

BSc Thesis Creative Technology

Using an interactive diner table to influence eating rate in a social setting

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Abstract

This research aimed to slow down the eating speed of young adults. Eating too fast can result in overeating, which in its turn can result in longterm mental problems and physical problems such as obesity and other ailments. Since young adults (aged 18-30) are generally less obese than the average older age groups, educating the young adult group on their eating speed while they are still healthy could help change their eating behaviour in order to stay healthy in the future. By letting the young adults dine at a Sensory Interactive Table (SIT), on which animations based on user eating speed can be shown, young adults might be motivated to decrease their eating speed. This SIT is equipped with many LEDs under its surface and loadcells of which the latter was not used for this research. In this study, the LEDs under the surface of the SIT were used to test whether colors (green is good, red is bad) and elements of gamification (using game elements outside in a non-game context) had an influence on the eating speed of 12 participating students. Students were interviewed about their experience of eating at the SIT. The answers from these interviews were analysed using ATLAS.TI and the participants were filmed during the use of the SIT to study their (social) behaviour during the experience. Results showed that most self-reported fast eaters in this research did feel encouraged to change their eating speed during their experience at the SIT. Most participants even think the animations from the SIT could change their eating behaviour in the long run given they are intrinsically motivated to do so and they are completely sure what the animations aimed to influence.

1 Introduction

Overeating can happen during a dinner with others, this might even sound familiar to some. Eating too much every once in a while is acceptable, however, complications can arise when one structurally exhibits eating behaviour that exceeds the standard limit of food consumption the body needs to sustain itself. These potential complications as mentioned by the Dutch Ministry of Public Health, Well-being, and Sports [1] include obesity, diabetes, cardiovascular diseases, multiple types of cancer, osteoarthritis, infertility, and mental illnesses such as depression and anxiety disorder, among others.

Even though there are initiatives that promote and guide people through eating healthily and playing sports to reduce and hopefully prevent obesity, the National Prevention Agreement [2] mentions no usage of products or projects utilising products in order to encourage healthier eating habits. One such product that could be considered is an interactive diner table. One such table that can potentially deliver feedback on one's eating behaviour has already been developed by Haarman *et al.* [3], appropriately named the Sensory Interactive Table, or SIT for short. Briefly, this table can measure weight on the table and, when programmed, deliver visual feedback in the form of lights. Experiments surrounding this table were conducted in 2020 during G. Keizers [4] Master Thesis. This thesis describes that more physical experiments should be conducted using the SIT to see what effects exactly the table could have on one's eating behaviour. What is interesting about Keizers's findings is that participants asked about visual feedback concepts during his research showed a preference for gamified visual feedback. In Keizers's case this meant to achieve some sort of visual reward for altering eating patterns according to the visual feedback given. Both individual rewards or rewards gathered in duos proved to be motivating factors for participants when choosing which visual feedback concept they favoured the most. Since these gamified concepts proved to be motivating factors for participants to potentially change their eating behaviour, this bachelor thesis aims to look into more concepts that build upon Keizers's previous findings regarding game-like factors to promote, in case of this study specifically, a slower eating speed or rate for users.

There are many ways to go about effectively changing eating behaviour such as decreasing portion size [5], setting up mindfulness-based interventions [6], or actively showing the person who is eating real-time feedback. The SIT considered in this research falls under the category of showing real-time feedback that can potentially positively influence one's eating behaviour. This real-time feedback, in case of the SIT in the form of lights, will be investigated during this study.

During this research, the main goal is to program light patterns into the SIT and test whether this feedback can help those at the table decrease the tempo at which they eat. To be more precise, the main question is as follows:

”How can young adults in a social eating setting be motivated to eat slower by means of visual feedback from the interactive diner table?”

In search of the answer for the main question, and to support and dive deeper into the required material and literature research, the sub questions are set-up as follows:

What are the most prominent factors influencing eating behaviour in general when dining with other people?

What is considered eating ‘fast’ and ‘too fast’?

Why does it matter whether people eat fast?

Why consider young adults as the target audience for this research?

What is the state of the art of products that slow eating behaviour?

What is gamification, and why is it so effective?

What is the SIT and how does it work?

2 Background Research

This section aims to elaborate on the sub-questions formulated in the introduction of this thesis. These sub-questions give more context surrounding the graduation project and help gain more knowledge and insight into the topic that can be used to make valid and effective design concepts further down the line.

2.1 What is considered eating ‘fast’ and ‘too fast’?

Generally, classifying eating speed of people is something that becomes tangible during a meal with other people. Some people around the table eat faster than others, and can therefore be classified as ‘fast eaters’ in that situation. For every social eating event this eating tempo concept changes based on the group of people eating and social dynamics. Since the concept of defining eating rate heavily depends on social, psychological, and environmental influences, it is hard to come to a globally accepted measurement scale of what is meant by eating slow, average, or fast. Eating fast compared to others is of itself not a bad thing. When it gets in the territory of eating too fast however, short term as well as long term problems can occur that will be discussed later in this chapter. During this research, eating too fast is defined as eating at such a rate that the body can not process the food intake on time to let the consumer know it has had enough. This can result in overeating. Even though measurements of eating rate are difficult to establish, studies like that of van den Boer and Mars [7] have their own way of classifying what is considered slow, average, and fast eating based on the amount of bites taken per minute. As a comparison, a study conducted by Ohkuma *et al.* [8] split participants up in four groups namely slow, medium, relatively fast, and very fast eaters based on the participants’ view of their own eating behaviour in terms of eating rate. This difference in approach to observing eating rate in participants adds to the claim that no central measurement system for eating rate is in place. To conclude this sub-question, there is no standardised measurement scale that will help evaluate which people are considered slow, average, or fast eaters. Therefore asking the participants of experiments how they would rate themselves when it comes to eating tempo would be the best course of action considering other studies followed those same steps.

2.2 Why does it matter whether people eat fast?

As briefly mentioned in the introduction, systematically overeating can cause issues such as obesity, diabetes, cardiovascular diseases, etcetera [1]. Overeating and eating rate are vastly different variables though, so is there interest in researching eating rate as opposed to overeating? The answer is yes, it was found in studies by Robinson *et al.* [9] and Xia Zeng *et al.* [10] that eating rate has an influence on obesity, though more research is needed on the gravity of the influence. This does suggest however that apart from overeating, eating rate is positively associated with obesity which supports working on the main question of this research. So far, overeating and eating rate were discussed as separate variables,

but a journal article by Kakkinos *et al.* [11] found, in simplified terms, a positive relation between eating quickly and overeating. Therefore, it can be stated that eating fast can lead to overeating and from there, the issues posed by overeating also come into view as a result of eating fast. There is an interesting question to ponder about when investigating literature on why eating slower generally improves health. Is there such a thing as eating slow to the point it can cause comparable harm as eating too fast? This question seems to be not previously investigated, or alternatively research confirming eating too slow is not a problem might not be relevant to look into further, and therefore no literature can be found.

2.3 Why consider young adults as the target audience for this research?

The first answer to this question is a personal one. From experiences with friends and housemates, I observed that in some groups I would consider myself an average or slow eater, while in other company I ate fast compared to others at the dinner table. This difference in self-labelled eating speed as well as possible subconscious changes in eating behaviour when with peers of my age made me curious about investigating whether the same happens in other social circles surrounding young adults. The more grounded in literature answer is that according to numbers presented by CBS [12], an organisation that provides statistics on the governments request, suggest that the age group between 18 and 30 years old has the least amount of moderate and severe overweight population. Compared to older age ranges, the 18 to 30 year olds have at least 12,5% less cases of moderate overweight people and almost 3% less cases of severe overweight people. Furthermore, in a study by Shah *et al.* [13] it was shown that slowing ones eating rate proves to be more useful on people in the normal weight category as compared to people obese/overweight group. These findings could suggest that building healthier eating habits from a younger age can have lasting benefits in terms of eventual subconscious eating behaviour.

2.4 What are the most prominent factors influencing eating behaviour in general when dining with other people?

As established earlier during defining what is considered fast eating, it is difficult to find a consensus on how to measure eating rate. The reasons for this are the many factors influencing ones eating behaviour whether it is social, environmental, or psychological and general health related. These three generalised factor labels will be discussed starting with social factors such as relationships between people, then environmental factors including music and light, both luminance and colour are mentioned, and lastly psychological factors such as current health state of one's body and colour association are discussed. A brief discussion on what to do with the factors researched and how some are directly related to the experiments and SIT concludes this subsection.

2.4.1 Social Factors

As supported by an article by Higgs and Thomas [14] that considered many studies in the field of eating behaviour in social settings, factors such as social and cultural norms and values, stereotypes set by society, as well as the behaviour and expectations of others around the table have influence over one's actions while eating. These social factors should not be overlooked since a study by Cruwys *et al.* [15] found when looking at 69 social modeling studies, which briefly explained is learning behaviour by observing others, that these social factors are large determinants for ones food intake. Another article, this one by Higgs *et al.* [16] found that participants self-reported that they, overall, would eat less in company of a stranger or acquaintance, and the same amount of food, if not more, when eating a regular meal with family or friends. A study conducted by Christakis *et al.* [17] poses a more detailed look into interpersonal relationship's effect on overall weight which ties social modelling to increased obesity cases. According to Christakis *et al.* [17], increased risk of obesity is most prevalent in relationships between friends, whether it is one's own friend or a mutual friend, the latter having the highest increase of risk of developing obesity. This obesity claim is further proven by a systematic literature review done by Fletcher *et al.* [18]. Their literature review focused on secondary school students and the relationship between their social network and their eating-related behaviours. It was found that the young people were more likely to pick their friends if they had the same characteristics [18]. It was also noted that the immediate social circle within a young female's life tends to affect their eating patterns. Examples of these are rapid weight loss and binge eating. The young males were also found to be susceptible to consuming more fast food within their peer groups [18]. Overall, there seemed to be an effect on teenagers eating patterns based on their friendships. Furthermore, though not quite of influence for this specific research, in a study done by Tofteland [19], the participants, who were college students, recall having neutral dietary habits in their younger years. This study shows that there was a statistically significant difference between eating behaviors under their own volition versus when they are affected by parents [19]. Parenting styles affect how they handle their eating habits. It has proven that authoritative parenting style have a beneficial effect on eating patterns whereas neglectful/permissive parenting styles affected their eating behaviours negatively [19].

2.4.2 Environmental Factors

Environmental factors with relation to social factors are portion and bite size. Both factors speak to the consumers' sense of comfort among their peers to eat bigger portions and bite sizes. Complete environmental factors include light and light color changing the food's perceived colour as supported by Yang *et al.* [20], music pace as seen in a study by Sato *et al.* [21], among other factors such as cutlery and dish colour which prove to have a relation to eating behaviour according to Spence's [22] research. This relation being that colours of surrounding objects on the dinner table can influence perceived appeal, taste, and how

much of the meal a person ends up consuming in total. Interestingly, and contrasting to Yang *et al.* finding previously stated, generally light colour does not change ones willingness to eat food according to a study conducted by Cho *et al.* [23]. Furthermore, his research found that impression and intensity of the meal's taste were not affected by the light colour. These opposing results from studies could be explained by that the research by Yang *et al.* [20] focused mainly on apples and not other foods. The specificity of that study could explain the difference in conclusions by the the studies, however, more research regarding light colour and its effect on eating behaviour has to be done.

Further in the light and light colour influences, ambient light and its effect is especially interesting for this research. Light luminance and light temperature can both have effect. In two studies by Wansink [24] and Wansink and Ittersum [25] it was seen that there is a significant difference between regular 'fast-food' dining and fine dining in terms of effect of light colour and luminance on eating behaviour. In the fine dining groups where soft and warm light was present in the dining room it was seen that participants ate longer, but less in total and at a slower rate compared to the participants in the fast-food areas where harsh and bright light was present. Furthermore, in a study by Suk *et al.* [26] it was seen that yellow light stimulates one's appetite more than red or blue light. Additionally, it was found that white light with coloured nuances are preferred over pure coloured light. Suk *et al.* [26] also accounted for the influence light colour can have on appetite when compared to the actual food on the table. When the colour of the food and the lighting are similar, appetite was stimulated, whereas dissimilar light and food colour discouraged appetite.

2.4.3 Psychological Factors

Lastly, psychological and general health related factors include current state of obesity, diabetes, cardiovascular disease, etcetera, as well as, former experiences with foods, time of day during which a meal is eaten, and emotional state as seen in a study by Macht *et al.* [27] that discovered students experiencing negative emotions such as stress and anxiety tend to eat more to rid of these feelings than when they feel more positive emotions. Though already discussed in the previous paragraph, colour of itself and what emotions colours can evoke is also considered a psychological factor. Studies such as one by Takahashi and Kawabata [28] found that positive emotions are often related to high brightness and saturation of colours. Additionally, colours such as red are often associated with panic, fear, and other general negative emotions whereas yellow is most associated with pleasant and positive emotions such as happiness as found by Sutton and Altarriba [29]. On more neutral colours, a study by Clarke and Costall [30] found that especially blue and green and associated with calm, peace, and neutrality. Things often used in combination with colour are shapes. A study by Larson *et al.* [31] found that participants felt uncomfortable when faced with downward facing V shapes, but circles were seen as pleasant. upward facing V shapes were also found to be unpleasant, but less readily than downward facing

ones. Interestingly, when the downward facing shapes shown to participants did not have pointed acute angles, it was not experienced as unpleasant. This finding suggests that the presence of pointed acute angles in shapes could be factor that gives people a feeling of unease [31]. For this research it is good to have a grounded comparison between colour and shapes in terms of which is more effective, especially considering the SIT's way of providing visual feedback. An article by Jin *et al.* [32] describes that between colour and shapes, colours improve cognitive performance more than shapes, a helpful finding for the ideation process later down the line.

2.4.4 Discussion

Looking back at all factors discussed above, there are quite some factors capable of influencing one's eating behaviour for better or worse. Factors most important to keep in mind or manipulate for this research include the social relationships between participants, environmental factors such as objects' colours seen from ones peripheral and music presence, already existing bodily or psychological anomalies in participants, and lastly, lighting luminance and colour, and shapes used by the SIT to best encourage slower eating. For this research it is important to consider most factors as variables that could have influence over the end results, this however will be further delved into in Chapter 3's requirements section.

2.5 What is the state of the art of products that slow eating behaviour?

The SIT is not the only project which can be utilised to investigate eating behaviour and potentially altering it. Other projects have attempted to conceptualise a product that can influence eating behaviour, and even products with this exact aim have been brought to the market.

2.5.1 Products on the Market

Starting off with the products, smart cutlery such as a spoon or fork [33] that provides the user with feedback in the form of a small light blinking as well as a vibration to signal the user is eating too quickly. In case of the fork by HAPIlabs, this product has the addition of an online tracking tool that helps the user keep track of whether they are eating too quickly. Interesting to note is the study by Hermsen *et al.* [34] that conceptualised, created, and tested a smart fork that is remarkably similar to the HAPIfork. Though not as specifically geared towards slowing eating rate, mindfulness applications on smartphones do have to be mentioned in this section since there are apps out there that can spark awareness about ones eating rate, though these applications are more passive compared to other products and projects in this section.

2.5.2 Research Projects

When it comes to other cutlery related products, a project by Chen *et al.* [35] designed and made a prototype of a transforming spoon in an effort to reduce eating rate and bite size based on the food that is on the spoon. Results under ideal circumstances suggested a positive relation between using the transforming spoon and reducing both the participants' bite sizes and eating rates. As briefly mentioned before, Hermsen *et al.* [34] designed and tested a smart fork with the intention on slowing the user's eating rate. Participant results proved positive in the sense that participants felt more aware of their eating rate, and all but one participant slowed their eating rate. A thing to note though is that there were participants that got frustrated with the slower eating and would much rather return to their higher eating rate. This could be an indication that either the smart fork needs more work, or that this medium of trying to slow down eating rate proves less effective than others. Perhaps a project that is more aligned in the department of visual feedback that the SIT also aims to investigate are the smart chopsticks developed by Nakaoka *et al.* [36]. Through equipping chopsticks with a camera and complimentary programming, Nakaoka *et al.* [36] were able to let a user of the chopsticks paint a virtual canvas based on the user's eating rate and choice of dishes in terms of colour, assuming a variety of colours is in line with a balanced meal. The eating rate would determine the amount of smudging of colours in sections of the canvas, while the colours of the dishes chosen by the user would represent the colours that can be added to the canvas. So far no experiments have been performed using the smart chopsticks, but it could potentially give the user motivation based on artistic interest to change their eating behaviour. Though less defined than previously mentioned projects, a literature review by Limone *et al.* [37] looked into the current state of serious games and their possible influence on eating behaviour. Briefly, serious games are games that have been created with the purpose of the game being something than solely entertainment. Examples of this are making games to teach a user certain skills or convey knowledge. It was found that among different age groups that serious games can have a significant effect on healthy eating behaviour and food intake. Furthermore, these serious games help the user gain knowledge on healthy eating which promotes future healthier food and behaviour choices. Interesting to note for this research is that Limone *et al.* [37] also found that especially feedback and rewards were most frequently seen as influencing factors according to the self-reported evaluations across all studies mentioned in the review. An elaboration on serious games and, in a way their counterpart and more applicable to this research, gamification is required to put this knowledge to use in this research project. This more detailed look can be found in the next sub-question.

2.5.3 Discussion

A connection between the research projects and products on the market can be spotted in the smart fork developed by Hermsen *et al.* [34] and the HAPIfork. Though hard to pinpoint if there is a connection between the two, it is undeniable that both parties saw an

interest for visual and haptic feedback to alter eating behaviour. Furthermore, interesting to note is the possible effectiveness of serious games on eating behaviour according to Limone *et al.* [37] literature review. Especially the feedback and rewards mechanics used in serious games also give more weight to Keizers's [4] choice of concepts trying to integrate gamified elements into these visual feedback ideas. Lastly, Nakaoka *et al.* [36] research on smart chopsticks by speaking to one's artistic motivations is an interesting take to change eating behaviour. When developing concepts for the SIT, the use of artistic vision and aesthetics used in the visual feedback could prove just as valuable as gamified visual feedback. This statement however would need more research to claim true, and can be read about in more depth in the next section.

2.6 What is gamification and why is it so effective?

In the previous State of the Art section there were mentions of serious games potentially being impactful when it comes to changing eating behaviour, as well as the term 'gamification'. As a brief recap on what a serious game is, the following definition stated by Abt [38] gives a still up-to-date clarification.

We are concerned with serious games in the sense that these games have an explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement.[38]

Some uses for the games that Abt [38] refers to can include teaching skills to users, sharing knowledge with users or 'gamifying' regular tasks such as physical exercise, chores, etc. This last mention of the word 'gamifying' refers to 'gamification' which in the words of Deterding *et al.* [39] means to use design elements characteristic for games in non-game contexts. An easy to understand example of gamification is the use of leaderboards, experience points, and achievements in apps such as 'Ommetje'. Briefly, this app tracks how many kilometers and how frequently the user walks and based on those gathered data, the user receives achievements that in case of 'Ommetje' lead to experience points which then result in the user being put on a leaderboard to see how well they are doing compared to other users of the app. In the field of corporate and educational training, a study by Wang *et al.* [40] investigated the most effective gamification elements to use during training by going through an iterative process of asking expert opinions on the matter. From this study, twelve elements were seen as most effective according to the experts' opinions. These elements from most important to less, but nonetheless also important include: Integration with training goal, Rapid feedback, Game rules, fairness, task with challenging goals, teamwork, points or scoring, time pressure, increasing difficulty, experiential activities, competition, and freedom to fail [40]. In the end, gamification strives and is successful in engaging users more in whatever medium the gamification is applied to. It is used in apps such as previously mentioned 'Ommetje' as well as other lifestyle apps, social media (likes, comments, etc.), education, corporations, among many more fields.

The next question becomes: Why do we feel so motivated by gamification? A study by Sailer *et al.* [41] saw that participants that were at the very least slightly aware of the presence of the gamification elements felt that some psychological needs were met. Specifically, these needs included satisfaction for the need of feeling competent as well as perceived task meaningfulness. These results came specifically from the gamification elements of leaderboards, badges, and performance graphs that acted as feedback on the users' actions. Furthermore, elements such as stories, avatars, and teammates caused for an experience of social relatedness. These elements shared in the group introduced a shared goal and led to feelings of relevance [41]. Important to note is that the engagement factor and efficacy of gamified elements comes down to the person exposed to them. Someone who is not used to exposure to gamification would likely have less significant outcomes than a seasoned gamer that knows what is to be expected and gained from the experience.

