Dinner Time!

Using technology for the gamification of mealtimes of children with autism to overcome eating problems.

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Abstract

Eating problems are pervasive in children with autism and there is a lack of accessible interventions. Around 70% of children with autism have eating problems, where food selectivity is the most common problem. Food refusal, accepting a limited variety of food, and a high-frequency intake of one kind of food, all fall under the term food selectivity. Children with autism and food selectivity do not eat a varied diet which means that they do not get the nutrients they need to grow up healthily. This research project is done on behalf of Praktijk Forza, a children's practice specializing in eating problems. Praktijk Forza wanted to know if technology can help children with autism to overcome their eating problems. Therefore, this research focuses on finding a way to help these children to overcome their eating problems by using technology for the gamification of their mealtimes. The choice was made to make a game for young children with autism, which can be used during dinner times. A prototype version of the game was developed and evaluated. The results of the evaluation indicate that gamification of mealtimes has the potential to help children with autism and eating problems to learn to eat new or unpreferred kinds of food. Therefore, the game could be used by Praktijk Forza to help children with autism and eating problems. However, the evaluation has some limitations which means that the results first need to be validated.

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Chapter 1 – Introduction

1.1 Situation

Children with Autism Spectrum Disorder (ASD) often show rigid eating behaviours. A review of 16 different studies in 2006 [1] concluded that between 46% and 89% of autistic children show unusual food acceptance behaviours. A more recent study by Zickgraf & Mayes [2] confirms this by stating that the prevalence of atypical eating behaviour is 70.5% among children with ASD. This points out that eating problems are highly pervasive in children with ASD. It is important to note that there is a clear difference between eating problems in children with autism and their typically developing peers. Even though eating problems are also present in typically developing (TD) children, the prevalence is higher in children with autism [3]. Furthermore, TD children mostly "grow out" of their eating problems, whereas children with autism do not. Van Dijk et al. [3] conclude that changes in eating problems in children with autism are unrelated to age. Tanner et al. [4] also do not find significant differences in age between children with ASD who are selective and non-selective eaters. Research [5] points out that food selectivity is the most common feeding problem in children with ASD. Because of this selectivity, the children generally eat a narrow variety of food. Zimmer et al. [6] observe poorer food variety scores among children with autism, compared to TD children. This is problematic, as it can lead to nutrient deficiencies, which in turn have the potential to harm the child's growth and development [7]. Tang et al. [8] even report on two children who were hospitalized due to their severely restricted diet. To overcome the development of nutrient deficiencies, the eating behaviour of the children needs to change.

1.2 Problem

Mealtimes can be described as stressful and difficult for both the child and the parents. Most parents understand that a nutritious diet is important for the development of the child. They try to feed their child accordingly, but usually do not manage to keep up with this. The many underlying reasons for the problematic behaviour of the child make it difficult to find ways to ensure that the child eats a more varied diet. These underlying reasons range from the typical core symptoms of autism, such as a need for sameness, to having difficulties with certain smells or textures of food [9]. When the parents try to feed the child a novel or non-preferred food, the child will keep on refusing the food and will engage in problematic behaviour such as crying and being angry. This can have a huge impact on the family's dynamics and psychological well-being [10]. Parents tend to adjust their behaviour to make sure that the child eats food without too many difficulties. This means that parents will tolerate more and cook the food that the child already knows and accepts [11]. As stated before, children with autism do not simply "grow out of" feeding problems. When parents only feed their child preferred kinds of food, their child's food repertoire will stay narrow or get even more narrow. To ensure that children with autism and eating problems eat a healthy variety of food, intervention is needed by parents, caregivers and potentially also experts.

1.3 Existing interventions

There have been several efforts to improve family mealtimes for the child and the family. Intensive treatments are not always an option due to availability issues or the nature of the child. There have been attempts to improve this situation by coming up with an effective intervention that is more accessible. For example, a study [12] successfully tested the so-called "teaspoon method", a training program for feeding disorders in high functioning autistic children. By feeding the child with a small amount of food in a teaspoon, the goal is to prevent children from panicking and help them to overcome their food selectivity. There are also other intervention methods which are meant for groups of children with autism and eating problems. For example, the BUFFET programme [13] is a multi-family group cognitive behavioural treatment for children with autism and eating problems. During 14 weekly sessions, children and their parents come together and build up exposure to new or unpreferred kinds of food. Another example of such an intervention is Esther the Eater [14]. This intervention takes place in a classroom, where the teacher dresses up as a cook called Esther, who likes to see children eat healthy food. The main idea of the intervention is that each child can choose a kind of food, which all the children have to taste. At first, the children are asked to choose between foods that they like. However, the kinds of food are changed every session and are slowly built up to unpreferred kinds of food. Both the BUFFET programme and Esther the Eater are effective interventions for improving the eating behaviour of children with autism. Still, currently existing interventions commonly do not target very young children with autism. Furthermore, there are no existing technology interventions which specifically target eating behaviour in children with autism.

1.4 Challenge

Praktijk Forza, a children's practice in Twente which specializes in eating problems, wanted to see if technology can be used for improving dinner times for children with autism and their family. Nowadays, the use of technologies, such as computers and smartphones, is common among people with autism. People with autism enjoy interacting with these devices and are engaged in it, because the interactions occur in a safe and trustworthy environment [15]. The main challenge of this project is to increase food acceptance and decrease problematic behaviour of the child with autism, where dinner times should be a family activity which is part of their daily routine. According to Praktijk Forza, children with autism and eating problems can practically be split up in two target groups: children who make emotional choices, and children who make rational choices. The children who make emotional choices have a developmental age of 2 to 4 years old. These children do not have an intrinsic motivation to eat, and the parents generally do not manage to give them an extrinsic motivation. The usage of rewards or rational reasoning does not motivate the children to eat. As there are no existing interventions for these children yet, their eating problems continue to exist. According to Praktijk Forza, the children's interest should be sparked in order to motivate them to eat. Therefore, the challenge of this project is to find out how the interest of a child can be sparked using technology, in order to motivate him or her to eat and behave better during dinner times.

1.5 Research questions

The choice was made to make use of gamification to motivate the child to eat. Gamification is the practice of making activities more like games in order to make them more interesting or enjoyable [16]. A review of several studies which effectively used gamification [17] states that points and rewards, a leader board, a digital badge, challenges, and feedback are common elements of gamification.

The main research question of this Bachelor thesis is: *To what extent can gamification of mealtimes help children, who have autism and eating problems and cannot make rational choices, to learn to eat new or unpreferred kinds of food?*

In order to support the answer to the main question, three sub-questions will provide more detailed information on each sub-topic:

1. *What factors play a role when a child with autism refuses to eat a certain type of food?*
2. *What kind of technology interventions already exist and have proven to be effective for changing the behaviour (in general) of children with autism?*
3. *How can you capture the interest of a child with autism through nudging?*

1.6 Structure of the report

This bachelor thesis is built up based on the design process for Creative Technology. This design process consists of the following phases: Ideation, Specification, Realization and Evaluation [18]. During the ideation phase, the goal is to come up with ideas that are related to a specific design question. In order to start with the ideation phase, background research was done on this project's topic. In Chapter 2, the background research, a summary can be found on the information that was obtained during the research process. A definition of Autism Spectrum Disorder is given, followed by the specific eating problems of children with ASD. Afterwards, the state of the art is given on technology and non-technology interventions that target eating behaviour, or other behaviours, among children with autism. Chapter 3 gives an overview on the ideation phase. In this chapter, one can read about the process of coming up with ideas and changing these according to information obtained from experts. At the end of the ideation phase, a final concept is chosen based on the feedback of experts. The second phase of the design process for Creative Technology is the specification phase. During this phase the goal is to work out a prototype which finds the correct balance between the usage of technology and user experience. In Chapter 4, the chosen concept from the ideation phase is specified based on functional and non-functional requirements. Furthermore, two personas and a user scenario are given. Then, during the realization phase, the final prototype is made. In Chapter 5, one can read about this process. The last phase of the design process is the evaluation phase. During this phase, the goal is to evaluate whether the prototype can

achieve the desired outcome. In Chapter 6, an explanation is given on how the evaluation is done, and the results and a discussion on the results are given. In Chapter 7, a discussion is given on the whole scope of the project. The main research question is answered, limitations are addressed, and recommendations for practical implementation and future research are given. Lastly, in Chapter 8, a conclusion is given which summarizes the outcomes of this research project. It is important to note that the terms “autism”, “autistic”, and “ASD” are used interchangeably throughout this report and refer to the term Autism Spectrum Disorder.

Chapter 2 – Background research

2.1 Introduction

This chapter describes a selection of literature on Autism Spectrum Disorder (ASD), eating problems in children with ASD, and the state of the art on interventions that target eating or other behaviour in children with autism. First, to better understand what ASD entails, I looked at the definition, the diagnosis and the prevalence of ASD. Then, I did literature research on the problems that these children encounter during mealtimes. The role of the family was also uncovered, to get a better picture of the family situation and the mealtimes. Afterwards, research was done on different kinds of interventions that are available to help children with autism with certain problems. These problems could be related to their eating behaviours, but also to other things such as their social skills. The interventions were both with and without technology support.

2.2 Autism Spectrum Disorder

2.2.1 What is Autism Spectrum Disorder?

Autism Spectrum Disorder (ASD) is an umbrella term for several neurodevelopmental disorders. Back in the days, there were four separate autism diagnoses, known as autistic disorder, childhood disintegrative disorder, pervasive developmental disorder-not otherwise specified (PDD-NOS) and Asperger syndrome. In 2013, the American Psychiatric Association merged these four different autism diagnoses into one diagnosis called Autism Spectrum Disorder. Their Diagnostic and Statistical Manual of Mental Disorders (DSM-5) [19] characterizes ASD by two main symptoms: persistent deficits in social communication and social interaction; and restricted, repetitive patterns of behaviour, interests, or activities. The first symptom can express itself in several ways such as reduced sharing of emotions or interests, failing to start or respond to social interactions, a lack of facial expressions and nonverbal communication, and deficiencies in developing, maintaining and understanding relationships. The second symptom can, for example, become apparent by stereotyped or repetitive motor movements, need for sameness and routines, very restricted interests with abnormal intensity or focus, and hyper- or hyporeactivity to sensory input. On top of the core symptoms, many people with ASD also have an intellectual impairment and/or language impairment. Even those who show average or high intelligence can show difficulties in adaptive functional skills. Therefore, ASD is a complex disorder that can consist of several symptoms.

2.2.2 Diagnosis of Autism Spectrum Disorder

A person gets diagnosed with ASD if the two core symptoms are present from early childhood, and limit or impair everyday functioning [19]. The symptoms are usually found during the second year of life, but depending on the severity of the symptoms they may be noted earlier or later on too. The first signs of ASD involve delayed language development, a lack of social interest, atypical ways of playing, and uncommon ways of communicating. During the second year of life, strange and repetitive behaviours, and atypical play become more apparent. Sometimes, these symptoms are difficult to distinguish from behaviours of typically developing children, as they also have strong preferences and enjoy certain forms of repetition, such as watching the same movie over and over again. After the diagnosis of ASD, children's behaviour can more easily be explained. This also allows targeting the behaviour and making use of specific interventions or activities. For most people with ASD, their behaviour improves over the years. However, some people's behaviour deteriorates during adolescence. Still, getting a diagnosis is certainly important to give the child the help that is needed.

2.2.3 Prevalence of Autism Spectrum Disorder

The prevalence of ASD has been rising over the past years. The DSM-5 [19] estimates that around 1% of the population has ASD. An American study from 2016 even found that the prevalence of ASD among children aged 8 years is 1.85% [20]. The rise in ASD cases could have multiple causes. It might be that ASD, as an umbrella term, causes more people to get diagnosed with ASD. Another reason could be that there are differences in methodology between current and previous studies. However, it could also be that there is a true increase in how many people have ASD. Future research will have to shine a light on this. ASD is diagnosed four times more often in boys than in girls [1, 2]. The DSM-5 [19] states that in clinic samples, girls tend to have a higher

probability to show accompanying intellectual disability. It has been suggested that this difference might exist because girls with ASD, without intellectual impairments or language delays, may not get diagnosed with ASD due to more subtle symptoms of social and communication difficulties. It would be interesting to see if future research can confirm the true cause of why ASD is more prevalent in boys than in girls.

2.3 Eating problems in children with Autism Spectrum Disorder

The information down below is partly based on a literature review which I previously wrote for a course on Academic Writing. This literature review can be found in Appendix 1.

2.3.1 Prevalence of eating problems in autistic and typically developing children

Many children with ASD experience eating problems. A review of 16 different studies [1], which was published in 2006, concluded that between 46% and 89% of autistic children show unusual food acceptance behaviours. A more recent study from 2019 with 1112 children with autism [2] states that 70.5% of the children show atypical eating behaviours. These studies show that the prevalence of eating problems in children with autism can be considered to be very high. Eating problems are also common among typically developing children, but the prevalence is significantly lower. Children are picky eaters when they are very selective about what they eat. The prevalence of picky eating in typically developing children peaks at the age of 2, where about 50% of the children are picky eaters [6]. The eating problems in typically developing children decrease after the age of 2 and are nearly gone at the age of 5 [6]. This situation is quite different from the one of children with autism. Even though the prevalence of atypical eating behaviours decreases after the age of 3, the prevalence of atypical eating behaviours is still notably high among children with autism. According to Zickgraf & Mayes [2], the prevalence of atypical eating behaviours in children aged 1 to 3 years is 80%, whereas that of older children up to the age of 18 is 68%. Therefore, it becomes clear that intervention is needed in order to help the children with autism to overcome their eating problems.

2.3.2 Different kinds of eating problems

Children with autism often refuse or avoid food because they do not want to eat. The most common kind of eating problem is food selectivity. Food selectivity is a term that is used in literature for describing multiple kinds of concepts such as food refusal, accepting a limited variety of food, and a high-frequency intake of one kind of food [21]. Schreck et al. [5] and Sharp et al. [22] found that over 70% of children with autism were reported to eat a narrow variety of food and show low to moderate food acceptance. Furthermore, Tanner et al. [4] point out that children with autism, who show selective eating, have higher food refusal rates than those who do not. Another eating problem which is seen among children with autism is food avoidance behaviour. Examples of such behaviours are food neophobia, emotional undereating and food fussiness [7]. These behaviours are common, but their prevalence is lower compared to food selectivity. There are multiple kinds of problematic behaviour that come along when the child gets presented with a novel or non-preferred food. Sharp et al. [23] point out that children usually push the food away, turn their head away from the food, and start crying. Next to that, they can use negative statements and show aggression towards caregivers, but such behaviours are less common. To be able to improve the child's eating behaviour, it is important to find out what kind of eating problem the child has.

Some children with autism also show eating problems which might be less common. One of those problems is pica. The Diagnostic and Statistical Manual of Mental Disorders (DSM-5) [24] describes pica as the persistent eating of non-nutritive, non-food substances for at least 1 month, which is inappropriate to the developmental level of the individual and not part of cultural practice. They state that ASD and intellectual disability (ID) are most commonly comorbid with pica. According to the DSM-5, the prevalence of pica is unclear. However, a recent study by Fields et al. [25] found that the prevalence of pica, among children aged 2.5 to 5 years, was 28.1% among those with ASD and ID, and 14.0% among those with ASD without ID. This suggests that pica may be common in young children with ASD, especially in those with ID. Another behaviour that can appear among children with autism, is rapid eating. Van Dijk et al. [3] found that children with autism have shorter meals than typically developing children. Leader et al. [26] confirm this and state that rapid eating is the third most common feeding problem, next to food selectivity and food refusal. Pica and rapid eating can both negatively impact the health of the child, as they can for example lead to gastrointestinal issues [26]. Therefore, it is important to consider these issues when designing an intervention to improve eating behaviour.

2.3.3 Underlying reasons for eating problems

There are many underlying reasons for the previously mentioned eating problems. In most cases, there is not simply one cause. A good starting point is to look at the main symptoms of ASD. According to the DSM-5 [19], ASD can be characterized by two core symptoms. One of these core symptoms is restricted and repetitive patterns of behaviour, interests, or activities. This symptom is often translated in a need for sameness, which leads to food refusal during dinner times. Fisher et al. [27] found that children who engage in change-resistant behaviour, such as refusing new kinds of food, do this to avoid unpredictable consequences. By frequently showing this kind of behaviour, the probability of predictable consequences increases. Therefore, the children like to have control over situations to ensure that things stay predictable. Children with autism who refuse more food are found to show more problematic behaviour, such as crying [22]. This is a way of trying to get control over the situation again. One way of dealing with such problems is to give the child a choice between eating and an unattractive situation which takes away a part of the daily routine of the child [12]. For example, the child has to eat the unpreferred food, or the child has to go to bed early. Most children will prefer eating the unpreferred food over the unattractive situation. Therefore, by using such kinds of interventions, the eating behaviour of the child can be improved.

Children with ASD experience the eating of food differently than typically developing (TD) children. Kral et al. [7] found that children with ASD and TD children differ significantly in oral sensitivity status. This means that these children show different responses to oral stimulation. Hubbard et al. [9], for example, found that 49% of the children with ASD, compared to only 5% of TD children, were reported to avoid certain tastes and smells. Children with ASD commonly experience sensory processing difficulties, which is linked to their oral sensitivity status [28]. A review [29] also concluded that impaired sensory processing is positively associated with feeding difficulties. There are different kinds of food characteristics that can play a role when the child shows problematic behaviour such as food refusal. Several studies, [5, 9, 22], all confirm that the food type and texture of the food are the main determinants. According to Hubbard et al. [9], foods that are mixed are also not preferred. Oral sensitivity can lead to food selectivity, a lack of appetite, emotional undereating and other problematic behaviour among children with autism, mainly due to negative emotions about having to eat the food [7, 26]. Therefore, it is important to take oral sensitivity into account when targeting the behaviour of these children.

Children with autism suffer from problems in the stomach and the intestines, which might be the cause of certain eating problems. A review by Marí-Bauset et al. [21] mentions that gastrointestinal problems (GI problems) are more common in children with ASD than TD children. The study states that some behaviours that are associated with ASD, such as food refusal, are found to be significantly related to GI problems. The study also claims that constipation and abdominal pain are the most frequently reported GI problems. According to Leader et al. [26], GI problems can partly predict rapid eating. Furthermore, Maenner et al. [30] state that abnormal feeding behaviours, such as pica, can appear because of GI problems. The study explains that the actual underlying reason for pica could be the inability of the child to communicate the existence of the GI problem with parents or caregivers. This links to the first core symptom of ASD: persistent deficits in social communication and social interaction [19]. Still, one should wonder what the causal relationship is between pica and GI problems. In contradiction to what Maenner et al. state, Fields et al. [31] say that children and adults who engage in pica, are at increased risk for GI problems. Therefore, it can be concluded that it is unclear what the actual relationship is between GI problems and eating behaviour.

