figure 24: Beat Saber [28]

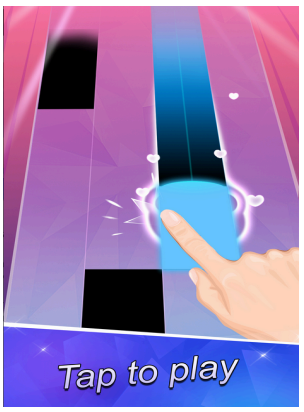


Figure 25: Piano Tiles [29]

In these games, a song is divided into small blocks for a player to hit. In Piano Tiles, the music is played based on the tiles you actually click, whereas in Beat Saber it is more about the rhythm of the song you move on, and the music continues even if some blocks are missed. The ideas behind these games were redesigned to fit on the table. During the game, there are seven hexagonal tiles used at the bottom of the table, ensuring they are in reach of the player. The tiles slowly fill in, and if it is full, it changes to their chosen colour and can be clicked. If it is clicked in time, the music continues and the whole song can be played with the tiles that follow. Together with others, they can play the notes alternately, or with a simple song, one can play a harmony.

5.3.2 App

The app will have a brighter colour palette than currently is chosen. The lock screen stays in the final design, as it provides users with a sense of safety. The options will be minimal and shown in a simple but clear way. Users can use the app to personalise their experience with the table. This includes sound options and how much is shown on the table. The family/ friends tab will stay in the design, as for some people it can have a benefit. Others who could not want it can choose to not interact with that part of the app.

6. Realisation

In this chapter, the process of realising the final ideas for the table and the app will be described. A model of the SIMT was created in Unity, and the musical game and additional interactions were implemented. This was tested on a connected screen to ensure the implementation worked and could later be tested during the user evaluation. The Figma design of the app is further developed, incorporating the improvements suggested in the previous chapter.

6.1 The table

Due to the table still being in construction, a model of the table was created in Unity, with the C# programming language. The full code can be found on Gitlab [30]. This Unity model will be shown on a screen, to recreate the interaction users would otherwise have with the physical SIMT. In the Unity model, there users can interact with the table and have the possibility to play a game. This game is redesigned to fit the requirements of the older adults .

The total interaction with the table starts at the homescreen. A choice can be made about what a user wants to do with the table. There is the option for the music game, showing different colours on the border of the table, or have the table light up wherever they press. If they choose the music game, they first get to customise their own tiles, by choosing their own colour. Once a colour is chosen, they can start the game. It will count down from 3 to prepare them for the start of the game. They have the option to mute the sound if they do not enjoy listening to it. At any time, they can also go back to the home screen. If the game is finished, it will show a message based on their scores.

To create this musical game in Unity, first a basic model was made: a big circle for the table, and the hexagonal tiles, each filled with small squares for the LEDs, as shown in Figure 26. The table, the tiles and the LEDs all got their own scripts with their basic setup. To manage all the scripts, an empty gameObject was created and given the GameManager script. There, the game is created. An additional sphere was created to track the mouse and can be seen on the left in Figure 26.

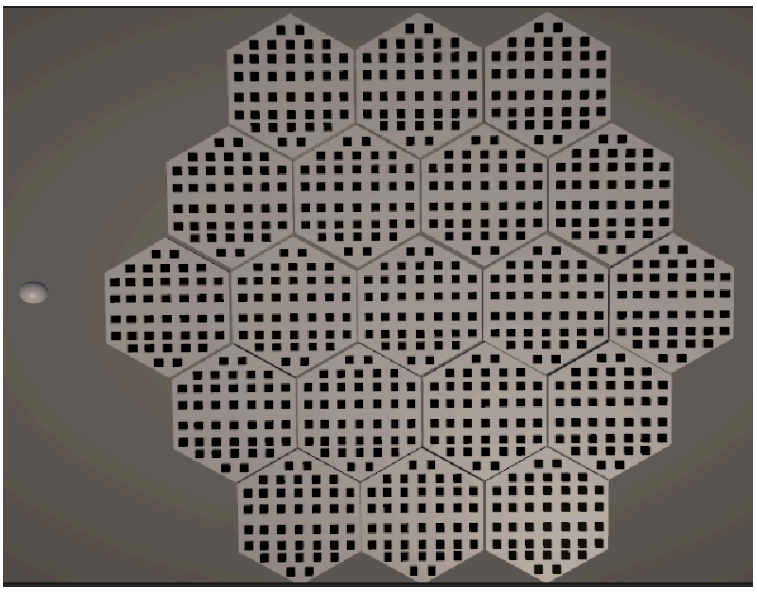


Figure 26: The model of the SIMT in Unity

As a starting point, a drawing function was created. Wherever the mouse goes, the LEDs below it change colour. However, it was realised that drawing on the table would not be possible, as there is only one load cell per hexagon. The table will, therefore, not be able to determine what you are drawing, only which hexagon is being pressed. When discussing this with Janine Ruumpol, the bachelor student who is working on the code of the SIMT, she mentioned that it could be possible to draw on the table, if it is controlled from an app or website. In that case, this function could be added into the app, and users can draw on the table through the app. Therefore, it will be left out of the interaction with the Unity model, and added to the Figma prototype.

Then the game parts were created. Different letters and pictograms were created within one hexagon of the table. The LEDs used for these figures were stored in a list, which can then later be called when the figure is needed on a specific tile. Each interaction with the table is divided into different states, so if a user interacts with the table, a new state with a new display is shown. For example, the home screen is state 0 and has a music note displayed for the music game. If the user clicks on the music note, state 1 is called, and the game introduction is shown. This can be seen in Figure 27 and 28 below. The following states are shown in Figure 29, 30, 31 and 32.