2.6.1 Player types

With gamification also comes looking into what a target audience's needs are. Naturally, this differs per person. To get a clearer picture of how to cater to one's needs in terms of gamification use, sorting users into player types is a helpful tool. Bartle [42] can be seen as one of the pioneers defining player types in the early stages of this concept. According to Bartle [42], there are four player types, these being: Achievers, Explorers, Killers, and Socialisers. Briefly, achievers have a focus more related to obtaining status and achieving goals quickly and/or completely, explorers seek to explore and discover in hopes of uncovering something new, killers have a focus on winning, achieving ranks, competition, and reaching heights on leaderboards, and lastly socialisers put value in social aspects such as chats, network development of friends and contacts, going at tasks together, etc. Stereotyping each player into these four boxes was a good start in the process of developing more refined and specific player types. Using only the four stereotypes by Bartle [42] would not be the best choice though since most people fit into more than one of the stereotypes. In more recent times, other studies have been conducted that work further upon Bartle's work to identify more and different player types to more accurately describe variations of Bartle's original four types. One of these studies being Tondello *et al.* [43] research and validation on six player types instead of Bartle's four. Though there are differences, the similarities are also evident. Tondello *et al.* [43] describe the following player types: Philanthropist, Socialiser, Free Spirit, Achiever, Player, and Disruptor. Philanthropists tend to find pleasure in helping others in terms of orienting in new situations and wellbeing, and sharing knowledge. Socialisers are very similar to Bartle's socialisers since these player types like interacting with others, being part of a team, enjoying group activities, etc. The free spirits are similar to Bartle's explorers since curiosity is key, trying new things brings fun, and following their own path is the way to go. Achievers, much like Bartle's achievers, like mastering difficult tasks, they like to complete these tasks, and defeating obstacles is part of the achievers' ways. The player type 'players' are motivated by rewards and like to think about the risk versus reward mechanic when it comes to carrying out tasks. Lastly,

disruptors like to provoke, try to actively look for loopholes, and ignore the rules where possible. Using these player type theories can help guide and determine for which audience you are building an experience or prototype, but in the end catering to all of ones needs becomes borderline impossible when not mixing player types together.

2.6.2 The connection between persuasive design and gamification

Though certainly not one of the first things one would think about when being presented with the term ‘gamification’ and how it works, this term proves useful in the field of persuasive design in general. When it comes down to it, gamification elements try to engage the user in a way where the user feels inclined to keep using the application, device, etc. that uses these gamification elements. Depending on the context where gamification is used, the aim of its usage apart from engagement could also entail altering the user’s behaviour or attitude. This given brings an interesting term forwards, this being ‘persuasive design’ and ‘persuasive technology’. To briefly explain, a persuasive system is a system with the aim of changing a user’s behaviour and/or attitude [44]. A paper by Oinas-Kukkonen and Harjumaa [44] describes design principles and functionalities that are needed and useful to create a persuasive system. When looking at these design principles, some lines can be drawn between these principles and gamification elements. For example, in helping a user complete a primary task set by a system, having the system tailor its information to the users need is a valuable design principle to follow. A parallel between this tailoring and the gamification element of feedback can easily be drawn seeing as they serve the same objective. Another one of these task support design principles is self-monitoring. This principle helps a user keep track of their performance or status. The gamification equivalent of this principle could be a healthbar (status) or progressbar (performance). Similar to this principle and gamification element in the design principle of the system offering the user praise. Showing images, symbols, or sounds related to the user doing a good job when they are is seen as motivating feedback. In game worlds, this principle can be seen when killing an enemy where the player is rewarded with an accomplishment sound or cheers as well as text or images rewarding the player for their efforts. There are many examples that draw parallels between persuasive design and its connection to gamification, however, one more example that can be especially interesting for this research will be mentioned. A persuasive system can also make use of social features to engage users. Two of these include cooperation and competition. Both these aspects seek for social interactions between users to keep each other hooked on wherever these components are used. Naturally, in gamification these elements are also often seen, using the same terminology as well. A subtle form of competition can be seen in the earlier mentioned ‘Ommetje’ application. This app is also a persuasive system since it tries to get users out and about in terms of going on walks in order to stay healthy. The rewards, and clear gamification elements connected to these, consist of ranks and leaderboard positions among users of ‘Ommetje’ to encourage the users to keep trying to one-up each other with the eventual goal of getting users to go on walks.

2.7 What is the SIT and how does it work?

The SIT that was developed by Haarman *et al.* [3] is a round dining table with load cells and LEDs just below its surface. A maximum of six people can take place around it. There are 199 individually-controllable hexagonal modules, all of which are equipped with one load cell that can each handle a maximum weight of 5kg. As for the LEDs, the LED panel contains 42 digital RGB LED strips spaced neatly apart from each other. What can the SIT be used for? In Haarman *et al.* [3] own words:

the SIT allows us to study: (1) the eating behaviors of people in a social setting, (2) the social interactions around the eating behaviors of people in a social setting, and (3) the continuous cycle of feedback through LEDs on people's eating behavior and their response to this feedback in real time, to ultimately create an effective dietary support system[3]

During tests and experiments, the loadcells can send feedback that can be transformed into graphs that, when interpreted correctly, can tell the researcher what actions happened at the table. The LEDs can be controlled individually from the load cells, but using the load cells' feedback as prompt for the LEDs to react to, that's where interesting experiments come in. Though the table is not 'smart' in the form of implemented AI, correct interpretation, and in its turn, programming of visual feedback into the LEDs, makes for the illusion of a 'smart' table and an infinite amount of configurations and experiments.

3 Methods and Techniques

For this project, the Creative Technology Design Process by Mader and Eggink [45] which can be seen in figure 1 is utilised. Though most often used when designing prototypes from scratch, this design process proves useful for ideating, establishing, and ultimately creating visual feedback concepts for this particular graduation project in a somewhat guided manner.

First, user/stakeholder requirements was setup using both interviews with these stakeholders, as well as literature found and discussed in Chapter 2 of this research. Next up was the creation of concept mock-ups and sketches using the established requirements to get a feel for what kind of visual feedback would be most effective to bring to the SIT. These mock-ups were discussed with both the graduation project supervisors as well as the stakeholders to see whether the created mock-ups held up, needed improvement, or should have been discarded entirely. After conducting user interviews with the stakeholders using the concept mock-ups, one of the mock-up concepts was picked as the final concept to actually program into the SIT. From here, the concept that was brought into reality by programming it into the table and fine-tuned where needed. From this point onward, the experiments with users/stakeholders were held to gather results in interview and observational formats. Lastly, these results were analysed using an inductive thematical analysis approach to see whether the final concept yielded positive or negative results and whether other notable occurrences happened.

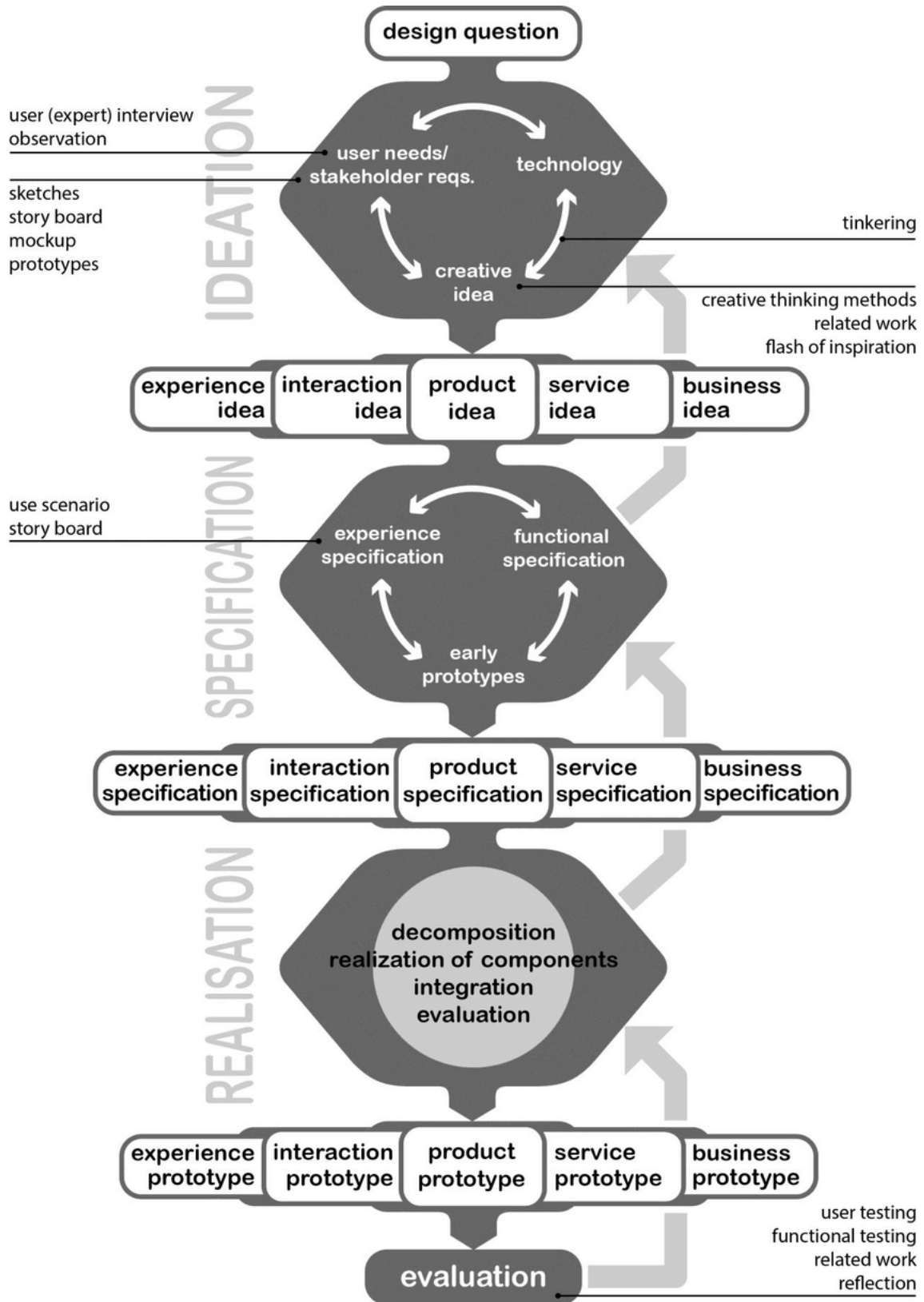


Figure 1: Creative Technology Design Process

4 Ideation

4.1 Stakeholders

This section briefly discusses stakeholders such as the researchers of this project, participants, and future researchers.

4.1.1 Participants

This project could give participants, the primary stakeholders for this project, insights on how their eating rate is considered too fast to be healthy, or already a healthy rate. For some participants it could mean a small nudge or eureka moment towards a healthier eating style than before they interacted with the SIT.

The target audience, or in other words the participants for this study's experiments, consist of University of Twente students living specifically in student houses on and around the campus of the University of Twente in order to test social eating behaviour during the experiments with the SIT. 'Around campus' is meant as students living in student houses in either Hengelo, or Enschede. The assumption made is that these students frequently eat together with their housemates because of their accommodation where 'frequently' and 'together' mean that the students have at least 3 meals together per week with at least 5 other housemates. So why choose these students specifically? There can be major differences between fast and slow eaters during a student house meal. To explain the feelings this difference can evoke, imagine the following scenario:

Diana and Jonas are eating together with their housemates for dinner today. Halfway during the meal, Jonas is done eating while Diana has only finished half of her plate. When Diana looks around, she notices most of her housemates are already almost done eating or have cleared their plate already. This gives Diana a sense of pressure that she needs to eat more quickly. It is the kind of pressure as if you have a deadline to catch, definitely not a pleasant feeling. Diana starts to think about possible reasons her housemates seemed in her opinion to be in such a hurry. Do they have deadlines or plans for tonight? Do they just want to have the luxury of an early and longer evening? Is Diana the person holding them back and possibly being an annoying factor in this regard? Is this the reason some housemates are already putting their plates near the dishes?

Evidently, it can be quite uncomfortable to be one of the last if not the last person to finish their dinner. Furthermore, if a conversation is going on between the people that are done eating and one person is still eating, this person might want to jump in to the conversation, but does not because they might feel like they have to finish their food first. This can result in a small social disconnect. It's not necessarily something bad, but it can be avoided if everyone somewhat was eating at the same pace. This scenario paints a picture of why student houses specifically are chosen as the target audience without the literature supporting why eating fast should not be done. Apart from this scenario, the literature does also support the choice of this target audience. Seeing as most students on

and around campus are part of the group of people aged 18-30 years old, which is the least likely to be obese age group and thus building healthy eating behaviour to keep this risk low is helpful, this audience is a valid choice as the target audience of this research.

Important to note is that there were two categories of participants, those that help give feedback on the ideated concept designs, and those that actually participated in the experiments related to the SIT. Naturally, both participant parties were part of the target audience. To briefly explain the participant split, the participants that were asked to give feedback on design concepts were told about the goal of the research and the animations' aims, but not in full detail. Instead of relaying the aim of changing eating speed, the participants were told the concepts were meant to influence an aspect of eating behaviour in general. It was asked to these participants whether this goal could be achieved with the current concept design. During the experiments with the SIT, there would also be no explicit importance laid on eating speed in order to combat subconscious changes in participants' eating behaviour based on what they were told the study revolves around. The difference between the participants from the ideation user interviews and participants of the experiment is that if the participants from the user interviews would already know what to expect from the experiment. For the actual experiments, there should be no bias from the participants from previous encounters with the SIT's animations.

4.1.2 Current researchers

As Haarman *et al.* [3] describe in their paper, the SIT is meant to study eating behaviour of people in a social setting, the social interactions around eating behaviour of the people at the table in a social setting, and lastly the effect of the visual feedback the SIT gives on eating behaviour of those around the table in real-time to ultimately create an effective dietary support system. Especially the last statement is a good reason to consider current researchers as stakeholders since this research can offer insights on what visual feedback from the table can be effective to slow ones eating rate, possibly effectively enhancing ones eating behaviour.

4.1.3 Future researchers

Many studies can be done using the SIT. In the field of eating rate, this research could be used by future researchers to further develop concepts that were first introduced in this project, either as reference, or as a starting point when it comes to improving concepts mentioned here. Additionally, apart from eating speed, other occurrences during the experiments can be read about in order for researchers to get a better idea in what ways participants felt influenced by the SIT. Furthermore, since this research captured quite a list of other studies when investigating Chapter 2, this work could be used as literature review in terms of a small collection of differently categorised factors that influence eating behaviour.

4.2 Design Question

What kind of visual feedback is most useful to create and implement into the SIT and what problem does it solve?

The second part of this question can be answered here. When considering the user scenario that was sketched in the participant stakeholders section, it is clear the situation can use some improvement. Without the SIT as dinner table, the dinner situation is likely to turn out as a usual occurrence for Diana and Jonas. Perhaps for the other housemates who are done quickly with eating like Jonas, the situation might also be not optimal since they might feel somewhat required to stay seated until everyone is finished eating. If in the scenario the regular dinner table were to be replaced with the SIT, assuming the implemented animations help reach the goal of a more streamlined eating experience for all in terms of eating speed, this situation could turn out better for all housemates around the table. The slower eaters, one of which is Diana, do not have to feel the time pressure and uncomfortability of being the ones last to finish a meal, and the faster eaters will not have to be annoyed at sitting their time out and do not overeat themselves. For average speed eaters, nothing changes. To reiterate what is considered average or fast eating, as mentioned in the background research, no statistics or measurement scales are available to measure eating speed. Therefore, in this study a measurement scale specifically for this study was designed which can be read about in chapter 7 in greater detail. All in all, introducing the SIT as a tool to use during dinners in student houses with housemates could prove useful to both stimulate a nicer atmosphere for all, as well as deter faster eaters from overeating.

4.3 Parameters and Requirements

For this section, the parameters, requirements, and stakeholders associated with the ideation of visual feedback concepts are discussed. Furthermore, the previously mentioned factors influencing eating behaviour that can be found in Chapter 2 need at the very least be taken into account as static variables that cannot be controlled or are out of the scope for this project. If not for the use of setting boundaries for what this project considers being present, but will not be further looked into, factors influencing eating behaviour will be purposefully used and manipulated when designing visual feedback and constructing the experiments.

4.3.1 Parameters

The parameters meant in this section are the factors that can influence eating behaviour. Some of these factors can be manipulated such as music, light, and colour of surrounding objects. Other factors however, such as behaviour between users at the dining table or starting point satiety cannot be manipulated by the researcher. It is key to list as many parameters that cannot or simply will purposefully not be influenced. By keeping track of

all parameters that could have influence over the experiments' results, it is both clearer and easier to discuss potential outer influences during the experiments later down the line. Naturally, making a list of factors that the research *can* influence is also important to keep an overview of what can be manipulated using the SIT or surrounding environment. The categories of these factors of influence are labelled the same as in Chapter 2, namely: Social and Environmental factors. Psychological factors such as current health status or diet choices could be listed as well, but considering during participant selection, factors like these will be asked about in order to pick out suitable participants prior to the experiments, this category is kept outside the scope of the listed parameters with relation to the SIT experiment.

Factors that cannot be influenced by the researcher:

Social factors:

- Upbringing
- Social and cultural norms and values
- Behaviour and expectations of others around the table
- Familiarity with others around the table in terms of interpersonal relationships between housemates

Environmental factors:

- Bite size
- Perception of food based on other surrounding smells
- Room colours

Factors that can be influenced by the researcher:

Social factors:

- Familiarity with others around the table in terms of inviting student houses

Environmental factors:

- Portion size
- Other items on the table (pans, drinks, telephone, etc.)
- Perception of food based on surrounding music and ambient light

Psychological factors:

- Time of day during which the meal from the experiment is eaten
- Subconscious emotional state based on surrounding music and ambient light
- Subconscious emotional state based on light colour, shapes, and luminance from the SIT

4.3.2 Requirements

This section lists requirements for the visual feedback concepts used in experiments based on literature discussed in Chapter 2. These requirements are set-up using the MoSCoW method which lists requirements from absolute must haves in the concept to elements the concept simply will not have. This method was chosen seeing as the researcher has experience using this method for other projects as well as the method's ability to quickly map what elements a prototype must have, definitely will not have, and in between functions or features that could be added based on user interviews.

Must have:

- Gamification elements (feedback, rewards, associated to next point: colour)
- Use of different light luminance.
- Ease of understanding/readability by user

Should have:

- Colour theory associated with emotions
- Simple concept (simplicity is key, for both user and programmer)

Could have:

- Ease of altering code based on amount of participants around the table
- Adaptability of concepts based on amount of participants around the table

Will not have:

- Visual feedback meant to shame or embarrass users
- Epilepsy inducing light patterns
- Build-in functions that allow for types of colour-blind people to have the same experience as non colour-blind individuals

4.4 Ideation of concepts

This section discusses why gamification specifically was considered as an element to use in concepts as well some concepts the researcher envisioned that might have effect on slowing users' eating rate based requirements earlier established. The researcher's vision for how the concepts work stemmed from personal experience with gamification, serious games, and their different stages of complexity and game likeness. The concepts ideated and explained in this section were evaluated through user interviews from which one concept was derived to use as the final concept. This user evaluation can be found after the sections describing the the concepts and how they function.

The following words and phrases are used to explain mechanics occurring in one or more

of the concepts:

Weight Peaks: The amount of times a person either slightly presses into the table to grab another bite, or the amount of times an amount of weight equal to a bite size leaves the table. To determine which of these two ways proves best as a measurement system will be discussed with supervisors and be further explained in next chapters. These measurement systems are meant as a way to measure whether a person eats too quickly as opposed to measuring total weight decrease over time which is better suited for gauging whether a user is eating too much.

Ripple: A spreading out burst of dimming and brightening of LEDs to signify a change of some kind on the SIT.

4.4.1 Gamification elements eligible for use in concepts

First and foremost, it is a valid assumption that the target audience has run into gamification elements before when using social media, using lifestyle or mindfulness applications, or interacting with contemporary technology. There are naturally also cases of the target audience interacting with the purest form of gamification namely where gamification originally was derived from, this being (video)games. This assumption is pivotal to note since according to Sailer *et al.* [41] it was seen that the engagement and efficacy of exposure to gamification elements comes down to how well versed someone is with games and gamification based on previous interactions with these two factors.