Other reasons for the eating problems in children with autism are from a wide range of causes. Potential causes for pica, aside from GI problems, are sensory processing difficulties, challenges in understanding the difference between food and non-food objects, and nutrient deficiencies [24, 31]. In case of nutrient deficiencies, the DSM-5 [24] states that usually no specific biological abnormalities were found in the children. This suggests that these nutrient deficiencies can easily be solved through a specific diet or supplements. Lyall et al. [32] found that children with ASD have hyperactivity and deficits in attention, which could lead them to easily lose interest in eating and could potentially explain the rapid eating behaviour. Another cause of rapid eating, and food selectivity and food refusal, could be the occurrence of multiple forms of psychopathology [26]. However, Zickgraf & Mayes [2] do not find a relation between atypical eating behaviours and psychopathology scores. One last unexpected finding is that some children with ASD have higher levels of leptin than TDC, which causes them not to feel hungry [33]. Leptin is a hormone that functions

as a feedback mechanism to inhibit food intake [34]. When this feedback is missing, a child will need extrinsic motivation to eat. These different potential causes of eating problems should be considered when designing a behaviour intervention.

2.3.4 Influence on the child's health

The eating problems can negatively impact the health of the children with autism. When these children do not eat a varied diet, this can lead them to develop nutrient deficiencies. Zimmer et al. [6] found that children with autism have poorer food variety scores compared to age matched typically developing children. In general, vegetables are the most likely food group to be never consumed by children with autism, compared to all other food groups [22]. A study by Sharp et al. [23] points out that many children with autism with severe food selectivity eat no fruit and vegetables. From all children with autism and severe food selectivity, 60% consumed a diet that omitted all vegetables, whereas 27% omitted all fruits. Sharp et al. also found that 78.5% of the children with autism and severe food selectivity were at risk for inadequate intake of five or more nutrients. Zimmer et al. [6] confirm that selective eaters with autism are more at risk for nutrient deficiencies compared to non-selective eaters with autism. Especially nutrients such as calcium, zinc, vitamin D and vitamin B12 were missing. Nutrient deficiencies can negatively impact the growth and the health of the child. In some cases, the child's eating problem is so severe that hospitalization and an intensive intervention program are needed to ensure that the child can live a healthy life [8]. It is proven that a diet which addresses nutritional needs can improve the child's health significantly [35]. This highlights how important a child's diet is.

2.3.5 Influence on the family

The child's eating problems can have a negative impact on the family. A study [36] indicated that spousal stress during mealtimes is higher among parents of children with ASD, compared to parents of typically developing children. Furthermore, the study states the food preferences of a child with autism have a bigger influence on what other family members eat, compared to the food preferences of typically developing children. A small study [37] confirms this, as mothers state that their autistic child's food selectivity limits other family member's food choices. Sometimes, parents prepare multiple meals to be more inclusive to other family member's wishes and nutritional needs [37]. However, this increases meal preparation time, and can also result in conflicts between siblings who want to eat the same kind of food as the child with autism. Sometimes, siblings have the role of demonstrating desired eating behaviours, but parents are also concerned that the siblings will copy the atypical eating behaviour of the child with the eating problem [10]. Two studies [10, 37] state that family mealtimes are negatively impacted by the child's eating problem. It is mostly not possible for the whole family to participate in mealtimes together, and if it is possible, the mealtimes lack meaningful positive interactions and rituals. The child shows problematic behaviour, such as refusing to sit or eat, or disrupts other family members. Therefore, mealtimes are described as being unstructured, chaotic and stressful [37]. Thus, it becomes clear that the whole family would be able to benefit from an effective intervention which tackles the child's eating problems.

2.3.6 Influence of parents on the child

Parents have a lot of responsibility when it comes to feeding their children. They are the main feeders and their child almost entirely depends on the food that they serve. Kral et al. [7] found that parents of children with ASD engage in higher levels of prompting and encouragement during mealtimes than parents of TD children. The study also highlights that parents of children with atypical oral sensitivity engage in more emotional feeding than those of children with typical oral sensitivity. Sometimes, parents try to implement interventions such as playing with the food, exploring new foods in a stepwise manner, and following the child's specific rules during mealtimes to ensure that the child eats or at least stays at the table [10]. A small study with 14 mothers [10] found that there is a lack of understanding and support concerning mealtimes from partners, friends and relatives. As a parent, this makes you feel helpless and misunderstood. In the end, parents tend to stop feeding the child novel or unpreferred food because of the constant struggles and stress during mealtimes [11, 23]. Some families implement a special diet for the child or make use of nutritional supplements to target the eating problems [22, 37]. However, these things do not solve the eating problem of the child. Therefore, it is crucial to find a way for parents to effectively deal with their child's eating problems.

2.4 State of the art

In the state of the art, multiple kinds of interventions that target eating behaviour of children with and without autism, or other kinds of behaviour of children with autism, are described. These interventions are split up in technology and non-technology interventions. The non-technology interventions each specifically target the eating behaviour. However, due to a lack of existing technology interventions which target eating behaviour, many of the technology interventions target other kinds of behaviour of children with autism. These technology interventions range from apps to social robots. Often, the technology interventions are focused on improving the communication and social skills of children with autism. The goal of the state of the art is to get a better understanding of the kind of interventions that already exist for children with autism. With these interventions in mind, it is easier to come up with ideas during the ideation phase.

2.4.1 Non-technology interventions targeting eating behaviour

The teaspoon method

The teaspoon method is an intervention for paediatricians in a general hospital that targets selective eating among children with autism [12]. This method consists of assignments that are given to parents and their child with autism and an eating problem. When parents visit the paediatrician with their child, the paediatrician will explain the assignment to the parents and the child at the same time. As the assignment is given by the paediatrician instead of the parents, conflicts between the parent and the child are avoided. During the first month, the child should eat one teaspoon of vegetables every day at dinnertime at home. If the child succeeds in doing so during dinnertime, the child can continue eating his or her preferred food. The child will also receive positive, social reinforcement. However, if the child refuses to eat the bite of non-preferred vegetables, this leads to a choice that can only be considered once. The child can either choose to eat another kind of non-preferred vegetables to then afterwards continue with their preferred meal, or go to bed without reading a bedtime story. The main idea of the intervention is that children learn that eating is a normal activity, which is necessary for their body to function properly. In this way, the child will learn to get used to eating new and non-preferred foods.

The method is structured in a logical way, using follow-up assignments. During the first month, the goal is to let the child eat one teaspoon of non-preferred vegetables, the kind that the rest of the family is having for dinner. During the first month, teaspoon bites are used to allow the children to overcome their fears or other reasons for not wanting to eat. In the second month, the family receives a new assignment. If they did not succeed in fulfilling less than 50% of the first assignment, the same assignment will be repeated with different consequences. When the family did succeed in fulfilling the assignment, the number of vegetables will be increased to one tablespoon. Afterwards, in the third month, the amount will be increased to two tablespoons, and in the fourth month, it will be increased to three tablespoons, if the previous assignment was fulfilled successfully. In the fifth month, the parents will switch to feeding the child a different food group. Examples of such food are dairy products, fruits or meat. At that point, a small amount is not necessary anymore, as the child is used to eating food he or she does not prefer.

The teaspoon method turned out to be a very successful intervention for high functioning autistic children, aged 3 to 14 year old. By making use of positive and negative reinforcements, the behaviour of the children can be changed. If the children did not want to eat the teaspoon with vegetables, the avoidable situation was introduced by their parents. After children experienced this one or two times, most of them did not want to experience it again and almost immediately accepted to eat the vegetables. The acceptance rate in such cases almost increased to 100%, as they knew that their parents were serious about the consequences. There were exceptions, as most children had a few types of vegetables that were very disliked. In that case, children would prefer the unattractive consequence over eating the food. An important aspect of the method is that the parents should be very creative and show determination. Every day during dinner time, they have to prepare at least two different bites of vegetables for the child, plus the meal that the child would normally eat. On top of that, they need to be strict to make sure that the child understands that the consequences are real. Nevertheless, this intervention is very meaningful as it allows eating together as a family, while changing the eating habits of the child at the same time.

The BUFFET programme

The BUFFET programme is a multi-family group cognitive behavioural treatment for selective eating in children with autism [13]. BUFFET stands for Building Up Food Flexibility and Exposure Treatment and uses Cognitive Behavioural Therapy (CBT). For the BUFFET programme, 11 boys with ASD and selective eating were recruited together with their parents. The boys all had a verbal IQ higher than 80 and were aged 8 to 12 years. The programme consists of 14 weekly sessions that each focus on a different topic. The first six weeks focus on building skills for managing anxiety and increasing flexibility. Two of the goals are to establish the thought-feeling-behaviour connection and introducing the concept of reshaping negative, nonadaptive thoughts about food into positive, constructive thoughts. Furthermore, in the fifth week, the idea of flexibility is introduced to let the children explore why it can be good to be flexible, what the consequences of inflexibility are, and what strategies they can use for being more flexible. In the sixth week, key concepts are reviewed and connected. Every session also has room for a parent conversation, where topics that address the parent's role in their child's selective eating are discussed. Furthermore, the conversations focus on how parents can support their child in a step by step manner to be brave and deal with their food selectivity. During every session, weekly homework assignments are given which support the repetition and rehearsal of the treatment concepts. In the first half of the programme, these assignments are focused on practising the skills learned during the sessions.

Exposure activities play a key role in the second part of the intervention. These activities are targeted toward the specific treatment goals of each child. During a group session called Snack Time, preferred and non-preferred food are presented to all children, parents and therapists. The children do not have to eat the snack, but it must stay on their plate. For each Snack Time, the children complete a food dictionary that guides them to characterise the smell, flavour, texture, look and food category of a certain snack. They also discuss how someone could eat the food, practice restructuring negative thoughts about the food, and give the food a score. The individual session on practising exposure is called BUFFET building. Parents and their child work together on identifying a target, such as trying a new food or eating more of a certain food. These target food goals are different per child, but the practice sessions are still highly structured. The use of scripts and routines is very useful for self-regulation of the children with ASD. It also makes the activities more predictable for the children. The exposure steps are supported by clinicians and can differ per child. This is important, as the children may not have the same underlying reasons for their food selectivity. In the second half of the programme, food exposure practice assignments are given.

The BUFFET programme was tested successfully. In general, all families were very satisfied with the results. They indicated that the service quality was excellent and that they would return to the program if they needed help again. Half of the families indicated that all of their needs were met, whereas most others indicated that most of their needs were met. Only a small part of the families indicated that few of their needs were met. The results indicate that the children prefer the hands-on, individualized exposure activities over the psychoeducational activities. In general, these findings are promising. One key element of the programme is that children are given self-advocacy and empowerment. While they learn certain skills, they also learn the reasons why they may be struggling with eating a certain food. It allows them to think about it and to learn how they can improve. All in all, the BUFFET programme can help out children and their families tackle selective eating.

Esther the Eater

Esther the Eater is an intervention designed for classroom usage, to help children with ASD aged 8 to 12 years to overcome eating problems in a fun and interactive way [14]. In a classroom setting, two teachers are present together with the children with autism and eating problems. One of the teachers will leave the room to dress up as Esther the eater, a chef who loves to see children eat good things. When she enters the room again, she brings a bowl, an oversized spoon, preferred and non-preferred foods, and plates. The other teacher will monitor the progress of the children. Esther will put the food in the "soup" bowl, and use the spoon to stir the soup. During the session, each child has to choose a certain kind of food from the bowl which all the children have to eat. The pieces of food are very small, to make it easy for the children to eat and swallow it. At the beginning of the programme, only preferred foods are available. This allows the children to practice with compliance and get used to the intervention. The children are taught a catchphrase, which is repeated throughout the session: "Even if you don't like it, you still have to try it!". Once children are used to eating the food, target foods are added to the soup. This is the most essential step, as it teaches children to eat

unpreferred foods. Usually, the foods that children have previously tried at home will be added to the soup first. Afterwards, non-preferred foods will be added which the children have never tried before. In this way, children get used to eating unpreferred food in a predictable and routine-based manner.

The intervention uses certain methods to ensure that the children are motivated and maintain what they have learned. Esther the eater visits the children once a day, every day of the week. The preferred foods are rotated so that each child stays motivated to participate in the exercise. All children get access to a glass of water, to allow for easy swallowing. Furthermore, a spoon is provided and targeted foods are allowed to be placed on top of a preferred food item before eating. Children who already eat a wider variety of food are seated next to more selective eaters. The first goal is to let children eat the food with minimal protesting, across 2 or 3 days. Afterwards, the process of generalization and maintenance is important. The goal is to apply the same intervention to new types of food. Usually, the first new food is the most difficult. Afterwards, new foods are quickly generalized due to the routine that the children are used to. If a child shows extraneous or maladaptive behaviours, these are ignored. The children are only allowed to leave when they ate all the targeted foods. Other ways to include generalization are to present the food in class when Esther is not around, eventually also at home. To ensure that foods periodically re-occur during the exercise, targeted foods are rotated. This ensures that the child will continue to eat the food without high levels of prompting. This programme can be very helpful in targeting food selectivity in children with ASD in a classroom environment.

The intelligent plate

A Dutch company called HAK, which manufactures preserved vegetables, designed an intelligent plate which helps children of the age of 4 to 8 years old to unconsciously eat more vegetables [38]. The design of the plate is based on five scientific assumptions. First of all, children copy what their parents do. By giving the child a plate that looks like plates that adults eat from, the child will feel more motivated to copy the healthy eating behaviour of the parents. Second of all, the gap in the plate allows the parent to serve more vegetables without it being visible to the child. Thirdly, the plate is a lot bigger than a usual children's plate. Therefore, the portions of vegetables look smaller too. This effect is called the Delboeuf-illusion. A fourth way to ensure the child eats more vegetables is by placing the gap with the vegetables closest towards the child. Lastly, the white colour of the plate ensures that the brain finds the food more attractive. That's why the vegetables are placed at the whitest part of the plate, as the children will experience the vegetables as being more tasty. The company designed the so-called "helping plate" because their mission is to help everyone to eat more vegetables and legumes. In the Netherlands people structurally do not eat enough vegetables, which already starts at a young age. The intelligent plate is able to change the eating pattern of these young children. The plate can be bought in the Netherlands for €12,99.

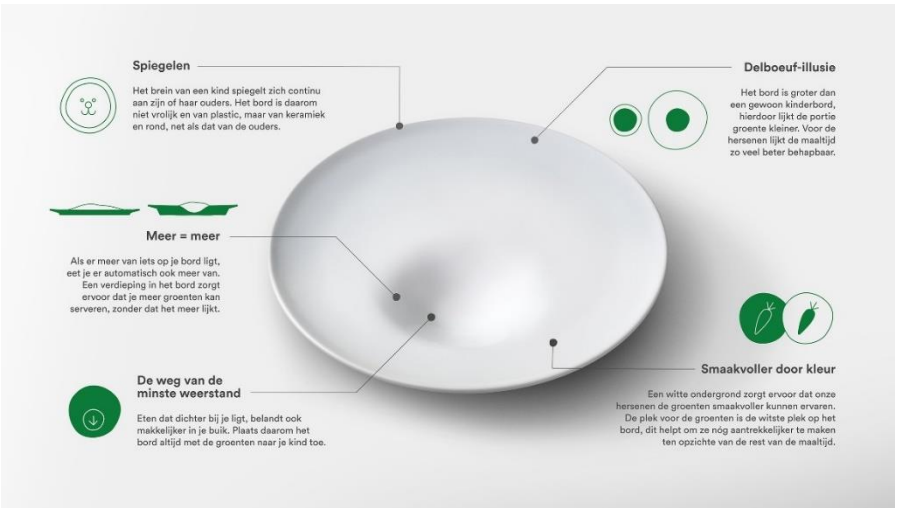


Figure 1 – The intelligent plate by HAK

2.4.2 Technology interventions targeting eating or other behaviour

Food Explorer Club

The Food Explorer Club app is made for parents who have children who are picky eaters [39]. The app encourages children to eat nutritious food in a fun and positive way by earning badges and reward points. The goal is to let children try new food and eat more healthily. Furthermore, it can decrease stress during mealtimes because children have fun playing with the app. Children can earn badges for each type of food, where sometimes a surprise badge will pop up when making healthy choices. Children can also obtain reward points, which are based on the goals that the parents set for the child. Furthermore, there are more surprise elements implemented in the game with extra badges. Children can also read facts and interesting information about the new food that they learned to eat. The app is free and can be downloaded in the Apple App Store and the Google Play Store.

Proloquo2Go

Proloquo2Go is an iOS app made by AssistiveWare which gives people who cannot speak a tool for daily communication and construction language skills [40]. By using Augmentative and Alternative Communication (ACC), the app enables non-verbal children, teenagers and adults to speak. The app uses symbols to help the users to learn how to express themselves. By clicking on the symbols, the app will pronounce the words. It is also possible to form sentences by putting words in a row. The app is available in English, Spanish, French, and Dutch, and has one hundred voices which the user can choose from. These voices are either children, teen or adult voices and differ in emotion. The app is very customizable, which means that many different people can benefit from the app. For example, non-verbal children with autism can use the app to communicate. The app costs €279.99 and can be found in the Apple App Store.

Figure 2 - Proloquo2Go with a 7x11 grid and all buttons showing

Otsimo Special Education

Otsimo Special Education is an app designed to help children with disabilities [41]. It consists of many different educational games and also has a simple Augmentative and Alternative Communication (AAC) tool. The app has a free and a premium version, which both do not make use of any advertisements. The free version allows the child to use the communication tool and 10 educational games. The premium version has the possibility of playing many more games. The premium version costs around 250 euros a year, but discounts can lower the price to 120 euros a year. After downloading the app, the user is asked to fill out some information on the child's characteristics and abilities. These are things like age and speech level, but also the ability to play with puzzles and recognise pictures. Afterwards, a personal evaluation report is given which shows potential areas of improvement, such as social-emotional skills. The parent or caregiver can choose how long the child should practice per day, where 16 minutes is recommended. The app can help children to learn many different basic skills, such as counting and recognising fruits and vegetables. There are also games and stories that teach more

complicated subjects, such as learning about emotions or coping with food fears of new foods. The app keeps track of the child's achievements by giving an overview on the parent's page of the app. The child can also achieve badges when a certain game is successfully played for the first time.