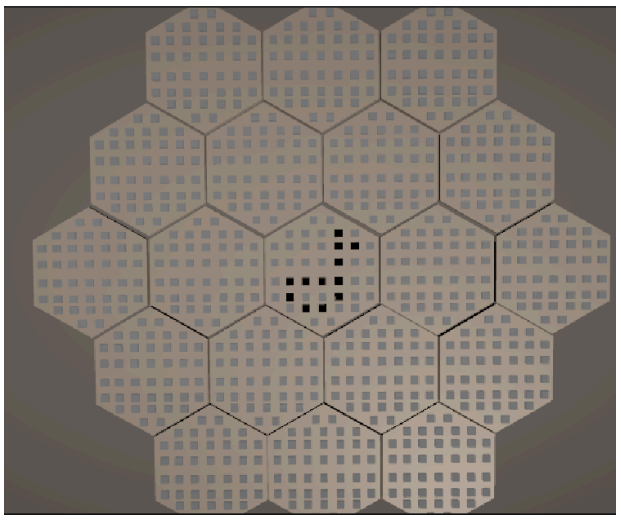


Figure 27: State 0: Home screen

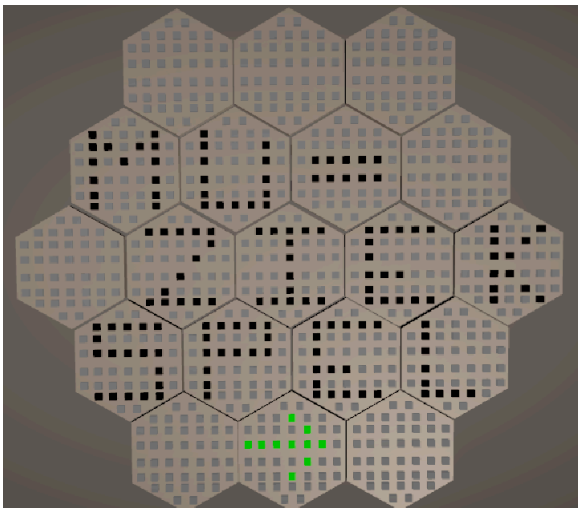


Figure 28: State 1: Game introduction

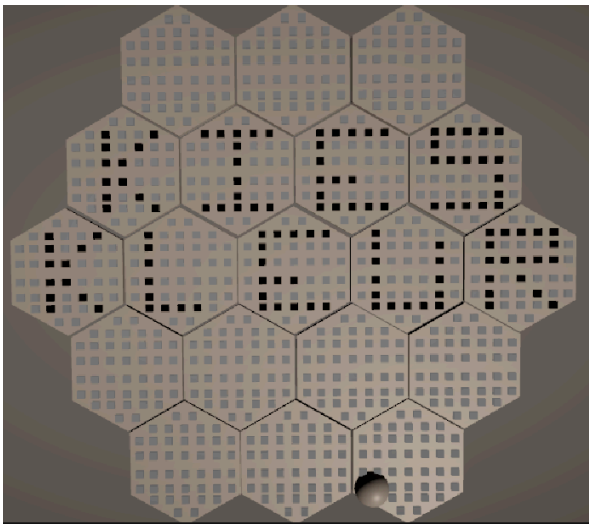


Figure 29: State 2: Choose a colour instruction

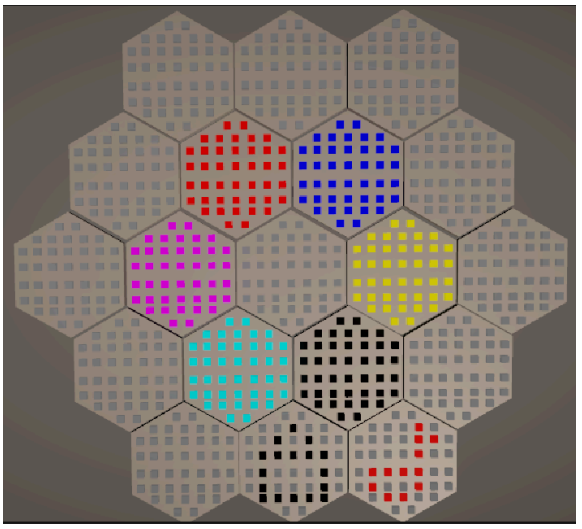


Figure 30: State 3: Choose a colour

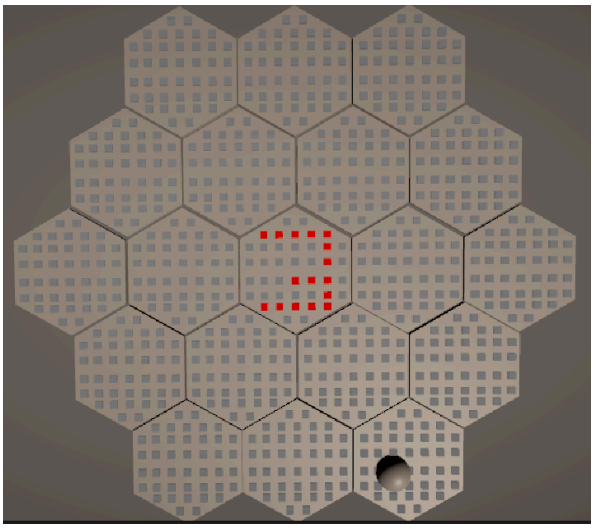


Figure 31: State 4: The countdown

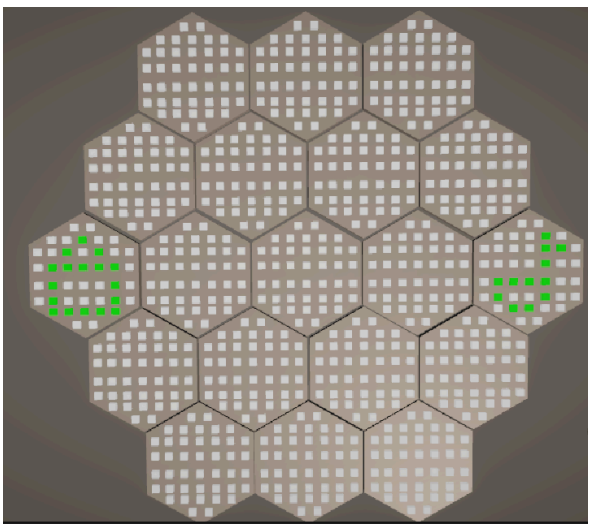


Figure 32: State 5: The start of the game

Following up on the game introduction is the option to choose a colour, shown in Figures 29 and 30. There are six tiles with different colours, and if a user clicks on one of these colours, the middle tile will light up in that colour. Once a colour has been selected, the music note will turn green and can be clicked. Clicking the music note will start the game, whereas clicking the house button will take the player back to the home screen. If the music button is pressed, it moves to state 4, which is the count down (Figure 31). This will count down from 3 till 1, to let players know the game is starting. After 1, it will move to state 5: the music game itself (Figure 32). Players still always have the option to go back to the home screen, by pressing the house on the left, but also have the option to mute the sound, by pressing the green music button. It will become red if the sound is muted. All these states are made by calling up the lists where the figures are made and displaying them if the state is active. If the mouse is clicked on the right tile, it can move to the next state. The countdown, however, is regulated with a timer and will count down by itself. This is also the case for the colour choosing instruction. It will be shown for about five seconds, after which it will move on to the next state.

As this unity model will be shown on a screen, this was also tested after creating the first few stages to ensure that it was working properly. The screen available is a VisBoard screen, which comes with a writing pen. It is essentially a big drawing tablet. This pen works the same as a mouse in Unity, and after testing it was confirmed that there did not need to be additional alterations made in the code. If the pen is held a bit above the screen, it will still be shown on the screen, and moving it around right above the screen is then seen as the dragging of the mouse. If the pen touches the screen, it is considered a mouse click. The added use of the pen on the screen, instead of a touch screen, can help participants of the evaluation of the prototype imagine as if they are pressing on the table with an object, instead of with their hands. This can be useful as older adults can have a lowered strength in their hands, and interacting with the table with an object might be easier for them.

After testing the Unity model on the screen, it was further improved and new states were added. Additionally, the “LEDs” got an added hue to make them look more like the LEDs on the SIMT itself, and to replicate the table as much as possible. This also ensured that the letters had more similarity to how the letters would be shown on the actual SIMT. The background was made darker to make the table stand out more. To activate the table, an on/off button was added, seen in Figure 33 below. On the homescreen, two more options were added (Figure 34). One option shows the border of the table in different

colours, shown in Figure 35, corresponding to idea 5 from Chapter 4.2.2. This is the button with the blue border. The other option is a small hexagon, and if pressed, the table will light up at the spot something is pressed or put on the table. This is shown in Figure 36.

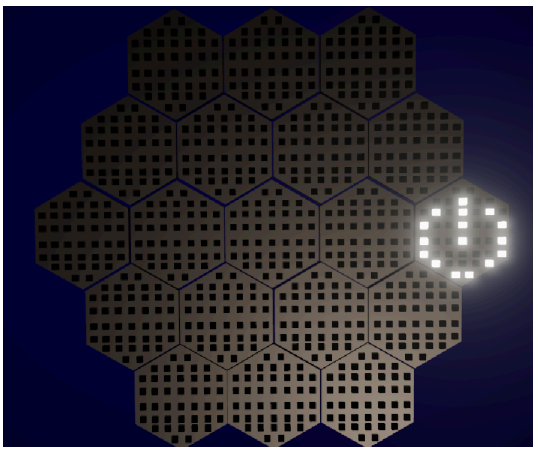


Figure 33: Activation button for the table

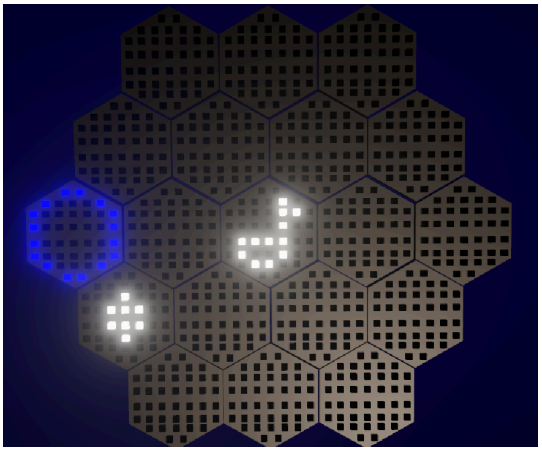


Figure 34: Homescreen table

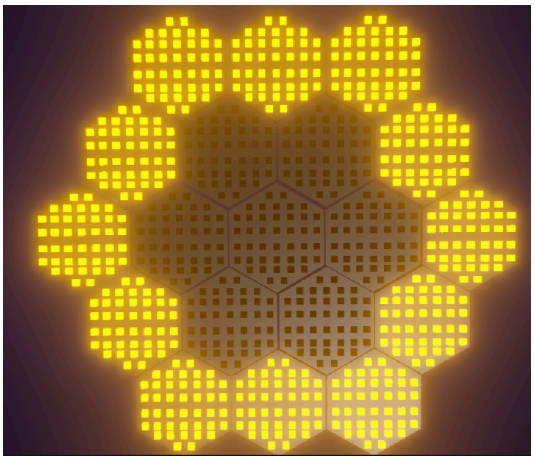


Figure 35: Coloured border option

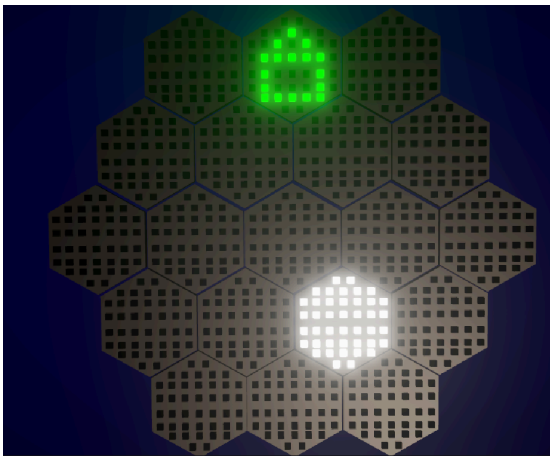


Figure 36: Light up the table where pressed

If the music note button in Figure 34 is pressed, the game introduction still works the same as described earlier. However, to give users some time to read, the arrow to move along with the game introduction, seen in Figure 37, starts off as red, and after a few seconds, it turns green and can be clicked. This was also added to the instruction to choose a colour, shown in Figure 38. Once pressed on the green arrow, the players can choose their preferred colour (Figure 39) and if they do, they can click the music note, to start playing the game (Figure 40).

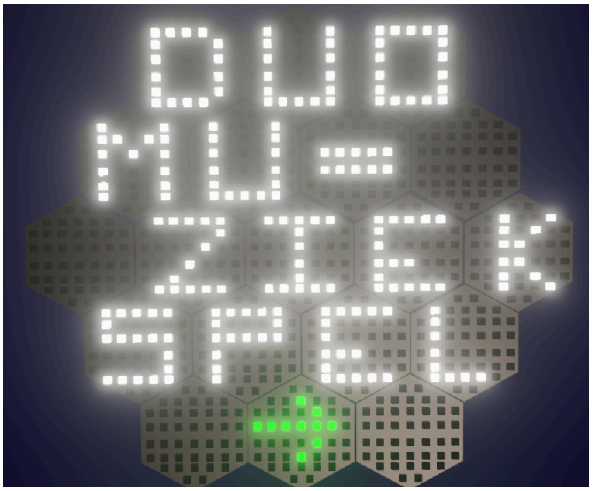


Figure 37: Game introduction

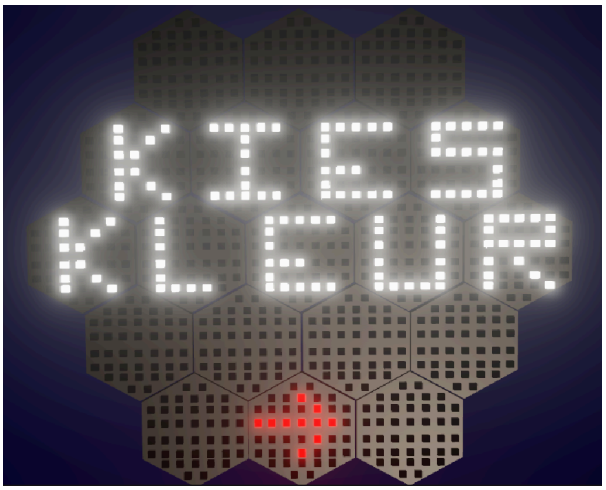


Figure 38: Choose colour instruction

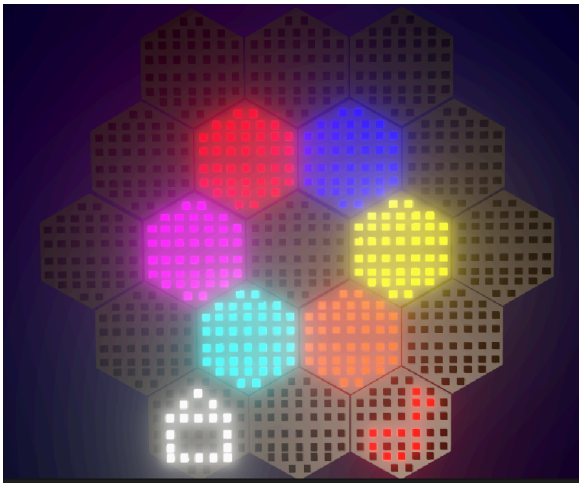


Figure 39: Option to choose a colour

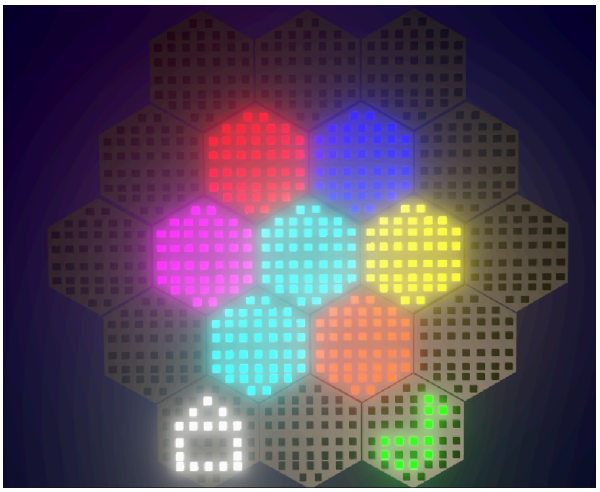


Figure 40: Colour chosen

The table will show a countdown from 3 until 1 (Figure 41), after which the game will start, shown in Figure 42. The music starts playing and a random tile on the player's half of the table is chosen, and slowly starts to fill in. First only the outside border, then another row, etc., until the whole hexagon has filled in with white. Once this happens, the tile changes to the colour the player has chosen previously, and the tile can be clicked. If it is clicked within the short timeframe the tile is visible, it will add +1 to their score. If the tile is not clicked on time, it will simply disappear. If their score is at least 50 percent of the total possible score, at the end of the game it will display: “Well done” (figure 43). If they scored lower, the table will display: “Too bad” (figure 44). In both cases, the home button is displayed again, which will take players back to the homescreen.