Seeing as gamification helps in feeling competent and helps achieve task completion in terms of feedback given in the form of badges, leaderboards, and performance graphs, this feedback on user performance seems to be a good tactic to influence users around the SIT. Showing a leaderboard and badges would prove to be difficult using the SIT, so feedback on performance will be given in other ways than these two specific elements. Examples include changing colours that have good associations such as green and blue, or showing some sort of victory animation. Furthermore, introducing a teammate mechanic leads to users having a shared goal which helps feeling social relevancy and thus task engagement. Concepts using these mechanics could prove to keep the user engaged and paying attention to what is displayed on the SIT. The same could hold true for a competition mechanic seeing as this, like teamwork, was mentioned in the top twelve most important gamification elements used in educational and corporate training fields. Other elements from this top twelve that can prove effective are rapid feedback and experiential activities. Since this study's nature revolves around providing real-time feedback to participants as well as the experiments with the SIT being an experience in themselves, the rapid feedback and experiential gamification elements are omnipresent in every design concept. For this reason, these two gamification elements are not mentioned in each concept seeing as the concepts are not differentiated by these elements.

4.4.2 Concept 1 King of the Mountains

The first concept uses the following influential factors:

- Gamification element: Competition among users

How the influential factors in this concept make the concept a valid candidate as a final concept:

This concept relies most on the gamification element of competition between users. This element gives all users the same goal, but only one can achieve being ‘the best’. Like cooperation among users, the twelve most prolific gamification elements to use according to Wang *et al.* [40] study also includes competition, though it is listed less high than cooperation. The expectation is that the competition element will keep the users engaged with this concept since a sense of achievement is likely to be sparked among users. Naturally this also depends on the kind of user around the table, so going for this individual central approach might not be as effective on all users like cooperation. However, the competition element can start discussion among the group, acting as a factor that can hype others up to become the winner. Unfortunately, this competition element is the only well-supported gamification part or generally stand-out factor in this concept which could to be insufficient during the user interviews. This concept also uses the gamification element of ‘performance status feedback’ in showing how a user’s eating behaviour is affecting their piece of the table over time, however this element has a less strong influence as a gamification element as in it is not present within the top twelve listed by Wang *et al.* [40]. Furthermore, this element is present in all other concepts as well anyway, so to name it an element making this concept one-of-a-kind would be incorrect. For this reason, this gamification element is also not mentioned in this concept’s ‘influential factors’ list above this paragraph. In terms of player types, it is expected that Bartle’s [42] killer player type would fare best with this concept seeing as competition and winning this competition are this concept’s key elements.

How does this concept work?

Every user (6 in total) starts with roughly 1/6th of the table as their own ‘mountain’. The users’ mountains all have different colours to easily differentiate between the users as can be seen in Figure 2. Furthermore, in the figure it can be seen that each user has a certain amount of modules they can call their own. This can be seen in the coloured numbered bulbs right outside of the table. Only the module in the middle of the table is a bright white light and not claimed by any of the users.

Every 30 seconds, the middle module of the table sends a ‘ripple’ of luminance stretching outwards, affecting all users. When a ripple occurs, one piece of each of the users’ mountains ‘crumbles’. This means that modules closest to the middle of the table loses it’s vibrance to indicate it’s gone for all users’ mountains. The gamified feedback comes in when a user has a higher amount of weight peaks around their plates versus time than what is established

as ‘average’ amount of weight peaks versus time. If too many weight peaks occur in a given time frame that is yet to be established, a ripple from the user’s side towards the middle of the table is created, effectively making the user responsible for making their mountain crumble a bit more. More broken down mountains can be seen in Figure 3.

A winner is chosen based on the user with most modules left after the duration of the meal. Alternatively, if a user lost all their mountain modules, the game is stopped prematurely and a winner is chosen based on the user with the most active modules left on their piece of the table. Assuming purple wins, the middle module that was previously white turns purple and from there the purple spreads across the table in a circular pattern, showing off the purple user’s victory as can be seen in Figure 4.

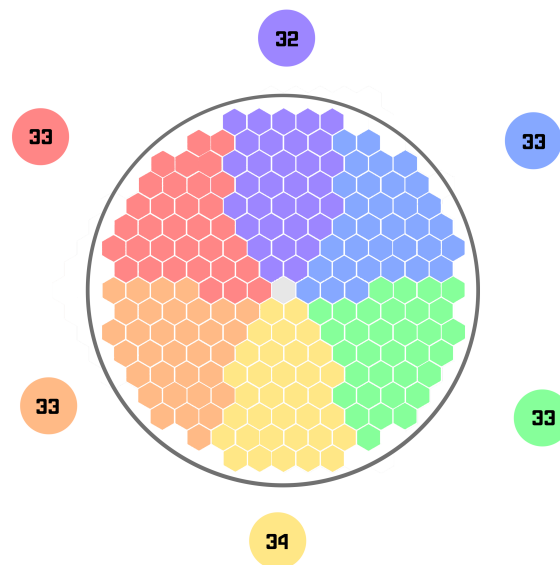


Figure 2: Start of King of the Mountains visual feedback on the table

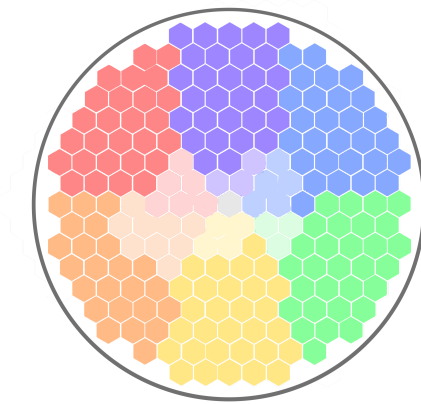


Figure 3: King of the Mountains concept mid-game

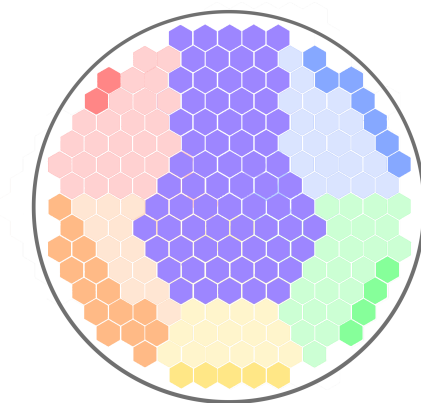


Figure 4: King of the Mountains where the purple user won, their colour is spreading from the middle

4.4.3 Concept 2 All Hands on Deck

The second concept uses the following influential factors:

- Gamification element: Cooperation among users
- Gamification element: Story
- Gamification element: Lives

How the influential factors in this concept make the concept a valid candidate as a final concept:

This concept heavily leans on the gamification element of cooperation among users. This element gives all users the same goal, and social relevancy. This social relevance is especially visible in how the game works as this concept relies for the most part on the users communicating since each user is responsible for how well the other users fare, and ultimately, the fate of whole group of users. This gamification cooperation element is supported by Wang *et al.* [40] study which described cooperation among users or teamwork to be in the top twelve of most useful gamification elements. As for the element of a story being present, this could very well be a too optimistic view on the researcher's part. It could be possible that the users do not see or understand the story aspect of this concept, the story being the users having to keep a raft animation afloat during their meal. However, if this element proves noticeable, it could serve as an extra element of engagement for the users since according to Sailer *et al.* [41] a story element increases the feeling of relevancy. The gamification element of lives was added with less intent of it boosting engagement in the experience, but more so as a helpful tool to show users around the table how well or not well their parts of the raft are doing without having to constantly keep an eye on the middle of the table where the most important animation is displayed. Perhaps interesting to note is that this element of lives was also almost rated the least influential gamification element to use according to Wang *et al.* [40]. In terms of player types, it is expected that Bartle's [42] socialiser player type would fare best with this concept considering the aspect of other players being responsible for each other's actions, sparking social interactions.

How does this concept work?

The table starts with showing a flowing pattern that is meant to resemble the sea consisting mostly of blue RGB light with some green hints to give the illusion of seawater. When the game is started, a raft appears in the middle of the table, as well as four fully coloured modules on the table edges where users are seated. The colour of the modules closest to the user signify their playing colour. A representation of the table when the raft and lives have appeared on the sea can be seen in Figure 5.

Each user is closest to a cluster of three coloured modules near the middle of the table that aren't their own colour. When the eating rate of a user is registered as too fast, the user forms a ripple or 'wave' that 'crashes' into the cluster of three colours. This causes one of the three modules to turn to seawater colour, effectively 'breaking' a piece of the

raft off. The module that was ‘broken’ has a colour of another user on the other side of the table. This user will see that their lives decreased by one since one of their coloured modules was eliminated. After this cluster of three colours that aren’t a user’s own colour, there is one module, or rather one life left. This one is the user’s own colour that they need to protect by adjusting to an, according to the SIT, average eating rate. Figure 6 shows a ripple created by the red user which destroys a green module. It can be seen that some other modules have already been ‘broken’ on the raft, and the life bars of users are updated as well based on how the raft is doing.

If two users’ colours are completely wiped from the raft, all users fail the game. An example of this situation can be seen in Figure 7. In case of failure, all pieces of the raft, including the ‘broken’ ones, and the life bars, light up in the colours of the users one last time before spreading across the table as if the colours were dropped in from above the table, converted into a digital pattern. Figure 8 tries to illustrate this. After this, the table returns to an empty seawater pattern. The only difference is that specks of the users’ colours can be seen ‘drifting’ across the table from time to time as can be seen in Figure 9.

Alternatively, if time runs out (the meal duration has finished), and the raft is still afloat, the users win! All pieces of the raft, including the ‘broken’ ones, and the life bars, light up in a bright white light before spreading across the table as if the colour was dropped in from above the table, converted into a digital pattern. Figure 10 tries to illustrate this. After this, the table returns to a seawater pattern with a white raft in the middle. Occasionally white specks of light can be seen ‘drifting’ across the table from time to time as can be seen in Figure 11.

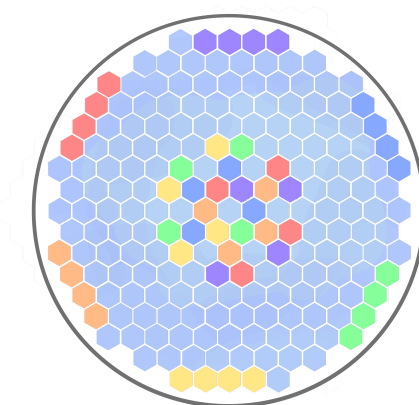


Figure 5: Start of All Hands on Deck visual feedback on the table

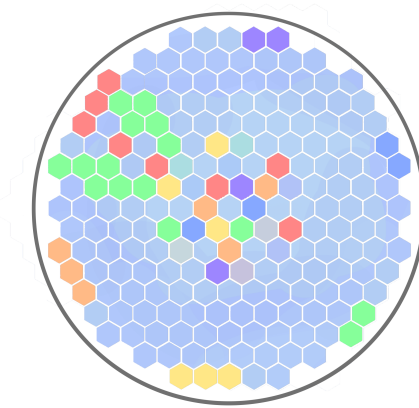


Figure 6: Mid-game representation of some raft parts being broken and the red user causing a ripple

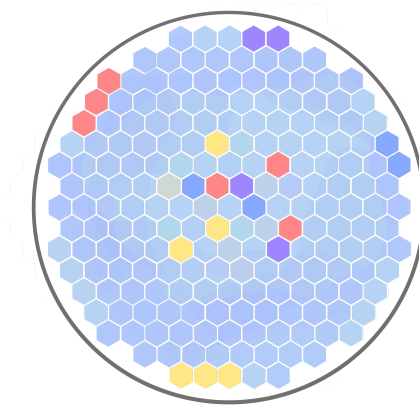


Figure 7: Two users' colours are eliminated, all users lose

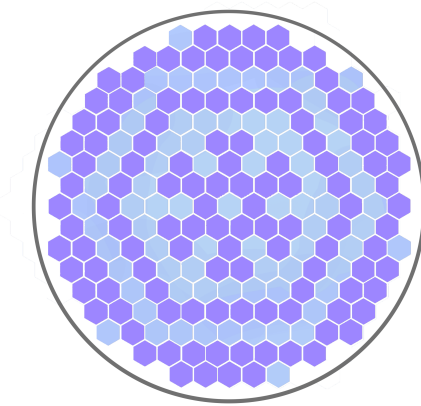


Figure 8: Bad ending: The raft and life bars assume the colours of the users one by one. In this case, the purple user ripples through

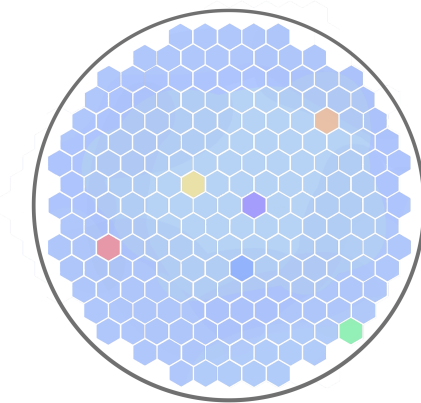


Figure 9: After the bad end, this will be the standard pattern on the table until reset

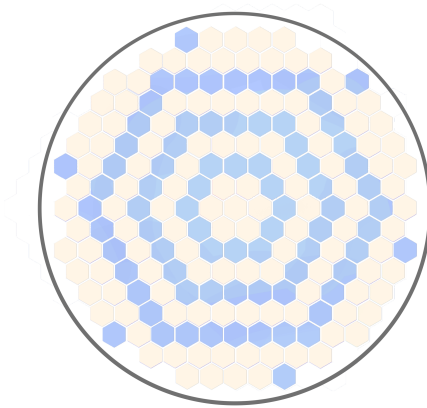


Figure 10: Good ending: The raft and life bars assume a bright white colour

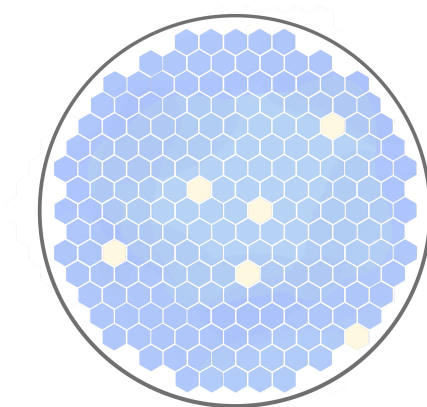


Figure 11: After the good end, this will be the standard pattern on the table until reset

4.4.4 Concept 3 Claim the Table

The third concept uses the following influential factors:

- Gamification element: Freedom to fail
- Gamification element: Cooperation among users
- Gamification element: Competition among users

How the influential factors in this concept make the concept a valid candidate as a final concept:

This concept uses both the gamification elements of cooperation among users and competition between users to give users both a sense of social relevance as well as a shared goal [41]. The expectation is that these elements come together in a way that will keep all users engaged, and perhaps stimulate strategic schemes in both teams of users. To defend this choice, the study by Wang *et al.* [40] listed both cooperation and competition's importance in education and corporation training in the top twelve most effective gamification elements. So why not join the two in a concept that seeks to get the most engagement between users and the SIT? Though education and corporations are different fields than the specific changing of eating behaviour that this study tries to achieve, the gamifications' elements of success could bode well for this field of study as well. Other than competition and cooperation, the element of freedom to fail which was also listed in the top twelve in Wang *et al.* [40] study aims to not make this concept not too harsh and actually winnable. In case of this concept, if one user of team A does not exhibit the required eating speed, no punishment is given. In case two users eat too fast, a small punishment is given to signify something needs to change in the team A's eating behaviour. Naturally, in case all users in team A eat too quickly, a more severe punishment is given that favours team B to show that something drastic needs to happen. In terms of player types, it is expected that Bartle's [42] socialiser and killer player types would fare best with this concept considering both competition and winning as well as social interactions between teammates are encouraged to become the winning team.

How does this concept work?

As can be seen in Figure 12, each team starts with about 1/3 of the table in their team colour. 1/3 of the table is quite literally up for grabs, and for now, unclaimed. Every 30 seconds, a table update comes through. These updates can differ depending on a team's eating behaviour.

Assuming the teams are 3V3, if two people in a team eat too fast, and the other's pace is acceptable, no modules of either the previously unclaimed section or other team's section is claimed by the team's colour. If one person in a team eats too fast, but the other two eat at an acceptable pace, no modules of the team's colour are lost, and if there are still empty modules in the empty section, one of these modules is claimed by the team's colour. If all teammates eat at the right pace, a white burst of colour with increased luminance goes

across all the team's coloured modules, both a module of the enemy as well as a module from the previously unclaimed territory section will be claimed by the team's colour. If all 3 users in a team eat too fast, a red burst of colour with increased luminance goes across all the team's coloured modules, removing one of the team's previously unclaimed section claimed modules, OR, if they have claimed enemy territory modules, they lose an enemy module which is then returned to the other team. A representation of claiming both unclaimed section modules as well as enemy modules can be seen in Figure 13.

The game ends when the unclaimed territory section is filled with the opposing teams' colours. The team with the highest amount of claimed modules has won the game. To signify who has won, all the losing team's modules will be coloured in the colour of the winners.

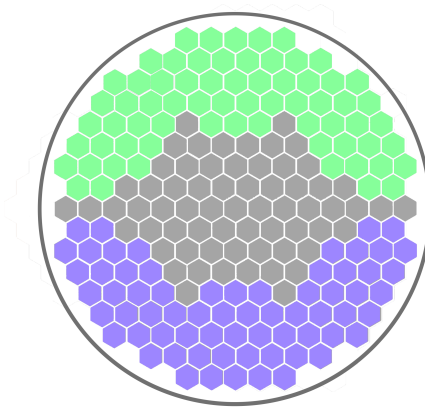


Figure 12: Start of Claim the Table visual feedback

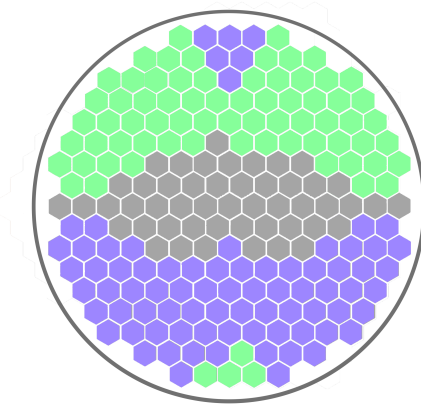


Figure 13: Mid-game Claim the Table representation

4.4.5 Concept 4 Error of Abundance

The fourth concept uses the following influential factors:

- Gamification element: Cooperation among users
- Colour theory (Blue = Neutral/Safe, Yellow = Approaching danger, Red = Danger)
- Pattern recognition (less streaks = Neutral, more streaks = Overloaded)

How the influential factors in this concept make the concept a valid candidate as a final concept:

This concept uses the gamification element of cooperation among users to give users both a sense of social relevance as well as a shared goal [41]. The expectation is that this element will keep the users engaged with this concept since their actions also influence their teammates. To further defend this choice, the study by Wang *et al.* [40] listed this gamification element's importance in education and corporation training in the top twelve most effective gamification elements. Though education and corporations are different fields than the specific changing of eating behaviour that this study tries to achieve, the gamification's element of success could bode well for this field of study as well. The actual feedback the SIT gives utilises colour theory and pattern recognition. The colour theory comes in when users eat either at the right pace, slightly too fast, or way too fast. These speeds are respectively signified by the colours blue, yellow, and red. The pattern recognition adds to the colour theory element. The more streaks appear on the part of the SIT of a specific user, the more 'overloaded' their part of the table becomes. In terms of player types, it is expected that Bartle's [42] explorer and socialiser types would fare best with this concept seeing as .

How does this concept work?

This is a game that has a bigger focus on colour theory and pattern recognition. All users must work together to make sure the table does not 'shut down'. Story wise you can see this game as a reactor that needs energy to run, but too much would break its components and eventually completely shut it down. Each user possesses 1/6 of the table, they are separated from each other by light borders. From each user's table edge, streaks of light fly towards the middle of the table. Figure 14 illustrates this setup.

If a user eats at a reasonable pace, their 1/6 of the table stays blue, and only a couple light streaks fly towards the middle of the table from their side. When a user eats faster than acceptable, their table piece turns yellow, and every 30 seconds they lose the function of one of their modules. They're essentially 'breaking' their piece of the table. Furthermore, more light streaks appear to fly towards the center of the table, and at a faster speed than before. If a user eats way too fast, their piece of the table turns red. Even more streaks of light at great speed travel towards to middle of the table. Additionally, every 30 seconds, the user in the red-zone loses 2 of their modules. When 3 or more user are in the red-zone at the same time, the borders between the users will turn red, as well as the modules

in the middle of the table, and they will dim and brighten in a slow pace. This serves as a warning to the users. As an example of what the table can look like about halfway through, please refer to Figure 15.