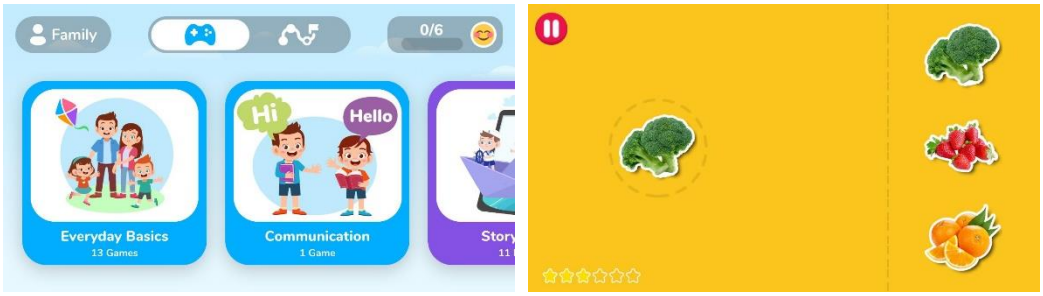


Figure 3 - Screenshots of the Otsimo Special Education app

Sensor-embedded fork

Kadomura et al. [42] developed a sensor-embedded fork with an accompanying mobile application which encourages children to eat a diverse variety of food during mealtimes. The sensing data of the fork is transferred to the mobile application. The mobile application, called Hungry Panda, consists of two parts: an interactive picture book which parents can read to their child before mealtimes, and an interactive game with which the child can collect points during mealtimes. When the child plays the game, the panda encourages the child to eat different kinds of food. The digital panda imitates the child's eating behaviour by copying the status of the sensor-embedded fork. The panda will ask the child whether he can have some more food. The child will build up sympathy for the panda, and will comply with the panda's wishes. The fork uses a photocell sensor to detect the colour of the food. In this way, the fork is able to differentiate between different kinds of food. The app uses coloured bamboo sticks to indicate the different kinds of food that the child ate. When the child presses the finish button, an animation will be shown to reward the child's eating behaviour. The more points the child obtained while playing the game, the more impressive the animation will be. The game was successfully tested to target picky eating and a lack of focus.

Figure 4 - Hungry Panda game application

Augmented Reality and Video Modelling

Some researchers have tried to use augmented reality or video modelling for behavioural interventions for children with autism. Augmented reality (AR) is a form of technology that adds a computer generated image to the user's view of the real world. A simple form of AR is adding an image or 3D object to a camera view. This can be done by using marker based AR. By laying a physical card on a table and scanning these cards with a camera of a phone, a 3D object can be added to the camera view. Bouaziz et al. [43] used this technique for teaching children with autism food skills. They want to help autistic children who suffer from distraction and difficulty in learning to be able to adapt to the desired eating behaviour. Bai et al. [44] also used AR for the development of an interactive system that attempts to elicit pretend play in children with ASD. The system was successfully tested, pretend play significantly increased among the children who used the system. Video modelling is a method in which a video recording is made from a certain target behaviour, which is then viewed by the person who has to learn that specific behaviour. A study by Hillman [45] found that video modelling can be an effective method to increase food acceptance among children with ASD, especially in combination with reinforcement. All in all, AR and video modelling may be effective methods to change the eating behaviour of autistic children.

The KASPAR robot

The KASPAR was initially developed in 2005 as a human-robot interaction research platform [46]. KASPAR stands for Kinesics and Synchronisation in Personal Assistant Robotics. The robot was then used to investigate how it could be used as a therapeutic intervention for children with autism. After the first robot was made, five more generations of the KASPAR robot have been developed over a period of 12 years. These new versions focused on improving the robot's functionality and usability as a therapeutic and educational tool for people working with children with ASD. KASPAR can teach children with autism about communication and social interaction in several ways. It can use a range of simplified facial and body expressions, gestures and speech to interact with the children. Furthermore, it can also respond to touch using sensors on the robot's cheeks, arms, body, hands and feet. In this way, children can learn tactile interaction which is perceived as socially acceptable. Next to that, the robot can help out with other social skills and cognitive learning. These robots are really impressive and could possibly also be used to teach children the desired eating behaviour.

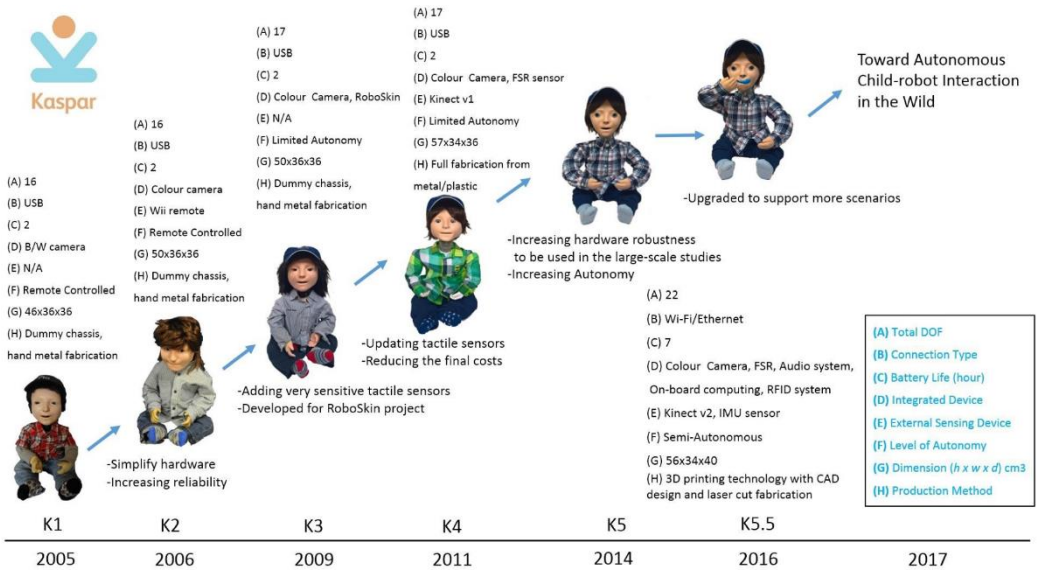


Figure 5 - Different versions of the KASPAR robot from 2005 onwards

Zeno

Zeno is a robot developed by the DE-ENIGMA project, a project funded by the European Union's Programme for research and innovation [47]. The project started in February 2016 and ended in December 2019. The goal of the project was to develop artificial intelligence for the Zeno robot, which could teach school-aged autistic children emotion-recognition and emotion-expression. The robot is able to process the children's motions, vocalizations and facial expressions to respond to this by presenting feedback, support and play. The children can control the robot with their face. Zeno tracks the child's face and will then copy the facial expression of the child. The children can experiment with facial expressions by interacting with the robot. The children are encouraged to do so in a fun way, by which they learn to practice social interaction.

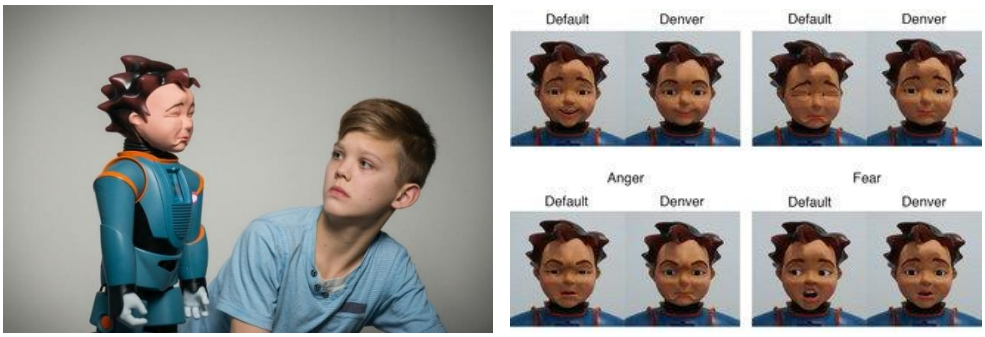


Figure 6 - Zeno the robot mimics facial expressions of a child called Denver

2.5 Conclusion

The background research gives insights to relevant information needed for the ideation phase. It is now possible to answer the sub-research question about which factors play a role when a child with autism refuses to eat a certain type of food. First of all, no child with ASD is the same which means that the autism symptoms that influence the child's eating behaviour also differ a lot. In general, eating problems are often related to the atypical oral sensitivity and sensory processing difficulties of the child. The child has a difficult time eating the food, which is why the child rather does not eat. However, it can also be that a child engages in change-resistant behaviour, such as food selectivity, because he or she has a hard time dealing with unpredictable consequences. Furthermore, the inability to communicate the existence of gastrointestinal problems to caregivers can lead to eating problems, such as pica. All in all, it can be concluded that it differs per child which factors influence the child's choice to refuse to eat. When looking at the different kinds of eating problems, children most commonly experience food selectivity. However, some also experience other eating problems such as food avoidance behaviour, pica and rapid eating. As these problems differ so much from each other, it is difficult to make an intervention which can solve multiple problems at once. As food selectivity is the most common problem among children with autism, the focus will be on solving this problem.

Literature highlighted that improving the child's eating behaviour is not only for the benefit of the child, but also for the benefit of the parents and the rest of the family. Of course, the child's health will improve a lot by tackling the eating problem. However, it would also be very helpful to the family when mealtimes are less stressful and chaotic. In general, the family is very much affected by the child's eating problem. Parents put in a lot of effort to adapt to the child's wishes, while the child's eating problem only turns worse. Siblings also do not understand why the child with the eating problem is allowed to eat food which they are not allowed to eat. Together with the problematic behaviour of the child with the eating problem, this leads to struggles during mealtimes. Next to that, parents indicated that family members and friends do not show enough understanding for the eating problem of their child. This makes parents feel helpless and misunderstood. Therefore, it would be meaningful if the parents and siblings of the child could experience more normal mealtimes together with the child with the eating problem.

When looking at the state of the art, it becomes clear that there are only non-technology interventions that specifically target the eating behaviour of children with autism. There are some interesting techniques and methods used in those interventions, which might be helpful for my own intervention. Still, these interventions are quite complex and do not make use of technology. Most of them are also not very accessible as professionals need to be involved. The intelligent plate, on the other hand, is very accessible as parents can simply buy it in the store. The accessibility of an intervention is very important, as more people of the target group can be reached. The target group of this project are children with autism and eating problems with a developmental age of 2 to 4 years old. It may be that some of these children are still too young to get help from professionals. To ensure that this project's concept is accessible enough, the decision was taken to make something which the parents can use together with their child, where the involvement of a professional is helpful but not strictly necessary.

From the state of the art it is possible to answer the sub-research question about the kinds of technology interventions which effectively change the behaviour of children with autism. As stated before, there are no technology interventions that specifically target the eating behaviour of children with autism. Still, there are technology interventions that target other kinds of behaviour for children with autism. First of all, there is the Proloquo2Go app which can assist non-verbal children with autism in their daily communication using Augmentative and Alternative Communication (ACC). Furthermore, it can teach the child to build up language skills. The second intervention is called Otsimo Special Education, an app with educational games and an ACC tool. The app allows the parent to set areas for improvement, by for example focussing on social-emotional skills. There is also the possibility to use augmented reality or video modelling to change the behaviour of children with autism. However, it is not very clear how these techniques work and whether they are effective. The last two technology interventions are robots called KASPAR and Zeno, which both have the ability to help children with autism to improve their communication and social interaction skills. It must be noted that these robots are very sophisticated and took a long time to develop in collaboration with many people. The ways in which the children with autism are approached by the apps and the robots can be helpful for my ideation phase.

The kind of technology interventions which are mentioned in the state of the art do not really fit the target group. First of all, it does not feel right to make an app for such young children. Nowadays, children are inseparable from their iPads and forget that there are other things they can do such as playing outside. Children with autism might be more prone to get addicted, as an app or game allows them to stay in a world where things are very predictable. Another reason for not wanting to make an app is that, from a personal perspective, I do not like the usage of smartphones and tablets during mealtimes. In order to make something which can create a better atmosphere during mealtimes, an app would not be the right way to do so. Augmented reality and video modelling both use a screen or a smartphone, which means that these technologies would also not be practical to use during dinner times. A robot would be very cool to make and could change the eating behaviour of the child. However, the scope of this project seems to be too small to be able to design something with such complexity. Therefore, the decision was made to look for ways to incorporate a form of technology, while still designing a game that would fit the target group.

Chapter 3 – Ideation

3.1 Introduction

This chapter explains the phases of the ideation and the corresponding outcomes of these phases. The goal of the ideation phase was to come up with multiple solutions for the given problem: "*To what extent can gamification of mealtimes help children, who have autism and eating problems and cannot make rational choices, to learn to eat new or unpreferred kinds of food?".* After finishing my background research, I decided that I wanted to help the group of young children who are not able to make rational choices yet. My clients emphasized that these children do not have the motivation to eat, which is why someone or something else needs to give them that motivation. This motivation should be coming from something that interests them, as the children are not sensitive to rewards. The concept ideas of the ideation phase try to address this. Another goal of the concept ideas is that the game should give the ability to make dinner times a family activity again.

3.2 Outline of the ideation phase

In order to come up with ideas, I went through several design phases. These phases can be seen in Figure 7 - Overview of the design phases. First, I looked at existing games for typically developing children aged 2 to 4 years. I used this as a starting point because it would help me to understand how children play. Afterwards, I looked up what the main differences are between how typically developing and autistic children play. By combining all the information, I worked out my first concepts. Then, I did interviews with several people who know a lot about children with autism. The interviews were focused on how children with autism play and act. Based on all the new information that I received, I adjusted my concepts. For the final steps, I discussed my ideas with my clients. Based on their feedback I chose a final concept which I would work out during the specification phase.

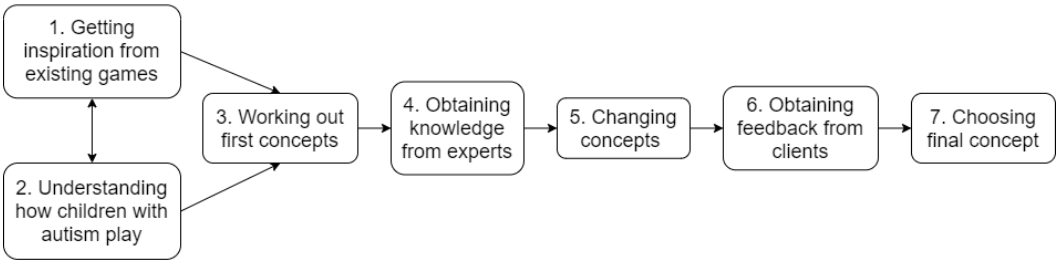


Figure 7 - Overview of the design phases

3.3 First phase: getting inspiration from existing games

3.3.1 Process

For the first phase, I made a mood board with games for typically developing children. I mainly looked for games for children aged 2 to 4 years, but I also added some more advanced games. I figured it would help me a lot to get an overview of such games as I do not have a lot of experience with working with young children. Creating a mood board would help me to step into the child's shoes, so to speak. My focus was on games which, from my point of view, can be transformed into a technology game or already make use of technology. To find childhood games, I looked on the internet for websites and pictures. As search terms I used both Dutch and English words, such as "Games 2-year-old" or "Wooden games young children".

3.3.2 Outcomes

To give an impression of the kind of games that I found, I will show you a small mood board with some of the games I found during my search. This is not the complete mood board I made, but it gives an overall impression. I will not include the big mood board due to copyright issues. Instead, I will explain a bit about the games in Figure 8 - Mood board of childhood games8 and give a general conclusion about what I learned from the process.

Figure 8 - Mood board of childhood games[1]

In general, the games that I found do not have complex rules which are needed to play the game. For some of the games, one could even wonder if a "game" is the correct definition. As adults, we often tend to imagine a game as something which has a goal, a certain end stage that you want to reach when you play the game. However, for young children this often is too complicated. For them, a game does not have to have a goal and can also just be a fun activity. When looking at Figure 8 - Mood board of childhood games8, one can distinguish the goal-based games from the other ones. The games corresponding to picture number 4, 7, 8 and 11 are examples of goal-based games. In picture number 4, the goal is to make the coloured dots match the coloured dots on the wooden cards. In picture number 8 the goal is to find the matching colours underneath the black dots of the ladybird and in picture number 11, the goal is to shoot all the discs to the other side of the playing field. In picture number 7, the goal is to catch the fish. In a way, these games are easy to understand because there are clear rules that define how the game should be played. Nevertheless, it may be that games which are less defined are more fun for children. Such games enable children to use their creativity and play the game in a way that they can understand.

For a lot of games, there is a clear instruction on how to use it, even though the game does not necessarily have a goal. In Figure 8 - Mood board of childhood games8, picture number 1 is a perfect example of such a game. The idea is that children can cut and build fruits and vegetables. However, it also allows children to combine fruit parts that do not fit together. Therefore, there is no real goal. The main idea is to let the child explore the elements of the game. The same goes for picture number 2, the child can play with the train set in a way that is interesting to him or her. One could say that picture number 9 has a real goal, which is to catch the butterflies that the elephant blows into the air. However, I know from personal experience that as a child it is also interesting to solely try to keep the butterflies floating in the air by trying to keep them on top of the elephant's trunk. So, I would say that the intended goal of the game is not always considered by children. Picture number 10, the marble track, is also endlessly fun for children. It allows them to build their own tracks and to watch the marbles travel all the way down. Even though these games are not goal based, we can easily understand why it would be fun to play these kinds of games.

There are also a few games which seem to be undefined in how they should be used. Pictures number

[1] Images are taken from several websites. The numbers next to the image are linked to the image, with the following sources: 1 - Kinderkeukens.nl, 2 - Wooded.nl, 3 - Amazon.nl, 4 - nl.aliexpress.com, 5 - Littlegreenrockco.com, 6 - Walmart.com, 7 - Lobbes.nl, 8 - Urbanstores.me, 9 till 11 - Bol.com, 12 - Geeektech.com.