Due to a lack of time, the continuation of the music depending on the rate that players click the tiles was not implemented. Instead, the users hear the music and are able

to click on the tiles, but missing a tile does not influence the music. This also means that the feeling of playing together may get a bit lost.

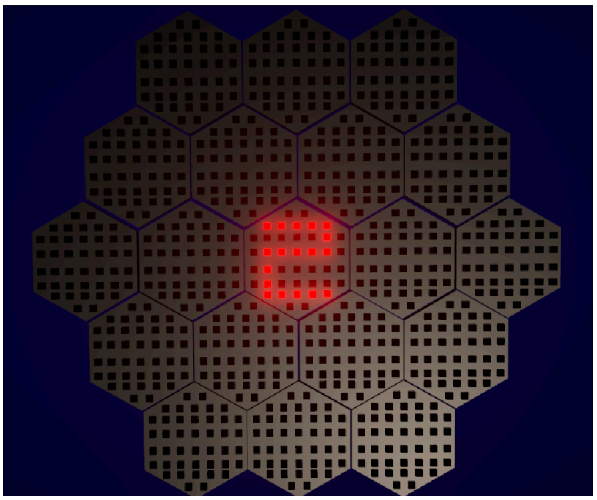


Figure 41: Countdown

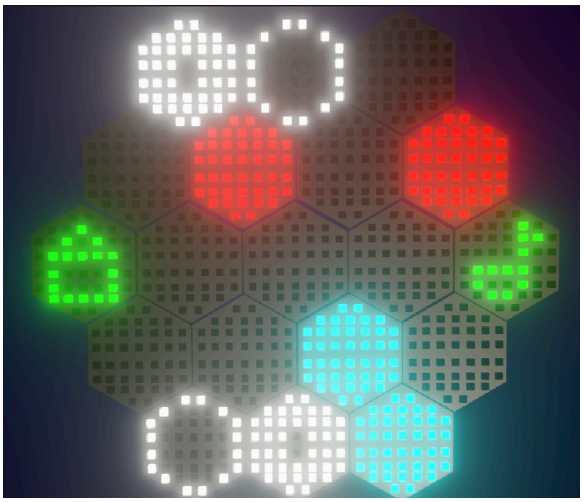


Figure 42: Music game in progress

Figure 43: “Well done” message

Figure 44: “Too bad” message

As it was beyond the scope of this research to actually implement the ability for a user to play with another player, the actions performed by the person at the other table are hardcoded into the game. In the upper half of Figure 42, it can be seen that there are also tiles lighting up in red. This is the colour the other player has ‘chosen’, and these seven tiles at the other side of the SIMT would be played by the other player. In this version of the game, these tiles are set to disappear as if clicked, but it does not influence the score of the person playing during the user evaluation.

During the interaction with the table, the GameManager oversees all necessary actions. The summary of its functions can be seen in Figure 45 below. Each component of the table: the table itself, the tiles, the pixels and the sphere, has its own script assigned. In

addition to this, an empty object was created and assigned a script managing the sound. In this script there are three functions: 1) Getting the music, 2) Starting the music, and 3) Stopping the music. In the script of the sphere, the location of the mouse is tracked. In the Pixel script, colours of individual pixels can be changed. The Tile script takes care of the different shapes and letters that can be displayed on a tile by storing the pixels included in the shape in a list, and "drawing" the shape in a function. In the Table script the different tiles that could be needed are managed. This division of tasks within the scripts was done this way to ensure all parts are managed on the right "level" and to keep the GameManager more organised. During interaction with the table, the amount of frames is counted in the GameManager. Each time the frame count divided by 20 equals zero, a new tile begins to fill up during the music game. Additionally, it keeps track of how many coloured tiles have been displayed during the game, the Tile Counter. In this prototype, the limit was set to 30. After 30 tiles, the message will be displayed based on the score.

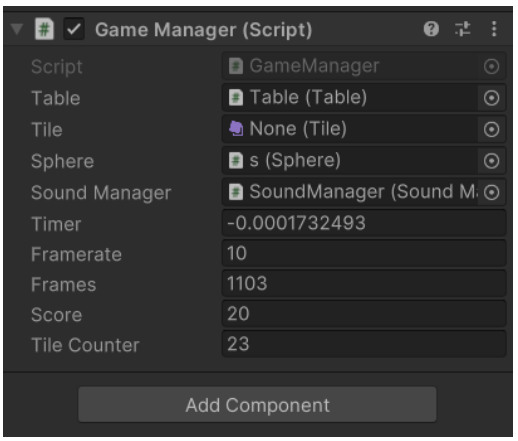


Figure 45: GameManager

6.2 The app

Several changes and additions have been made since the first prototype of the app, and the result of this can be observed in Figure 46 below. One of the points of feedback for the first prototype was that the colours needed more contrast. Therefore, the colours have been updated to blue and orange. These colours are opposite of each other on the colour wheel, providing clear contrast. The buttons and sliders are clearly visible, and the letters are large enough to read comfortably. Blue is also known to be a calming colour. In addition to this, the drawing function has been incorporated. This feature allows the user to draw in the square, with their drawings appearing on the table. The lock screen also has a light orange

hexagonal grit as background, emphasising the hexagonal shapes of the tiles in the SIMT. The connection page has a new function: if a user clicks on the bar, a new page opens to show a new connection has been made. There have not been any additional pages, ensuring the app remains simple and easy to use.

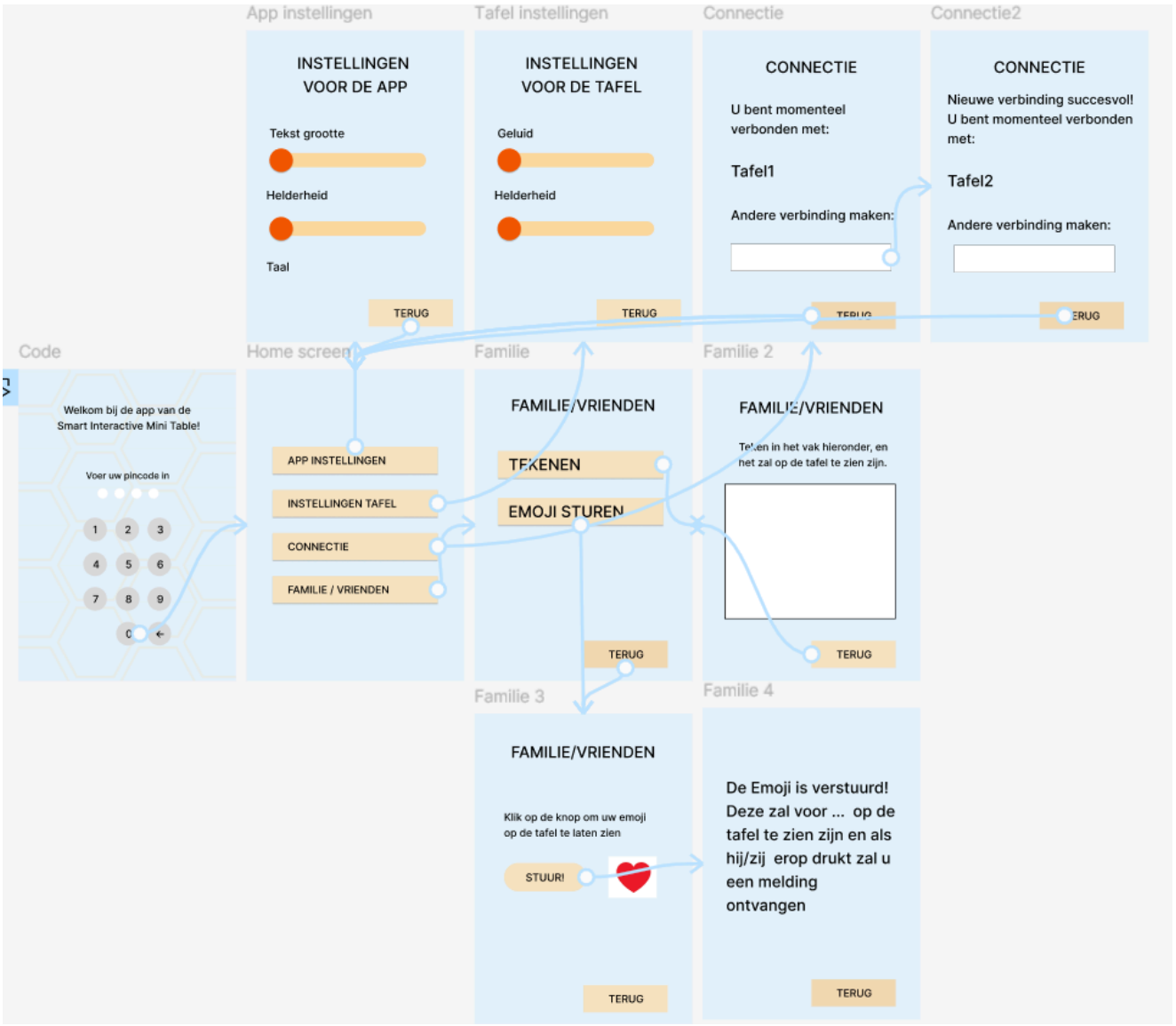


Figure 46: The Figma prototype for the app.

7. Evaluation

In this chapter, the evaluation of the prototypes, explained in the previous chapter, will be detailed. Several people who also attended the co-creation sessions said they would like to evaluate the final prototype, and were contacted again for a date and time for the final evaluation. First, the goal of the evaluation will be explained, followed by the layout of the evaluation session. Finally, the results will be presented.

7.1 The goal

The primary goal of the evaluation session is to evaluate the following requirements:
Functional requirements:

- A3: Must be easy to use
- B2: Must provide alternate interactions to eating
- B6: Must be connected to an app
- B3: Should incorporate sound
- B4: Should have a low pace of interactions

Non-functional requirements:

- A1: Must provide a form of company or communication
- A7: Must have simple interactions
- A8: Must provide engagement during the day
- B7: Should be easy to set up

Requirements B6 and B3 are inherently fulfilled due to the existence of the app, and sound being incorporated in the music game. During the evaluation, it will be tested whether the app is easy to use and if the sound is enjoyable for the users and therefore enhances the engagement, specified in requirement A8. The requirements will be translated into questions, which will guide the evaluation session. The interaction is evaluated through questions such as: *How do you rate the interaction with the table?* and *How clear was the activation of the table?*. The engagement is evaluated with questions such as: *How much did you enjoy the game?* and *Would you like to play the game again?*. A requirement will be considered fulfilled if at least 50 percent of the participants agree with the questions.