When either 1/3 of the table's total amount of modules has shutdown, or one user has no more modules left, the entire table, except for the edges the users are seated at, will light up in red, and all remaining modules will shutdown one by one until the table is no longer emitting light. Figure 16 provides a visual for this. Alternatively, if after 5 minutes of complete inactivity of weight shifts from the table occurs, the game is considered 'done'. The table will brighten and dim, returning all yellow and red-zones back to blue, restart all 'shut down' modules, and return to its original state

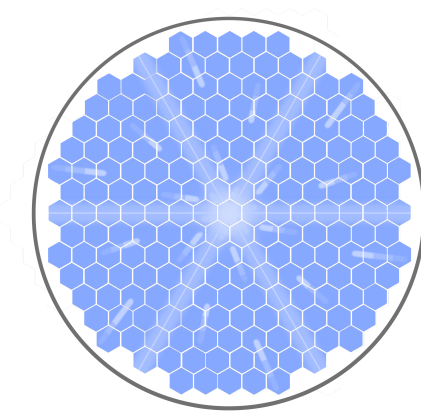


Figure 14: Start of Error of Abundance visual feedback

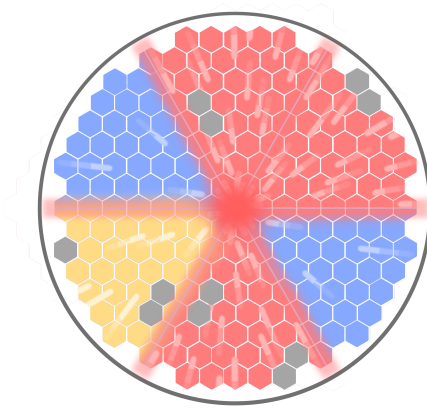


Figure 15: Mid-game Error of Abundance where the borders and middle are red because of three red-zone users

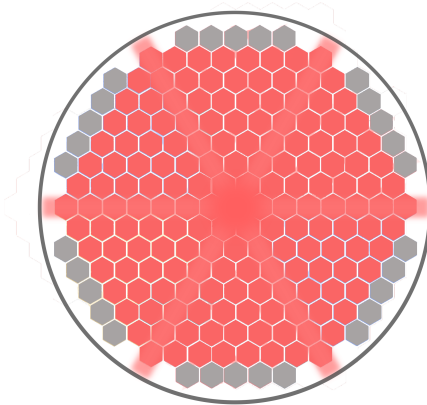


Figure 16: Bad ending Error of Abundance

4.4.6 Concept 5 Firewatch

The fifth concept uses the following influential factors:

- Gamification element: Cooperation among users
- Gamification element: Story
- Colour theory (Green = Neutral/Safe (good), Red/Orange/Yellow = Fire (bad))

How the influential factors in this concept make the concept a valid candidate as a final concept:

This concept is very similar to concept 4 with the addition of a story element, and a subtraction of the pattern recognition element. Like concept 4, this concept uses the gamification element of cooperation among users to give users both a sense of social relevance as well as a shared goal. The expectation is that this element will keep the users engaged with this concept since their actions also influence their teammates. To further defend this choice, the study by Wang *et al.* [40] listed this gamification element's importance in education and corporation training in the top twelve most effective gamification elements. Though education and corporations are different fields than the specific changing of eating behaviour that this study tries to achieve, the gamification's element of success could bode well for this field of study as well. The actual feedback the SIT gives utilises colour theory. The colour theory comes in when users eat either at the right pace, or too fast. These speeds are respectively signified by the colour green and the colours that give the sense of fire, so red, orange, and yellow. This use of fire colours supports the story element of this concept as well as adds to the colour theory element. The storytelling part is also immediately visible since a tree in a field is displayed from the start. How the table changes animations is described below.

How does this concept work?

All users must work together to make sure the tree in the middle of the table does not burn down. Each user possesses 1/6 of the table, they are separated from each other by slightly yellow light borders. From each user's table edge, little fires that 'flicker' using decreasing and increasing luminance start to pile up depending on the user's eating speed. How the table starts off when users just started their meal can be seen in Figure 17.

If a user eats at a reasonable pace, their 1/6 of the table stays green to emulate grass. When a user eats faster than acceptable, after 20 seconds, a module on their part of the table turns into a fire. These fires can only be put out if the user eats at the right pace for a whole minute. The animation that plays when a fire is put out is shown as a wave of green rolling over the 1/6 of the table that is doing well, afterwards the fire that gets put out shows up briefly as a blue light to hint towards the idea of water. After this, the module turns the same green as it was before it caught fire in the first place. As an example of what the table can look like about 1/4 into the meal, please refer to Figure 18.

When one user's part of the table is filled with fires that reach the tree in the middle, the tree catches fire, all other users' fires become dim to see which part of the table caused the fire, and the game ends. Figure 19 provides a visual for this. After this animation, all fires on the table disappear, and the person who did best with the least amount of fires on their side of the table gets added saturation of their grass that pulsates for a few seconds. Afterwards, a white arrow appears on the table pointing at the best user after which the arrow turns into a green check mark. After this display, the table resets back to the start of the game.

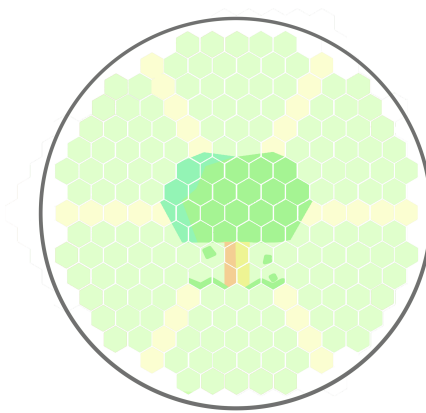


Figure 17: Start of Firewatch visual feedback

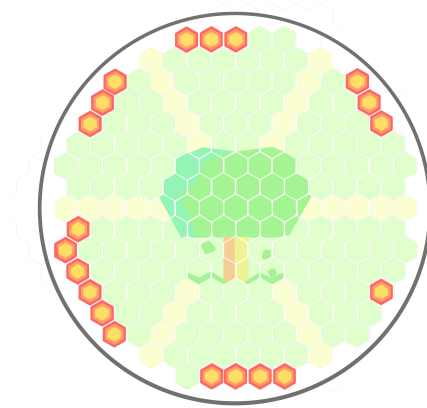


Figure 18: Mid-game Firewatch where users have some fires going on their parts of the table

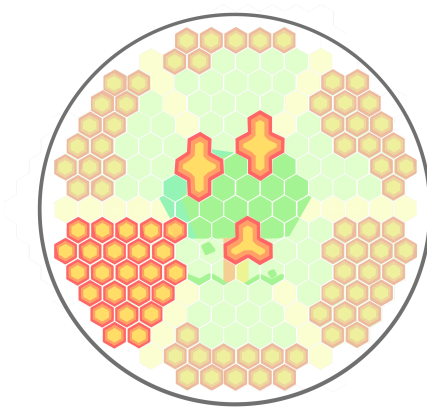


Figure 19: End of the Firewatch game where a user filled their part of the table with fires

4.4.7 Preferred concept

Considering literature on game elements that prove to be effective, colour and shape theory that can influence one's emotions, light luminance that can influence one's eating behaviour, and the requirement that states the concept has to be easy to understand, concept 4 or 5 could prove to be the best choices for this graduation project's experiments according to the researcher.

However, without asking actual potential users, it would prove impossible to choose a preferred concept as of now. To find out which concept potential participants find most effective in terms of aesthetics, readability, and functionality, the questions asked to target audience members can be found in the next paragraph that describes the interview procedure as well as the questions that were asked during these interviews. Important to note is that during these user interviews, it was not explicitly disclosed that the concepts aim to alter eating speed, but rather eating behaviour in general. When asked what eating behaviour entails, the researcher will reply with examples such as portion size, bite size, etc.

4.4.7.1 The User Interview Procedure

The procedure for the user interviews follows a set-up that briefly consists of inviting the participants, explaining the ideated concepts one by one with questions after each explained concept, and afterwards asking the user two more general questions about which concept they think would be most influential to other users as well as whether they feel like currently there are elements missing from this particular concept to make it live up to its full potential.

In total, three participants were separately invited to the user interviews. To reiterate, these participants were not invited for participating in the experiments with the SIT itself as they would be too biased and knowledgeable about the study. These participants were asked beforehand whether they experience different eating speeds among housemates during meals shared together. In case they answered this question with 'yes', the participants were asked to be interviewees for the ideated concepts. The researcher met with the interviewees individually in one of the buildings on campus. From here, the researcher presented the interviewee with an informed consent form and verbally asked for permission to record the conversation. By recording the conversation, all answers to the established questions as well as answers to non-written down follow-up questions could be recorded. The interview was setup in a way where the interviewer and interviewee sat across each other, with a monitor in between them that was visible for both. This monitor was connected to the researcher's laptop to display what was shown on the researcher's laptop. On the monitor, the concept that was currently being explained was displayed with all animation transitions from the ideation chapter for that concept. To specify, only the concept pictures from the ideation chapter were shown (view from above) which is not true

to the real display on the SIT. Both the interviewer and interviewee were able to point and see what is going on during the explanation of the concept or during the asking and answering of questions regarding the concept. Just before the interview started, it was clearly conveyed that the ideated concepts revolve around trying to influence users' eating behaviour in general in the context of a regular meal with housemates.

This is where the interview started. First, the researcher explained the concepts one by one. After each of the explanations of the concepts, the following questions were asked:

What is your impression of the visual feedback overall from this concept?

What elements of the visual feedback of this concept do you like or not like and why? (Colours, light luminance effects, what's displayed and when, changing of the animations, etc.)

Do you think you would be motivated to change your eating behaviour if you were to see the visual feedback of this concept?

The following fourth question was asked in case of the concepts with cooperative elements in them, meaning all concepts except for concept 1.

Say for example I'm your housemate and we're eating together and my part of the table is doing bad, would you talk to me about changing something in my behaviour so the rest of the users still have a chance at 'winning' the displayed game?

Once all concepts are explained and their respective questions were answered, the interview finished with two slightly more general questions:

Which concept's visual feedback did you think would be most effective in changing eating behaviour and understandable for a user that doesn't know the table changes based on eating behaviour?

Are there visual feedback elements from other concepts you think might add to the concept you named in the previous question?

4.4.7.2 The User Interview Results

According to the user interviews' results, concept 5 was perceived as most intuitive, potentially influential, and most aesthetically pleasing due to its relation to real-life imagery. For the intuitive feel, concept 3 was also mentioned by two of the interviewees since they could easily imagine the opposing sides as pieces of land divided by water that needs to be 'conquered' and can be lost. The other interviewee considered concept 1 as concept that with some changes could be imagined as being more real-life like which would give it an edge over most other concepts. All three interviewees also mentioned the colour palette of concept 5 making the most sense in terms of using the traffic light colours with

an additional blue to calm the fires down, this fortifies the real-life imagery feel as well. Furthermore, one of the interviewees mentioned that the hexagonal modules consisting of more colours than one solid colour gives the sense that the SIT is capable of more than it was led on. Another interviewee mentioned that the clean borders between each visual element, especially the well-defined borders between the users is something they found nice. This same interviewee also mentioned that it is nice to have the feature of fire disappearing after showing 'right' eating behaviour. This feedback shows you can fix the mistakes you made earlier and does not motivate the thought process of "Well I'm already not doing great, might as well continue with that since it is not recognised when I do better anyway". All in all, it was clear from the user interviews that concept 5 had the most enthusiastic responses and could prove to be a useful tool of visual feedback to influence eating behaviour.

5 Specification

5.1 Participant recruitment for experiments

To select the participants for this study, some questions were asked to ensure reliable participant results for each of the participants. Potential participants and consequently their housemates were asked the following questions:

How often and with how many housemates do you usually share a meal in a week?

Do you have illnesses or diets that influence otherwise regular eating behaviour?

Do you consider yourself a slow, average, or fast eater?

Would you be willing to perform a preliminary experiment prior to the experiment with the SIT?

To elaborate on the last question, as could be seen in Chapter 2, there is no global measurement scale what is considered eating slow, average, and fast. For this reason, having a preliminary experiment where participants are asked to tally their amount of bites taken every five minutes during a meal gives the researcher a direction on when to change the SIT's animations during the actual experiments.

Recruiting the participants was done by the researcher reaching out first and foremost in real life to friends, acquaintances, their student houses, and other student houses. What followed was reaching out to fellow students through WhatsApp to ask them whether they knew anyone who would be willing to participate with their student house in the experiment. To respondents that are potentially interested, an additional information brochure was sent as well as the dates on which the experiment were going to be held. This information brochure can be found in Appendix A.

After asking around for participants by the researcher, it was found that all potential participants were at most able to come together with 4 housemates in total instead of the previously ideated 6. For this reason, the concept was changed to fit 4 users instead.

5.2 Functional and non-functional requirements

Both the SIT and the environment it is placed in have their functions in how they can manipulate a user's eating behaviour. The environment of the SIT is a recreation of a small apartment with a kitchen, livingroom (in which the SIT is stationed), bedroom, and bathroom. This location is referred to as the eHealth House on the campus of the University of Twente. To explain the factors that can or cannot be manipulated by the researcher in correlation to the concept chosen in chapter 4, so concept 5, a look at the functional and non-functional requirements is necessary. Briefly, functional requirements state what a system must be able to do and is thus more focused around user requirements. Non-functional requirements are more focused on user expectations, user experience (UX), and usability.

5.2.1 Functional requirements

SIT related requirements:

1. The SIT's animations is usable for 4 users around the table as required capacity
2. The SIT modules' light colour and luminance
 - The spreading and reducing of the fires is noticeable due to their luminance changes
 - The SIT's animations' fire that's displayed can spread towards the tree in the middle of the table
 - The SIT's animations' spreading fire can be reduced
 - There is an animation for fire spreading onto the tree in the middle of the table that can be played in case a user's fires reach the tree
 - There is an animation for fire disappearing from the tree in the middle of the table that can be played in case all users' fires have been reset back to their original empty state

Starting off with the SIT's light luminance it can emit. From background research it was found that soft (less luminant) light succeeded best in keeping people seated longer, having a longer mealtime, but also slowing their eating rate in the process. This is important to keep in mind for the SIT's concept animations since inadvertently causing users to eat quicker because of the light luminance of the table could result in different results than with full luminance at all times. Unfortunately, making use of the table's luminance functionality during its more static states would be detrimental to the users' visibility and thus readability of what is displayed on the table.

As for the colours emitted by the SIT, colours that generally have effect on people are red, yellow, and green, the traffic light colours. Red is often associated with danger, panic and fear, yellow with caution and interestingly more positive emotions such as happiness as well, and green with words with positive associations such as accomplishment or achievement. Conveying feedback through these three colours was used since it could prove most effective since they have such strong emotional connections with people.

Environment related requirements:

- Ambient light luminance
- Ambient light colour
- Smell
- Sound
- Miscellaneous objects around

Next up are the functional requirements related to the environment in which the experiments with the SIT were held. Concerning light luminance and colour, ambient light can also be a factor of interest. Usually during meals, especially dinner, people eat in warm

light emitted from an overhead lamp, smaller lamps, christmas lights, etc. Since these lamps usually emit warm light and not harsh bright light, replicating this warm ambient light during the experiments with the SIT was required to ensure ambient light colour and luminance have as little effect as possible on the experiment results. However, this is assuming the light from outside would not be enough to grant enough visibility in the room. Since the experiments were held during days when the sun is very much present until at least 22:00 and the experiments were held far before that time, using a lightsource inside the room with the SIT was not necessary.

The other environment related functional requirements smell, sound, and miscellaneous objects on the table could be influenced by the researcher and were. To get rid of any remaining smells in the room of the experiments, the room was ventilated using windows, doors, and possibly a ventilation system if present. Sounds in terms of music were not present as to emulate a regular dinner setting and nullify the possible side-effects different genres of music can have on the users' eating behaviour. Lastly, no objects except for the regular plates and cutlery were on the table. Additionally, only the necessary objects that had to be in the room of the SIT were present. Users' belongings were put away in a way where they would not be visible from where the SIT is stationed.

5.2.2 Non-functional requirements

This subsection mentions UX related requirements that are to be met using the current concept during the experiments.

- Curiosity about what animations the table can display based on user behaviour
- Awareness of what is displayed on the table in terms of imagery
- Reflection in terms of triggering users to talk to each other about what is displayed on the table

These non-functional requirements listed speak for themselves. Naturally, it is more of an assumption rather than a set in stone given that these requirements will be successfully achieved. It can vastly differ per student house that is invited for the user testing whether the requirements are met. In chapter 8 the success-rate of these non-functional and functional requirements is discussed based on the user interview results.

5.3 User Personas

During the user interviews that were held to determine the ideated concept with the most potential to influence eating speed, some user 'types' could be identified. To further tailor the concept to their liking, getting a better picture of who these user types, or rather 'personas' are is a helpful procedure. These user personas do not directly reflect the interviewees from the ideation phase user interviews, but rather they are meant to display general user types from the same target audience. The following user personas make use

of fake names and AI generated faces, therefore the people visible in these personas are anonymous.

5.3.1 User Persona 1

In figure 20 Frederike Meyer's user persona can be seen. She states that she lives in a student house with mostly other internationals and that she plays tennis. Based on this as well as her 'Personality' description, it is fair to assume she is a social person with an active network. Nothing specifically is mentioned about whether she hangs out with her housemates or not, but her eating behaviour does state that she does socialise far above average and her eating speed is average. Furthermore, looking at her study programme and goals, it is fair to assume she has an affinity for helping others. Considering these observations, the concept could play into Frederike's interest in cooperative play which is found in her tennis hobby. It would be likely, considering her socialising during dinner, that she would start or at least hook into conversations about what is happening on the SIT during a meal. Perhaps her studying psychology could also help in identifying what the significance of the colour changes of the animations are. Frederike also mentions in her goals that maintaining a healthy lifestyle is something she at least somewhat busies herself with. This point could motivate Frederike to find out what the SIT is trying to influence or help better in her eating behaviour. All in all, Frederike could prove a participant that provides useful feedback. However, Frederike is quite an exceptional participant since she checks many if not all boxes for whom this concept is created. Naturally this is good for the researcher, but there are so many types of people with different interests and personalities that looking into other user personas is necessary to get a better picture of an overall demographic for this concept.



Figure 20: User persona Frederike Meyer

5.3.2 User Persona 2

In figure 21 Dennis van Deijken's user persona can be seen. He states that he lives in a student house with other Dutch people and likes playing videogames with friends or alone. Based on this as well as his 'Personality' and 'Motivations' descriptions, it is fair to assume he can socially engage with others when prompted. Since Dennis likes playing games, he might be one of the first to recognise the animations on the SIT as a sort of game. Dennis' eating behaviour does state that he does socialise, but not more than others. Furthermore, his eating speed is very fast which is one of the qualities that makes him a great participant for this research. This could be a stretch, but Dennis' study programme might prompt him to be more aware of his health than other non-medical related courses. Perhaps this could help him in identifying the SIT wants him to change something about his eating speed apart from the animations portraying a type of social game.



Figure 21: User persona Dennis van Deijken

5.3.3 User Persona 3

In figure 22 Noah Garcia's user persona can be seen. Noah does not state anywhere that he actively seeks out social contact and his hobbies also do not give the impression he is looking for networks. This is nothing bad of course, but it could affect the social aspect of interacting with the SIT if Noah and housemates were to interact with it. On the other hand though, Noah does enjoy being creative and playing around with electronics. His creative view could cause him to more easily identify what is displayed on the table or at least could keep him interested and guessing in what the animations could resemble. The interest in electronics could cause Noah to generally engage more with the table to see if it has motion or pressure sensors which also draws his attention to the surface of the table. Noah's eating speed seems to be average which is also fine for the SIT experiment since there is a high chance the animations on the table will change for him as well.