3, 5, 6 and 12 might not easily be recognised as games. In picture number 3, you can see a board with a grid, which allows the child to put down coloured balls. We might not define this as a game, maybe a “game” is indeed not the right word for it. However, for children it can be very interesting. It is a way to practice recognising colours, to lay down patterns or to even build things such as a flower. The game in picture number 5 is actually more abstract compared to the game in picture number 3. The wooden board has a track that resembles the shape of a rainbow. Therefore, together with the coloured balls, a child can build a rainbow. However, there are also many other ways the child could lay down the coloured balls. This gives the child a lot of freedom to play. The game in picture number 6 allows children to take out the caterpillars from the apple, by using a stick which sticks to a caterpillar by using magnetism. They can also make the caterpillars switch places or figure out why caterpillars do not stick to each other. Lastly, in picture number 12 you can see a fidget toy. Children can pop the bubbles, which creates a popping sound. There’s also a possibility to lay marbles underneath the surface, so that the child has to guess where the marble is. We could say that this category of games is explorative and supports the development of the child.

I learned a lot from looking at these different kinds of games. First of all, I realized that a game can be quite simple and that a lack of rules can be the strength of a game. You should not look at a concept idea from an adult’s perspective, as adults might tend to overcomplicate things. Instead, you should wonder whether a child would be fascinated by it and how the child might use it. Secondly, I realized that I have a small preference for simple, wooden games. As stated before, I selected games based on whether I thought that they could use technology. I assume that my preference for wooden games comes from the fact that it is easy to implement a form of technology in it, while keeping a traditional look. Thirdly, I found that colour is very important in a game. Most of the time it is used just to make the game look more attractive. However, sometimes colours can also be part of the game or at least play a role in the development of the child. Lastly, I realized that many of the games that I found rely on the motor skills of children. In almost all games you must use your hands to be able to play the game. These games are made for typically developing children. The question is whether children with autism also like these games and can play them in the same way.

3.4 Second phase: understanding how children with autism play

3.4.1 Process

As my background research about children with autism mainly focused on the main symptoms of autism and specific eating problems, I did not know anything about how children with autism play. I assumed that their social and motor skills would be different from those of typically developing children and that stimuli would affect their playing experience, but furthermore I had no clue. Therefore, I looked for information on how children with autism play so that I could come up with concepts that would fit these children.

3.4.2 Outcomes

The game development of children with autism differs from that of typically developing children. A document made by Steunpunt Autisme noordelijk Zuid-Holland [48] explains how the game development of children with autism looks. Four kinds of phases in game play can be distinguished among young children: playful manipulation, playful combining, functional play, and symbolic play. These phases and the corresponding age for typically developing children can be seen in Table 1 - Overview of phases of game development for typically developing children. Children with autism also go through these phases, but not at the same speed. The phases of game development for children with autism are delayed and the transition to a new phase does not come automatically. The parents need to help the child to take that step. When comparing the behaviour of TD children and autistic children, the game development of children with autism is also at a lower level inside each phase. During playful manipulation, the children show less variation and engage in repetitive movements. During playful combining children also show less variation by making stereotyped or inadequate combinations. During functional play, the children use the object less often for its intended use and are more focused on the object than on other people or children. Symbolic play is generally absent in children with autism and when it is present, the content is weak. Children with autism have a disorder in imagination, which has a big effect on their symbolic play. These differences in play between TD children and autistic children give an insight in how children with autism play.

Phase	Age TD child	Behaviour
Playful manipulation	0-12 months	Grabbing toys
Playful combining	from 12 months on	Stacking objects or putting objects into something
Functional play	from 18 months on	Playing with object, focused on yourself or someone else
Symbolic play	from 24 months on	Fantasy play: act as if something is there/happening

Table 1 - Overview of phases of game development for typically developing children

Children with autism do not have the same interests as typically developing children when they are playing. The child misses the curiosity to discover the environment and therefore sticks with stereotyped, repetitive actions. Compared to typically developing children, a child with autism feels way less attracted to new or unknown things. The child also experiences playing in a different way. Instead of being fascinated by the way in which the toy car drives just like a normal car, the child is interested in the weight of the car and finds it funny when the wheels move. Many young children with autism get stuck in the early game development phase. This means that they keep feeling, licking and tasting things, without using their eyes and ears to explore the world. A child with autism investigates an object to experience pleasure from the simple, sensory perception of the object. Therefore, the way a child with autism plays can be described as unusual.

To help children with autism in their game development, it is important to ensure a safe environment and enough time to discover something new. Other methods that can improve the child's game development are: confirming, rewarding, showing how it should be done, playing together, copying the child, helping, structuring, putting it into words, giving coherence, stimulating, encouraging, stopping and intervening. To get the attention from the child, it is important to work on communication with the child. This can be done by using certain games or by for example rolling a ball to the child. A lot of games should first be done by the parent before the child will adopt the way of playing. By offering structure and predictability, and by clearly stating the limits, the game possibilities can be enlarged gradually by taking small steps. It is important to not include too many details into the game, as those can distract the child from playing. Furthermore, playing at a different location means that the game has to be taught again from the beginning, as the situation is new and different. The transition from what the child knows in the previous situation to the new situation, will not go automatically.

The game should fit with the level of development of the child. The age but also the intellectual level of the child should be considered. Games should not be too complicated, and the motor skills of the child should be considered. Clear and simple instructions should be given, consisting of one single task. By using simple and specific languages in these instructions, it is more likely that the child will follow the instructions. Rewarding is also important, to tell the child "Well done!". However, these rewards should also be phased out again to ensure that the child does not become dependent on them when playing the game. To motivate the child to play a game, it is possible to first play games that fit with the child's interests. For example, if the child loves Mickey mouse, it would be great to start out with Mickey mouse puzzles or colouring books. Furthermore, there are a few things that the child should know before he or she starts to play:

- What do I have to do?
- Where do I have to do it?
- For how long do I have to do it?
- How do I have to do it?
- With whom am I going to do it?
- What do I do when I am finished?
- What do I do when something goes wrong?

3.4 Third phase: working out first concepts

3.4.1 Process

Based on the previous phases of the ideation, I came up with some first concept games. The mood board I made in the first phase was an important source of inspiration for coming up with game ideas. Furthermore, I used the information on how children with autism play to come up with concepts which would fit my target group. In total, I worked out seven ideas which can be seen below. All the games have as their main goal to let the child eat new or unpreferred kinds of food. They all use a form of technology, but none of the games work in the same way. Just like many children's games, it depends on the child's development whether the game can be played individually. As motor skills are very important for the concepts that I made, it may be that, depending on the development of the child, the parents must help the child to play the game.

3.4.2 Outcomes

Idea 1: Interactive board

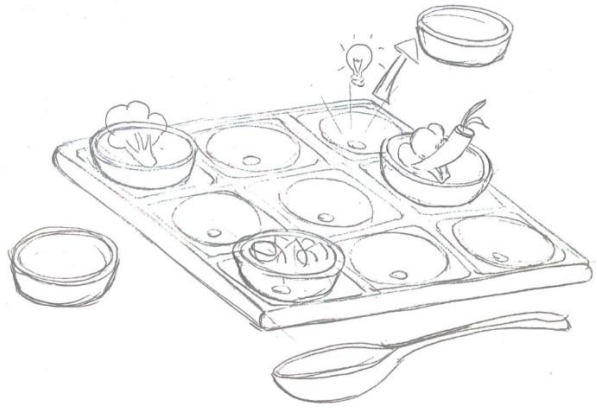


Figure 9 - Drawing of LDR idea, made by Marcos Montero Grande

This idea, which can be seen in Figure 9 - Drawing of LDR idea, made by Marcos Montero Grande, is based on game number 3 of the mood board, which can be seen in Figure 8 - Mood board of childhood games. By using light dependent resistors in each hole, it is possible to measure whether a hole is covered with a little plate. In each plate there is a certain kind of food which the child should try to eat. When the child lifts the plate and puts it back after taking a bite, the device can measure this and, for example, give feedback by saying: "Well done!". The main idea is to make it fun for the child to eat.

Idea 2: Train

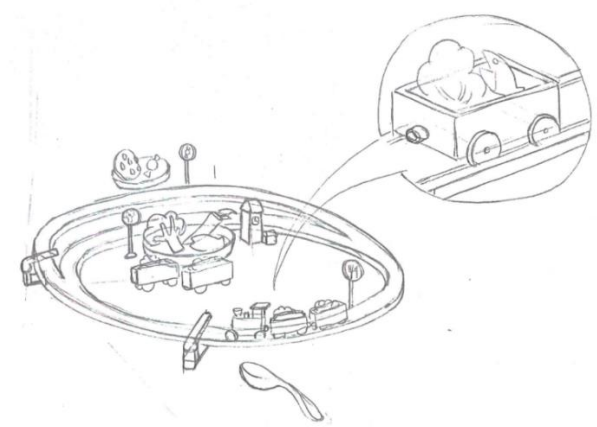


Figure 10 - Drawing of train idea, made by Marcos Montero Grande

The second idea, which can be seen in Figure 10 - Drawing of train idea, made by Marcos Montero Grande, is based on game number 2, which can be seen in Figure 8 - Mood board of childhood games. In this game, a train drives on a certain track. In order for the train to keep driving, the child has to take a bite of food from the wagon. Otherwise, the train will stop. To make the game more fun, it is possible to include sounds and lights to the game. In Figure 10 - Drawing of train idea, made by Marcos Montero Grande, there are three places where the train can stop: at a station where the child has to eat, at a station where the wagon can be filled with non-preferred food, and at a station where the wagon can be filled with preferred food

Idea 3: Stacking blocks

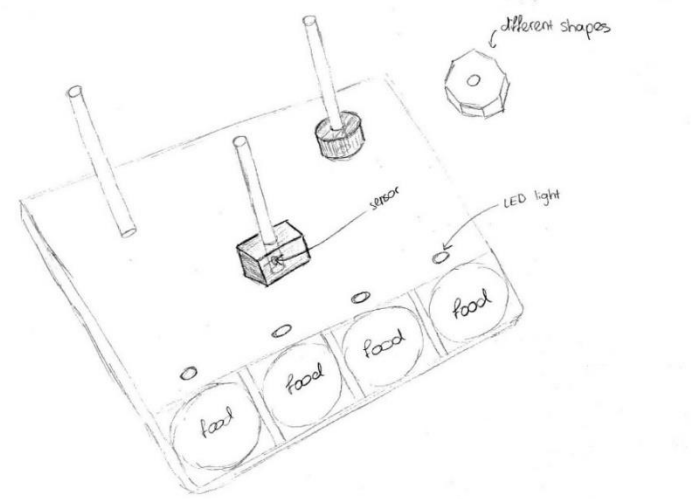


Figure 11 - Drawing of stacking blocks idea

The third concept, which can be seen in Figure 11 - Drawing of stacking blocks idea, enables children to build towers out of blocks. These blocks have different kinds of shapes. All blocks have a hole that fits with the sticks on the board. Depending on how the child builds the towers, one of the lights will light up above a corresponding plate. Each one of these plates is filled with a certain kind of food. The child should take a bite from the food of the plate from which the light turns on. After taking a bite, the child can again stack a block. The system can also give feedback through sound.

Idea 4: Interactive plate

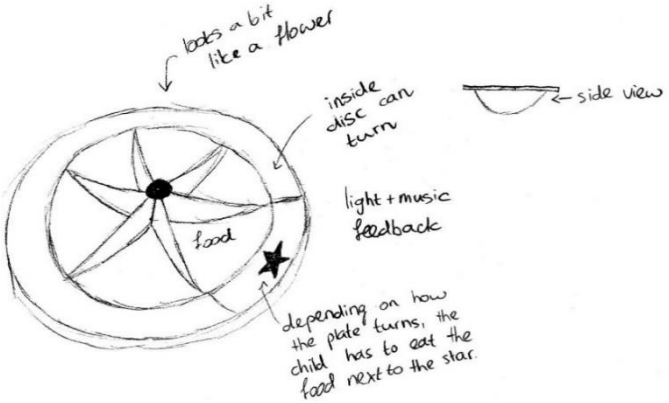


Figure 12 - Drawing of interactive plate idea

The fourth idea, which can be seen in Figure 12 - Drawing of interactive plate idea, is based on a turning wheel. It works in exactly the same way but is placed horizontally instead of vertically. As you can see in Figure 12 - Drawing of interactive plate idea, there is a deep plate which has another smaller plate on the inside. This smaller plate has the ability to turn. Furthermore, the plate has several sections to allow the food to be separated. When a child turns the plate in the middle, a certain kind of food will end up next to the star on the edge. This is the food that the child has to eat.

Idea 5: Children's FEBO

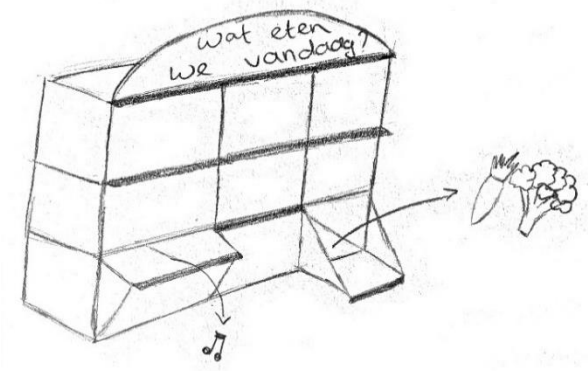
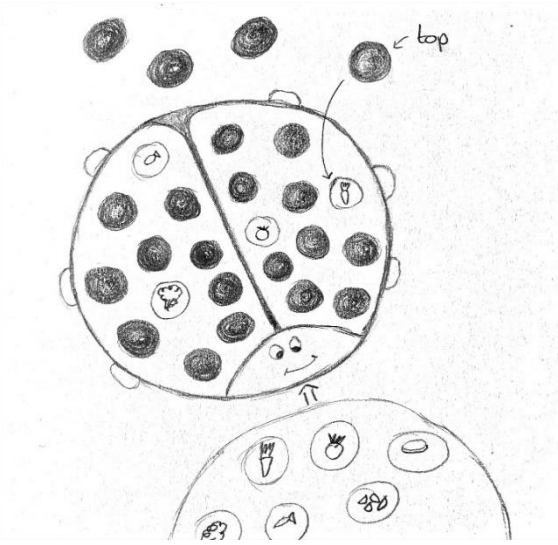


Figure 13 - Drawing of Children's FEBO idea

If you are Dutch, you probably know the Dutch FEBO, a fast food chain which allows you to take your favourite snacks from an automatic wall. This idea, which can be seen in **Error! Reference source not found.**, works in a similar way. However, the goal is to serve healthy food instead of unhealthy snacks. The child can choose which box he or she wants to open. Music will play when a box is opened. Then, the child has to eat the food which is behind the open door. Feedback can be given through sound.

Idea 6: The ladybird



This idea, which can be seen in Figure 14 - Drawing of the ladybird idea, is based on game number 8 in Figure 8 - Mood board of childhood games. The dots of the ladybird can be lifted. Underneath the dots are images of certain kinds of food. These images can easily be changed by sliding a paper underneath the surface of the ladybird. The child can lift the dots and has to eat the corresponding kind of food. The system can give feedback to the child using lights or sound.

Figure 14 - Drawing of the ladybird idea

Idea 7: Marble track

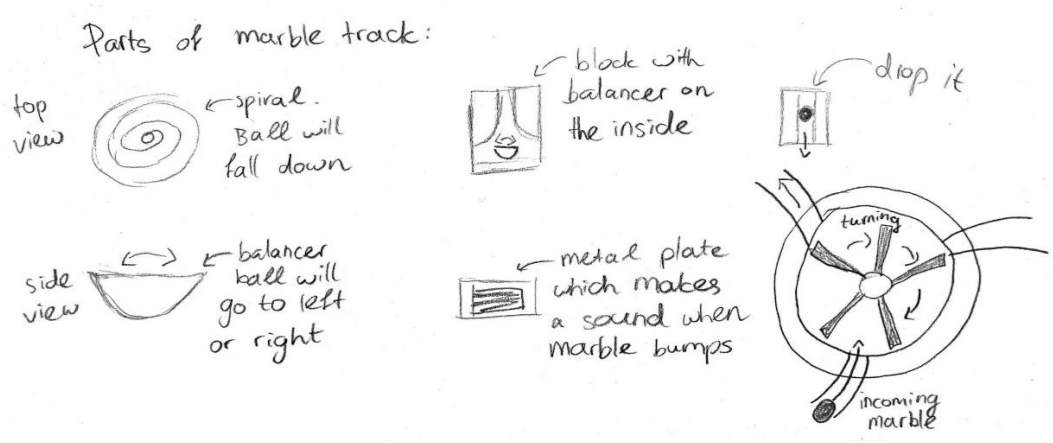


Figure 15 - Drawing of marble track idea

This idea combines old fashioned marble tracks with new technologies. In the mood board in Figure 8 - Mood board of childhood games, game number 10, there is a plastic kind of marble track. However, there are also a lot of marble tracks to find which are made of wood. Some of those allow the child to build more creative tracks, as these wooden pieces allow for making more combinations of tracks. There is even a kind of wooden marble track, called Xyloba[2], that makes music when the marble travels downwards. I think a marble track would be interesting for children with autism and could easily be transformed into an eating game. I made a few drawings, which can be seen in Figure 15 - Drawing of marble track idea, that show the different kinds of stages that the marble could pass through. By allowing the marble to travel different kinds of pathways, the marble can end up in different places. If the marble track would have different end stages, these could each be connected to a plate with a certain kind of food. Depending on where the marble ends up, the child has to eat from the corresponding plate. Only after eating a bite, the child is allowed to put a new marble on the top of the track.

[2] See https://www.xyloba.ch/ch-ch/en_GB/.

3.5 Fourth phase: getting knowledge from experts

3.5.1 Process

To validate, alter or discard the ideas that I came up with so far, I decided to talk to people who know a lot about children with autism. Therefore, I called three different people who have different experiences with children with autism. First of all, I talked to Siety Haarman, a student who is finishing her Master in Remedial Education. She has a bachelor's degree in Educational Sciences, works as peripatetic supervisor and did an internship at the infant and child team of an organisation that offers mental healthcare, forensic healthcare and care for elderly. Secondly, I talked to one of my clients who works at a children's practice as a family therapist. Lastly, I talked with a parent who has a son with autism. The goal of this phase was to get inspiration and new knowledge on how young children with autism play, how their development looks and to get feedback on the concept ideas that I made.