7.2 Evaluation session

Before conducting the evaluation sessions, ethical approval was obtained from the Ethics Committee at the University of Twente. After receiving the approval, participants were invited to attend the evaluation session via email. The email contained details about the layout of the evaluation session and offered possible dates for the sessions. The participants could respond with their day and time of preference. A total of three sessions were conducted, each with one participant. The participants were all female between the ages of 60 and 80.

The session started with a brief introduction, explaining their right to stop the session at any moment and the purpose of the session. Any questions participants had were answered. Once everything was clear, participants were given the opportunity to test out the Unity prototype. They could freely interact with it, and ask questions if something was unclear. As they were testing the prototype, some observational notes were made by the researcher, which were discussed later with the participants. After testing the prototype to their satisfaction, participants were asked to fill in a short Likert scale questionnaire about the functionality of the prototype. Due to a preference, visible after the co-creation sessions, to talk about ideas instead of writing them down, this was followed by other questions that were prepared beforehand and then discussed in a semi-structured interview, allowing the participants to expand on their experiences, without being bound by the questionnaire. Throughout the interview, key notes were written down and all the results will be presented in the next part. Following the discussion of the Unity prototype, the Figma app was presented to participants. They were again encouraged to freely interact with it, until they were satisfied. Afterwards, the same process of getting feedback, as with the Unity model, was conducted. The questionnaire and the interview questions can be found in Appendix 7.

During the evaluation sessions, it became clear that the participants had difficulties reading the screen, due to the angle they saw the screen when seated. The screen appeared quite dark with a lowered visibility, which may have impacted their evaluation.

7.3 Results

In the following section, the results from the user evaluation are presented. First, the results from the evaluation with the Unity model of the SIMT will be described, followed by the results from the app evaluation.

7.3.1 Table evaluation

Following interacting with the Unity model of the SIMT, participants were asked to evaluate their experience. The feedback indicates that the table itself was easy to use, and the total interaction with the table scored an 8 out of 10. All participants found the activation button to be very clear. Other positive aspects highlighted about the table were: the colours, that the table reacts to whatever you click, minimal need for reading and the ability to invite strangers for a game instead of having to rely on family members. The game, however, turned out to be difficult to understand without any further explanation, to various degrees, seen in Figure 47. In this Figure and Figure 48 afterwards, 1 means unclear and 5 means very clear. However, when asked during the interview, all participants did consider the game to be easy to play, if it has been played once or twice.

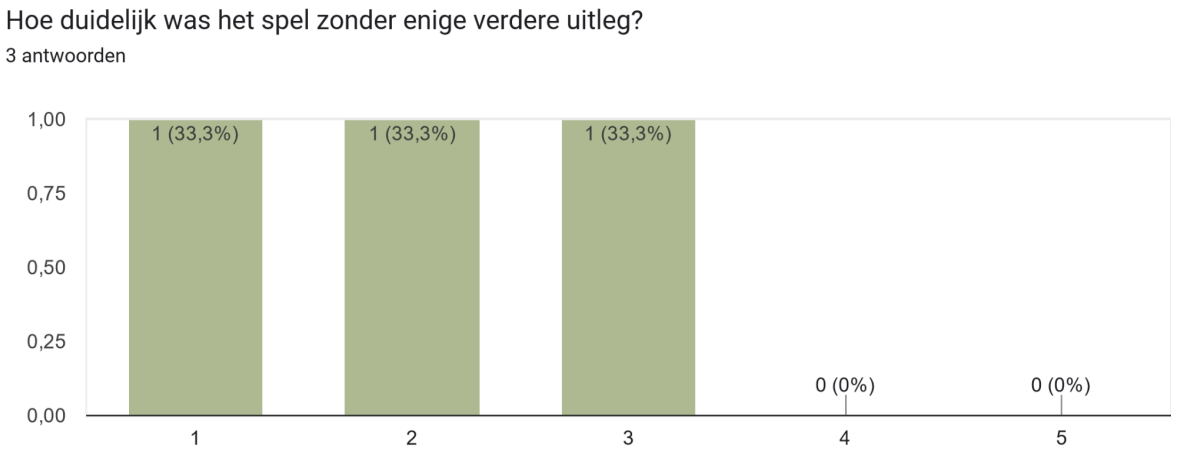


Figure 47 : How clear was the game without any further explanation?

The game idea itself got 3.7/5. The enjoyment the players got out of the game did differ per person, as seen in Figure 48 below. During interviews, participants expressed that, if the music indeed stopped and continued playing depending on the tiles clicked, it would have added to the game experience and increased the enjoyment. Additionally, it would have

added to the feeling of playing with others. One participant suggested showing a form of contact with the other player before the game. This could be in the form of a waving hand and she felt like that would add a sense of connection to the other player.

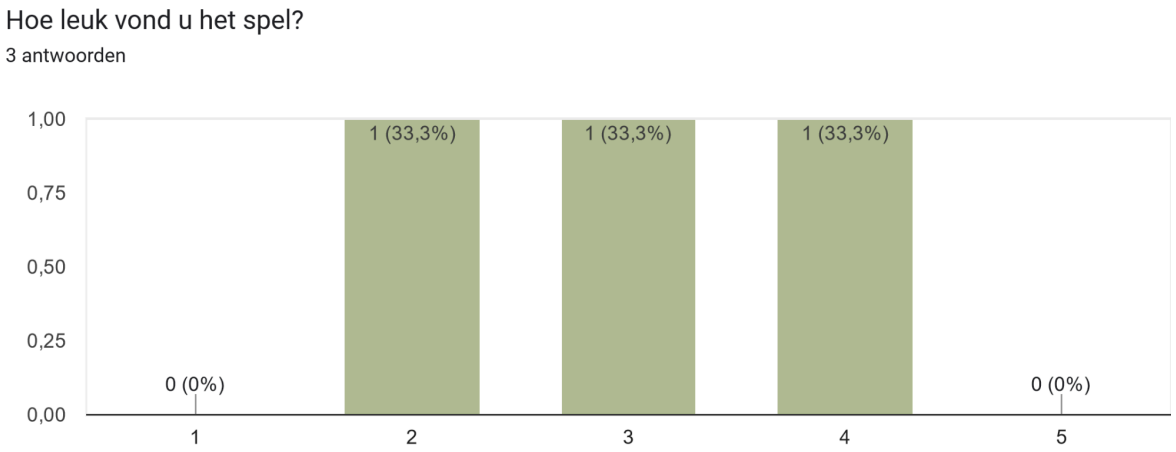


Figure 48: How much did you enjoy the game?

One participant however, felt like the game was too much depending on speed and would prefer the music game to be more dependent on the brain instead of the mobility. She offered the option of musical memory instead, having the players remember the different places of music pieces, or remembering the order of the music tiles lit up. The other participants did feel like this music game was engaging and suitable for older adults. The fact that it had music in the game was well received, with the sidenote that it was preferably a music style that they could choose themselves. The addition of more games over time was also something that all participants would like to see.

Two participants enjoyed the option where the table lit up if something was put down, while the other participant did not feel like it added something to the table. The option where the border of the table lights up with different colours was good, if users could set their own pace.

7.3.2 App evaluation

The app turned out easy to use, scoring 4.3 out of 5 in usability. The overall interaction with the app scored positively in the upper half, but also a bit spread, as seen in Figure 49 below. The app was considered clear to use by all participants and the colours were well received. It was considered simple enough also for older adults, higher in age, and the interactions possible did not need further explanations. Options to draw on the table and

add a connection with a stranger or a friend were well-received. The ability to change the language was pointed out by one participant, to be also helpful for those from another culture. None of the participants was missing something in the app, or wanted to change something.

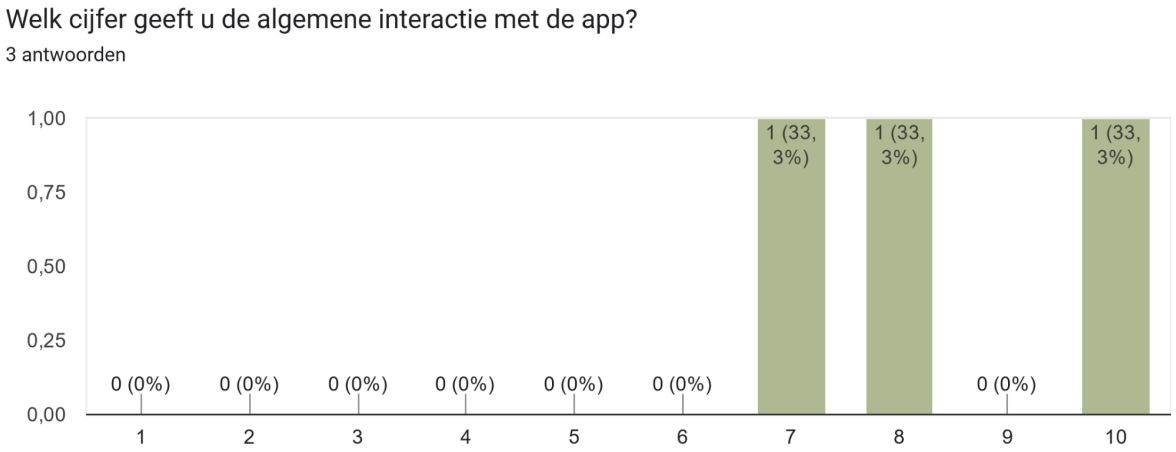


Figure 49: How do you rate the interaction with the app?

8. Discussion and future work

In this chapter, the results from the user evaluation from the previous chapter will be discussed, along with their implications. Additionally, the results will be linked back to the requirements set in Chapter 4 and the research question formulated in the Introduction. Limitations encountered will be addressed. Finally, this chapter will conclude with future references and potential next steps.

8.1 Discussion

The goal of the user evaluation was to assess the level of usability and engagement of the SIMT for older adults. The results presented in the previous chapter indicate a generally positive reception of the table. Participants considered the SIMT a valuable addition to the lives of less mobile older adults, living alone. The table is engaging, and playing games on the table is well received. Adding more games over time could be beneficial. The addition of music to the games was good, and all participant enjoyed this. The musical game tested could make use of a few changes and additions. An option for difficulty and style can be added, to allow older adults to choose their own pace and music preference. Additionally, a short explanation through audio can be added if the game is played for the first time, with some visuals of the game, to ensure the players understand the game before they start playing. If the game is played more often, it does not need to explain the game anymore, but the explanation can be played as an option, if a help button is pressed, as the game is considered clear after playing it once or twice. Adding audio to the game or other buttons on the table can also reduce the need for the text displayed on the table, as this turned out to be quite difficult to read. One participant just saw a green arrow and clicked on it, without even taking interest in the text displayed. When pointed to the text later in the evaluation, she reacted surprised, and still had difficulty reading the text that was furthest away from her. As the game and Unity model were not in the final stages yet, participants did mention, if it was worked out more, and the idea was fully worked out, they would give higher scores. To increase the feeling of connection, implementing the feature of music depending on the tiles clicked, for both players on each table, would be useful. Besides this, showing a connection made between players, or a waving hand, as suggested by one of the participants, could add to a sense of playing with others. All these options would increase the engagement and improve the effectiveness of the SIMT for older adults. Lighting up the

table where pressed and the colour indication of time passed can be useful to the target audience. Some might appreciate it more than others and it could provide more types of engagement during the day, also if they do not wish to play games at that moment.