Figure 22: User persona Noah Garcia

5.3.4 User Persona 4

In figure 23 Mia Polachek's user persona can be seen. Judging by Mia's 'About Me' description, she seems quite responsive to social contact and actively seeks it out by being in the livingroom and attending association events. Mia seems to have both a competitive and cooperative side which is quite useful for engaging with the SIT. To elaborate, her cooperative side as well as her social demeanor help in talking about what is happening on the SIT and what the animations could mean. Her competitive nature could help in talking to housemates to change their eating behaviour for the sake of the other users around the table since you would assume nobody would want the tree in the middle of the table to burn down, right? When looking at Mia's eating behaviour, the contradiction of high eating speed, but also being a picky eater makes for an unpredictable user around the table. She has a high eating speed, but since she will be busy picking out ingredients from her food, this could be a detriment to her eating speed, possibly falsely making her appear as an average to slow eater.



Figure 23: User persona Mia Polachek

Though these personas are quite different from each other, all of them have at least some qualities to them that the SIT's experiment could speak to. Also, a student house does more often than not consist of the exact same type of people that are also following the same studies. For this reason, solely judging these user personas as viable participants for the SIT does not do the rest of the house justice, whether for better or worse with regards to the experiment. Furthermore, these personas describe users with average to fast eating speeds. This on itself is not uncommon, but there is a high chance one or more of their housemates could be a slow eater to which the SIT will respond less actively since it is trying to influence fast to average eaters. In this case, it is assumed the users around the table, seeing as they are housemates, will talk about what is happening on the parts of the table of users where animations are happening. This could become a problem the researcher can observe during experiments, but it cannot be guaranteed whether the experiment will or will not be useful with the acquired participating houses. If anything, this could prove an interesting discussion point about the concept in chapter 8.

5.3.5 Hypothetical scenario diagram

The flowchart that can be seen below shows how and what user interactions with the SIT and surrounding activities may happen and what their consequences could be.

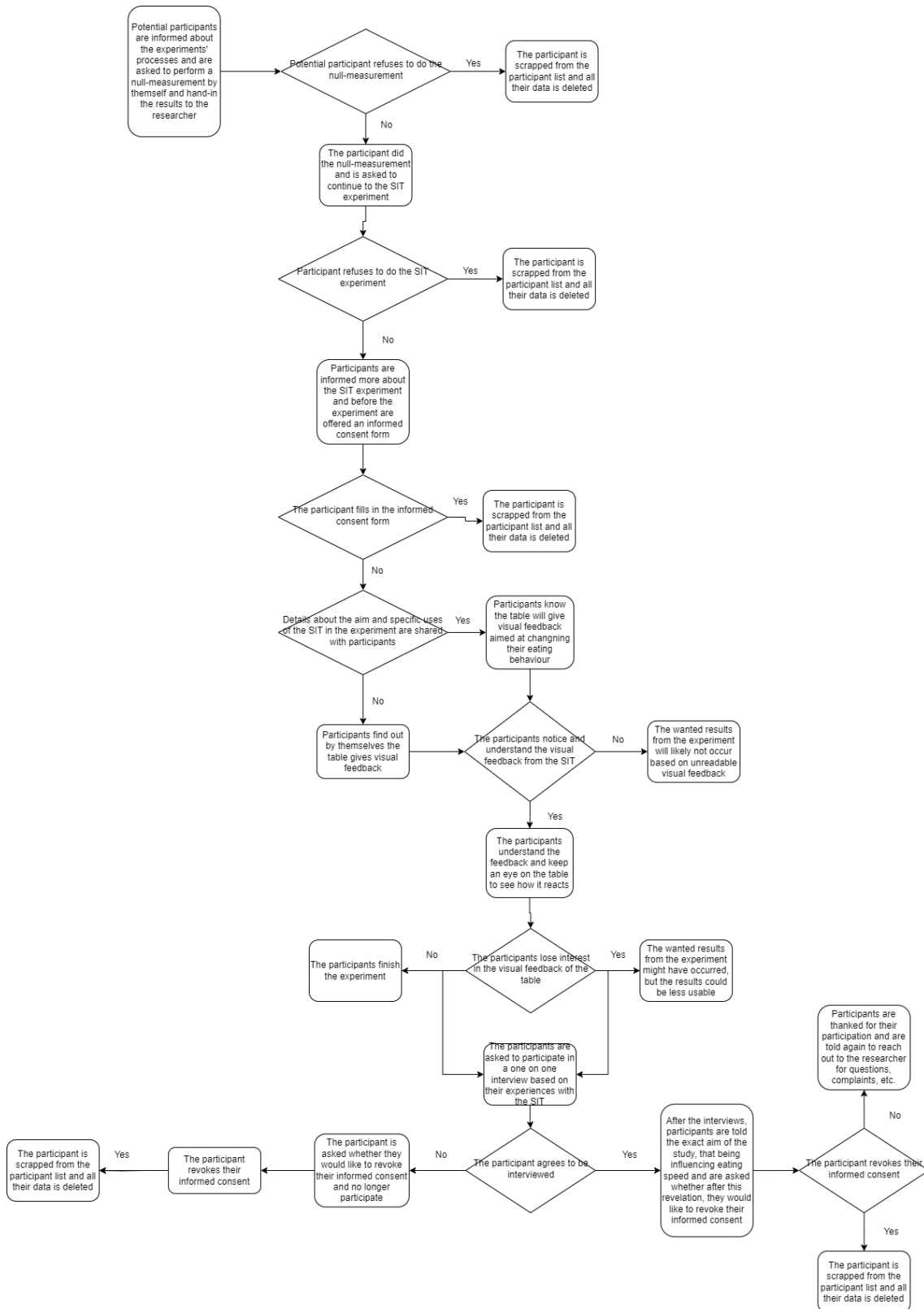


Figure 24: Flowchart hypothetical scenarios SIT experiment

6 Realisation

Following the specifications of the final concept that followed after the user interviews, realising the concept and the user testing of the concept are the next steps. The realisation using Unity is elaborated on in this chapter. Briefly, Unity is a cross-platform game engine developed by Unity Technologies. It is most commonly used to create 2D and 3D games. The actual testing procedure comes with a lot of preparation of which the steps are mentioned in the next chapter with each step having its own elaboration.

6.1 Implementing the concept into Unity

When trying to figure out how to SIT functions and how light is displayed in colour as well as luminance, part of this concept as well as other small images and animations were partially build into Unity already by the researcher for trial and error. This resulted in a smoother workflow since the researcher already knew to find their way around the Unity environment.

6.1.1 The wiki and trial animations

To get started with making animations on the SIT, the researcher was provided with an online wiki on GitLab that describes in detail how to change and animate both individual hexagons on the table as well as how to generally project images that span over multiple hexagons. After installing the right version of Unity, the researcher started off with using concept images from the ideation chapter to see how to implement and display images on the table. The first image that was chosen was Figure 25 which can be seen below. This image showed a lot of white space in between the hexagons on the Unity display and was therefore filled in with colour to avoid white light strips from appearing on the actual SIT. A real life representation of what this looked like on the SIT can be seen in Figure 26. From this point, the researcher implemented concept 4 from the ideation chapter which can be seen in Figure 27. This trial also served as practice to implement an animation which is the white stripe that can be seen on the left side of the table. The animation made use of changing the position of a separate white stripe displayed above the blue background of the table.

From this point onwards, the researcher experimented with luminance, colour changes, sprite changes, and scale changes. Multiple different images were used for these practice experiments, but since these were solely seen as a crutch to learn how to animate in Unity, they will not be shown here.

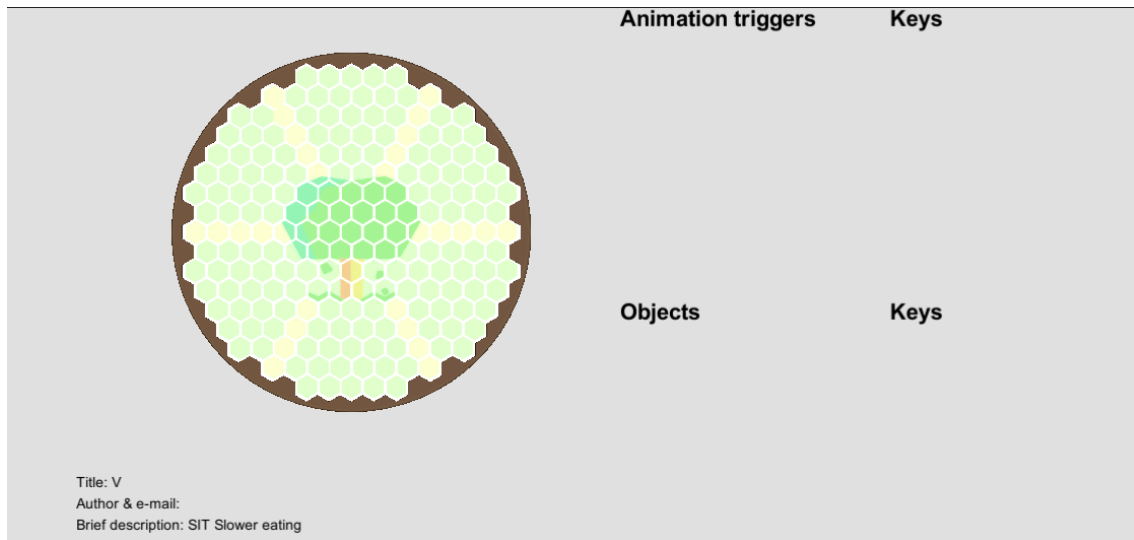


Figure 25: First Unity concept display of concept 5



Figure 26: Real life display of concept 5

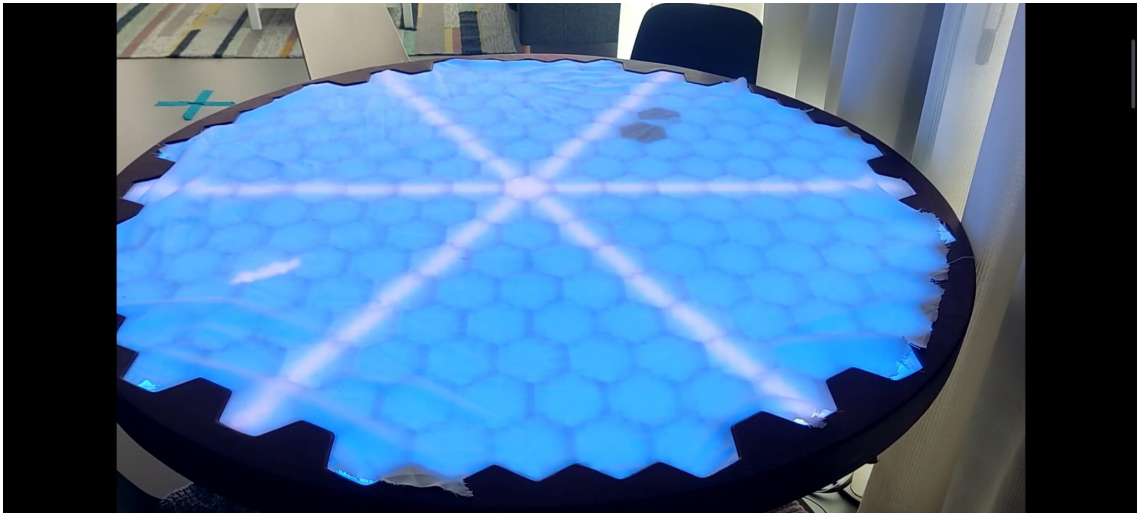


Figure 27: Real life display of the concept 4

6.1.2 Implementing and animating the final concept

It took a while to figure out how to display all images in sequence by making them into animations, but eventually a system was found that allowed the researcher to animate each 1/4 of the table separately using four different animation groups in Unity which can be seen on the left in Figure 28. The groups are called TLF, TRF, BLF, and BRF. These abbreviations stand for Top Left Fire, Top Right Fire, Bottom Left Fire, and Bottom Right Fire respectively. The animation creation, conditions, and in-between states can be seen in Figure 29. This Figure shows specifically BRF's animations, but these animations are exactly the same for all three other parts of the table. To briefly explain what is displayed on the figure, all blocks with numbers refer to animation states where fire is added to the piece of the table, and all 'w' with a number blocks state the transition from a fire state to a water state back to a previous fire state. In addition to these groups, a separate animation from the user animations was used to set the tree in the middle of the table on fire. The animation page and its conditions can be seen in Figure 30. This fire is clearly visible in the Unity display, however, for this function, paper notes on the keyboard will be used for the researcher's convenience during the actual experiments with participants.

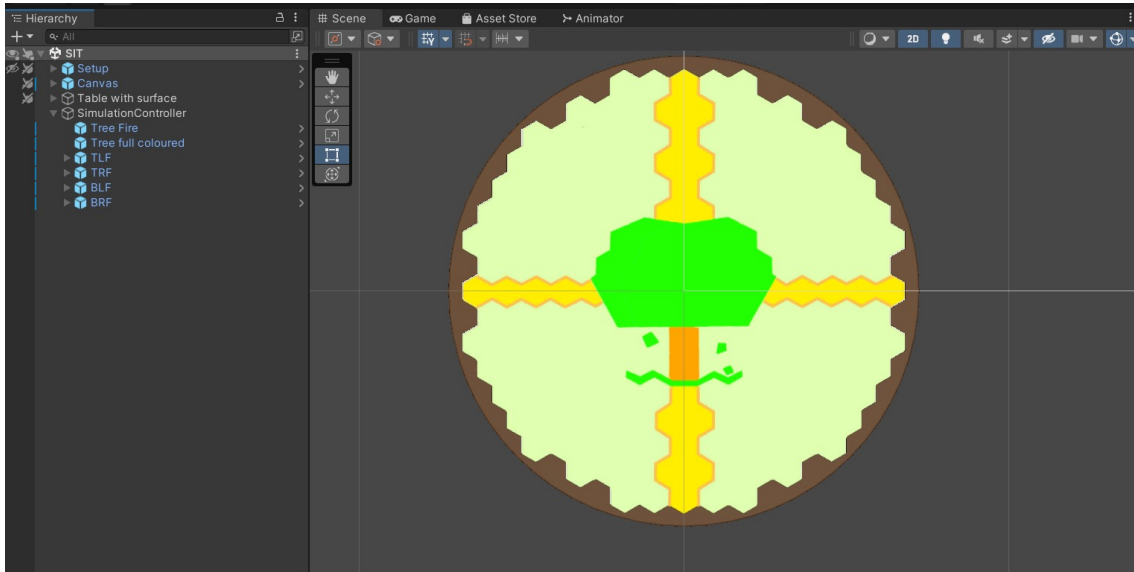


Figure 28: Unity display of the concept and the layer hierarchy

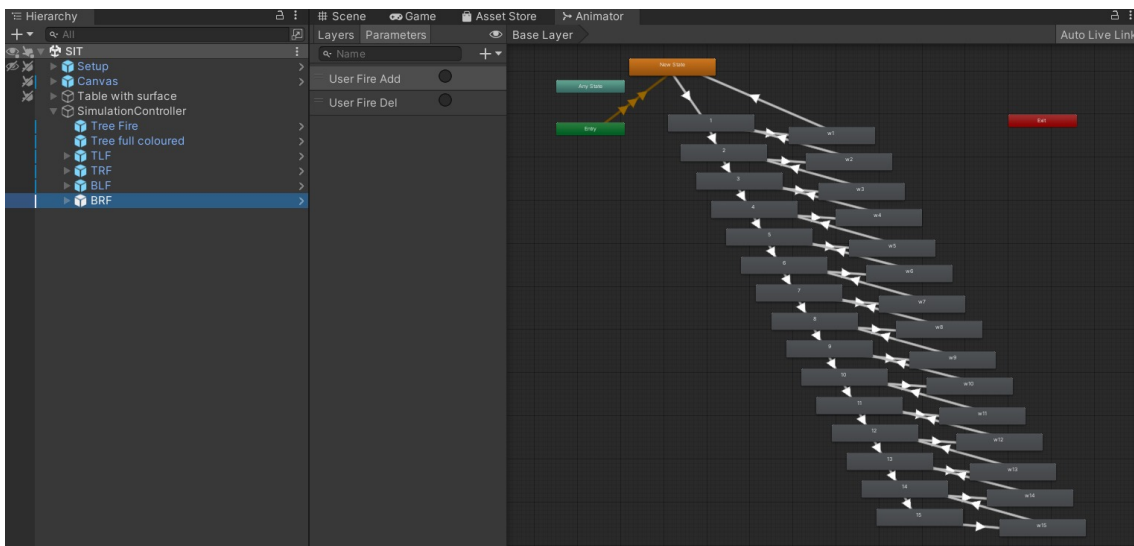


Figure 29: Unity display of the concept's animation page for each quarter of the table

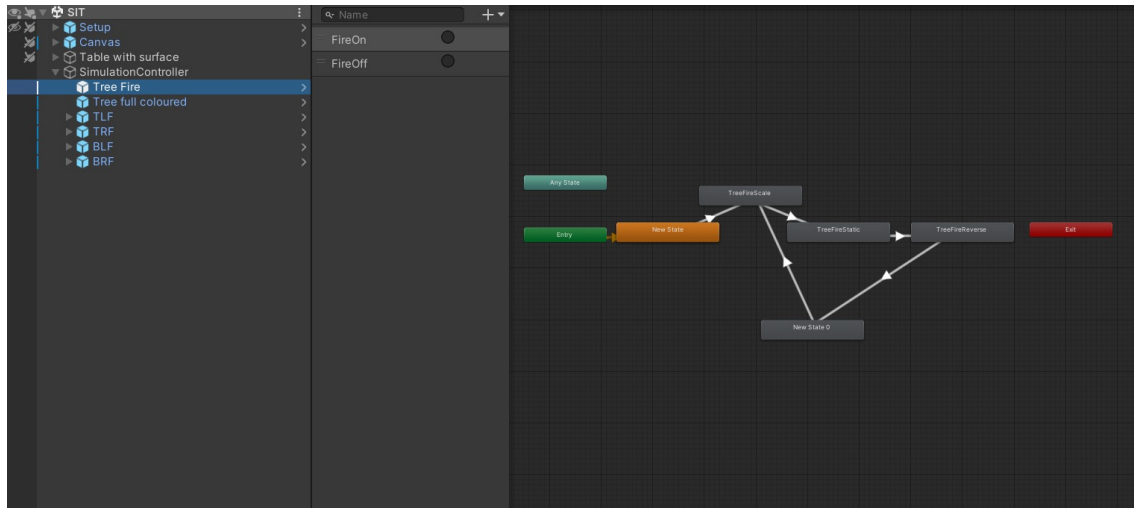


Figure 30: Unity display of the concept's animation page for the fire in the middle of the table

As can be seen in Figure 29, each user has a total of fifteen fire configurations in their 1/4 of the table that they can experience before they set the tree in the middle on fire. The users are divided by a path strip of yellow light with an orange lining. Each time either a fire appears or disappears for a user, not only do those specific fires appear on the table, but their previously accumulated fires also briefly disappear and reappear. The choice for this was logical to make since during a meal, something quite substantial has to happen on the table for users to notice differences among the eating and socialising that is going on. The fire in the middle does not use this fade-in and fade-out effect, but rather a scaling function as if the tree is burning from the inside out. Whenever a user sets the tree ablaze, their fire-ridden modules stay around for a while, while all other users' fires (if there are any) are snuffed out until their pieces of the table are empty again. By this time, the user that caused the fire in the tree will now also start to lose fire modules and the tree's fire will decrease in scale again, signifying it is not burning any longer. By implementing this delay of removing users' fire modules with the perpetrator having their modules staying ablaze longer hopefully conveys to all users around the table that that person was responsible for burning the tree. As a last-minute change, the tree in the middle was changed from a design with more detail colours into two static colours, namely green (the leaves and grass) and orange (the trunk). This made the imagery of tree clearer than it was before with the use of four colours in total to emulate a tree with shadow parts.

As can be seen in Figure 31, the hotkeys and what they do for each separate user is not clearly conveyed in the display shown in Unity at all. For this reason, small note papers that correlate to associated user colours were placed onto the keyboard keys that control each user's part of the table. The researcher merely had to press the hotkeys in order to activate their animations. The final set-up of this colour and note association can be seen in Figure 32 and 33 below.