3.5.2 Outcomes

Interview with a Master student in Remedial Education

In contrast to typically developing children, children with autism have a very discordant development profile. For typically developing children, the development profile is reasonably equal. A child aged 4 years also has the social-emotional development of a child of 4 years old. The same goes, for example, for their self-reliance and cognitive skills. All the different domains of development are at an equal level that fit the real age of the child. However, a 4-year-old child with autism can have a social-emotional development of a one-year-old or even a baby. Of course, these are the more extreme cases that clearly stand out from the rest. When these children grow up, the difference between their real age and their developmental age can become even bigger. A child aged 12 years can, for example, be on the development level of a 6-year-old. The development profile differs per child: sometimes there are outliers upwards and other times there are outliers downwards. One thing is for sure, the development profile is not equal. Therefore, it is smart to always work with the lowest level of development. When looking at the different domains of development, you base the child's developmental age on the youngest level of development. This level can, for example, be the social-emotional level, but can also be based on self-reliance or cognitive development. It is important to not ask too much from a child when he or she is not at that level of development yet.

It is usual to make a sensory profile when a child with autism is 4 years old. In this sensory profile, a distinction is made between stimulus seeking, stimulus avoiding, stimulus sensitive and poor registration. This distinction is made for several domains such as seeing, listening, feeling, smelling, tasting, proprioception and interoception. The sensory profile can differ a lot per child. For example, it can be that a child has poor registration for flavours and, therefore, is stimulus seeking when it comes to flavours. This can mean that the child only likes very intense, salty or sweet flavours. Paprika powder is, for example, very popular among those children with autism. Another example can be that a child is very sensitive to taste, structure or temperature. For many children, the food should not be too warm, because they do not like it. For others, it is helpful to limit the tastes or structures by making a puree from the food. Therefore, it is practical to have strategies on how to help these children with eating depending on their specific sensory profile. For my intervention, it would be helpful to take this into account by, for example, including an explanation on how to deal with different sensory profiles.

For this project's target group, specific things should be kept in mind. The children often still want to investigate their environment because of the sensory stimulus. This can, for example, be based on how something moves, feels or tastes. For example, it is fun to look at how things move or to put cars next to each other. They can also be obsessed with playing with sand, mud, or clay. In terms of playing, children do not really engage in fantasy play because they find it difficult to distinguish between what is real and what is not. The children of the target group are in a phase of development where imitating happens a lot. Therefore, they will copy things that family members, such as parents or siblings, do. It depends if they copy it correctly, but they will often try. Furthermore, most children of the target group will be in their first individualization phase, which means that they are looking for individualization and autonomy. Therefore, it is necessary to make sure that they are supported in a way that enables them to enlarge their autonomy. It has to happen within clear limits and with a clear structure, where the use of language is also important. When you say: "Are you coming with me?", it seems like you give the child a choice. It is better to say: "Come, we are going!".

There are multiple factors that play a role during playtime of a child with autism. First of all, structure and predictability are really important. The child should understand what is going to happen, for example by using pictures or icons as a reference. These are particularly useful to indicate transitions between activities. the game should be interesting to the child. It is smart to try to gain the interest of the child. This can, for example, be done by using toys that can be moved, such as cars, trains or balls. Windmills, soap bubbles, and marbles are also very popular among children with autism. A lot of stuff can happen when playing with toys, so it is important to consider how a child might react to something. Thirdly, the attention span of the child plays an important role. The attention span differs per child but also depends on certain requirements that should be fulfilled. For example, a quiet environment without many distracting factors can increase the attention span of a child. These requirements also differ per child, and it is sometimes hard to find out what these specific requirements are. For example, a child can get distracted by the incoming light from the window, or by the reflection of the chair leg. When children are young, it may be difficult to figure out what the exact requirements are due to a lack of communication.

Communication plays an important role during playtime. Pivotal response treatment is a method which is used to stimulate the communication between the child and the parent. The goal is to provoke communication by taking small steps in this development. For example, the parent counts to three and then rolls a ball to the child. This is fun for the child. Once the child understands that the ball will only roll once the count is at three, the parents will challenge the child. Instead of counting to three, the parents will count to two and wait for the child to say 3. Only then, the parent will roll the ball towards the child. Once the child starts to understand how these things work, they adapt to this in a very rigid way. In general, taking small steps is important for the child to understand what he or she needs to do. When a certain task consists of multiple steps, the parent should ask the child to do these steps one by one.

Regarding the seven concept ideas, Siety prefers some ideas over other ideas. She is most enthusiastic about ideas number 2, 3, and 4: the train, stacking blocks, and the interactive plate. The train idea seems like a lot of fun to her. Still, there are some things that should be avoided according to her. First of all, it is important that the parents do not get involved when playing the game. Children with autism do not like it when others engage in their game and will give more resistance when playing the game. Secondly, recognising colours may be difficult for some children. It could be helpful to make it more visually apparent by using pictures or icons. Thirdly, it is best to let the child eat from a plate instead of a wagon. You want to keep it as close to reality as possible because children with autism have a lot of difficulty with transitions. Lastly, the transition to not using the game anymore will be difficult. It would be smart to figure out if certain game levels could make this transition easier for the child. The stacking blocks idea is Siety's favourite idea. The game can be personalized by responding to the way a child processes sensory stimuli. For example, the blocks that the child likes the most can be linked to food that the child does not like so much. Furthermore, the idea is less distracting for family members who join at the dinner table compared to the train idea. The interactive plate has potential, but only if the game rules are clear. It could be nice to let the child choose between two kinds of outcomes, to increase the child's feeling of autonomy.

Siety has some doubts about the rest of the games. For idea number 1, the LDR game, she thinks that the child may feel encouraged to play the game without eating any food. In the end, the game does not stop the child from lifting a little plate and putting it back again without eating the food. Idea number 5, the children FEBO, is a fun idea but the concept seems to be built around fulfilling assignments. Maybe there are games that are more fun to play. The ladybird, idea number 6, is a nice concept but may not be interesting enough for the child. Once the child remembers the places of the pictures of the food, the child can manipulate the game very easily. It would be difficult for parents to intervene, as the game is then not fun anymore for the child. For the last idea, the marble track, Siety is concerned that the game might be too complicated and that it takes up too much space. Furthermore, the marble should be quite big because the children will try to eat it. All in all, it can be said that the game rules should be clear, the game should not allow for easy manipulation, and the child should find the game interesting.

Interview with a family therapist

Children with autism depend a lot on their surroundings and their parents. Many children like to go out to discover new things, maybe they do this more than on average. IMH Nederland has written a piece that is called the circle of safety and trust. A drawing of this concept can be seen in Figure 16 - Circle of safety and trust from the IMH toolbox by IMH Nederland . The idea is that the parents offer the child trust and safety. The parent allows the child to discover new things. It is important to help and pay attention in this phase. The parent should think ahead about what might happen, put limits, give structure, be proud and praise the child for what he or she did. However, the parent should also be prepared to calm down the child and fix the situation when something goes wrong. For this process the parent should comfort the child, deal with the child's anger, fix the relationship after a misunderstanding, and share the fun. The family therapist often sees children who are not attached to their parents in a safe way. The children are often very curious, but they do not involve their parents in what they are doing. This often leads them to wandering off too many times.

Figure 16 - Circle of safety and trust from the IMH toolbox by IMH Nederland [3]

The environment in which the child plays an important role. Often, when children are surrounded by all kinds of games, they find it difficult to start to play. Therefore, it is useful to make sure that the room is not too full of stuff. Once a game is chosen, it is not such a problem if it is a bit busy, because the focus is on the game. Music does, for example, not have to be too much for the children to handle. Music can also be a good way to stimulate language development. Lights, sounds and images also fit with the development of the children. The usage of black and white icons is very common and works really well for the children. To start playing, children should feel comfortable. The rules and structure should be clear. That's also why children love video games so much, as they do not have to think about all the rules that apply, everything is predictable.

Children also copy a lot from what others do, but the speed at which they learn to do so differs a lot from that of typically developing children. Typically developing children learn things from others, they copy it and then use it in different situations. These steps are difficult for children with autism. First of all, it takes a long time to copy the behaviour. Secondly, it is difficult to use a certain skill in different situations. Therefore, it takes a long time before patterns are ingrained. Children with autism also tend to do the same kind of thing repeatedly. They like to put cars in line, they enjoy doing this repeatedly. They also like movement. When it comes to feeling, there is often an overstimulation or understimulation. Children have difficulty with touching sand, water and mud. They think it is dirty, while typically developing children love it. Therefore, it is something that people try to stimulate by letting the child get used to how different things feel. This is necessary for their development. Children can look at a windmill for hours, but this does not help them for their development.

[3] See https://www.imhnederland.nl/toolbox/.

Therefore, it is important to capture their interest. The children should be curious about what is coming next. You can ensure this by working in levels. The power of repetition plays an important role.

Autonomy is very important in a game for a child with autism. The child should have the feeling that he or she is in charge. For example, during dinner times a parent can prepare two kinds of food, where the child can choose which food he or she wants to eat. Even though the child has to eat an unpreferred or novel food, the child feels that he or she has autonomy and that it is his or her choice. However, some children find it difficult to make a choice, particularly when they are of the age of 2 to 4 years. When there are too many options to choose from, making a choice is too difficult. Therefore, a choice should be simple to avoid conflicts. You want to ensure that the child can make a choice by him or herself, because having to make the choice for the child will lead to struggles. In general, the children of the target group can do a lot of things, as long as the rules and limits are clear.

The children with autism often have a delay in their communication skills. The usage of language is not present in a way that you can always communicate in an effective way. Often, the parents are mainly communicating but they do not get anything back from the child. Therefore, it can be difficult to tell whether the child understands the rules of a game after you have explained them. You learn to recognise whether the child understands by trying. Often, the family therapist also tries to make the parents aware of how they communicate with the child and what are ways to change the communication. When looking at dinner times, the family therapist discusses with the parents what their values and principles are. Based on those, they lay down a plan. For example, sometimes it is necessary not to talk during dinner times. The child should first learn how to eat, and sometimes complete silence is needed to make this happen. Afterwards new things can be added, to allow the child to get used to new things in a stepwise manner.

The attention span of children with autism is shorter than that of typically developing children, but it really depends on the child and the environment. The attention span of the children is between 15 minutes and half an hour. At the end of the day, the children have taken in so many stimuli that they are too tired to truly engage in the dinner time. The motor skills needed to eat can also ask a lot from the child. If this does not work well anymore, the child does not want to eat anymore. Therefore, it is sometimes useful to have dinner in the afternoon instead of the evening, or to swap dinner and lunch time. If the motor skills of the child are underdeveloped, the parents can also feed the child. The child can always decide to close his mouth, which still allows for the autonomy that these children want.

Dinner times are often problematic for the child and the parents. The children do not understand the concept of eating, which is why the parents should explain what should happen. Often, parents think that the child will adjust his or her behaviour automatically, as that is what they are told at the consultation office. Because of this, parents do not take action which makes the eating problems even worse. The earlier parents take action, the easier it is to solve the problems. Sadly, when the parents walk into the practice of the family therapist, the eating problems have become so bad that the parents are simply desperate. The parents only have two choices at that point: they take on the fight with their child, or they let it be and watch how the child starts eating less and less every day. Therefore, the parents feel powerless, also because outsiders do not understand the trouble that the parents must go through.

Interview with a parent

Just like the student and the family therapist, the parent emphasized how important it is for children with autism to have control over a situation. They need this control to take away any uncertainties. The need for autonomy, to have a choice, is important for the children too. Next to that, the parent also confirmed that children with autism do not play together with others. There are ways to improve the game development of the child. For example, Dr. Stanley Greenspan, an American child psychiatrist, developed an intervention called Floortime which is a method to build upon the strengths and abilities of the child through interacting and creating a warm relationship. This method can also be used to improve the game development of the child.

To ensure that the envisioned game works out as it should, the parents, child and supervisors should work well together. The behaviour and attitude of the parents plays a very important role. You should give the parents hope and look closely to find out what the reason is for problematic behaviour. The parents should join the child's perspective, should bring structure by stating the game rules, and a mutual trust should be built between the parents and the child. There are a lot of methods and books available which explain more about what works well for children with autism. Anneke Groot wrote a Dutch book called "Houvast" which explains how a parent can provoke contact-oriented play and learning in children with autism. Furthermore, Collete de Bruin wrote a Dutch book called "Geef me de 5", which is a method that explains to caregivers and professionals what autism is and how they can deal with it. Having these kinds of methods in the back of your mind can be very helpful when designing a game for children with autism.

The parent also showed me some technology games which his son liked to play when he was young. One of them is a clock with which a child can practice telling the time. The clock asks the child to put the correct time. The child has to move the hands of the clock and press a button to save the time. The clock will tell the child whether the setting is correct. In case the setting is not correct, the clock will ask the child to try again. If the setting is correct, a simple music sound is played, and the clock will praise the child. Then, the clock will ask the child to set a new time. According to the parent, his son could play this game for a long time. The simple and predictable feedback worked very well for his son. As the parents do not have to be involved in the game, the child can just keep trying to put the correct time until it works out. If the parents would be involved, this would not be possible as they would lose their patience at some point. Another game which the parent talked about is the Press 'n Play Learning Board from Vtech. By playing the game, a child can learn to count, find, and learn by playing together with Winnie the Pooh and his friends in the Hundred-Acre Wood. On the top of the board, there are five activities which can be played to learn letters, phonics, counting and more. There are fifty touch-sensitive areas on the board, which interact with the game mode. Feedback is given with the real voice of Winnie the Pooh. The son of the parent was very fond of this game, even though he did not understand all the functionalities at first. Over time, this improved, and he was able to play all game modes.

Figure 17 - Two technology games: The learning Clock and the Press 'n Play Learning Board [4]

[4] Pictures obtained from degrotespeelgoedwinkel.nl and amazon.co.uk.

3.6. Fifth phase: changing concepts

3.6.1 Process

Based on the information that I received during the interviews, I changed the concept ideas. Two of the previously mentioned concepts did not seem to be a solution to the problem. These ideas were the LDR game and the children's FEBO. The games would not provoke the desired behaviour because of the way they were designed. I decided to discard the concepts, as I did not see how I could improve the concepts. I adjusted the other five ideas according to the feedback and information. Furthermore, I made different versions of some of those ideas to show the different kinds of possibilities that a certain game has. The new concept ideas can be seen below.

3.6.2 Outcomes

Idea 1 – Train

I made three different versions for the train idea.

<u>Version 1:</u>

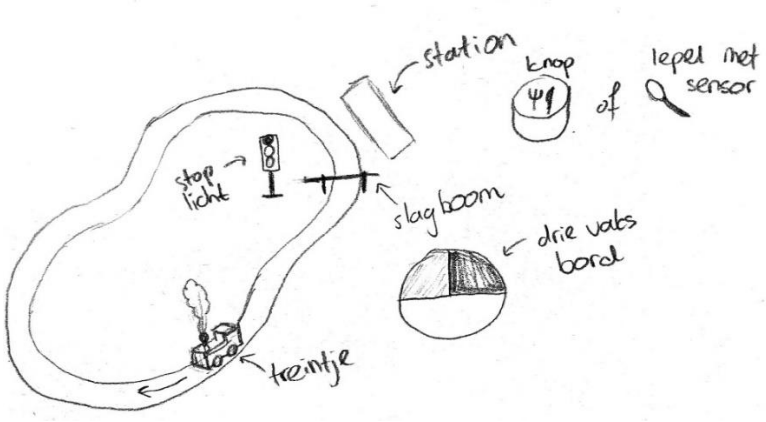


Figure 18 - Drawing of adjusted train idea, version 1

In Figure 18 - Drawing of adjusted train idea, version 1a train drives on the track which is configured as a circle. When the train arrives at the station, the train can only continue driving if the gate is opened. To open the gate, the child has to take a bite from the plate. Depending on the colour of the traffic light, the child should eat from the part of the plate with the corresponding colour. When the child takes a bite, this can be measured by either using a button or a spoon with a sensor. Positive feedback will be given through a speaker: "Well done! The train continues to drive.". The train will continue to drive over the track, until it arrives at the station again. The colour of the traffic light will change when the gate is closed again. If the child does not take a bite on time, causing the train to stay at the station, the speaker will give feedback: "Oh oh, the train stopped driving. Take a bite to let the train drive!".

<u>Version 2:</u>

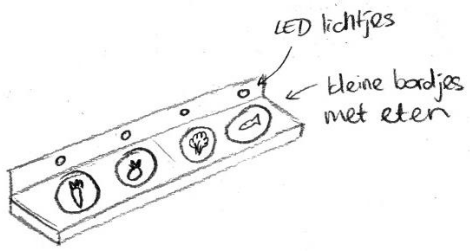
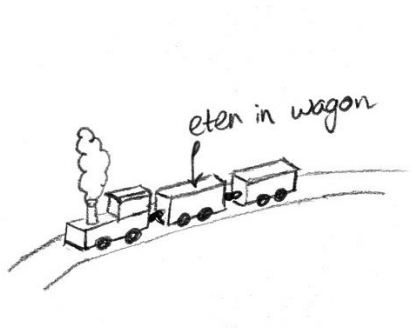


Figure 19 - Drawing of adjusted train idea, version 2

In Figure 19 - Drawing of adjusted train idea, version 2, the concept is the same, but instead of a plate with different sections with colours which correspond to the colours of the lights, there is a section with small plates with a light above these plates. Depending on which light turns on, the child should take a bite from the corresponding plate.

Version 3:



The concept in Figure 20 - Drawing of adjusted train idea, version 3, is similar to the first version, but this time the child does not eat from a plate. Every time that the train arrives at the station, it will release one of its wagons. These wagons contain food. The child should take a bite from the food from the

Figure 20 - Drawing of adjusted train idea, version 3

Adjustments:
The game should stay interesting and challenging. Depending on the version of the game, the following game changes can be made:

- To ensure that the transition to eating food from a normal plate goes smoothly, it is possible to make a transition to using pictures instead of small bits of food on a plate. The child needs to recognize the food on the picture, to then eat the food from the normal plate.
- The driving speed of the train could be adjusted to make the game more challenging.
- It could be an option to allow the child to build the train track by using tracks that allow for different kinds of configurations. It could be part of the preparation for the dinner time to let the child build the train track.
- It is possible to change the sounds and/or interactions, for example per day or week, to keep the surprise element in the game.

Idea 2 – Stacking blocks
I made three different versions for this idea.