The app was reviewed as simple and clear. This was precisely what it needed to be. There were no additions needed, showing that the design of the app is good enough for this version of the SIMT. The addition of the app has shown to be useful, as older adults do not have to use the table to adjust their settings. During the evaluation, some letters and symbols were difficult to read and understand, and adding other symbols for the settings may just end up confusing the older adults. By managing it all in the app, the table becomes easier to understand and enjoy. This design of the app was something that was deemed useable by the target group themselves. If the SIMT has more additions, the app may need some alterations too. If alterations are done to the app, it should be ensured that it stays accessible for older adults themselves too.

With these results, the requirements evaluated are revisited. All the functional requirements: *A3: Must be easy to use, B2: Must provide alternate interactions to eating, B6: Must be connected to an app, B3: Should incorporate sound,* and *B4: Should have a low pace of interactions* are met. The participants considered the SIMT easy to use, fulfilling A3, and by providing options for interaction with the SIMT, B2 was fulfilled. The addition and evaluation of the app made sure B6 was fulfilled, and besides the fact that the app exists, it was also positively reviewed. The music game ensured that B3 was met in a worthwhile way. Allowing users to click the buttons at their own pace, means that B4 is also fulfilled. For the non-functional requirements, *A7: Must have simple interactions, A8: Must provide engagement during the day, B7: Should be easy to set up* are met. The participants considered the interactions with the table nice and simple, which means A7 is met. The engagement of the table varied per participant, but by incorporating the full idea of the music game into the SIMT, the engagement was deemed to be higher. As the game idea scored 3.7/5 and the enjoyment of the game 3/5, with the current state of the game, requirement A8 is just met. However, as the scores would be higher with a more final version of the game, this requirement can be comfortably fulfilled. As the activation of the table was very clear to all participants, B7 is also met. The last non-functional requirement A1: *Must provide a form of company or communication,* is with the current state of the game not met. Technically, the table does provide the possibility to play with other people, thus meeting the requirement, but if the users do not perceive this as such, this is pointless.

One participant did feel like she was playing with somebody else, but for the two others this was not the case. One of them was more focussed on clicking the tiles than with the music or the other person. However, by implementing more cues that the connection is being made, and hearing in the music what tiles the other person is playing, this requirement could still be met.

Besides the discussed requirements, it is important to ensure that the requirements for the project, formulated in Chapter 1 are also met. These requirements were: 1) *The table needs to be connected with another table. 2) It should preferably add something to the research being done by one of the people at the BSS faculty at the University of Twente. 3) The use of the tables should not provide any medical claims or intent to be used as medical support for illnesses or disabilities. 4) The features of the table (the LEDs and the load sensors) should be used.* Requirements 1, 3 and 4 are met with these interactions with the SIMT. The second requirement is not fully met. This requirement is however not a must have requirement, but was preferred to be met during the project. The research field established in Chapter 2 is E-Health. Within E-Health, one of the important aims for healthcare is “to support people in coping with vulnerabilities and to live pleasant, engaged and meaningful lives, also in the presence of physical and mental challenges. … there is the high potential of technology to support and innovate healthcare.” [31]. By providing engagement during the day for older adults who live and eat alone, possibly with a lower mobility, this research does connect with E-health. However, it has shifted a bit from the use case provided by the researcher who works at the E-Health department.

With this knowledge the fourth subquestion, defined in Chapter 1: *Which interactions need to be implemented in order to achieve the greatest benefit for the patient group?*, can be answered, as the first three were already answered in Chapter 2. The answer that followed from Chapter 2 was: interactions that would enrich the eating experience of older adults, with the addition of providing engagement during the day. In the following Chapters, the enrichment of the eating experience part was not focussed on anymore, due to, among other reasons, the participants not finding this necessary, and instead the focus became providing engagement during the day. The greatest benefit would be providing engagement during the day, with the possible effect of lowering feelings of loneliness and gloom. The interactions that need to be implemented to achieve this, are simple and fun multiplayer games. In addition to this, the table can provide other simple interactions by lighting up when objects are placed on the table or showing different colours

depending on the time past. These options could also be used during dinner time, without being too distracting and in that way enriching the eating experience, at moments chosen by the user. However, this has not been tested during the user evaluation.

The goal of this research, as stated in Chapter 1, is to answer the following research question: *How can the Smart Interactive Mini Tables be put to use in healthcare?* Through expert interviews, literature and co-creation sessions, the target group was defined as older adults, who are less mobile and could benefit from more engagement. By providing these people with several options of interaction on the SIMT, including simple multiplayer games, their level of engagement can be improved. By connecting the older adults with others, they can still have a sense of social interaction, allowing them to expand their horizon within their own needs. As the table can be adjusted to personal preferences through the app, more people are also able to use the SIMT.

8.2 Limitations

Some limitations in this project are present. The interaction was not tested with the actual target population, and therefore the response to the interaction does not automatically imply that the actual target group would react the same. But the participants were within the same age range as the target group, so there still is some validation. Additionally, due to limited access to the target group, the amount of people that participated in the user evaluation is quite low. Moreover, all the participants of the user evaluation were female. Therefore, the discussion is based on a very limited sample size and the credibility of the outcome can be questioned.

The screen used during the evaluation was also not of the same look and feel as the SIMT itself, and due to the low visibility on the screen, some letters and symbols could have been less readable, as it would have been on the SIMT. This impacted the way the participants reacted during the user evaluation, which may have been different from how they would have reacted if it was displayed on the SIMT. As a consequence, some points of improvement could be unnecessary, and the experience of the music game on the SIMT may be perceived differently. The game was also not fully implemented as planned and was missing a clear connection between the tiles clicked and the music that was played. This also impacted the way the game was experienced and a better implementation of the game could have had a more positive review.

Another limitation is, the focus towards general engagement during the day has not been researched as actively, as the option for an enriching eating experience, due to the shift in focus later on in the research. Though it is still based on literature and the input of older adults, this could still benefit from more in depth research. In addition to this, the long term effects of engagement with the SIMT have not been tested, as there is a time limit set on this research. The level of engagement found during this research could decline over time.

Due to time limits the explanation video has not been made or tested with the older adults. This video could add to the ease of use of the SIMT, and clearly explain the concept without needing much people to explain. If this video was made and shown to the participants before the evaluation, the use of the table and possibly the game could have been more clear from the start.

8.3 Future work

To ensure the interactions with the SIMT are of use for older adults, with a decreased mobility and possible feelings of loneliness, the multiplayer game should be tested with these people, preferably on the SIMT itself. As a screen will not grant the same experience as the SIMT, it is important to also test the interactions on the SIMT. This will also clarify if the letters and symbols currently displayed on the Unity model are clear and understandable. Based on their experiences, the interactions could be adapted and expanded, with the options previously discussed. Other than that, creating the video and showing them to the older adults could help them understand the table by themselves, without needing someone to explain. Besides the interactions, the ideas for the physical design of the table, discussed in Chapter 4 and 5, can be tested, and if they are fit to use, the SIMT can be designed and created. With time, the long-term effects of the SIMT can then also be researched.

Implementing more sounds and sound effects for actions, as suggested by one of the older adults, could be interesting. This could entail nature sounds, but also sound effects with certain actions. It should be optional and regulated in the app, and afterwards also tested with the target group, ensuring the use of these sounds is of use.

Besides testing the music game, more in depth research could be done about additional preferred ways of engagement for older adults. With this knowledge the use of the SIMT can be expanded, and work towards an interactive mini table that allows older

adults to experience increased engagement during the day. The eating experience can also be tested and evaluated with the target group, and the addition of the interactions during mealtimes can be researched. This could possibly lead to an enriched eating experience.

Options in the app could also be expanded on. It could be interesting to add the option for users to change the names of the people or table they are connected to. If they enjoy a certain connection, they could change their name in the app to something they can remember easily, if they want to come back to that connection later. An option to favourite certain connections could also be added. Another addition could be for users to be able to choose what interactions they can have with the table. If users do not wish to display certain games or interaction modes as buttons on the table, they can turn of these buttons in the app, ensuring the table only provides options they enjoy and to keep it as simple and easy as possible. Besides this, it could be fun for older adults to draw on the table, also with other users. By implementing this, the table could provide another form of entertainment.

It can also be interesting to explore the use of the SIMT with other groups of society that have a decreased mobility or difficulty interacting with others. As interaction with the SIMT does not need conversing with others, a sense of social interaction without speaking could add to their lives as well.

9. Conclusion

In conclusion, the aim of this research was to find a good use for the Smart Interactive Mini Tables, through the research question: *How can the Smart Interactive Mini Tables be put to use in healthcare?* Based on expert interviews, literature and co-creation sessions, it can be stated that the Smart Interactive Mini Tables can be used in healthcare with the older adults. As this group is expected to stay at home longer, but their mobility can be decreasing, they can experience feelings of loneliness and gloom. The Smart Interactive Mini Tables could be used to improve their levels of engagement during the day, by providing fun interactions and simple multiplayer games. With these games, they can enjoy their time with others, increasing their social interactions on a very low threshold.

Continuation of this research could lead to older adults living alone longer and more comfortably. Expanding the SIMT to also aid other groups both during the day and during meal times, could have a positive impact in healthcare. Different types of games and communication could be implemented, allowing all users to interact with each other in their own preferred way.

References

[1] J. A. Haarman, R. A. de Vries, E. C. Harmsen, H. J. Hermens, and D. K. Heylen, “Sensory interactive table (SIT)—development of a measurement instrument to support healthy eating in a social dining setting,” *Sensors,* 2020, doi: 10.3390/s20092636

[2] S. Jordà, G. Geiger, M. Alonso, M. Kaltenbrunner, "The reacTable: Exploring the Synergy between Live Music Performance and Tabletop Tangible Interfaces", TEI, 2007, doi: 10.1145/1226969.1226998

[3] H. Gondal, M. Over-Rein, S. Munir, M. Afzal, A. Khalid, K. Çarçani, “An Interactive Coffee Table: Exploring Ludic Engagement During Lunch Breaks,” *Communications in computer and information science*, pp. 421–428, Jan. 2020, doi: 10.1007/978-3-030-50726-8_55.