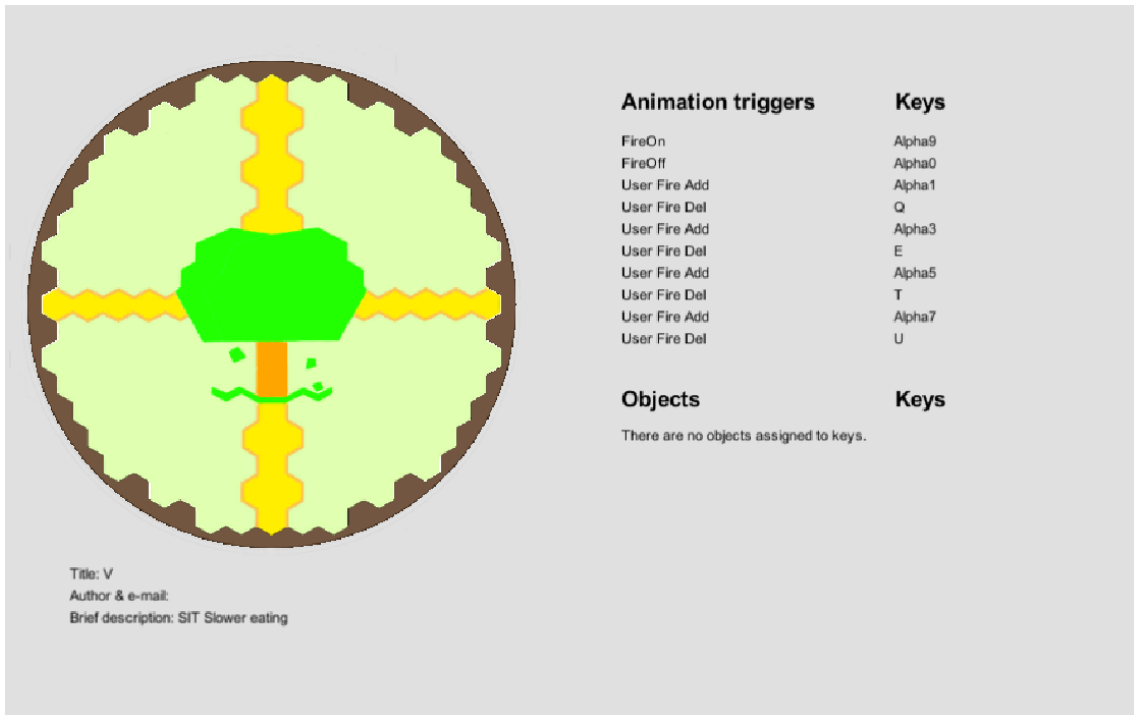


Figure 31: Unity display of the concept



Figure 32: Experiment keyboard set-up

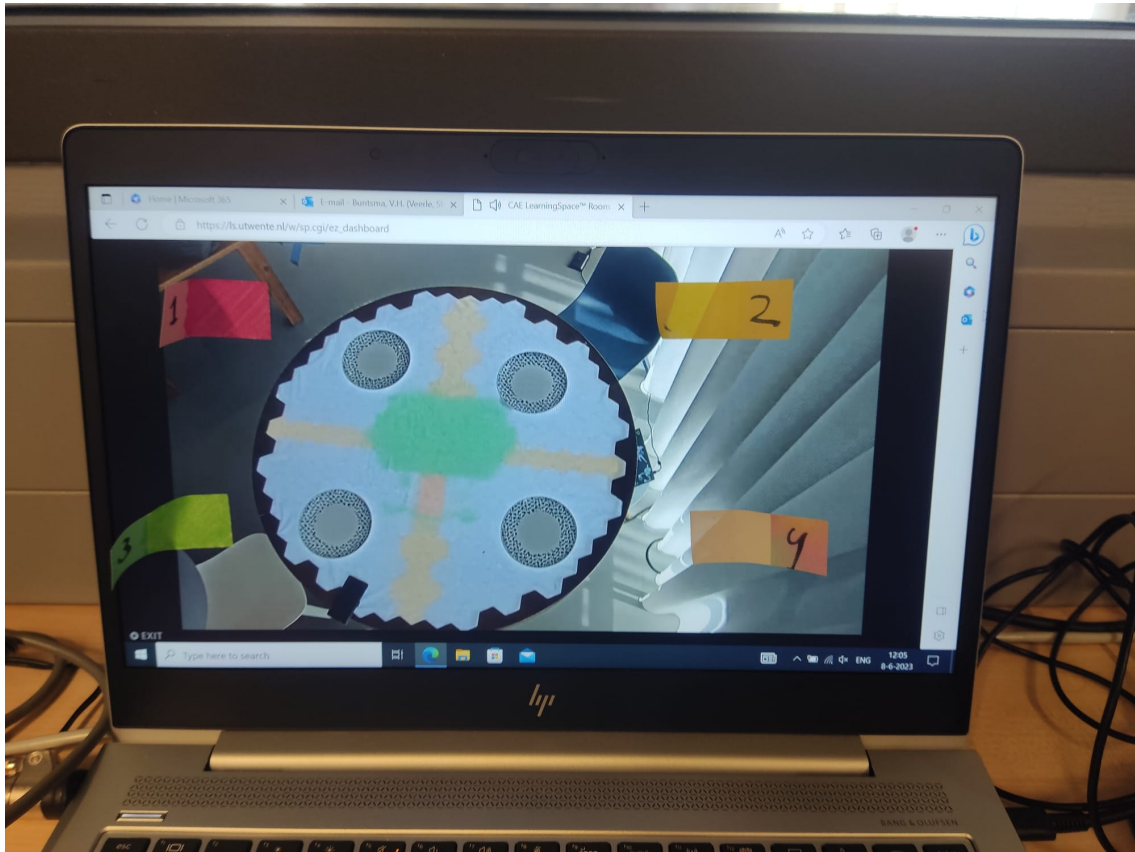


Figure 33: Experiment camera set-up

7 Evaluation

This chapter looks into the SIT experiments' set-up, preparations, experiment procedures, and the experiment results. The preparations listed below gives an overview of all things that need to be in order to set-up and start the SIT experiments.

7.1 Experiments and preparations

7.1.1 List of all preparations needed for the SIT experiments

Naturally, some materials and preparations before the actual experiments had to be taken care of. Whether it was buying groceries for the pasta pesto, printing informed consent forms, or having CCTV footage access, all needed to be in order before the experiments started. The list below shows all things that needed to be ready on the days of the experiments.

1. User testing preparation experiment (preliminary experiment)
 - Participant recruitment
 - Explaining what is expected
 - Sending reminders
 - Calculating a house average eating speed based on experiment results
2. Implementing the concept into Unity
3. User testing actual SIT experiment
 - Pasta pesto ready in the eHealth House's fridge
 - Pilot test to familiarise the researcher's handlings during the actual experiment
 - Informed consent forms printed
 - Briefing and debriefing information rehearsed
 - Second researcher available for help in observing participants during the experiment
 - CCTV footage available for viewing
 - Bluetooth keyboard with easily readable hotkeys to change animations on the SIT
 - Prepared pens, papers, and a stopwatch to tally bites per minute per user

The format of the informed consent form that the participants filled in can be seen in Appendix B. In order for the participants to fill in the consent forms, these forms were printed before the experiments started. To get access to the CCTV footage in the eHealth House, one of the University of Twente staff members who busy themselves with the CCTV cameras was emailed about the access.

7.1.2 User testing preparation experiment (preliminary experiment)

To determine eating speeds of participants in both numerical values and self-report formats before it can be determined how the SIT experiments would have to be tackled,

participants were asked to do this preliminary experiment. This experiment consisted of all participants having a meal as they usually would with their other participating housemates. It was clearly conveyed to the participants that for this preliminary experiment, they were supposed to have dinner with only the other participating housemates. Before the meal the participants were asked by the researcher to keep track of their amount of bites taken every five minutes of the meal by tallying each bite they take on a piece of paper. It was emphasized multiple times to the participants that each five minutes of the duration of one of their regular meals at home together, they were supposed to tally their amount of bites. Just in case, several reminders with the same detailed explanation of what was expected as well as the importance of getting these results before the actual experiments with the SIT were sent to the participants. The explanation for the participants looked as follows:

Dear [participant name], please do not forget to carry out the preliminary experiment a (few) day(s) prior to your meal at the eHealth House. For your convenience, you can find a reminder of what I would like you and your participating housemates to do during this preliminary experiment.

- *Have dinner with your other participating housemates at a table at home.*
- *Please tally **every 5 minutes** of your meal how many bites you took during those 5 minutes on a piece of paper.*
- *Send me a photo of your and your housemates' results so I can more accurately program the table to your group.*

If you have any questions, please let me know, and thanks in advance!

When the results came in, the researcher calculated the student house's average eating speed by first taking the average amount of bites taken every five minutes for each user individually. This was done by adding up all bites per five minutes results over the course that all housemates were eating and dividing this number by the amount of five minute rounds the meal consisted of in total. After this, all participants' five minute averages were divided by five to get each user's average bites per minute, and lastly all these bites per minute averages were added up and divided by the amount of housemates for the experiment, which was four. The number that follows from this calculation was then (if necessary) either rounded up (≥ 0.5) or rounded down (≤ 0.5). This final number was seen as the student house's average eating speed on which the animation changes for the actual experiments per house would be based.

The average eating speed of house 1 was determined to be two bites per minute, for house 2 this was three bites per minute, and for house 3 this was four bites per minute.

7.1.2.1 The Pilot test

For the researcher and helping researcher it was important that they could accurately replicate each observation procedure across the participating student houses. For this reason, a pilot test was arranged where friends of the researcher came to have lunch at the SIT. For this test, the users around the table were given a shared average eating speed of three bites per minute as a substitute for the calculated averages of the participating student houses. Since the actual participating student houses' averages combined and divided by three came down to three bites per minute, this was used as the substitute value during the pilot test.

How the system worked for the pilot test as well as the actual experiment was that the average shared eating speed (referred to as average student house eating speed in the actual experiment) was that eating at the shared average speed was already seen as 'too fast', but not to the full degree. After a minute of eating at the shared average eating speed, a user gained one cluster of fire on their piece of the table. This equated to one press of a hotkey on the keyboard by the researcher. In case a user ate one bite faster than average or more, two fire clusters got added to the user's part of the table. In case the user ate below the house average speed, one cluster of fire would disappear by becoming blue and returning back to the original state.

The researcher's and helping researcher's tasks here included tallying how many bites each user took every minute of the meal, keeping track of a phone's stopwatch chimes that indicated a minute had passed, and lastly after a minute had passed, pressing the right keys to either add or remove fire to/from the users' parts of the table. To clarify, the researcher and helping researcher divided the participants among themselves, so each researcher kept track of two participants' behaviour.

7.1.3 Miscellaneous preparations

Naturally, for this experiment, food had to be prepared by the researcher. Some days in advance of the actual experiments, the researcher got the groceries that were mentioned in the previous chapter. The night before the experiments started, the pasta pesto was cooked by the researcher and immediately chilled in the fridge to keep it as fresh as possible. In Figure 34 the pasta pesto dish can be seen right after it was done cooking.



Figure 34: The pasta pesto dish served to participants

Some other points that needed to be in order are the printing of informed consent forms and a rehearsed story for the briefing and debriefing of the experiments. The briefing consisted of the researcher welcoming the participants into the eHealth House and asking if they would like to look around for a bit. At this point, the SIT was still turned off. When all participants had looked around or agreed not to look around, they were asked to be seated in the livingroom for a bit. The participants were thanked for being present and were explained that the researcher was doing research about general eating behaviour such as bite sizes, weight shifts of plates, socialising during eating, etc. Eating speed was specifically not mentioned. The researcher also made an effort to mention that the table registered changes and reacted by itself on these changes by changing animations. From here, the researcher explained that they would be in the observation room making notes and observing the group from the CCTV camera above the table. It was clearly stated that this camera footage was also recorded for further observation after the experiment. After this, the researcher also reminded the participants of the one on one interviews after the dinner and that these would be voice recorded. The researcher handed out the informed consent forms and presented the participants with pens. During this part it was clearly stated that participants were allowed to step out of the experiment at any moment without giving a reason. The debriefing consisted of all participants and researcher gathering in the livingroom where the researcher explained that they were the one who changed the animations on the table, and that eating speed was specifically observed. The researcher stated that, with this new information about deceiving the participants, the participants were still allowed to revoke their consent if they wanted to.

Furthermore, the CCTV footage in the eHealth House needed to be available to watch and

ideally record to both execute the pilot and actual experiments as well as watch back what happened during each student house's meal in addition to their interview results. Also, keeping track of all users during the pilot and experiments was impossible for one person, therefore, the researcher needed a helping hand to observe two of the four users around the table for each of the experiments so the workload was divided to a point it was workable for both observers. Two separate helping researchers were asked to help out since one of the two could not be available during certain timeslots and vice versa concerning the other helping researcher. Lastly, a bluetooth keyboard had to be arranged so the animations' hotkeys could be pressed from a distance, as well as small note paper that could be put on the keys. Next to this, papers and pens for the researcher and their helper during the observations was a necessity to keep track of the amount of bites users took each minute of the meal.

7.1.4 User testing actual SIT experiment

Based on the pilot test, some small changes were made for the actual experiments. These changes include putting the keyboard hotkeys further apart from each other so no accidental presses happen, as well as making the papers on which the researchers tally the amount of bites per minute more neat and organised.

The experiment was conducted using the following procedure:

The three groups of participants were asked to either have lunch or dinner in the eHealth House in the Technohal building on the campus of the University of Twente.

Before the participants arrived for their day and timeslot, the researcher and the assistant had tested the interactive diner table to see if all animations are functional as intended as well as whether the camera placed above the table was in working order. The pasta pesto from the fridge was also warmed up on the stove. After these checks, when the participants arrived, a quick verbal briefing about the experiment was laid out on the participants. This briefing kept hidden that the researcher was the person to change the animations on the table instead of the table itself as well as the fact that specifically eating speed was observed during the experiment and based on that the animations changed. Participants were told in broad terms that their general (social) eating behaviour was observed and that the table would likely change animations throughout the meal the participants were about to have. After this briefing, the participants were presented an informed consent form that briefly repeated what the researcher just explained in the briefing and were explicitly asked for permission to be recorded, both on video for the experiment and as an audio recording for the interviews.

When the informed consent forms were filled in, the participants were asked to enter the eHealth House and be seated at the interactive table. The researcher set out the food onto the interactive table in front of the participants. The participants were explicitly asked to

not put any other items on the table and not yet touch their food but instead wait for the researcher to tell them to start over the intercom.

From this point onwards, the researcher and the assistant would be seated in the observation room that looks out over the experiment room. By looking through the real time CCTV footage, the participants' placement around the table was observed and the researcher and assistant clearly state who and thus which part of the table they would observe and change the animations for. From here, researcher's phone was set up as a stopwatch that chimed after every minute that passes. Pen and paper with a total of 25 minutes to be tallied for were also ready for the researcher and assistant to keep track of how many bites each of the assigned participants took every minute of their meal. Once all this was in order, the participants were asked to enjoy their meal and start eating. During this time, every time a participant at the table took a bite, the researcher or assistant (depending on which participant was assigned to who) tallied the amount of bites taken every minute. After each minute, depending on the tallied number of bites for each participant, the animations on the table were changed by the researcher or assistant's hand according to each participant's eating speed during the previous minute. This cycle repeated until all participants' plates were either empty, or through observed behaviour by the researcher and assistant it could be seen that the participants have had enough food. This was seen as the end of the meal and thus the experiment.

The assistant was thanked for their help with the experiment and sent away to make sure the following interviews with each participant were strictly between the researcher and participants. The researcher went back into the room with the participants to ask whether the meal was alright. From this point onward, participants were asked to come with the researcher one by one to be interviewed in the meeting room that was also part of the eHealth House. The questions asked during the user interviews after the experiment can be found in appendix C

After having interviewed all participants, a debrief was held. During this debrief it was revealed that the research was specifically about influencing eating speed and the researcher and assistant were the ones changing the table's animations behind the scenes. After this reveal, participants were once again told that their informed consent could still be revoked if they wish to do so and that this would result in all their collected data being terminated. Naturally this also followed that none of their collected data was used in this thesis.

Each of the experiments that were held and the interview results they garnered were to be transcribed and put into an Excel table. From this table, the researcher looked for correlating answers from all participants and comment on these in the next subsection.

7.2 Results

This section describes the results garnered from both the camera and general user behaviour observations as well as the transcribed user interview results. Furthermore, this section looks into the functional and non-functional requirements from chapter 5 and whether they were met.

From the observations (both from camera footage as well as user interview observations) as well as the user interview results, the researcher derived themes that form the basis of the results of this research. In case of the user interview results, a table in appendix D describes a generalised overview of all participating student houses' answers with extra context in some cases where necessary per the researcher's judgement. To create this table, an inductive thematic analysis [46] was conducted using the user interview results as well as ATLAS.TI to perform the coding needed to create the table. Briefly, this analysis looks first and foremost into the answers the participants gave and derives themes and codes from this analysis. From these codes and themes, an estimate of overarching themes across the participants can be made. The difference between inductive and deductive analysis is that inductive derives themes based on user answers whereas a deductive approach requires the researcher to establish themes before the participant answers are acquired. The researcher for this project decided on an inductive approach since according to them, it would result in themes more tailored to what the user interviews' results could entail. For this project, since the amount of participants is small and the user interviews were geared towards a thematic analysis, no correlations and other statistical evidence can be drawn. However, based on the results acquired, the thematic analysis can show the overarching experiences and answers of participants, effectively making it possible to see whether the (non-)functional requirements were met and draw conclusions based on the themes and researcher's observations during the experiments.

7.2.1 Theme 1: Experiencing the concept

When asked how participants experienced eating at the interactive table, the most prevalent answers across all three student houses were 'fun', 'interesting', and 'distracting'. Across different questions, four different participants from house 2 and 3 also mentioned the animations on the table felt like a game they played with their housemates.

7.2.2 Theme 2: Aim of the concept

During the user interviews, participants were asked some questions that aimed to find out whether the participants realised and understood the aim of the concept, this aim being to slow eating speed. Of the participants that reported being slow eaters (4 in total of which one in house 1 and 2 each, and two in house 3), none of them felt encouraged to change their eating speed in general. Of the participants that reported being average to fast eaters though (8 in total), seven participants felt encouraged to change their eating

speed in terms of eating slower.

On multiple occasions, the participants were asked about what they think the individual animation changes meant. During these questions it became clear that the animation of hexagons changing from green to red and from red to blue to green were best identified compared to the tree burning animation in terms of what they meant to convey. In case of the animation of green hexagons becoming red, the majority of the participants identified it had to do with either eating speed or doing something wrong, but the following possible meanings were also mentioned:

- Something posture related
- Measuring social interaction
- Interacting with the plate
- Not sure what the animation meant
- Aggression
- A timer

In case of the animation of red hexagons becoming blue and green afterwards, the majority of the participants identified it had to do with either eating speed or doing something right. Compared to the green to red and burning of the tree animations, this red to blue to green animation seemed to be most well understood by participants. However, just as with the green to red animation, participants also mentioned other possible meanings of the animation such as:

- You are interacting less with others
- You finished your meal
- A timer cooldown
- You are close to finishing your meal
- Not sure what the animation meant

The animation of the tree burning, or rather the yellow, orange, and red lights appearing in the middle of the table was confusing for most participants. Most participants were not able to identify what the appearing of the yellow, orange, and red lights in the middle meant. Some users also mentioned not seeing the animation in the middle of the table. The users that did see the animation mentioned the following alternatives for the animation's meaning:

- Bite distribution
- Not sure what the animation meant
- Not talking enough
- People are done eating
- Timer shifts

Lastly, the fire in the middle of the table and all users' fires disappearing were visual feedback that more than half of the participants associated with starting over and/or improving this time around. Some users did not notice this disappearing of all fire from the table at all. The users that did notice the changes also mentioned this change possibly meaning that they completed their meal or that they did not know what it meant to convey.

7.2.3 Theme 3: Animations of interest

During the user interviews, participants were asked about which animations stood out to them, which they liked seeing and which they disliked seeing. A small majority of the participants mentioned the animation changes specifically standing out. These animations include the changing of green to red, or the changing of red to blue to green. Though not specified by every participant, some participants mentioned that the change of colours pulled their interest since it was something changing on the table instead of being a static image they were looking at. As for the animations that most participants liked, seeing the blue light was mentioned by half of the participants. Interestingly, burning the tree and the red lights appearing were also mentioned as liked animations. As for the dislike of animations, most participants were neutral on this question, however two participants mentioned that they did not like burning the tree. Lastly, another participant gave the insightful comment that red lights appear too close to the plate which made them hard to notice at the start of the meal.