Version 1:

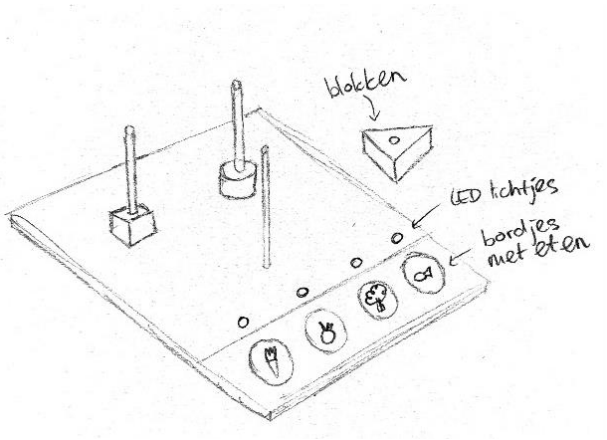
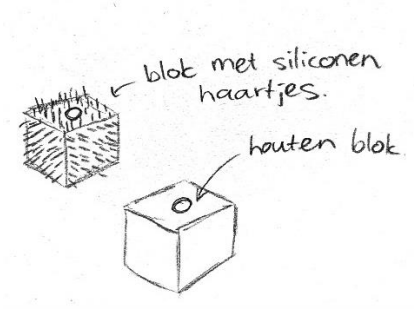


Figure 21 - Drawing of adjusted stacking blocks idea, version 1

Figure 21 - Drawing of adjusted stacking blocks idea, version 1shows a game which is played by stacking blocks on three sticks. In this version, there are blocks of different shapes, which each have a hole in the middle which the sticks fit through. Depending on the configuration of the blocks, an LED lights up above one of the small plates with food. Each plate is filled with a different kind of food. When an LED lights up, the child should take a bite from the corresponding plate before he or she can stack new blocks. When the child takes a bite, the game will give positive feedback by a speaker saying: “Well done!”.

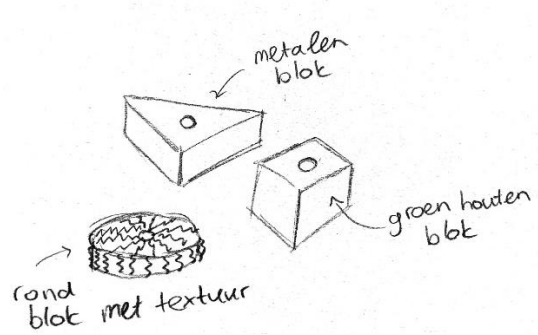
Version 2:



In the second version, which can be seen in Figure 22 - Drawing of adjusted stacking blocks idea, version 2, the sensory stimulation plays a more important role than in the first version of the game. Some children with autism really like certain materials because of the way it feels or looks. In this version the game uses square blocks which are made from different kinds of materials such as wood, metal and silicone.

Figure 22 - Drawing of adjusted stacking blocks idea, version 2

Version 3:



In the third version, which can be seen in Figure 23 - Drawing of adjusted stacking blocks idea, version 3 the blocks are not only made from different kinds of materials, but also have different kinds of shapes and colours.

Figure 23 - Drawing of adjusted stacking blocks idea, version 3

Adjustments:

The game should stay interesting and challenging. Depending on the version of the game, the following game changes can be made:

- To ensure that the transition to eating food from a normal plate goes smoothly, it is possible to make a transition to using pictures instead of small bits of food on a plate. The child needs to recognize the food on the picture, to then eat the food from the normal plate.
- The game could become more complex when the child gets challenged to build certain configurations using a picture with a certain configuration.
- The game could become more interesting when the use of certain blocks gets linked to eating a certain kind of food. If there is a block with a certain material which the child loves to build with, a consequence of using this block could be that the child has to eat the food that he prefers the least.

Idea 3 – Turning plate

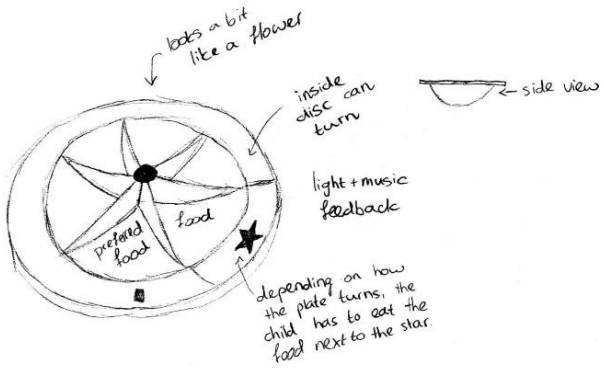


Figure 24 - Drawing of adjusted interactive plate idea

For this idea, which can be seen in Figure 24 - Drawing of adjusted interactive plate idea, I did not make multiple versions. The idea is still very similar to the one in Figure 12 - Drawing of interactive plate idea, where the plate has to be turned and the child needs to eat from the food that ends up at the star. The main change that I made is that the child now gets the option to choose from two kinds of food: the food that ends up at the star and the food that ends up at the square. Also in this game, positive feedback can be used together with sounds or light effects.

<u>Adjustments:</u>
The game should stay interesting and challenging. Depending on the version of the game, the following game changes can be made:

- To ensure that the transition to eating food from a normal plate goes smoothly, it is possible to make a transition to using pictures instead of small bits of food on a plate. The child needs to recognize the food on the picture, to then eat the food from the normal plate.
- The amount of food could be adjusted by using different kinds of plates. In Figure 24 - Drawing of adjusted interactive plate idea the plate has 6 sections. However, you could also use a plate with, for example, three or nine sections.

Idea 4 – The Ladybird

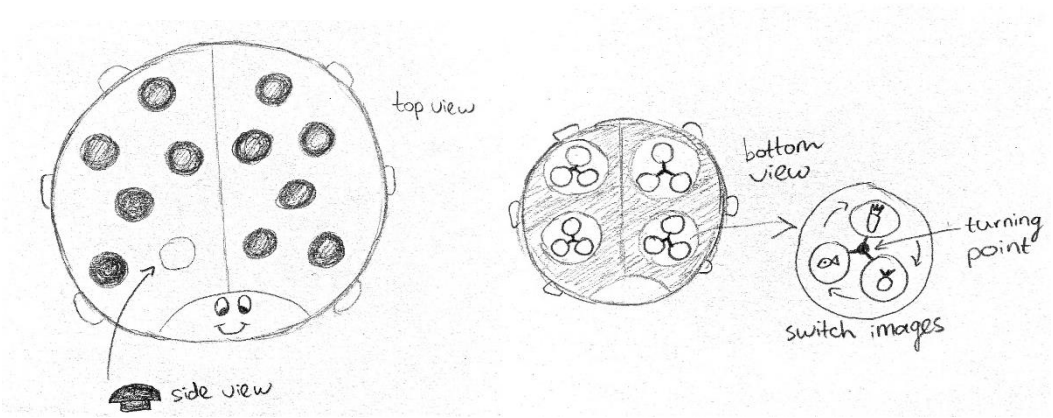


Figure 25 - Drawing of adjusted ladybird idea

As can be seen in Figure 25 - Drawing of adjusted ladybird idea, there is a ladybug with dots which can be lifted. Underneath the dots are images of food. The idea is to lift a dot on both sides of the wings of the ladybug, to find two pictures of the same food. If the child manages to do so, the child is allowed to take a bite from his or her favourite food. If the pictures underneath the dots are not the same, the child can choose which of the two kinds of food he or she wants to take a bite. When the child takes a bite, positive feedback can be given by a

speaker saying: “Well done!”. With a memory game you can easily cheat once you know where the pictures are placed. Therefore, I came up with an idea to make it harder to guess what is placed where. At the bottom of the ladybug, there is a system which allows the pictures to be rotated. Every time a child has taken a bite, these pictures can rotate. In this way, it is always a surprise to see which picture is where, as it could be that the pictures are not in the same position anymore.

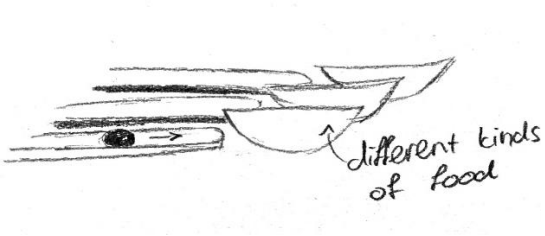
Adjustments:

- The amount of food can be adjusted by varying the pictures, with a maximum of six different kinds of food.
- The way in which the pictures turn after each round could be adjusted. For example, you could activate or deactivate the usage of LED lights which indicate which pictures have turned.
- When the child is not able to recognise different kinds of food, it may be easier to work with colours instead which are each linked to a certain kind of food.

Idea 5 – Marble track

For this idea, there are three different versions. For each of these versions, the main idea is the same. There is a marble track, where a big marble can travel different kinds of paths. Depending on the path it travels, the child has to eat a bite from a certain kind of food. In Figure 15 - Drawing of marble track idea are some examples that illustrate how the marble could travel different paths. When the child takes a bite of the food, a speaker can be used to give positive feedback by saying: “Well done!”.

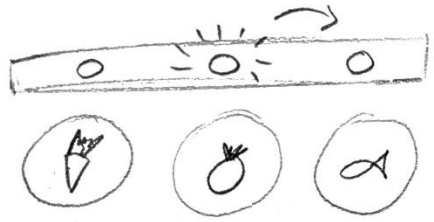
Version 1:



In the first version, which can be seen in Figure 26 - Drawing of adjusted marble track idea, version 1, the marble track has different end stages. The marble will end up at one of these places. The child will have to take a bite from the plate next to the marble.

Figure 26 - Drawing of adjusted marble track idea, version 1

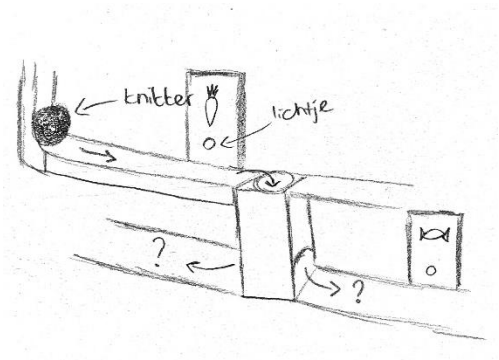
Version 2:



In the second version, which can be seen in Figure 27 - Drawing of adjusted marble track idea, version 2there are different plates which each have a corresponding LED light. When the marble travels down the marble track, it will pass multiple sensors. Every time a marble passes such a sensor, the next LED light will light up. When the marble is at the end of the track, the child has to eat from the plate the corresponds with the LED that is on before the child can put the marble again at the start of the marble track.

Figure 27 - Drawing of adjusted marble track idea, version 2

Version 3:



The third version, which can be seen in Figure 28 - Drawing of adjusted marble track idea, version 38, is similar to the second version of the game. The difference is that the points with sensors each have a corresponding image of food. When the marble passes such a point, an LED will light up at that spot. When the marble has travelled all the way down, the

Figure 28 - Drawing of adjusted marble track idea, version 3

Adjustments:

- When the child is not able to recognise different kinds of food, it may be easier to work with colours instead which are each linked to a certain kind of food.
- Depending on how many sensor points there are, there is a possibility to include many different kinds of food in the game.
- It would be a possibility to allow for changing the configuration of the marble track. In this way, the game stays exciting.

3.7 Sixth phase: getting feedback from clients

3.7.1 Process

In an online meeting, the five ideas were presented to the clients, two employees of Praktijk Forza. They gave feedback on the concepts, and each chose their favourite idea. The feedback can be seen below.

3.7.2 Outcomes

Feedback idea 1 – The train

Both clients really like the idea. It is a simple but strong concept. There is a nice interaction between the train and the child: by eating, the child gives the fuel that the train needs to drive. The clients highlight that the game should not become too complex and should also not be too far from the “normal” dinner time experiences. Therefore, they suggest not to use a sensor to measure whether the child ate, a button will do just fine. They also discourage me from putting the food in the train wagons, as the child would get used to it and would afterwards have to unlearn to eat from a train wagon. Furthermore, they think that using a light to indicate which food the child needs to eat will not be such a problem. Even though some children might not completely understand yet which colour is which, this could serve a nice distraction from eating. The parents can ask the child to think about which colour on the plate corresponds to the colour of the light. The clients also mention that you can take away the attention from the main task, eating, by saying: ‘Come on, let’s let the train drive another round!’.

Feedback idea 2 – Stacking blocks

My clients are less enthusiastic about this idea. They think that the concept is too difficult and that the children will not use the game as envisioned. The children will get distracted by how the blocks feel and look, which is why they would not be aware about the link to the food anymore. Furthermore, it is also difficult to understand exactly how a child would respond to using a certain block. Overstimulation or understimulation can take place but it is not possible to tell for sure which one of those would happen. Sometimes, the response of the child to a certain stimulus can change within five minutes. The clients do like the idea that the blocks give a visual insight in how many bites a child has taken.

Feedback idea 3 – Interactive plate

The clients had both positive and negative remarks on this idea. First of all, they like that the outcome of what the child has to eat is based on randomness. However, the fact that the plate with the food turns does not seem to be a good idea. If the child turns angry and starts turning the plate so fast that all the food falls out, this will turn into a drama. It would therefore be better to turn the edge of the plate instead. Even though autonomy plays an important role for these children, the clients think it is a bad idea to make the child choose between two kinds of food. Children have trouble making choices and they will also learn less from playing the game if they can always choose the food that they prefer. It is better to make the choice for the child. It is important to keep in mind what the goal of the intervention is: to add a game element which makes eating more fun. To give the child the feeling of autonomy, you could, for example, let the child decide which music will play while the plate is turning. Another remark is that this game would ask a lot from the parents. The parents would have to pay attention to several things, as playing the game easily can lead to conflicts. If the goal of the game would be to teach and support parents in the upbringing of a child, this game would be perfect. You could use it to learn how to set rules and how to stick with those. However, for motivating a child to eat, this concept does not really fit.

Feedback idea 4 – The Ladybird

The clients both find the idea very creative. They warned me that I should not label the food as "tasty" and "not tasty" and I should not give the choice to the children on what they should eat. However, they think that the game has potential and that children would like it once they get used to playing the game. They also think that it is an advantage that the game can easily be taken to other places. If the pictures of the food are simple, the children will be able to recognise the food.

Feedback idea 5 – Marble track

My clients really like this idea. The usage of this idea would allow for making many different combinations. They say that marble tracks are super popular among children with autism. However, this can be a pitfall as the children might pay more attention to the marble than to the food that they have to eat. It may be that the children are so focused on the sound of the marble traveling downwards, that they do not have any attention left for other things. Version 1 seems to work best for my clients, as the outcome is the clearest. However, it might be necessary to switch the plates occasionally, as some children may be smart enough to figure out how to get the ball at a certain spot. This also gives a new exciting change in the game. My clients emphasize that the parents have an important role as leaders of the game, because conflicts may arise easily.

Favourite ideas

When I asked my clients to pick a final concept, they both indicated that they had two favourite ideas which were the train and the marble track. They said that both games would motivate the child to eat, but the motivation would come from different things. The marble track concept would be less predictable than the train concept, but the train concept might put more emphasis on the fact that the child needs to eat. In the end one client preferred the train concept, while the other preferred the marble track concept.

3.8 Seventh phase: choosing final concept

3.8.1 Process

Based on the feedback of my clients, I made a choice for the final concept. As stated before, my clients were most enthusiastic about the train concept and the marble track concept. As these concepts differ so much, it was difficult to compare them to make a final choice. The train does not make a lot of noise, has nice and simple game rules, and fascinates children. However, the game is more predictable than the marble track, which makes it easier for the children to lose their interest. The marble track, on the other hand, is less predictable and fascinates children. Still, the marble makes more noise, is more difficult to build and takes up way more space on the dinner table. When looking at these advantages and disadvantages of both concepts, it was difficult to make a well-considered choice. I decided that, given the fact that my clients were really enthusiastic about both ideas, I just had to follow my heart and choose the concept that I thought would work best.

3.8.2 Outcomes

I chose the train idea as my final concept. I think that the game has a lot of potential and I also like the fact that the child needs to eat in order to give the train energy to continue to drive. As a child, I would have liked both the marble track and the train game a lot. I think that I might have liked the marble track more as a kid, as I was always fascinated by how the ball travels all the way down. However, when I look at the intended goal of the game and the target group, I am convinced that the train concept has a better chance at succeeding. The game rules are simple and allow the child to be focused on the train and the food at the same time. I think that the marble track concept does not allow for this to happen, as I expect the children to be too caught up in watching the marble travel down the track. As my clients emphasized that the concept should stay as simple and as close to reality as possible, I will work out version 1 of my adjusted train concept idea, which can be seen in Figure 18 - Drawing of adjusted train idea, version 1. In this version, the food is put on a plate with several sections.

Chapter 4 – Specification

The goal of the specification phase is to further specify the chosen concept. To do this, the specification phase is split up into different parts. First, the functional and non-functional requirements are stated. Secondly, the MoSCoW method is used to create an overview of which of those requirements are most important for the current project. Thirdly, an overview with the different parts of the game is given with a small explanation of why these parts are useful. Afterwards, an explanation will be given on how and when to use the game. Then, a persona and a user scenario are presented which explain how the game could be used in a real-life situation. Lastly, a conclusion is given on the process of the specification.

4.1 Requirements

The requirements for the game are split up into functional and non-functional requirements. Functional requirements define the system's basic behaviour, they specify what the game should do. If the functional requirements are not met, the game will not work. Where functional requirements define what the game must do, non-functional requirements define how the game should do it. Non-functional requirements do not affect the basic functionalities of the game. Still, they are important for usability purposes. Without non-functional requirements, the user experience and the quality of the game are negatively impacted. Down below the functional and non-functional requirements for the game are mentioned.

4.1.1 Functional requirements

Code	Requirement
FR1	A train that drives automatically.
FR2	An obstacle that prevents the train from driving past the station when the child has not taken a bite yet.
FR3	A track that allows the train to only travel one pathway, which can be repeated over and over again.
FR4	A way to divide different kinds of food which clearly indicates that different parts correspond to different kinds of food.
FR5	Something that automatically indicates from which section of the plate the food needs to take a bite.
FR6	A way to control the game.
FR7	Something that measures whether the train is at the station.

4.1.2 Non-functional requirements

Code	Requirement
NFR1	A way to allow the parents to set the number of different kinds of food that are involved in the game.
NFR2	A way to turn the game on or off.
NFR3	A form of feedback when the child takes a bite.
NFR4	A form of feedback when the train stops driving because the child did not take a bite.

NFR5	A way to allow the parents to adjust the settings of the game.
NFR6	Something that counts the number of rounds that the train drove.
NFR7	Music plays when the train drives.
NFR8	The train honks when it passes the station.
NFR9	A game manual.
NFR10	An option that allows siblings to play along.