[4] G. Beauchamp, A. Joyce-Gibbons, J. Mc Naughton, N. Young, T. Crick, “Exploring synchronous, remote collaborative interaction between learners using multi-touch tables and video conferencing in UK primary schools,” *British Journal of Educational Technology*, Jan. 2019, vol. 50, no. 6, pp. 3214–3232, doi:10.1111/bjet.12728

[5] S. Follmer, D. Leithinger, A. Olwal, A. Hogge, and H. Ishii, ““inFORM,” Proceedings of the 26th annual ACM symposium on User interface software and technology”, *UIST,* 2013, doi:10.1145/2501988.2502032

[6] S. Hauser et al., “Deployments of the table-non-table: A Reflection on the Relation Between Theory and Things in the Practice of Design Research,” *ResearchGate*, 2018, doi:10.1145/3173574.3173775

[7] R. Mitchell, A. Papadimitriou, Y. You, L. Boer, “Really eating together,” *Proceedings of the 6th Augmented Human International Conference*, Mar. 2015, doi:10.1145/2735711.2735822

[8] G. Yamamoto et al., "A user interface design for the elderly using a projection tabletop system," 3*rd IEEE VR International Workshop on Virtual and Augmented Assistive Technology (VAAT)*, 2015, pp. 29-32, doi: 10.1109/VAAT.2015.7155407.

[9] S.Hendriks, M. Heron, M. Obaid, “Tables Got Moves: A Review on Actuated Table Designs”, *Proceedings of the 2nd International Conference of the ACM Greek SIGCHI,* 2023, pp. 1-10, doi:10.1145/3609987.3609991

[10] Anon “Researchers emphasize on health-focused rather than a weight-focused approach to treating obesity,” *News-Medical,* Feb. 24, 2022. [Online.] Available: https://www.news-medical.net/news/20220224/Researchers-emphasize-on-health-focused-rather-than-a-weight-focused-approach-to-treating-obesity.aspx

[11] M. Choi, J. Bae, "'I eat to not die': Diet and exercise experiences of older adults living alone", *International Journal of Older People Nursing*, 2022, vol. 18, no. 2, doi:10.1111/opn.12523

[12] H. Wang, T. Tsuji, K. Ide, A. Nakagomi, L. Ling, K. Kondo, "Does eating with others promote happiness among older adults living alone? A 3-year longitudinal study of the Japan gerontological evaluation study*", International Journal of Geriatric Psychiatry*, Dec. 2023, vol. 38, no 12, doi:10.1002/gps.6033

[13] S. Ha, E. Nam "Perceived Risk of Solitary Death and Depressive Symptoms Among Older Adults Living Alone in Seoul: Can Structural and Functional Social Support Buffer the Impact?" *Journal of Applied Gerontology,* 2023, vol. 43, no 3, doi:10.1177/07334648231211452

[14] Fleury, Sylvain, and Noémie Chaniaud. "Multi-User Centered Design: Acceptance, User Experience, User Research and User Testing." *Theoretical Issues in Ergonomics Science* 25, 2024, no. 2, doi:10.1080/1463922X.2023.2166623

[15] T. Antunes, A. de Oliveira, R. Hudecb, T. Brusque Crocetta, J. de Lima Antão, et al., "Assistive technology for communication of older adults: a systematic review*"*, *Aging & Mental Health*, 2019, vol 23, no 4, pp. 417-427, doi:10.1080/13607863.2018.1426718

[16] L. Shore, A. de Eyto, L. O'Sullivan. "Technology Acceptance and Perceptions of Robotic Assistive Devices by Older Adults – Implications for Exoskeleton Design." *Disability and Rehabilitation: Assistive Technology,* 2022, vol. 17, no. 7 pp. 782–790. doi:10.1080/17483107.2020.1817988

[17] S. Neil-Sztramko, G. Coletta, M. Dobbins, S.Marr, "Impact of the AGE-ON Tablet Training Program on Social Isolation, Loneliness, and Attitudes Toward Technology in Older Adults: Single-Group Pre-Post Study", *JMIR Aging,* 2020, doi: 10.2196/18398.

[18] R. McCloud, C. Perez, M. Bekalu, K. Viswanath, "Using Smart Speaker Technology for Health and Well-being in an Older Adult Population: Pre-Post Feasibility Study" *JMIR Aging*, 2022, doi: 10.2196/33498.

[19] K. Balog, S. Faletar, T. Jakopec, "Older Adults' Attitudes toward Digital Technology and Perceptions of Its Usefulness: Example of the City of Osijek, Croatia", *Proceedings of the Association for Information Science and Technology*, 2023, vol. 60, no. 1, pp. 686-690, doi:10.1002/pra2.840

[20] M. Shishehgar, D. Kerr, J. Blake, “The effectiveness of various robotic technologies in assisting older adults”, *Health Informatics Journal*, 2019, vol. 25, pp. 892-918, doi:10.1177/1460458217729729
[21] R. Kachouie, Sedighadeli, R. Khosla, M. Chu, “Socially Assistive Robots in Elderly Care: A Mixed-Method Systematic Literature Review”, *International Journal of Human-Computer Interaction,* 2014, vol. 30, doi: 10.1080/10447318.2013.873278.

[22] P. Tiwari, J. Warren, K. Day, B. MacDonald, C. Jayawardena, et al. “Feasibility study of a robotic medication assistant for the elderly”, *In Proceedings of the Twelfth Australasian User Interface Conference*, 2011, Vol. 117, Australian Computer Society, AUS, pp. 57–66. doi:10.5555/2460616.2460623

[23] M.Kanoh, Y. Oida, Y. Nomura, A. Araki, Y. Konagaya, K. Ihara, et al. “Examination of Practicability of Communication Robot-Assisted Activity Program for Elderly People”, *Journal of Robotics and Mechatronics*, 2011, vol. 23, doi: 10.20965/jrm.2011.p0003.

[24] D. Korsgaard, T. Bjøner, N. Nilsson, “Where would you like to eat? A formative evaluation of mixed-reality solitary meals in virtual environments for older adults with mobility impairments who live alone”, *Food Research International*, 2019, vol. 117, pp. 30-39, doi:10.1016/j.foodres.2018.02.051.

[25] I. Stalling, BM Albrecht, L. Foettinger, C. Recke, K. Bammann, “Meal Patterns of Older Adults: Results from the OUTDOOR ACTIVE Study”, *Nutrients*, 2022, vol. 14, doi:10.3390/nu14142784

[26] A. Mader and W. Eggink, “A design process for creative technology.”, *Proceedings of the 16th International conference on Engineering and Product Design*, 2014, pp. 568–573, ISBN 978-1-904670-56-8.

[27] J. Schell, “The Game Begins with an Idea” in *The Art of Game Design : a book of lenses,* vol. 3, Boca Raton, FL, USA, CRC Press, 2020, pp. 73-94.

[28] Steam. “Beat Saber” https://store.steampowered.com/. Accessed: July 3, 2024. [Online.] Available: https://store.steampowered.com/app/620980/Beat_Saber/

[29] Google Play. “Piano Tiles 2™ - Piano Game” https://play.google.com/store/games?hl=en. Accessed: July 3, 2024. [Online.] Available: https://play.google.com/store/apps/details?id=com.kooapps.pianotiles2gp&hl=en&pli=1

[30] Gitlab. Accessed: July 4, 2024. [Online.] Available: https://gitlab.utwente.nl/bss_development/ehealth/sensory_interactive_table

[31] University of Twente. “Centre for E-Health & Wellbeing research: Our vision”. Accessed: July 3, 2024. [Online.] Available: https://www.utwente.nl/en/bms/ehealth/vision/

Appendices

Appendix 1: Search strategy

Scopus is a database full of (reviewed) papers that are widely available. The website offers the possibility to fill in certain keywords and specify where those keywords need to be found. It has searching features that allows filtering on numerous things including subject area, language and source type.

For literature about the interactive tables different keywords were used such as: *interaction, table OR tabletop OR desk, technology, connected OR remote OR connection, digital.*
Keywords for literature about the target group included: *older adults OR elderly, lonely OR alone, eating, meal, technology, AT.*
These keywords were used in different combinations to get a wide variety of results. They were all limited to appearing in the title, abstract or keywords to get relevant results. The results were limited to the English language and the year of publication of 2014 - 2024 to get readable papers with more relevant and up to date technologies and state of the current target group. Additionally it was filtered only on open access papers, to ensure access to the literature.
After scanning through the titles that came up after the search, of those relevant titles the abstract was read to make sure that it was relevant to the research topic. If it was indeed relevant the paper was added to a literature list with a short description of what the paper was about.
In addition to searching Scopus relevant literature was also found in the references of the papers that were in the literature list.

Appendix 2: Questions Expert interviews

Questions Expert Interview

Semi-structured interview, any question can be asked in any order and additional questions can be asked for further explanation.

Introduction
Hi, we are Janine and Thirsa, and we are currently doing our graduation project on the Smart Interactive Mini tables, under supervision of Frodo and Juliet. Janine will focus more on the technical aspects of the Mini tables, whereas Thirsa will explore the possible uses for the tables.

The goal of this interview is to find good use cases for the Smart Interactive Mini tables within your area of expertise. Maybe you could explain briefly what your area of expertise is so we have that clear.

[OPTIONAL]
The smart interactive dining table is currently in the Design lab and is being used to measure eating behaviours.

We are making a small version of the smart interactive dining table. It will have a diameter of roughly 50 centimetres and will consist of 19 led panels with each 42 LEDs, so about 800 LEDs in total. All LEDs will be individually controllable, and each of the 19 panels will also contain a load sensor that can measure the weight put on the panels. This is all similar to the big table, except that it is on a smaller scale. A feature that the small table has that the big table does not is that there are multiple tables that can connect to each other over the internet and exchange data between them.

Are there any questions so far?

Questions about the use of the tables

For the usefulness of your answers it would be nice if you could provide a specific user group with the remote aspect of the table incorporated.
Do you have any ideas on how the Mini Tables could be used within your research?

[OPTIONAL QUESTIONS IF NOT ANSWERED YET]
For what specific user group would this be?
Are there any specific demographics/characteristics that are associated with the user group.
In what way would this help the user group?
What is currently being done for this user group?

How would the Mini Tables add to this?
Why would the Mini tables be better than f.e. Calling or a multiplayer game on a tablet?
What kind of interactions would the user group have with the Mini Tables?
Why would these interactions be of influence on the user group?
In what way does the interaction over a distance add to the experience for the user group?
Who would be interacting with the other table over a distance?
Can you identify any risks or challenges that could come up when the Mini tables are being used within this user group?
In what kind of setting/space would this be used?
How long should the interaction duration be?
What kind of effect would the use of the Mini Tables have on the user group?
What would be the key performance/success indicators that would prove the effectiveness be?
How would these Mini Tables add to your research?

What would be the ideal outcome after using this table?
How long should the table be used before reaching a desired effect?

Technical questions about the tables

What kind of measurements would you specifically need?
Regarding the data storage/retrieval, are there specific requirements or preferences for how the data is saved?
How accurate and reliable should the data collected by the load cells be, to be useful in research?
What is the expected learning curve of the user group, how user-friendly does the interface need to be?
Are there accessibility features or accommodations that could be integrated into the table's design to be more inclusive for the user group?
How would the users interact with the table?
What feedback from the table would they get?
How many tables / users should be linked together? (There can be multiple ‘groups/pairs’ of tables)
How many users would potentially use this? Roughly.
What would limit the usefulness of the table? Think of, for example, the delay between the information sharing between two tables being more than 10 seconds.