7.2.4 Theme 4: Meal situation across houses

Even though all student houses reached the animation of the yellow, orange, and red lights appearing in the middle of the table (burning the tree), it is interesting to note how they got to that point as well as whether it was visible on the CCTV footage that they changed their eating speed. Furthermore, for all participating houses, the participants mentioned the SIT and its animations being a topic of conversation during the experiment's meal. Though all three houses were seen conversing and pointing towards changes on the table, the frequency of this happening and the type of responses the participants gave were different across the houses. House 1 was considered by the researcher to be the most active and engaged with the table. It also happened on multiple occasions that someone came with a theory and asked the others to try it out with them. This did not happen during the experiments with the other two participating houses. Furthermore on house 1, three participants reported they felt inclined to talk to their housemates to change their eating behaviour for the sake of the others around the table. House 2, but especially house 3 seemed more driven by individual interest and intrigue to figure out what the table wanted from them. Compared to house 2, house 3 did seem the least engaged with the table and coincidentally most answers given during the interview that contained not being sure what an animation meant or not having seen an animation came from this house. Additionally, in house 2 it was only one participant that reported feeling inclined to talk

to housemates about changing their eating behaviour for the sake of the others, and no participants reported this in house 3.

7.2.4.1 Camera observations house 1

From the camera recordings it could be observed that this house reached the animation of burning the tree. Furthermore, it could be seen that users 2, 3, and 4 changed their eating speeds at some point during the experiment. Two of these users actively changed their eating speed after the tree in the middle of the table caught fire, while the other user already started moderating their eating speed before the tree caught fire. User 1 ate slowly in general, so any active changes in eating speed for this user were not observed.

7.2.4.2 Camera observations house 2

From the camera recordings it could be observed that this house reached the animation of burning the tree. Furthermore, it could be seen that users 1, 2, and 3 changed their eating speeds at some point during the experiment. These three users already started moderating their eating speed before the tree caught fire. Interestingly, user 4 seemed to eat very quickly, but only took small bites. The eventual burning of the tree was caused by this user, but this user was also last to finish their meal. This observation suggest a strong correlation between bite sizes and eating speed.

7.2.4.3 Camera observations house 3

From the camera recordings it could be observed that this house reached the animation of burning the tree. Furthermore, it could be seen that user 1 slightly changed their eating speed after witnessing the tree burning. The other users around the table did not visibly change their eating speed. It could also be observed that compared to the other two houses, this house generally paid less attention to the table and the animation changes it displayed. Interesting to note is that user 4 took very small bites compared to the other users and did not finish their plate. When asked why user 4 did not finish their plate, they replied with not being that hungry.

7.2.5 Theme 5: Recognisability of the animations

Judging from how participants answered the researcher's questions during the interview, it could be seen by the language used by the participants that not everyone recognised the imagery displayed on the SIT. In total, five out of twelve participants mentioned phrasing such as "burning the tree", "cooling the fire down", and "fire spread to the tree" without the researcher having mentioned what imagery was displayed on the SIT in either the briefing or asking the user interview questions. This leads the researcher to believe that these five participants successfully identified the real life imagery which is one of the non-functional requirements.

Of these five participants, four came from the same participating house, house 1. The other participant came from house 2. None of the participants in house 3 gave the researcher the impression that they knew what was displayed on the SIT in terms of imagery.

7.2.6 Theme 6: Possible influence of the animations

Interesting to note is that eleven out of the twelve participants for this research said their regular eating behaviour might change if they were to eat daily at the SIT with the animations shown during the experiment. A big disclaimer for these claims is necessary though seeing as most of these participants did additionally mention that this change in eating behaviour will only occur if they can be absolutely sure what the table meant to influence and whether it is something they care about changing. Furthermore, some of these participants also mentioned the table's animations feeling gimmicky to the point where it would just assimilate into something regular and lose its influence over potentially changing the participant's eating behaviour.

8 Discussion & Future Work

This chapter discusses the results of the experiments with the SIT in reference to already existing literature where possible. Based on these discussions, the main research question is answered. Whether the (non-)functional requirements were met is briefly stated. Furthermore, limitations of this study and suggestions for future research are discussed.

It was this research's aim to answer the main question of *"How can young adults in a social eating setting be motivated to eat slower by means of visual feedback from the interactive diner table?"*. To answer this question, a sequence of animations that can be played on the SIT (Sensory Interactive Table) that can help answer this question was realised. The process started with collecting relevant background information to help set-up concepts of which one was chosen, concept 5. This concept was implemented into the SIT and used for the final experiments in which participants dined at the SIT. The results from these experiments can be found in chapter 7.

8.1 Discussion

8.1.1 Themes

Participants mentioned experiencing eating at the SIT as fun, interesting and distracting as stated in the results from theme 1. Additionally, four participants mentioned it felt like playing a game with their housemates. The words fun, interesting, and distracting combined point to something happening during the experiment that got these responses. These choices of words to describe the experience of eating at the SIT along with the answers of the SIT experience feeling like a game, it can be stated that the gamification element, though recognized by participants or not, did have an effect on the participants' experience. Combining this with the results from theme 4 where it is stated that participants were to varying degree engaged with the table as a group, the implementation of the cooperation gamification element becomes apparent. As stated by Sailer's study [41] from the background research, elements such as stories and teammates cause for an experience of social relatedness. This is because it introduces a shared goal and leads to feeling relevant [41]. The concept implemented into the SIT incorporated an element of story with it's tree, fire, and water, and necessary cooperation to keep the tree from burning. The result of these elements causing a more engaging experience for participants is in line with what Sailer [41] states, but it cannot be concluded that the gamification elements are all that caused the engagement with the table and the responses it evoked from participants. The direct relation between gamification, engagement, and eating speed cannot be concluded definitively because of the fact that not all participants acknowledged the concept as a game and the interpersonal relation differences between houses and their housemates were abundant. Moreover, elements such as the changing colours animations could have had an influence on the engagement with table and this element are discussed in later paragraphs.

Regarding theme 2, seven out of eight self-reported average to fast eaters felt encouraged to change their eating speed based on the SIT animations displayed. Of the four slow eaters, none felt encouraged to change their eating speed. This distinction between average to fast eaters being affected and slow eaters not being affected by the SIT's animations is noteworthy. This result can come from the animations being able to encourage users to change their eating speed when given incentive to do so. Since the slower eaters already ate at a speed accepted by the concept, these participants were not affected. However, it cannot be ruled out that social influences from housemates as well as subconscious remembering of the preliminary experiment could have helped achieve this result. Another thing regarding theme 2, though it was often reported by participants that the animations aimed to change eating speed, there were many other reports on what the aim of the animations also could be. This suggests that it was not clear to participants what exactly the animations aimed to influence. Especially the appearing of yellow, orange, and red colours in the middle of the table was not clear at all to participants. Though, all red lights and the lights in the middle of the table disappearing, returning the table to its original state was often identified as a means of saying 'start over' and/or 'improve this time'.

From theme 3 it could be derived that a majority of the participants mentioned the animation changes to be standing out due to seeing something change rather than a static image. Though not researched during the background research, according to a paper by Abrams and Christ [47], it could be that the onset of motion (something static starting to move) the animation changes provided captured the participants' attention. In Abrams and Christ's research [47] it was proven that among offset motion (something that's moving stops moving), continuous motion, no motion, and onset motion that onset motion was recognised the fastest among participants of the study. Abrams and Christ's research [47] is about the turning or spinning motion of shapes specifically though which is different from motions such as appearing and disappearing shapes in the concept from this thesis. To further support the claim that the concept's animation changes pulled the participants' attention, a study by Brockmole and Henderson [48] states that abrupt objects disappearing and appearing in real life settings pulled attention from participants. Again, research is not completely in line with the animations present in this research since this thesis concept uses fade ins and outs instead of abrupt changes, however, the fact that a change in scenery pulled the participants' attention according to Brockmole and Henderson [48] is a claim that is consistent with this thesis' results of the animation changes pulling attention of the participants. Apart from the motion component that the animations come with, it could also be the colour changes specifically that grabbed participants' attention. An article by von Mühlenen and Conci [49] proved that changing a singleton's (a small area or a singular shape) colour among a group of shapes of one different colour clearly captures a person's attention. These findings are also in line with an article by Turatto and Galfano [50] that showed that the colour of a singleton among other elements of the same colour, but a different colour from the singleton, automatically pulls attention. Still

on the topic of theme 3, when participants were asked what animations they liked, half of the participants mentioned seeing the blue light. This result is in line with previous research found in the background research that states that the colour blue has a neutral and arguably positive association with for example calmness as opposed to colours such as red which has a negative association like panic and fear [30] [29]. Though red generally has a negative association, it was noted that some participants liked seeing this colour appear as well as burning the tree. Though this is in opposition with the wish to avoid negative colours such as red, another explanation for liking the red lights and burning the tree can be given. It is possible that participants' curiosity led them to see what the full scale of animations of the table is and how to achieve it. Considering this logic, it is more understandable to see why some participants liked seeing more red lights appear and seeing the tree burn.

On the topic of theme 4, it was observed that the participating student houses had different levels of involvement as a group with what was happening on the table. House 1 seemed most involved as group with actively trying out theories about what was happening as a collective. House 2 talked about theories, but any theories a participant had were only tried by themselves. House 3 acted the same as house 2, but to a much smaller degree in terms of trying out theories and engaging with the table. Additionally to this information, most participants from house 1 reported feeling inclined to talk to other housemates about changing their eating behaviour for the sake of the others around the table during the experiment. For house 2 this was only one participant, and house 3 had no participants feeling this way. The difference in group or individual involvement between houses could have to do with how familiar the housemates feel with each other. It is especially interesting to note that house 1 was most involved with the table as a group and generally reported being more comfortable in talking about each other's eating behaviour for the sake of the others. An article by Higgs and Thomas [14] states that among many other factors, behaviour and expectations of others around the table have influence over one's actions while eating. Though not completely on the same topic as this issue, an article by Higgs [16] did suggest that the more comfortable people are with each other, the more (or less) food they consume. Combining the main points of these two studies, it is fair to assume that the level of comfortability the participants had with their housemates could have had a hand in how engaged they were with the table either as a group or individual.

Theme 5 looked into whether participants were able to identify the simplification of real-life imagery on the SIT in the form of a tree, fire and water. Less than half of the participants verbally identified the real-life imagery. A number of factors could have caused this result. Firstly, the simplification of specifically a tree and fire spreading towards it was too detailed and ambitious considering the capabilities of the SIT in terms of detailed LED displays. Secondly, displaying a tree, fire, and water is not considered easily identifiable iconic imagery like a check mark, cross, or a sun symbol. A check mark and sun would be more easily identifiable due to their use of simple, but iconic shapes. In case of a cross or sun

symbol, this would also nullify the problem of not being able to identify a picture from a certain angle seeing as most if not all sun and cross symbols looks the same from each viewing angle. Lastly, the researcher overestimated the identifiable nature of the concept due to personal bias and knowledge beforehand on what the concept entails due to being its creator. Because of this, the concept's display was not tailored to resemble a more iconic and instantly recognizable image.

The last theme, theme 6, showed that all but one participant said their regular eating behaviour might change if they were to eat at the SIT with the current animations daily. Participants however did mention this is assuming they know exactly what the animations aim to influence and that they are intrinsically motivated to change the eating behaviour the animations aim to change. This statement ties back to theme 2 where participants mentioned many aims the animations could have when it comes to influence (eating) behaviour. The animations were not clear in what they wanted from the participants. Furthermore, some participants reported the animations feel gimmicky to the point the animations would assimilate into something seen every day and lose their potential influence on changing eating behaviour. This gimmicky feeling could come from participants losing interest because of the simplicity of the concept. The concept used in this research only had limited amounts of animations, and when the final animation was triggered, the whole experience reset itself. Since this concept is not fleshed out and complex in the sense of many different animations that can occur, this could cause the gimmicky feel. Perhaps for future long term experiments it could prove valuable to consider using multiple concepts or variations of the same concept to keep users engaged with the SIT and decrease the chance of the animations feeling gimmicky. However, it is fair to think that one would not always be dining at the interactive table. In this case, it might be fine to have a singular simple concept as long as it makes an impact and causes a realisation in the user that they would need to change something specific about their eating behaviour whenever they do dine at the SIT.

To summarise these discussions, theme 1 and part of theme 4 showed that the gamification cooperation element that was used in this research's concept caused a more engaging experience for participants, but it is most likely not the sole element that caused this engagement. Regarding the results that can be seen in the theme 2 section, the original aim of changing eating speed did come across to participants, but not with much confidence seeing as there were many other aspects that the participants felt could have been the aim of the animations. This is not a big surprise seeing as less than half of the participants understood what imagery was portrayed as mentioned in theme 5. However, a positive finding is that the green to red and red to blue to green animations were able to be recognised by most the majority of participants as being eating speed influencers, which can have a positive effect on potentially slowing down eating speed. Interestingly, the animations after the tree burning (that being all fire disappearing) were correctly identified as a sign to start over and/or improve this time around. In conclusion, the general gist

of what the green to red, red to blue to green, and all red lights and yellow, orange, and red lights disappearing from the table meant was identified. Theme 3 discussed that most participants clocked the animation changes specifically, though apart from colour studies, a look at theory about motion and how it can capture attention is required. Theme 4 looked into to what degree the different participating student houses were involved with the table as a group and/or as individuals. The conclusion from this section is that varying levels of comfortability between housemates could have caused for different levels of engagement as a group or individuals with the SIT's animations. Theme 5 argued why the real-life imagery displayed was mostly not recognised by participants and suggested that displaying more well known icons and symbols could cause for a more identifiable display. This theme also mentioned the concept of this research having a too detailed appearance which is not suitable to be displayed on the SIT considering the table's capabilities. Lastly, theme 6 discussed the claim that participants felt like their regular eating behaviour might change if they were to experience the implemented animations daily. This claim was made assuming participants know the exact aim of the animations and are intrinsically motivated to change that specific eating behaviour. Also, some participants reported the animations being gimmicky and therefore maybe not suitable for longtime use if the goal is influencing eating behaviour every day. Making variations of animations using the same aim and influence could help overcome the gimmicky feel of the animations.

Again, this study aims to answer the question of: *"How can young adults in a social eating setting be motivated to eat slower by means of visual feedback from the interactive diner table?"*

By presenting young adults at the interactive diner table with animations involving colour association theory of green turning blue, or red turning blue and green, even when users are not sure what is displayed in terms of imagery, they can get the gist of the animations' aim to slow eating speed down due to the colour usage. Furthermore, providing the users with a cooperative gamification element that keeps them engaged with each other and what is going on on the table can have a positive effect on changing eating speed. The enthusiasm of participants also seems to have an effect on how well the aim of the animations is conveyed as well as how much users feel influenced by these animations.

8.1.2 (Non-) functional requirements conclusion

As a reminder, the non-functional requirements were as follows:

- Curiosity about what animations the table can display based on user behaviour
- Awareness of what is displayed on the table in terms of imagery
- Reflection in terms of triggering users to talk to each other about what is displayed on the table

Based on the results from the experiments in terms of user interview results and researcher observations, it can be concluded that house 1 achieved all non-functional requirements.

House 2 achieved two of the non-functional requirements and the ‘Awareness of what is displayed on the table in terms of imagery’ requirement was unfortunately only exhibited by one user in this house. House 3 achieved two of the non-functional requirements where ‘Awareness of what is displayed on the table in terms of imagery’ was not achieved by any of the users.

All animations were in working order before, and during the experiments, so it can be concluded that all functional requirements (as stated in chapter 5) for this research were achieved.

8.2 Limitations

This section gives an overview of some limitations of this research and thus some points of improvement for follow-up research.

Firstly, the concepts derived from ideation part of this research, though well-supported by the background literature, seem quite random in their ideation and ways they function. A more in-depth look at how the specific concepts came to be would have been a better choice to support each ideated concept and their potential as a final concept. For example, since the SIT displays animations, thus movement of some sort, studies on motion and how it can capture attention also should have been looked into during the background research phase.

Secondly, since twelve participants in total were invited for experiments, there is not enough evidence to speak of correlations and effectivity within this study’s results. The researcher’s judgement was that twelve is enough participants to provide results that can be interpreted as the final concept being or not being useful to motivate young adults in a social eating setting to eat slower. However, to give a conclusive answer that is proven beyond a shadow of a doubt, the amount of participants has to be higher to support statistical evidence. The thematical analysis that was done is a good start, but with a higher participant count, the use of ‘correlations’ and ‘effectivity’ can actually come into play based on statistical evidence.

Thirdly, due to not enough care on the researcher’s part in inviting participants for the preliminary experiment, participants could have already got the clue that this research revolves around eating speed and specifically slowing down eating speed. For future reference, when inviting participants for a preliminary experiment revolving around eating speed, asking the participants to keep track of more things other than how many bites they take every few minutes is a must. Examples include the type of dish and groceries for this dish, writing down how social other participants were during the preliminary experiment, keeping track of how many times one chews before swallowing each bite, how long they were seated at the table in total, if more people ate from spoons or forks, etc.

Another point worth mentioning is that a dangerous assumption made by the researcher was that all participants actively participate in conversation and that each participant would be motivated to try and understand what the table meant to tell the participants. More active participation and conversation could have been more insightful when you take house 3 for example. This issue could be avoided to asking potential participants whether they are usually very social during dinner, and whether their housemates are as well. Furthermore, during the briefing extra attention could be given to the participants in telling them that the table will display animations and the participants *have to* talk about them and figure out what they mean. On the otherhand, there are also other houses like house 3 in the world, so looking towards a method to motivate these types of persons to be more active in conversation, or tailoring a project to their needs could be worth another study of itself.

Furthermore, the user interviews during the ideation phase could have been done with the users being presented with the concepts different animation stages on paper instead of showing the concepts on a screen. This could have yielded more engagement from the interviewee seeing as pointing to and scribbling is easier done on paper rather than on a screen. Also, users would have been able to see the concept images from an angle as if looking at the actual SIT's surface. Furthermore, the users should have been presented more detailed representations of the concepts instead of being presented with the concepts as they are in the ideation chapter. The lack of detailed steps of each of the concepts during the user interviews resulted in an incomplete picture of the concept for the user interviewees. It could be the case that users would have chosen a different concept if the shown concepts were more compatible with the lay-out of the final table design. Also, there was no second round of user interviews concerning an improved version of the chosen final concept. If another round of feedback would have been possible, further specification of the concept could have yielded a more well-rounded and understandable concept for users.

Moreover, since the number of bites per participant during the experiments were counted by hand by humans, some small mistakes in bite counts occurred. Naturally, these occasional misses could have had some influence on how fast the fire spread for some users. However, when looking at the results of the user interviews, there are no answers given that suggest this issue had a snowball effect on the results. Another point about the experiments is that users were not allowed to use their phone during the meal and have drinks on the table. This could have caused a less regular dining setting than participants would usually have with their housemates and thus influenced social behaviour with the other participants.

Lastly, due to planning problems in the beginning of the research process, some deadlines and interview dates were too cramped together to give each part of the research process the care and attention it should have got.

Though not a limitation, there was an unexpected finding that has to be mentioned. Though house 1 seemed most engaged with the SIT animations, no one from this house verbally mentioned the animations feeling like a game as compared to the two other student houses.

8.3 Future Work

During the background research many factors potentially influencing one's eating behaviour were mentioned. Not all these factors could be (completely) controlled for this research. These factors include noise and light from outside, and general comfortability of the participants. Though it only happened for one participant during this research, it is interesting to investigate a possible correlation between frequency of taking bites and bite sizes. It could prove useful for future studies to investigate whether fast eating, but only taking small bites at the time would yield the same result of potentially overeating like eating too fast with normal to large bite sizes. A more SIT related idea is that it could be interesting to conduct studies on what imagery can be simplified and still identified using the SIT display system of LEDs beneath its surface. Furthermore, studies on displaying realistic imagery compared to icons/symbols and abstract shapes as a means to influence eating behaviour using the SIT could be worth a research project. Also, to conduct more longterm research projects studying the same participant(s) using the SIT's potential influence on daily eating behaviour, implementing variations of the same concept with the same aim could help the study be more engaging for the users instead of being perceived as a gimmick.

9 Conclusion

This final chapter looks back at this research's main findings and answers the main research question.

To reiterate, the main question of this research is: *“How can young adults in a social eating setting be motivated to eat slower by means of visual feedback from the interactive diner table?”*

By presenting young adults at the interactive diner table with animations involving colour association theory, they can get the gist of the animations' aim due to the colour usage. Furthermore, providing the users with a cooperative gamification element can have a positive effect on changing eating speed. However, more research regarding exactly the type of imagery and motions is necessary to narrow down and make the aim of the SIT's animations more well-defined for users. Also, implementing more complex and varied animations could help influence users' every day eating behaviour.