4.2 MoSCoW method

The MoSCow method is a technique which is used to prioritize different requirements for a project [49]. MoSCoW stands for four different things: must have, should have, could have, and will not have. Requirements labelled as “must have” are necessary to include in order to have a successful project. Requirements labelled as “should have” are still very important, but non-vital to the project. Requirements labelled as “could have” are less meaningful and will not have a big impact on the workings of the project if they are left out. Requirements labelled as “will not have” are not important for the current time frame but could be used at later stages in the development of the product. By prioritizing the requirements of my project myself, it is easier for me to see which functions the game should have, and which ones can be left out.

4.2.1 Must have

Code	**Requirement**	**Why?**
FR1	A train that drives automatically.	No one should be held responsible for how the train drives. Therefore, it is best if the train drives by itself.
FR2	An obstacle that prevents the train from driving past the station when the child has not taken a bite yet.	The parents should not get the blame for the fact that the train stops driving. Furthermore, the child should not be able to cheat by taking away the obstacle.
FR3	A track that allows the train to only travel one pathway, which can be repeated over and over again.	The game should be simple and predictable.
FR4	A way to divide different kinds of food which clearly indicates that different parts correspond to different kinds of food.	To ensure that the child can eat different kinds of food and can distinguish between these kinds.
FR5	Something that automatically indicates from which section of the plate the food needs to take a bite.	Once again, no one should be held responsible for what the child needs to eat. Therefore, the game should automatically tell the child what food he or she needs to eat.
FR6	A way to control the game.	To make sure that the game is interactive and responds to the user.

FR7	Something that measures whether the train is at the station.	The system should know whether the train is at the station, in order to give correct feedback.
NFR1	A way to allow the parents to set the number of different kinds of food that are involved in the game.	To make sure that the parents can always decide how many different foods they want to offer during dinner time.
NFR2	A way to turn the game on or off.	It is no use to have a game that you cannot turn on or off. And you do not want to let the batteries run out.

4.2.2 Should have

Code	Requirement	Why?
NFR3	A form of feedback when the child takes a bite.	It is important to praise the child for eating.
NFR4	A form of feedback when the train stops driving because the child did not take a bite.	The child should be made aware that the train will only continue if he or she takes a bite.
NFR5	A way to allow the parents to adjust the settings of the game.	To allow configuring the game to the child's specific needs.

4.2.3 Could have

Code	Requirement	Why?
NFR6	Something that counts the number of rounds that the train drove.	It allows the parents and the child to keep track of the rounds and can be used as a motivation for the child by saying: "Come on, let's do 7 rounds, just like last time!".
NFR7	Music plays when the train drives.	To make it more fun for the child.
NFR8	The train honks when it passes the station.	To make it more fun for the child.
NFR9	A game manual.	To make sure that the parents understand the game and explain it correctly to their child.

4.2.4 Will not have

Code	Requirement	Why?
NFR10	An option that allows siblings to play along.	This is too complicated and does not fit within the scope of this project.

4.3 Parts of the game

After using the MoSCow method to prioritize different requirements, I worked out the different parts of the game. Down below all the different parts of the game are listed with their corresponding utility.

Code	Part	Utility
FR4	A plate with separate coloured sections.	The child can eat from different kinds of food while the food stays separated from each other.

FR5	A light which can change colour.	The colour of the light corresponds to a coloured section of the plate, from which the child has to take a bite.
FR1	An electric train which stops if it bumps with something.	If the child did not take a bite, the obstacle will stop the train. Once the obstacle is removed, the train continues to drive.
FR3	Train track parts which allow for making a train track.	The train track can easily be built up and taken apart. The electric train can drive independently on the track.
FR6, NFR1	Two buttons.	The buttons can be clicked to let the system know the number of different kinds of food on the plate, or to indicate that the child took a bite.
FR7	A station with a sensor which measures if the train is at the station.	If the train is at the station and the child has not taken a bite yet, feedback should be given stating that the child has to take a bite in order to let the train continue to drive. If the train leaves the station, the sound of a train honk should be played, and the gate should close.
FR2	A gate which opens and closes automatically.	When the child has taken a bite, the gate will open to let the train pass. Once the train has passed, the gate will close again.
NFR3, NFR4, NFR8	A speaker.	To give feedback to the child using voice recordings and music.
NFR5	A volume knob	To allow the user to control the volume of the speaker.
NFR2	A cable which can be connected to a power bank.	To turn the game on or off.

4.4 How to use

The game is used at the dinner table together with the child and the parents. First, the game has to be built up. The train station can be placed on the table, onto which the child can build the train track with the help of his or her parents. The child should be seated facing the train station, so that the food button is easy to reach, and the light and the gate are visible. The parents can sit next to the child. Then, the parents place the plate with food in between the child and the train station, where each tray of the plate is filled with a different kind of food. The parents can choose between 3, 4 or 5 kinds of food. Then, the parents must turn on the game by pushing the power button. They can set the number of trays that are used by clicking on a setting button. Every time the button is clicked, the speaker will tell the parents the current tray setting. Once the parents have the correct setting, they can save the setting by clicking on the food button. The speaker will give feedback stating that the game can start, and a light will turn on. The colour of the light corresponds to one of the colours of the trays in the plate. Then, the parents can turn on the electric train by pushing the power button and put it onto the wooden train track. The train will start to drive and will stop when it bumps with the gate at the station. The speaker will give feedback by stating that the train can only continue to drive if the child takes a bite. The child will take a bite from the correct plate and click on the food button, where the parents can guide the child

if necessary. The speaker will praise the child for taking a bite, the gate will open, and the light will change its colour. The train will then start to drive again and leave the station. The speaker will play the sound of a train honking. Then the gate will close again. If the child takes a bite before the train enters the station, the child will be praised by the feedback of the speaker, the gate will open, and the train will continue driving without stopping. When the train passes the station, the speaker will play the sound of a train honking. The game can be played until the parents, or the child, decide that they want to stop playing. The parents and the child can set their own goals regarding how much food the child should eat. The system can be turned off by pushing the power button. Furthermore, the electric train can be turned off by pushing the power button, and the train track can be taken apart. The plate with the trays should be cleaned after every usage.

4.5 When to use

The game is meant to be used by children with autism and an eating problem together with their parents during dinner times. The children should have a developmental age of approximately 2 to 4 years old and should show signs of food selectivity or food avoidance behaviour. The game can help the children to learn to eat a wider variety of food. As children generally eat the biggest meals during dinner, the biggest impact can be made when targeting the eating behaviour during dinner times. However, it is also possible to use the game during other mealtimes, as the child may be too tired to play the game in the evening. For example, during lunch the child can learn to eat small slices of bread with different toppings, such as cheese and peanut butter. The game is meant for home usage but can also be taken to other places. For example, the game can also be played when being on a holiday or when being at another family member's house. The game should be played by the child with the guidance of the parents. In general, it is advised not to involve more people into playing the game. If more people are involved, this may confuse or upset the child. It is up to the parents and the child to decide how often the game should be played. It is possible to use it every day, but there is also the possibility to use it only on specific days when the child has to eat something that he or she dislikes.

4.6 Personas

4.6.1 Lucas

Figure 29 - Lucas, a Dutch 3-year-old boy with autism

This is Lucas, a Dutch 3-year-old boy who likes to see how the water of the river flows. Lucas lives in a small town in the Netherlands, together with his 5-year-old sister and his parents. From the outside, they seem to be a normal, happy family. However, when taking a closer look one would notice that Lucas is a child with special needs. Lucas has some special interests and acts different compared to his peers. He has difficulty with interacting and socializing with people. For example, he is not interested in playing together with his sister and does not like to make eye contact with people. He also has difficulty with expressing himself, as his speech and language skills are delayed compared to his peers. Next to that, Lucas finds it hard to deal with changes in his routine or surroundings. He can respond really fiercely to certain sounds, smells, tastes or feelings. These difficulties especially become apparent during mealtimes. Lucas has a lot of difficulty with eating food. At the moment, the only food he eats during dinner are mashed potatoes, chicken nuggets, fries and pancakes. He likes apples and strawberries, but furthermore he does not eat any fruit or vegetables. When his parents try to force him to eat, he starts to yell and cry, and tries to leave the table. Lucas finds it difficult to eat these foods because he has a high oral sensitivity and processing difficulties. This means that eating the food is a really tough and scary experience for Lucas, as he does not experience eating the food in a way that typically developing children do. Furthermore, Lucas is obsessed with looking at how things move. He likes to look at water, flying soap bubbles, windmills, trains, and cars.

4.6.2 Lucas' parents

Lucas' parents started noticing that Lucas was showing atypical behaviour when he was only one and half years old. They went to see a professional to find out why their child showed signs of atypical development. They went through a process of half a year before a final diagnosis was given. When Lucas turned 2 years old, he got diagnosed with autism spectrum disorder. Since then, Lucas' parents have put in a lot of effort to help Lucas

with his development. Even though Lucas has improved a lot at his social and communication skills, there are still a lot of struggles for Lucas and the family. One of those struggles has to do with the eating behaviour of Lucas during mealtimes. Lucas barely eats any food and engages in problematic behaviour when his parents force him to eat. Lucas' parents are very concerned about Lucas' eating problem, as he does not get the necessary nutrients via the food that he eats. This affects Lucas' health and growth in a negative way. His parents give him supplements in an attempt to meet Lucas' nutrient requirements. However, they know that they have to find a way to improve Lucas' eating behaviour. So far, they have not been able to motivate Lucas to try new kinds of food. Therefore, they are in desperate need of help.

4.7 User scenario

Lucas' parents visit a children's practice which specializes in eating problems to find out how they can help Lucas to eat more kinds of food. The paediatrician advises them to try to use a game during mealtimes to motivate the child to eat new or unpreferred kinds of food. She highlights that Lucas will probably like the game, as he is fond of trains. The parents decide that they want to give it a try so they take the game home. As Lucas first needs to get used to playing the game, they start off with eating food that Lucas already accepts. Before playing, they explain to Lucas that they are going to play a game, and how the game works. The first time Lucas plays the game, he is amazed by the electric train. While the train drives, Lucas completely focuses on the movement of the train until the train stops at the station. The game tells Lucas that he needs to take a bite from the food to allow the train to continue to drive. Lucas observes the game and feels sad that the train has stopped driving. His parents ask him if he understands what he needs to do. Lucas nods and stares at the train. Then, he asks his parents from which tray he needs to eat. The parents tell him that the light is green which means that he has to eat from the green tray. They help Lucas to recognise the colours by pointing at the light and the corresponding tray. Inside the green tray, there are strawberries, fruit that Lucas likes to eat. Lucas eats a piece of a strawberry and then clicks the food button. The gate opens and the train continues to drive while making honking sounds. Lucas smiles and starts following the train again. After only a few rounds, he understands the basics of the game.

Even though Lucas is able to understand how the game works, it takes some time before he is used to the system. Lucas' parents decide to first play the game only once a week, to allow Lucas to slowly get used to the change in his routine. After a month, when Lucas is used to using the game, they add one unpreferred kind of food to the game. Lucas clearly has more difficulty with playing the game now that he has to eat something that he does not like. Still, he wants the train to drive which is why the threshold for refusing to eat the food gets lower. He takes a very small bite of a banana piece and then clicks the food button to watch the train leave again. Lucas' parents are very happy to see that their son is motivated to eat the food, even if it is just a small bit. As time passes, Lucas' parents give their son more challenges. They also rotate the food so that it is a surprise which foods will be served and to ensure that Lucas starts eating the unpreferred food more easily. They also slowly increase the usage of the game to multiple times a week. They use a schedule to explain to Lucas on which days they will use the game. After half a year, they see an improvement in Lucas' eating behaviour. He now eats several kinds of fruits and vegetables, and also is able to eat different kinds of meat. There is still a lot of food which Lucas does not eat, but at least he is now able to get most of the nutrients he needs. This is already a huge relief for Lucas' parents. They will keep on using the game during dinner times, as it is a lot of fun for them and for Lucas.

4.8 Conclusion

In the specification phase, the game has been further specified with functional and non-functional requirements. All functional requirements are used, and most of the non-functional requirements are used. Non-functional requirements NFR6, NFR7, NFR9, and NFR10 are not included in the game because they are not important for the current time frame. In the specified game concept, three different parts of the game can be distinguished. First of all, there is a plate with several coloured sections, called trays, which allow the parent to serve different kinds of food while keeping the food separated. Secondly, there is a train which drives automatically on a track. The train can only travel one pathway, which can be repeated over and over again. Thirdly, there is the main part of the game, the train station, which has a train track built around it. At the station, there are several game elements: a light, two buttons, a gate, a speaker, a volume knob, a sensor, and a cable. The game should be played by the child, where the parents are involved the least as possible. It is up to

the parents to decide when to use the game. With this specified concept, it is now possible to come up with a prototype version of the game. It is important to keep in mind which requirements should be fulfilled. The game should also be user friendly. In order to achieve this, it should be kept in mind that the child with autism will be the main user.

Chapter 5 – Realisation

5.1 Introduction

The realisation of the prototype is split up into two parts. I first made sure that the game could function based on the hardware and software. During this process, I first made a train which stops when it bumps into something. Then I tested all the electronic parts individually and merged them into one circuit, using an Arduino Uno. The last step was to write the code to integrate all the different parts into a working prototype. At the same time, I worked on making a 3D model for the plate. I also made a first sketch for a laser cut design that would function as the train station.

5.2 Design process

5.2.1 The train station

The train station is the main element of the game and consists of a wooden base with electronic parts which are powered by an Arduino. A list of all the parts which are needed to build the train station can be found in Appendix 4A. To build the train, it is important to first test all the electronic components. These are the Arduino Uno, the power bank, the cables, the resistors, the RGB led, the servo motor, the buttons, the switch, the capacitor, the SD card reader, the amplifier and the speaker. If all components work correctly, the electrical circuit can be built according to the schematic which can be found in Appendix 5A. The wooden components of the train station can be made with a laser cutter. In Appendix 6, pictures of the laser cut files can be found with their corresponding dimensions. A list of the music files can be found in Appendix 7A. It is important to upload them to the SD card in WAV format because the system cannot read other music files. An explanation on how to correctly convert mp3 files to WAV files can be found in Appendix 7B. After successfully putting all parts together, the code can be uploaded to the Arduino, which can be found in Appendix 8. A picture of the final design can be seen in if all the connections are properly connected, the train station should have the following functions:

1. If the set button is pressed, the speaker says how many kinds of food are in the plate
2. If the food button is pressed, the speaker says “Eet smakelijk!”, and the light turns on
3. If the train switch is pressed and the food button has not been pressed, the speaker says “Oh oh, de trein is gestopt met rijden. Neem je een hapje? Dan rijdt de trein weer verder.”
4. If the food button is pressed, the speaker says “Goed gedaan! Je hebt een hapje genomen.”, the gate opens and the light changes colour.
5. If the train switch is released, the speaker makes the sound of a train honking. The gate will close after waiting for 2 seconds.
6. If the set button is pressed after the game has been started, the speaker says from which coloured tray the child needs to take a bite.
7. If the volume knob is turned, the speaker’s volume is adjusted.

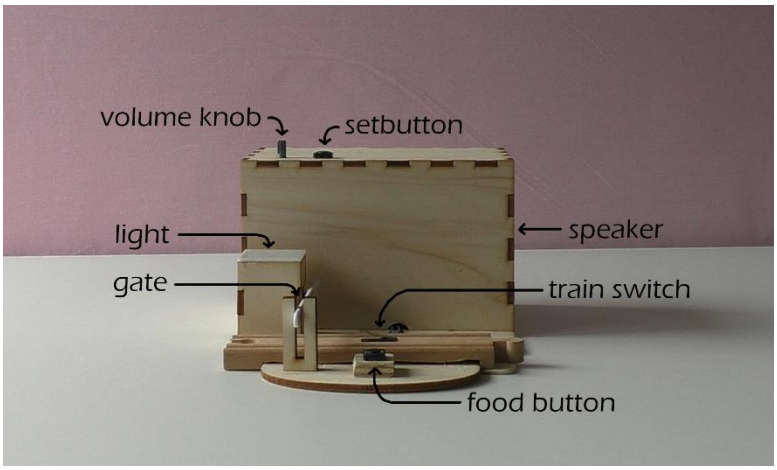


Figure 30 - Picture of the train station part of the prototype

5.2.2 The train

The parts needed are a train which is powered by batteries, a diode, a snap-action switch and some cables. A list with components used for this project can be found in Appendix 4B. First, the train should be opened by taking out the screws on the bottom of the train. Then, a piece of the front part of the train should be taken out so that the switch can be placed over there. Afterwards, the electrical circuit can be adjusted by adding a diode and a switch. To ensure that the train stops driving when it bumps with the gate, the snap-action switch is put between the power supply and the motor. A diode is added to make sure that the train drives a bit slower and the train is not able to drive backwards. A schematic of the adjusted circuitry can be found in Appendix 5B. If everything works correctly, the train should drive when the power button of the train is switched to the front. When the switch is pressed, the train will stop driving but the lights of the train will stay on. It should not be possible for the train to drive backwards. A picture of the electric train can be seen below in Figure 31 - Picture of IKEA LILLABO train with snap-action switch on the front side1.

Figure 31 - Picture of IKEA LILLABO train with snap-action switch on the front side

5.2.3 The plate

The 3D design of the plate is made in Solid Works. As I do not have much experience with designing 3D models, I got help from Roel van de Veerdonk to make the design. Two versions of the plate were made, from which the final version can be seen below in Figure 32 - Final 3D design of the plate2. More pictures of the designs can be found in Appendix 9. After testing the design on a 3D printer, the final design was made on an SLA printer. Pictures of both results can be seen in Figure 33 - Pictures of plate made by a 3D printer3 and Figure 34 - Pictures of plate made by an SLA printer4. After the print was done, the pieces were cleaned and cured. Then, the support material was taken off and all pieces were sanded using sandpaper. Afterwards, the edges were colour painted and a bit of Vaseline was added to give the trays a little glow. Pictures of this process can be found in Appendix 10.