Should there be any specific safety measures added to the table, to prevent harm?
If you could add an additional feature to the table to aid in this particular use case, what would it be?

[IF NOT MENTIONED]

How could the sharing of information between tables be useful in this context?
How could the weight sensors be useful in this context?
How could the LEDs be useful in this context?

Closing questions

Do you have another possible use case for the tables?
Could we contact you if we have more questions?
Do you have any other remarks or questions?
Thank you so much for your time and input!

Appendix 3: Informed consent form Expert interviews

Informed consent form

Consent Form for Expert interview Smart interactive mini table

YOU WILL BE GIVEN A COPY OF THIS INFORMED CONSENT FORM

Information

Thank you for considering participating in our expert interview regarding the Smart Interactive Mini Table. This interview aims to find good use cases for the Smart Interactive Mini tables within your area of expertise. There are no risks associated with participating in the interview, and the interview has been reviewed and approved by the Ethics committee. You have the right to withdraw from the study at any time without consequences. Personal information will be collected for the purposes of this research, with your consent. The collected data will be used exclusively for research purposes related to Smart Interactive Mini Table. You have the right to request access to, rectification, or erasure of your personal data. We appreciate your time and consideration in participating in our interview.

Please tick the appropriate boxes	**Yes**	**No**
Taking part in the study		
I have read and understood the study information dated _____-2024, or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	□	□
I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.	□	□
I understand that taking part in the study involves an audio-recorded interview. The audio will be transcribed as text, and the audio will be destroyed after 2 weeks.	□	□
Use of the information in the study		
I understand that information I provide will be used for background research and requirement gathering of the bachelor thesis.	□	□

(Cross out if not agreeable)

I agree that my
[Name]

[Occupation] □ □
[Research Group/Organization]
can be used in the background research and requirement gathering of the bachelor thesis.

Signatures

_____	_____	_____
Name of participant	Signature	Date

I have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

_____	_____	_____
Researcher name	Signature	Date

_____	_____	_____
Researcher name	Signature	Date

Contact details for further information or questions:

Janine Ruumpol, j.w.ruumpol@student.utwente.nl
Thirsa Chin-A-Kwie, t.l.chin-a-kwie@student.utwente.nl

Contact Information for Questions about Your Rights as a Research Participant

If you have questions about your rights as a research participant, or wish to obtain information, ask questions, or discuss any concerns about this study with someone other than the researcher(s), please contact the Secretary of the Ethics Committee/domain Humanities & Social Sciences of the Faculty of Behavioural, Management and Social Sciences at the University of Twente by ethicscommittee-hss@utwente.nl

Appendix 4: Overview of possible target groups

The target groups and the possible use cases are extracted from the expert interviews and put in this overview. The number before the target group refers to the Expert interview. So Expert 1 (1), Expert 2 (2) and Expert 3 (3).

Target group	Interaction with the table	Where is the table put?	What would be used for research?	Additional remarks	Requirements 1. Table connected to table/ other devices 2. Beneficial to research 3. No medical claims 4. Using the LED 5. Using the weight sensors
1 Older adults	The table provides feedback from a connection with other wearables and devices.	Home	The data from the wearables	Table is not connected to other table but to devices or phone	+, + , +, +-
1 Older adults	Medication table. Interaction means medication taken	Home	Medicine intake		- , -, +, ++
1 Older adults	Gamelike interactions	Home	-	Battle loneliness by letting elderly game with their grandchildren	+, -, +, ++
2 neuropathy patients	Writing on the table	GP office / hospital	Analyse the writing patterns and alert for possible neuropathy if the patterns are off	No Led feedback is needed	-, +, ? , -+
2 obesity patients	Using the table, having their arms on the table	Home	Measure weight in unobtrusive manner	Weight is sensitive topic for obesity patients, focus on foods may be unhealthy	-,+,+,?+
2 obesity patients	Share eating details with other obesity patients	Home	Food intake (grams), notifications?	Weight is sensitive topic for obesity patients, focus on foods may be unhealthy	+,+,+,++
2 obesity patients	Notifications if one has been sitting too	Home	Activity		-,+,+,++

	long at the table. Show future selves				
2 lymphedema patients	Arms on the table Use it as a stand	GP / hospital / home	Measuring weight of arms		-,+,+,-+
3 Older adults (with malnutrition)	Stimulation to eat more, for themselves and the other person at other table in their homes Additional Interact with grandchildren	Hospital / home	Speed people eat, how much people eat How to enrich experience. Eating behaviours	Keep cognitive functions and sensory impairments in mind. Could be combined with other devices as well	+,+,+,++ +,?,+,++
3 Older adults (with malnutrition)	Fun interaction to stimulate them to join others in dining room	Home	Speed people eat, how much people eat How to enrich experience. Eating behaviours		+,+,+,++
3 overweight people	Stimulation for physical activity,	home		Focus on food isn't great. Physical activity bit random for table	+,+,+, +?
3 overweight people	Bite frequency	home	Food intake		-,+,+, ?+

Appendix 5: Questionnaire Target group

Vragenlijst bachelor onderzoek

Hartelijk dank dat u overweegt deel te nemen aan een gebruikersonderzoek naar de Smart Interactive Mini Table. Dit onderzoek heeft als doel om goede eisen te stellen voor de Smart Interactive Mini Tables. Door middel van deze vragenlijst hoop ik een beter beeld te krijgen van mijn doelgroep.

Er zijn geen risico's verbonden aan deelname aan het onderzoek en het onderzoek is beoordeeld en goedgekeurd door de ethische commissie. U heeft het recht om u op elk moment zonder gevolgen uit het onderzoek terug te trekken. Er worden geen persoonlijke gegevens verzameld voor dit onderzoek, die terug te leiden zijn naar u persoonlijk. Wel worden algemene gegevens, zoals uw leeftijd en thuissituatie verzameld, voor dit onderzoek met uw toestemming. De verzamelde gegevens worden uitsluitend gebruikt voor onderzoeksdoeleinden met betrekking tot Smart Interactive Mini Table. Ik waardeer uw tijd en bereidwilligheid om deel te nemen aan dit onderzoek.

Met vriendelijke groet,
Thirsa Chin-A-Kwie
email: t.l.chin-a-kwie@student.utwente.nl

Ik geef vrijwillig toestemming om deel te nemen aan dit onderzoek en begrijp dat ik kan weigeren vragen te beantwoorden en dat ik mij op elk moment, zonder opgaaf van reden, uit het onderzoek kan terugtrekken. *

Ik begrijp dat de informatie die ik geef gebruikt zal worden voor het verzamelen van eisen voor de bachelorscriptie.

- ◯ Ja
- ◯ Nee

Ik heb de informatie gelezen en begrepen, en geef bij deze toestemming voor het verzamelen van de door mij ingevulde informatie. *

- ◯ Ja
- ◯ Nee

Doelgroep

Wat is uw leeftijd? *

- ◯ Onder de 60 jaar
- ◯ 60 - 70 jaar
- ◯ 71 - 80 jaar
- ◯ 81 - 90 jaar
- ◯ 91 jaar of ouder

Wat is uw woonsituatie? *

- ◯ Ik woon in een eigen huis/appartement met anderen
- ◯ Ik woon alleen in een eigen huis/appartement
- ◯ Ik woon alleen in een verzorgingscomplex
- ◯ Ik woon met anderen in een appartement/woongedeelte in een verzorgingscomplex
- ◯ Anders: _____

Met hoeveel mensen deelt u de maaltijd? *

- ◯ Ik eet de meeste of alle maaltijden alleen
- ◯ Ik eet meestal met anderen, maar sommige maaltijden alleen
- ◯ Ik eet altijd met andere mensen
- ◯ Anders: _____

Onderzoeksvragen

Hierna volgen de vragen voor het onderzoek. Sommige vragen kunnen wat persoonlijk zijn. Geen enkele van deze vragen is verplicht en als u liever een vraag overslaat, is dat prima en heeft verder geen gevolgen.

Welk cijfer geeft u uw leven?

1	2	3	4	5	6	7	8	9	10
○	○	○	○	○	○	○	○	○	○

Welke van deze opties word u blij van? U kunt er meerdere aanvinken.

- ☐ Sociaal contact
- ☐ Van de natuur genieten
- ☐ Reizen
- ☐ Werken/Vrijwilligerswerk
- ☐ Spelletjes/creatief bezig zijn
- ☐ TV kijken
- ☐ Dineren/koffiemomentjes met anderen
- ☐ Familie/vrienden bezoek
- ☐ Muziek
- ☐ Social media, zoals Facebook, WhatsApp, Instagram etc
- ☐ Anders: _____

Werkt u door de weeks?

- ○ Ja, een fulltime baan
- ○ Ja, een parttime baan
- ○ Ja, vrijwilligerswerk
- ○ Nee
- ○ Anders: _____

Hoeveel maaltijden eet u per dag?

- ◯ Altijd 3 maaltijden per dag
- ◯ Probeer 3 maaltijden per dag maar mis er soms een paar
- ◯ Soms 3 maaltijden per dag, maar meestal 2
- ◯ Altijd 2 maaltijden per dag
- ◯ Meestal 2 maaltijden per dag
- ◯ Altijd 1 maaltijd per dag
- ◯ Anders:

Als u soms maaltijden mist, om wat voor reden mist u deze?

Jouw antwoord

Wat doet u tijdens het eten? U kunt meerdere vakjes aanvinken. Als uw bezigheid er niet bij staat kunt u deze bij "Anders" invullen.

- ☐ Alleen eten
- ☐ Krant lezen
- ☐ Op telefoon / TV kijken / tablet etc.
- ☐ Bellen met anderen
- ☐ Anders:

Zou u graag meer interactie toevoegen aan het eten?

- ◯ Ja
- ◯ Nee
- ◯ Misschien/ Ik weet het niet
- ◯ Anders:

Zo ja, wat voor interactie zou dan graag toevoegen? U kunt meerdere vakjes aanvinken.

- [ ] Meer sociaal contact
- [ ] Meer afleiding van het eten
- [ ] Muziek
- [ ] Rustgevende geluiden
- [ ] Een spelletje
- [ ] Anders: _____

Wat doet u vaak in uw vrije tijd?

Jouw antwoord

Zou u graag wat meer interactie door de dag heen willen?

- ◯ Ja
- ◯ Nee
- ◯ Misschien/ Ik weet het niet
- ◯ Anders: _____

Wat voor interactie zou u dan graag meer hebben overdag? U kunt meerdere antwoorden kiezen.