The future of this research's concept could make for a means of slowing one's eating speed in a social environment while incorporating an element most people use while dining, a table. Optimistically speaking, the SIT could contribute to a healthier society in terms of making users realise their eating patterns so they can change them wherever necessary. In the future, the table might be able to provide the same level of support in this regard as already existing mindful eating apps or smart cutlery.

Appendices

A Information Brochure

Sensory Interactive Table (SIT) experiments and process

A graduation project by Veerle Buntsma

Hello dear potential participant! After the first questions I asked you, it was concluded you're eligible to participate in this research, also, you're still interested to help me out with this project, I'm very happy to hear that! This brochure gives you more information about what the two experiments for this graduation project entail and your role in this process if you choose to continue your participation.

The first experiment

This experiment consists of you and your housemates having a regular dinner as per usual at home with a small twist. My question to you is if you could keep track of the amount of bites you took from your meal every 5 minutes. This measurement gives me an idea on how to tailor the second experiment more your house's eating behaviour. You can view this experiment as a null measurement if you will.

The second experiment

This is where the fun starts! I will ask you and your housemates to have a meal, dinner or lunch to be more specific, in a lab with an interactive diner table to use as your dining table. This interactive table, also referred to as the SIT is capable of measuring weight shifts across its surface as well as display fairly intricate animations just below its surface. It can house 4 hungry participants at a time. As for the meal, I will cook you vegetarian pasta pesto that you will not have to pay for considering I would be grateful to have your help in carrying out this project! During your meal, the animations on the table will change based on you and your housemates' eating behaviour. After your lunch/dinner, I will individually ask you and your housemates to join me for one on one interviews that consist of questions about your experience eating at the SIT.

The last important notes

Before the first experiment starts, you will be presented with an informed consent form with a more fleshed out explanation as to how the experiments are to be carried out and what is expected of you as participant. Additionally, the consent serves as a means of allowing me to record your data with regards to this project's experiments. Naturally, you can revoke this consent at any time, and I will delete all previously collected data related to you.

My sincerest thanks for considering helping me in this project! If you are still interested in participating or have any questions, you can reach me through tel: +31 (0)6 57 1212 28 or email: v.h.buntsma@student.utwente.nl



B Informed Consent Form

Experiment Sensory Interactive Table Informed Consent

Researcher: Veerle Buntsma supervised by Juliet Haarman and Randy Klaassen

This research consists of two experiments, one being a null-measurement and the other being an experiment using an interactive dinner table as a dinner table with housemates. The null-measurement experiment consists of you having dinner like you regularly would with the twist of noting down how many bites you took from your food every 5 minutes. This measurement gives the researcher an idea of how to program the SIT for the next experiment. During the second and last experiment, participants have dinner together using the Sensory Interactive Table (SIT) as their dining table. To find out whether the animations displayed by the table influence your eating behaviour in a social setting, you are asked to have a meal with your housemates and afterwards have a one on one interview with the researcher about how you experienced and how impactful you found eating at the SIT. The researcher will clearly convey that the collected data will only be used for this project, and answers will not be able to be traced back to a specific individual.

This consent form is given to you after the initial briefing of what the SIT experiment will entail as well as the researcher having received the results from the null-measurement experiment, and questions from you and your housemates have been answered. It is expected that the second experiment (eating at the SIT experiment) will take around 50-90 minutes. During this time, the SIT changes animations based on your and your housemates' eating behaviour, and the researcher observes you and your housemates and measures the weight shifts on the SIT that occur during your meal.

The briefing before the actual SIT experiment explains that you are asked to have a meal together with your housemates as if you were eating at home. The researcher will observe you and your housemates' eating behaviour around the table, and at certain points during the experiment, the animations on the SIT will change. Once everyone finishes their meal, you will all be called away by the researcher. From here, you and all other participants are invited to a one on one interview with the researcher regarding how the SIT may or may not have altered your eating behaviour, eating experience and mood(shifts) at the table. When all interviews have been finalised, the debriefing starts. During this debriefing, questions may be asked and it will be explicitly stated again that after these interviews participants are still allowed to revoke their signed consent forms no matter their reason.

'I hereby state that I have been informed in a manner which is clear to me about the nature and ways in which this experiment will be conducted. My questions have been answered to my satisfaction. I agree of my own free will to participate in this research. I reserve the right to withdraw consent and accordingly ask for my data to be removed without the need to give any reason. I am aware that I may withdraw from the experiment at any time without any consequences.

If my research results are to be used in scientific publications or made public in any other manner, without my expressed permission they will have to be made completely anonymous. My personal data will not be disclosed to third parties without my expressed permission.'

If you would like to receive additional information or have complaints about this research, feel free to contact the researcher Veerle Buntsma, telephone: +31 (0)6 57 1212 28; email:

v.h.buntsma@student.utwente.nl

Signing section:

.....

Name subject

.....

Signature

.....

Name researcher

.....

Signature

C SIT experiment user interview questions

1. How did you experience eating in a different environment with your housemates?
2. How did you experience eating at the interactive table?
3. How would you describe the social eating process during your meal?
 - a. Were you more or less social than usual during a meal? Please explain your answer.
 - b. Were your housemates more or less social than usual during a meal? Please explain your answer.
 - c. Was the interactive table helpful in encouraging being more social? Please explain your answer.
4. Did you get the impression that the table wanted you to change something about your eating behaviour? Please explain your answer.
 - a. Did you feel like the table changed animations tailored to your eating behaviour? Please explain your answer.
5. Did you feel inclined to talk to your housemates about changing their eating behaviour for the sake of other users around the table? Please explain your answer.
6. What do you think the animation changes meant during your meal?
 - a. What do you think the animations aimed to influence during your meal?
 - b. Was your total amount of food eaten different from having your usual meals?
 - c. Did you feel encouraged to change your bite sizes based on the animations on the table? Please explain your answer.
 - d. Did you feel encouraged to change the speed at which you ate based on the animations on the table? Please explain your answer.
 - e. Did you feel like the animations on the table influenced your mood over the course of the meal? Please explain your answer.
7. The following questions are in reference to light colour changes of the animations and their meaning according to the participants' experiences
 - a. What do you think the changing lights from green to red colours that showed up in the animations meant?
 - b. What do you think the changing lights from red to blue to green colours that showed up in the animations meant?
 - c. The following three questions are asked in case the animation of the yellow/orange/red shapes in the middle of the table (the tree burning) is activated by a user
 - i. What did the red/orange/yellow colours appearing in the middle mean, you think?
 - ii. Please describe what happened after the middle was covered with red/orange/yellow colours.
 1. What do you think this animation meant to convey to you?
 - d. Were there any elements to the visual feedback/animations present that stood out to you? Please explain your answer
 - i. Were there any visual feedback/animations present that you liked? Please explain your answer
 - ii. Were there any visual feedback/animations present that you didn't like? Please explain your answer
8. If you were to eat at this interactive table every day with the implemented animations you just experienced, would it be of influence on your regular eating behaviour? Please explain your answer.
9. What were your expectations for this experiment with the SIT? (This can be about any part of the experiment process: The briefing before your meal, sitting at the table, the debrief, etc.)
10. Would you describe yourself as a slow, average speed, or fast eater?

D SIT experiment user interview results

| House and additional comments | How did you experience eating in a different environment with your housemates? | How did you experience eating at the interactive table? | How would you describe the social eating process during your meal? | Were you more or less social than usual during a meal? Please explain your answer. | Were your housemates more or less social than usual during a meal? Please explain your answer. | Was the interactive table helpful in encouraging being more social? Please explain your answer. | Did you get the impression that the table wanted you to change something about your eating behaviour? Please explain your answer. | Did you feel like the table changed animations tailored to your eating behaviour? Please explain your answer. | Did you feel inclined to talk to your housemates about changing their eating behaviour for the sake of other users around the table? Please explain your answer. |
|------------------------------------|--|---|--|---|---|--|---|---|---|
| H1 | Three users mentioned they found the different environment fun and exciting, but also lacking in ambience and being a little too uptight and neat. The other user mentioned the experience being alright, but being watched through a camera took some time getting use to. | Two users mentioned that it was fun and interesting to see what happens. One of the two users mentioned the table being distracting and the other user mentioned being scared at first because they were unsure of what they could expect. | All users mentioned that they were being social with each other like they are normally. One user specifically mentioned the table was a big conversation piece | Two users mentioned being more social while the other two users reporting being their normal amount of social compared to usual | Three users reported their housemates being more social than usual. While one user mentioned their housemates being the same amount of social compared to usual | All users reported the interactive table being helpful in encouraging being more social | One user reported not knowing what the table wanted from them. The three other users reported they noticed the table wanted them to change something about their eating behaviour | All users reported they felt the animations on the table were tailored to their own eating behaviour | Three users reported they felt inclined to talk to housemates about changing their eating behaviour for the sake of the other users around the table. The other user did not feel inclined to talk to housemates about changing their eating behaviour for the sake of the other users around the table |
| H2 | Three users reported the environment not having an impact on feeling different or less comfortable than usual. One other user mentioned that it took a minute to get used to the environment, but from there they became more comfortable | Three users mentioned the experience was fun. Of these three users, two as well as another user also reported the experience being interesting. One of the three users who found the experience fun also found it distracting. A user at one point also found it stressful because of what happened on their part of the table. | Two users mentioned being social as normal. Another user reported that they changed their conversation topics from their usual conversations. The last user reported they and their housemates were somewhat more social than usual. | Three users reported being the same amount of social as usual while the other user mentioned being less social than usual. | All four users reported their housemates being the same amount of social as usual | All users reported the interactive table being helpful in encouraging being more social | All users reported they noticed the table wanted them to change something about their eating behaviour | Three users reported they felt the animations on the table were tailored to their own eating behaviour. The other user felt like the animations were not tailored specifically to them but rather the whole group's behaviour | Three users reported they did not feel inclined to talk to housemates about changing their eating behaviour for the sake of the other users around the table. The other user felt inclined to talk to housemates about changing their eating behaviour for the sake of the other users around the table |
| H3 | One user reported that it felt odd since the environment did not feel like a student house. Two other users mentioned that it was different from usual since they normally don't eat at a table. The last user mentioned it was different than usual, but that they probably did not act differently because of the environment. | Two users mentioned finding the table and its animations confusing. One these users also mentioned the table being intriguing. Another user found the experience fun and the last user found the experience to be okay. | All users mentioned that they were being social with each other like they are normally. | Two users reported being more social than usual and two users reported being the same amount of social compared to usual | Two users reported their housemates being more social than usual and two users reported their housemates being the same amount of social compared to usual | Two users reported the interactive table not being helpful in encouraging being more social. The two other users reported the interactive table being helpful in encouraging being more social | Three users reported not knowing what the table wanted from them. The other user reported they noticed the table wanted them to change something about their eating behaviour | Three users reported they felt the animations on the table were tailored to their own eating behaviour. The other user felt like the animations were not tailored specifically to them but rather the whole group's behaviour | All users reported they did not feel inclined to talk to housemates about changing their eating behaviour for the sake of the other users around the table |
| Additional comments about the data | | | | | | The users that reported the table being helpful in encouraging being more social mentioned this was because the table and its animations made for another topic of conversation where housemates could actively talk about what they saw | The users that reported they did not feel inclined to talk to housemates about changing their eating behaviour for the sake of the other users around the table either gave the reason that it did not cross their mind or that it is not their place to tell others how to eat | | |

| House and additional comments | What do you think the animation changes meant during your meal? | What do you think the animations aimed to influence during your meal? | Was your total amount of food eaten different from having your usual meals? | Did you feel encouraged to change your bite sizes based on the animations on the table? Please explain your answer. | Did you feel encouraged to change the speed at which you ate based on the animations on the table? Please explain your answer. | Did you feel like the animations on the table influenced your mood over the course of the meal? Please explain your answer. | What do you think the changing lights from green to red colours that showed up in the animations meant? | What do you think the changing lights from red to blue to green colours that showed up in the animations meant? |
|------------------------------------|--|---|--|---|---|--|--|--|
| H1 | All users reported that the animations meant to comment on eating speed. One user also mentioned the animations could mean 'talk more' | All users thought the animations aimed to influence eating speed. Three users also reported that the table aimed to influence being social. Of these three users, one also reported that putting down cutlery could be an aim of the animations | Three users reported eating a comparable amount of food as they usually would. One user reported eating more than they usually would | All users reported not being encouraged to change their bite sizes | Three users reported being encouraged to change their eating speed. One user reported not being encouraged to change their eating speed | One user reported that their mood was not changed by the animations over the course of the meal. The three other users reported their moods did change over the course of the meal where one user mentioned the animations made them feel more comfortable, another user mentioned it sparked interest, and the last user mentioned that felt more enthusiastic | All users reported that this animation meant you're doing something wrong. Two users mentioned this animation meant you're eating too fast as well | Three users mentioned this animation meaning you're eating slower. One user of these three specifically mentioned the animation meant calming the fire down. The other two of the three users mentioned the animation meaning you're doing better. The last user not previously mentioned thought the animation meant you're doing something correct |
| H2 | All users reported that the animations meant to comment on eating speed. One user also mentioned the animations responded to vibrations of the plates, another user mentioned the animations could signal whether you finished your food | All users thought the animations aimed to influence eating speed. One user also reported that the table aimed to influence being social. Another user thought the amount of chewing could also be the aim of the animations. Lastly, another user thought the animations aimed to influence the timing of social interactions | All users reported eating a comparable amount of food as they usually would | All users reported not being encouraged to change their bite sizes | Three users reported being encouraged to change their eating speed. One user reported not being encouraged to change their eating speed | One user reported that their mood was not changed by the animations over the course of the meal. The three other users reported their moods did change over the course of the meal where one user mentioned it was slightly stressful towards the end of the meal, two users mentioned what happened on the table was fun and one of these two users mentioned it lifted the mood. | Two users specifically mentioned the animation meant you're eating too fast. One of these users also mentioned the animation could mean to represent a measurement of social interaction. A user not previously mentioned reported the animation meant eating speed over time and interacting with the plate. The last user mentioned the animation meaning to be a timer of some sort | One user mentioned the animation meant to be a cooldown. Another user reported the animation meaning you're doing better. A third user thought the animation meant cooling the red light down. The last user mentioned the animation meant calming the fire down and you finished your meal |
| H3 | One user mentioned the animations had something to do with pressure shifts on the table. This same user along with another user mentioned the amount of talking as well. The other user also mentioned eating speed. The two other users not previously mentioned had no general clue what the animations on the table meant | Three users thought the animations aimed to influence eating speed. Of these three, one of the users thought the animations also aimed to influence bite sizes. The other user reported that the table aimed to influence being social | All users reported eating a comparable amount of food as they usually would | Three users reported not being encouraged to change their bite sizes. One user reported they were encouraged to change their bite sizes | Three users reported not being encouraged to change their eating speed. One user reported being encouraged to change their eating speed | One user reported that their mood was changed by the animations over the course of the meal in terms of it sparking excitement and feeling more active. The three other users reported their moods did not change over the course of the meal where one user mentioned it was fun but at some point everything felt normal again | Three users mentioned this animation meaning eating speed over time. One of these three users also mentioned the animation meaning eating too fast. Another user of these three mentioned the animation meaning aggression as well. The last user reported not being sure what the animation meant. | One user mentioned the animation meant to be a cooldown. Another user reported not seeing the animation at all. A third user thought the animation meant cooling the red light down. The last user mentioned the animation meant you're slowing down your eating and you're close to finishing your meal |
| Additional comments about the data | One user from house 2 mentioned eating speed with the explicit explanation that they got this idea from the null-measurement experiment | | | | A user in house 2 mentioned they were encouraged to change their eating speed, but not by the table, rather by their housemates. This user is thus classified as not encouraged to change eating speed. The three users in house 3 that reported not being encouraged to change their eating speed commented they either discarded their theory that the table aimed to influence their eating speed when comparing their piece of the table with their housemates, didn't look at the table much, or that they weren't hungry anymore at the time they noticed the table could be about changing eating speed. | Important to note is that eight participants of the twelve mentioned that their housemates' reactions could have had to do with possible changes in mood | | |

| House and additional comments | What did the red/orange/yellow colours appearing in the middle mean, you think? | Please describe what happened after the middle was covered with red/orange/yellow colours. | What do you think this animation meant to convey to you? | Were there any elements to the visual feedback/animations present that stood out to you? Please explain your answer | Were there any visual feedback/animations present that you liked? Please explain your answer | Were there any visual feedback/animations present that you didn't like? Please explain your answer | If you were to eat at this interactive table every day with the implemented animations you just experienced, would it be of influence on your regular eating behaviour? Please explain your answer. | What were your expectations for this experiment with the SIT? (This can be about any part of the experiment process: The briefing before your meal, sitting at the table, the debrief, etc.) | Would you describe yourself as a slow, average speed, or fast eater? |
|------------------------------------|---|---|---|---|--|--|---|--|--|
| H1 | One user mentioned the animation meant to say more people are doing something wrong rather than right. Another user reported the animation meaning you're eating too quickly and not talking enough. A third user thought the animation meant lots of fire. The last user mentioned the animation meant burning down the tree | All users recalled what happened after the middle was covered with red/orange/yellow colours | Three users mentioned the animation meaning 'start over'. One of these three also mentioned the animation meaning 'improve this time'. The not previously mentioned user thought the animation meant to be an acknowledgement that they and their housemates are doing better | One user mentioned the hexagonal patterns standing out. Another user mentioned the tree standing out. The third user mentioned the split in quarters of the table standing out. The last user mentioned the animation changes standing out | Three users reported the blue lights appearing as something they liked. One of these three users also liked the yellow divisions between users. Another one of these three users mentioned they liked burning the tree. The last user liked the red lights | Three users did not dislike any visual feedback/animations. The other user mentioned disliking burning the tree | One user reported they would likely not change their regular eating behaviour. The three other users reported they might change their regular eating behaviour | Two users had no expectations. One user expected something to do with weights. Another user expected clearer animations about whether they or their housemates are doing something wrong | One user reported being a slow eater, two users reported being average to fast eaters, and the last user mentioned being a fast eater |
| H2 | One user mentioned the animation meant to say people are done eating. Two other users had no idea what the animation meant. The last user mentioned the animation meaning something to do with bite distribution and people finishing the fastest | Three users vaguely recalled what happened after the middle was covered with red/orange/yellow colours. The other user recalled what happened | Two users mentioned the animation meaning 'start over'. Another user was not sure what the animation meant to convey. The last user thought the animation meant that you completed your meal | All users mentioned the animation changes standing out. Two users also mentioned the red/orange/yellow colours in the middle of table appearing to be standing out | Three users reported the blue lights appearing as something they liked. The other user was neutral about what was displayed | Three users did not dislike any visual feedback/animations. The other user mentioned disliking burning the tree | All users reported that their eating behaviour might change | Three users expected free food. One user of these three also expected data tracking to happen. Another user expected animations that would really pull their focus to the animation | Two users mentioned being slow to average eaters, one user reported being a fast eater, and the last user mentioned being an average to fast eater |
| H3 | One user mentioned the animation meant explosion and this happens when one quadrant fills up. Two other users had no idea what the animation meant. The last user mentioned the animation meaning something to do with timer shifts | Two users recalled what happened after the middle was covered with red/orange/yellow colours. The other two users did not notice what was happening | One user mentioned the animation meant 'improve' and 'start over'. Another user mentioned the animation meant they completed their meal. The other two users did not notice the animation and therefore could not give an explanation | One user mentioned the animation meant 'start over'. Another user mentioned the animation meant they completed their meal. The third user was not sure what the animation meant. The fourth user did not notice the animation and therefore could not give an explanation | One user reported burning the tree as something they liked. Another user liked the disappearing of the red lights. The third user liked the fading in and out of colours. The last user was neutral about what was displayed | Three users did not dislike any visual feedback/animations. The other user mentioned not disliking, but finding it weird that the red lights started off so close to the plates since it was hard to see | All users reported that their eating behaviour might change | Two users had no expectations. One user expected something to do with weights. Another user expected to just see animations on the table and some general entertainment. The last user expected the experiment to have something eating speed related based on the null-measurement experiment | One user reported being a slow eater, another average to fast, another average, and the last one reported being a fast eater |
| Additional comments about the data | | | | | | | | It was often mentioned by users that are likely to change their eating behaviour that this would only apply if they knew exactly what the table wanted from them. Furthermore, any longterm use is hard to gauge seeing as the table's animations are generally seen as gimmicks that could lose impact in the longrun | |

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