- [ ] Meer sociaal contact
- [ ] Meer afleiding
- [ ] Meer structuur door de dag heen
- [ ] Mogelijkheid voor een spelletje met iemand anders
- [ ] Naar muziek luisteren
- [ ] Naar geluiden van buiten luisteren
- [ ] Herinneringen voor afspraken
- [ ] Mogelijkheid om makkelijk met familie te communiceren
- [ ] Mogelijkheid om makkelijker met anderen te communiceren
- [ ] Anders: _____

Appendix 6: Consent form Co-creation sessions

Geïnformeerd toestemmingsformulier

Toestemmingsformulier voor deelname gebruikersonderzoek Smart Interactive Mini Table

U KRIJGT EEN KOPIE VAN DIT GEÏNFORMEERD TOESTEMMINGSFORMULIER

Informatie

Hartelijk dank dat u overweegt deel te nemen aan een gebruikersonderzoek naar de Smart Interactive Mini Table. Dit onderzoek heeft als doel om goede eisen te stellen voor de Smart Interactive Mini Tables en eventuele prototypes te testen en evalueren.
Er zijn geen risico's verbonden aan deelname aan het onderzoek en het onderzoek is beoordeeld en goedgekeurd door de ethische commissie. U heeft het recht om u op elk moment zonder gevolgen uit het onderzoek terug te trekken. Er worden geen persoonlijke gegevens verzameld voor dit onderzoek, die terug te leiden zijn naar u persoonlijk. Wel worden algemene gegevens, zoals uw leeftijd en thuissituatie verzameld, voor dit onderzoek met uw toestemming. De verzamelde gegevens worden uitsluitend gebruikt voor onderzoeksdoeleinden met betrekking tot Smart Interactive Mini Table. U heeft het recht om toegang te vragen tot uw persoonlijke gegevens en om deze te laten corrigeren of wissen. Ik waardeer uw tijd en bereidwilligheid om deel te nemen aan dit onderzoek.

Gelieve de vakjes van toepassing aanvinken	**Ja**	**Nee**
Deelname aan het onderzoek		
Ik heb de studie-informatie van _____-2024 gelezen en begrepen, of deze is mij voorgelezen. Ik heb vragen kunnen stellen over het onderzoek en mijn vragen zijn naar tevredenheid beantwoord.	□	□
Ik geef vrijwillig toestemming om deel te nemen aan dit onderzoek en begrijp dat ik kan weigeren vragen te beantwoorden en dat ik mij op elk moment, zonder opgaaf van reden, uit het onderzoek kan terugtrekken.	□	□
Gebruik van de informatie in het onderzoek		
Ik begrijp dat de informatie die ik geef gebruikt zal worden voor het verzamelen van eisen voor de bachelorscriptie.	□	□

Ik ga ermee akkoord dat mijn leeftijd en woonsituatie gebruikt mag worden bij het verzamelen van eisen voor de bachelorscriptie. □ □

Handtekeningen

_____	_____	_____
Naam deelnemer	Handtekening	Datum

Ik heb het informatieblad nauwkeurig voorgelezen aan de potentiële deelnemer en mij er naar beste vermogen van verzekerd dat de deelnemer begrijpt waarmee hij/zij vrijwillig instemt.

__Thirsa Chin-A-Kwie _____	_____	_____
Naam onderzoeker	Handtekening	Datum

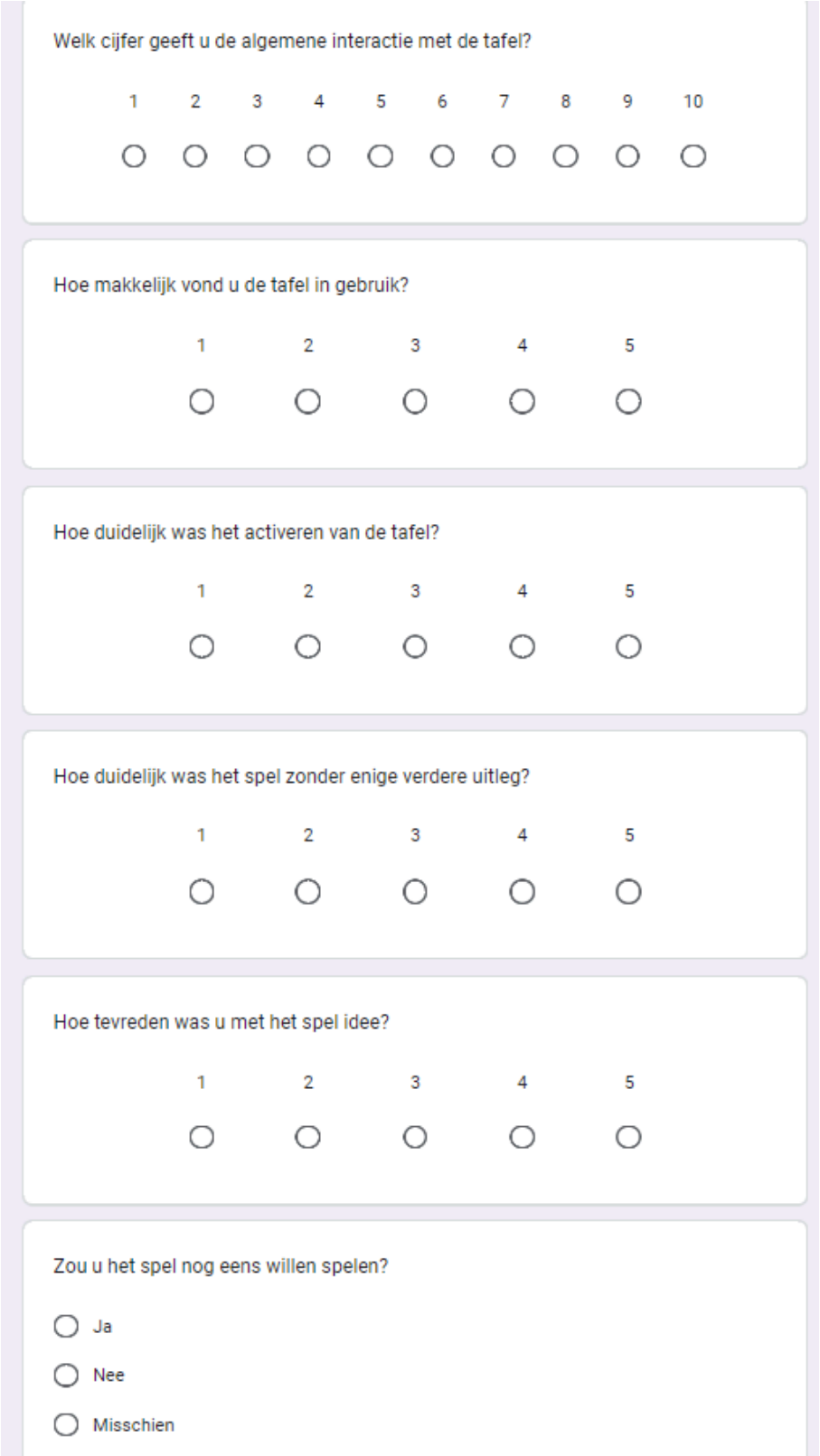
Contactgegevens voor nadere informatie of vragen:
Thirsa Chin-A-Kwie, t.l.chin-a-kwie@student.utwente.nl

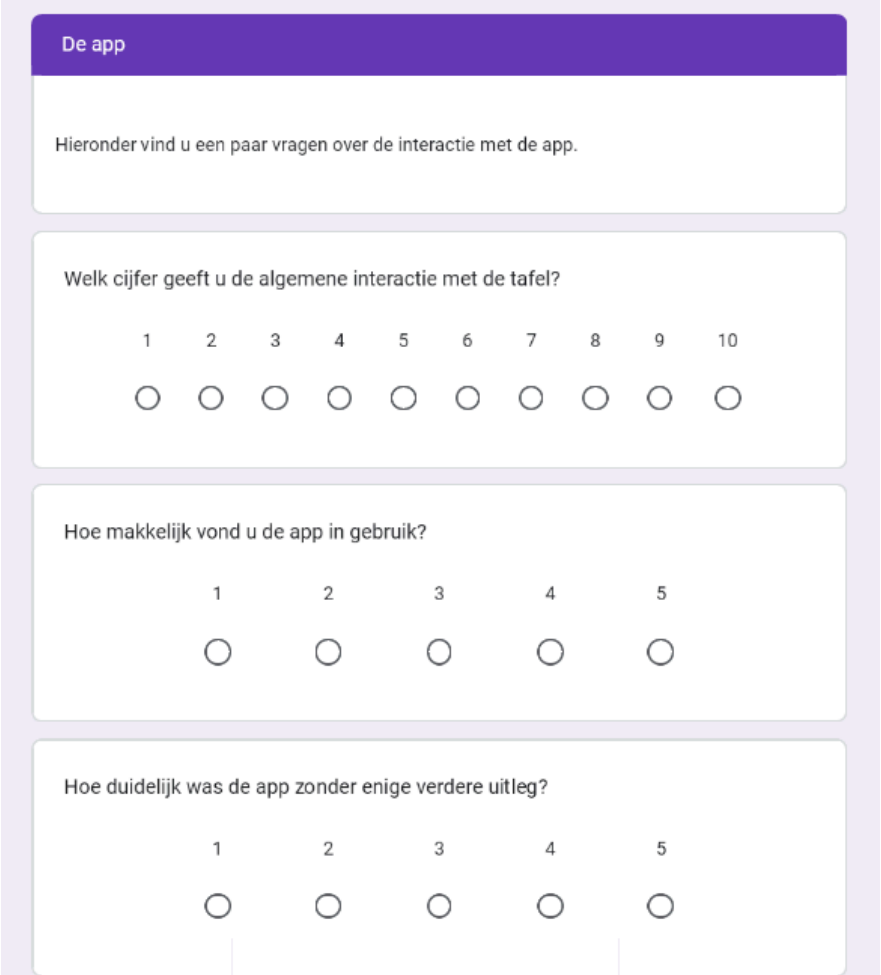
Contactgegevens voor vragen over uw rechten als deelnemer aan het onderzoek

Als u vragen heeft over uw rechten als onderzoeksdeelnemer, of als u informatie wilt verkrijgen, vragen wilt stellen of zorgen over dit onderzoek wilt bespreken met iemand anders dan de onderzoeker, neem dan contact op met de secretaris van de Commissie Ethiek/domein Geesteswetenschappen & Sociale Wetenschappen van de Faculteit Gedrags-, Management- en Maatschappijwetenschappen van de Universiteit Twente via ethicscommittee-hss@utwente.nl

Appendix 7: Evaluation forms

7.1 Likert scale questionnaire





7.2 Interview questions

Evaluatie interview vragen

De tafel

1. Wat vond u van de tafel?
2. Wat vond u positief aan de tafel?
3. Als u één ding kon veranderen, wat zou u willen veranderen aan de tafel?
4. Hoe makkelijk was de interactie met de tafel?
5. Wat vond u van de interactie met de ander?
6. Wat voor andere opties zou u nog willen toevoegen om te doen?
7. Hebt u zelf nog opmerkingen of toevoegingen?

De app

1. Wat vond u van de app?
2. Wat vond u positief aan de app?
3. Als u één ding kon veranderen, wat zou u willen veranderen aan de app?
4. Hoe prettig vond u de kleuren in de app?
5. Hoe makkelijk was de interactie met de app?
6. Wat voor andere opties zou u nog willen toevoegen om te doen?
7. Hebt u zelf nog opmerkingen of toevoegingen?