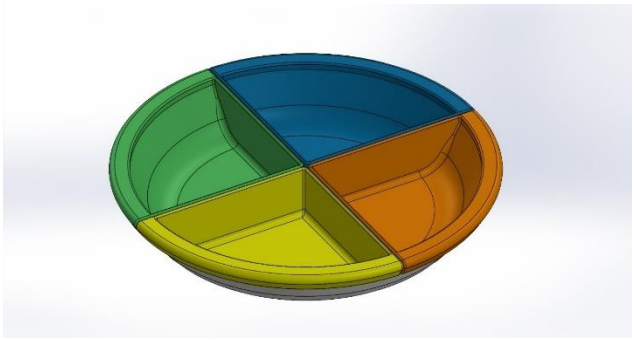


Figure 32 - Final 3D design of the plate

Figure 33 - Pictures of plate made by a 3D printer

Figure 34 - Pictures of plate made by an SLA printer

5.3 Final prototype

When putting all the elements together, the prototype is ready to be used. In Figure 35 - Pictures of the final prototype5 pictures of the final prototype are shown. As can be seen, the train station is powered by a power bank, which can be connected to the Arduino with a USB cable using the hole on the backside of the box. The hole at the back is made big on purpose, so that the backside can easily be taken out in case the circuitry needs to be checked or adjusted. We can also see that the train track is built up from several wooden train track pieces. These pieces can easily be taken apart and also allow for making different kinds of train tracks. The plate is positioned in front of the station and has three separate trays for food. The sides of the trays have a green, white and blue colour, which correspond to the colour of the light when playing the game. The train runs on batteries and can be turned on using the sliding knob on top of the train. When the button is pressed at the front of the station, the gate opens and the train can pass. In Appendix 11, you can find an overview of all functionalities with corresponding pictures of the prototype.

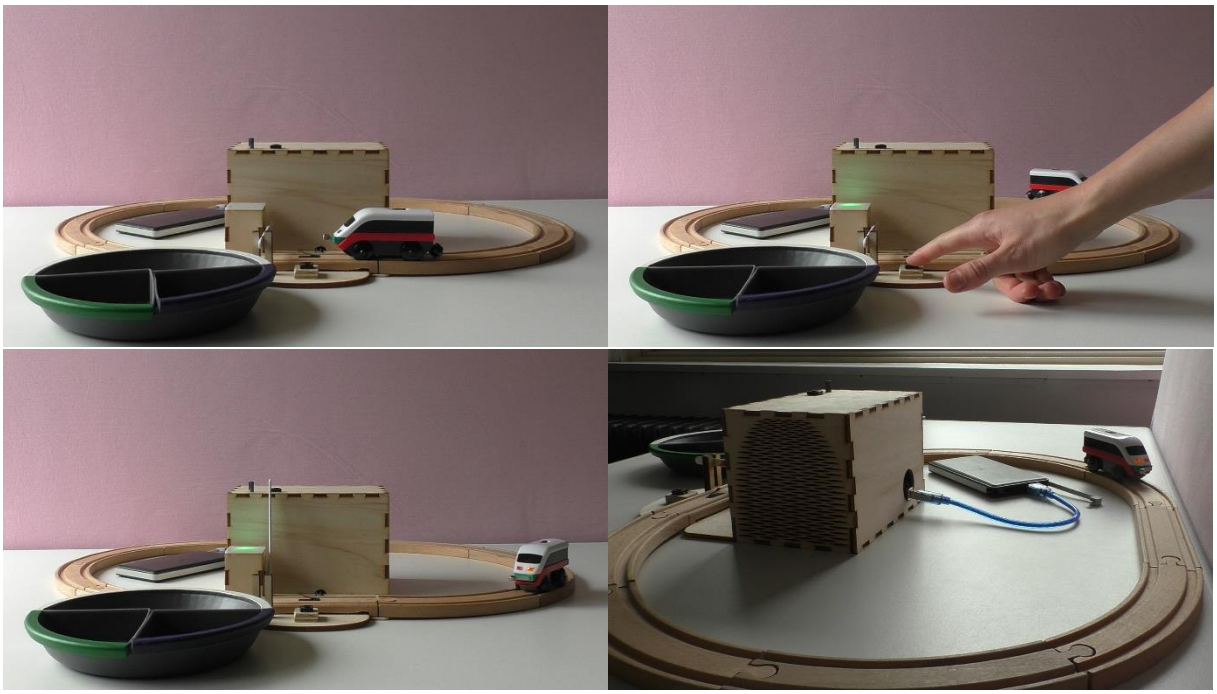


Figure 35 - Pictures of the final prototype

Chapter 6 – Evaluation

6.1 Methods

To find out whether the game can help children to learn to eat new or unpreferred kinds of food, multiple evaluation sessions were done in June 2021. During the evaluation sessions, qualitative research was done. Every evaluation session consisted of three parts and took around one hour. During the first part of the evaluation, the researcher asked the participant a few questions about how dinner times currently look. The second part of the evaluation was about showing the participant the game and letting the participant play the game. The last part of the evaluation consisted of a semi-structured interview with questions about the usage and experience of playing the game.

6.2 Participants

A total of 6 participants participated in the evaluation sessions. Participants were found with the help of Praktijk forza and friends of the researcher. To be included in the research, someone had to be a parent with a child with autism and/or a parent with a child with eating problems. Half of the selected participants have a child with eating problems without autism. These children are girls aged 4, 7, and 8 years old. One participant has an 8-year-old son with autism and eating problems. The two other participants, who are a couple, have two teen sons with autism aged 14 and 17 years old. The participants live in two regions of the Netherlands, Overijssel and Friesland.

6.3 Materials

During the evaluation sessions, multiple materials were used. First of all, a printed version of the information brochure and the consent form and a pen were available during the sessions. Participants who did not sign the consent form could read through the information brochure and sign the consent form on the spot. Secondly, a smartphone was used to make an audio recording of the sessions. Thirdly, a paper with introductory and semi-structured interview questions was used to make sure that all questions were asked to the participants. Next to that, the prototype was used for testing purposes. The prototype consisted of an electric train, a train station, train tracks, and a plate. To give the participants an idea on how the plate of the prototype could be turned into a plate with more than 3 separate trays, a 3D printed version of a plate with 5 trays was also used. More information on the prototype and the 3D printed plate can be found in Chapter 5.

6.4 Procedure

Before the start of the evaluation sessions, all participants were informed about the kind of research and had to sign a consent form. The information brochure and consent form can be found in Appendix 2 and Appendix 3. Each evaluation session took place at the home of the participant. There were a total of 5 scheduled evaluation sessions. At the start of each session, the researcher asked the participant if it was preferred to wear a facemask. The researcher kept distance from the participant at all times. Then, the participants were thanked for their participation and the different parts of the session and their duration were explained. The session would take around an hour, with 10 minutes for introductory questions, 10 minutes for testing the prototype and 40 minutes for interview questions. If the participant gave consent for making an audio recording, one would be started. Then, some questions would be asked about the current dinner times with their child. The researcher would ask if the participant could explain how current dinners look, what kind of problems he or she faces during dinner times, and what kind of things work really well at the dinner table. After the participant answered these questions, he or she was asked to make some space at the dinner table, so that the researcher could build up the game. After that, the researcher explained step-by-step how the game works. Afterwards, the prototype was turned on and the participant could test it. After the train drove a few rounds, the researcher would ask the participant if it was clear how the system works. If the participant confirmed it, the prototype would be turned off and the researcher would start asking questions about how the participant experienced using the prototype and what the participant thinks about certain topics related to the prototype. If a participant started discussing an interesting topic which was not on the list with interview questions, the researcher would come up with a suitable question at that moment. All questions of the semi-structured interview can be found in 12. After finishing the interview questions, the participants were thanked for their participation once more. The researcher would start collecting all the materials and would leave the house.

6.5 Data analysis

The data of the evaluation sessions were analysed in a stepwise manner. First, the audio recordings were transcribed to text and all answers were put in an Excel file. This created a clear overview on the answers of the participants to all of the questions. An overview on the transcribed text can be found in Appendix 13. After that, the results were grouped by themes and an Excel file was made showing the opinion of each participant per theme. This file can be found in Appendix 14.

6.6 Results

6.6.1 Look and feel

All participants responded in a positive and enthusiastic way to the questions about the look and feel of the prototype. They all agreed that the game is easy and fun to play. Three participants mentioned that pushing the button is fun or that it creates a positive distraction from eating the food. Furthermore five out of six participants mentioned that the prototype either looked simple or boring, but stressed the fact that that was actually a good thing. Especially for children with autism, there should not be too many distractions. The game should allow the child to be focused on eating. If more details would be added, the game could become a game on its own, where the child loses focus of the eating part. One participant mentioned: “Because of the simplicity, the idea is very powerful.”. All participants agreed on the fact that the compliments and sounds that are played by the speaker fit the target group. The language is clear and it is practical that there is a knob with which you can adjust the volume level. Furthermore, four of six participants indicated that it is not a problem that the game takes over the task of the parent. During mealtimes parents are generally the ones who have to motivate the child to eat. By using the game, this task is taken over by the game. One of the participants mentions: “I think the sounds and compliments are very nice for the child. It's an external factor, the parents are not involved. I think this can be very pleasant for a child, because parents are annoying and only complain, while this game is a rewarding system. Therefore, I think the child will take the message in a more positive way.”. Two other participants, who are parents of two sons with autism, say that once the system is accepted and fully understood by the child, you can start to get involved in the game as a parent by taking small steps.

All participants indicated that they would make at least one change to the look and feel of the game. Some of these changes were very similar to each other. Half of the participants would turn the box into a real train station, for example by painting one onto the box. They think that this will give a more realistic feeling of a train station. The participants who did not suggest changing it, are the ones who were most enthusiastic about the simplicity of the game and the ones who highlighted that simplicity is key for children with autism. Three participants said that they would like to add wagons to the train. Two of those people wanted to put the food in the wagon, while the other one would add a wagon as a reward. When I explained to two of them that a child with autism may end up not wanting to eat from a normal plate anymore because the child is used to eating from wagons, one of the participants changed her mind about what she had previously said. However, the other participant still preferred to let her child eat from a wagon if that would motivate the child more to eat. To her, the motivation is the most important, she believes that later on it will be possible to make a transition to eating from a plate. Other suggestions for changing the game were to change the holes at the speaker side because the current pattern is too distracting, to integrate the plate into the game and to use identical colours for the light and the plate.

6.6.2 Functionalities

Participants also made suggestions on changing the functionalities of the game. One of the most important suggestions came from a mother with a child with autism and eating problems. She said that for her son, taking a bite from food that he does not like would be too big of a step to do at once. For her child there are four steps that need to be taken before the child will taste the food. These steps are looking, hearing, smelling, feeling and tasting. According to her, the game would only be effective if these steps would be part of the game. She did mention that for children without autism, these steps may not be necessary, which may explain why none of the other participants gave this feedback. Another participant mentioned that the train was driving too fast. She suggested that either the speed of the train should be slower, or the train track should be longer. Other participants did not mention that the time in between bites was too fast. It may be that depending on how you want to play the game, the speed is good or not. If the child should take a bite once the

train has stopped driving, the speed is fine. However, if you want the child to eat before it arrives at the station, there may not be enough time to do so. Other suggestions for changing the game were to add a reward after driving taking a certain amount of bites, to have a controlling button for the food button, and to put a timer on the buttons so that clicking them does not become a game by itself.

Four out of six participants indicated that they want to involve siblings into playing the game. These siblings generally did not have eating problems and were either younger or older than the child with the eating problem. Two participants suggested that, in order to involve the siblings, one could use either an extra train station or an extra train. The advantage of having an extra station would be that the children play individually, but depend on each other in order to let the train drive to the other one's station. The disadvantage would be that the child can get jealous at the food that the other child has to eat. Therefore, the advantage of having two trains is that both children have to eat the same kind of food. This also creates a competition element, because both children want their train to drive first. The usage of an extra train station might be smarter, as the game functionalities can stay the same and the parent does not have to intervene. When adding an extra train, the parent will have to intervene as the gate should not open for the child who has not taken a bite yet. To avoid intervention of parents, the train station should be adjusted, where the train tracks split up and each train has their own gate and food button.

As I had two functions in mind which were currently not present in the prototype, I asked the participants whether they would want to add these functions. I asked the participants whether it would have added value to play music when the train is driving. All participants answered that would not be necessary or would even have a negative effect. Adding music would either be too distracting, annoying to the family, or could result in problems if (one of) the child(ren) does not like the music. I also asked the participants whether it would have an added value to let the system count the rounds that the train drives. Five out of six parents were against this because they think it is not necessary, or because they think that it would negatively influence the eating behaviour of the child. When thinking in numbers, the child is aware of how many times he or she has to eat and can use it as an excuse for not wanting to eat anymore. When playing together with siblings, you would get fights because they would compare each other's scores. Furthermore, according to another participant you should not think in numbers because you should already be happy if the child is eating any new food at all. One participant thinks that counting the rounds could be useful, because you can set a limit to the amount of bites. In this way, the child knows what to expect.

6.6.3 Usage of the game

All participants saw potential in using the game for their child. They think the child can use it to learn to eat new kinds of food and that it is mainly for home usage. All participants would recommend other people to use the game, but some of them would first want to try it out themselves. As the children of the participants were older than the children of my target group, most participants indicated that their child should be younger to stay motivated by playing the game. They all agreed that children of the target group would like to play the game, understand the game, and be motivated to eat. The link from the light to the plate is clear, but young children may need a bit more guidance from their parents. Still, it is easy to involve the child by teaching him or her to push the button after taking a bite. Three participants indicated that it is important to slowly build up the usage of the game, to ensure that the child stays motivated to use it. Some other participants wondered how long the children would stay motivated by playing the game. According to the participants, this mainly depends on the age and the interests of the child. One participant mentioned that the game should work to the child's advantage in order to stay fun. If the child would find out that the game is actually manipulating her, she would not want to play any game, or eat any unpreferred food, anymore. Therefore, the participant said that she should be careful with how often she will play the game, and in which way she will talk with her husband and child about the usage of the game. She said: "If I were to use it, I would have to tell her 'Hey! We're going to play a game during dinner'. I should not talk with my husband about that 'it worked' or that 'it is so nice she finally eats'".

The participants did not agree on when and how they would use the game. Only two out of six participants indicated that they would directly start using it for dinner times. All the other participants said they would not want to do so. Three of them would first like to build up the usage of the game before using it during dinner times. Dinner times were generally perceived as the most difficult meal times, which is why they would start out with breakfast, lunch or another moment to, for example, eat some fruit. Another reason for not

starting with dinner would be that the children would be too tired at that time of day. One participant indicated that she would solely use during a moment to learn to eat new kinds of food, for example on Sunday. She would find it too much effort to use the game every day, as she would not have time to prepare different kinds of food and expects that her daughter would barely eat anything of the prepared food. On the weekend there would be more time to work on learning to eat new kinds of food. Half of the participants would take the game to other places, while the other half would not. In general, all participants did agree that the usage of the game should stay inside the family. Reasons for doing so were to make sure that the child feels comfortable, to have a familiar and quiet environment, and also to allow the child to have a "day off" when not being at home, to not make playing the game an obsession.

Next to the fact that the participants would use the game at different times, they also would use the game in different ways. All participants agreed that younger siblings would be jealous when the child with the eating problem is allowed to play a game at the dinner table while they are not. Therefore, four out of six participants indicated that they would involve the siblings in playing the game. This would either be by letting them play together, or by buying an extra train or an extra station. The other two participants said they would not do this, because they think it is better to use the game one on one with the child with the eating problem. They think that it is easier for the parent and the child when there are not any distractions around. Furthermore, parents all had their own vision on how to use the game over time. While some participants were wondering whether the game would be motivating enough over time, others were already thinking of ways to make the game more interesting once the child would get used to it. Suggestions were to add rewards, such as adding wagons or building a tunnel. When I asked the participants how their child would feel about it if they would suddenly be involved in the game, I got different kinds of responses. Some participants said that it would not be smart to do so, because the child may not be able to deal with changing how the game works. Other participants said that it differs per child how they would deal with it and that as a parent you have to make an estimation, as you know what is best for your child. Multiple participants highlighted that the creativity of the parent plays an important role when dealing with such situations.

As many parents indicated that they would like to use the game, I was wondering to what extent they expect their child to be dependent on the use of the game during mealtimes. The four participants to whom I asked this question all said that the child would become very dependent on using it. They highlighted that it will take a while before the child is used to playing the game. However, once this happens, the child will probably depend on it a lot. When I asked them what they would do if the game would not work or they would forget to bring it, most participants needed some time to think. In the end, all of them were able to find a solution, such as playing the game manually, playing a different game, or simply eating food that the child likes. According to the parents who wanted to get involved in the game by playing the game manually, it would depend on the child and the creativity of the parent whether or not the child would accept their involvement. Three participants indicated that for children with autism it would be very important to phase out the usage of the game. You could, for example, do this by using the game less often and indicating this using a week schedule or icons. According to them, the child will have a hard time letting go and will not be able to simply stop playing the game. One participant said that the process of phasing out may take multiple years. However, he said that there will be a point in the child's life where the child realizes that the game is not needed anymore.

6.6.4 Effect of game on eating behaviour

Except for one, all participants agree that the game has the potential to have a positive effect on the eating behaviour of the child. One of them mentions: "I think that if you, as a parent, continuously have fights over eating with the child, this could be a really good option. It also gives you some time to rest as a parent. It is always about what the child needs, but this can also be about the parent, so that he or she can have a normal dinner too." The other participant stresses the fact that for children with autism there should be extra steps included in the game, to allow the child to first discover the food before tasting it. According to her, the game will not be effective without these steps. All the other participants think that the game can effectively be used as a tool to support eating new kinds of food, where the parents can adjust the game according to their child's wishes. To ensure that the game stays effective, it is important to understand what motivates the child. A participant said: "I think that at a certain point they do not want to play the game anymore. All new things are attractive, but this game would return every single day. I am not sure if you could add something to make it

more fun. You first will have to see what triggers the child, that differs per child.". As every child is different, it is not possible to make a universal solution to this problem. Therefore, it is the parents' responsibility to adjust the game accordingly. It is up to them to come up with things that trigger the motivation of the child. This will partly depend on the creativity of the parents and the nature of the child.

6.7 Discussion & Conclusion

The goal of the evaluations was to see whether the game is perceived as being helpful to teach children with autism and eating problems to learn to eat new or unpreferred kinds of food. When looking at the results of the evaluation sessions, it can be said that the game has the potential to let the target group eat a more varied diet. The game creates a positive distraction from eating, which helps the children in the process of learning to eat. In general, the children have no motivation to eat new or unpreferred kinds of food. When the focus is taken away from the eating process, it is easier to capture their interest and create motivation. The train, the food button, and the feedback are seen as elements which are fun and motivating for the child. Furthermore, it is a good thing that the parents are not involved, as that prevents the child from getting upset when something does not go as expected. Lastly, the simple look and workings of the game are adequate for the target group. In this way, the children can focus on the game without being distracted.

From the evaluation results it can be concluded that personalization is very important to be able to play the game. First of all, personalization is needed to motivate the child to play the game. It is important to decide how to introduce the game, when to use the game, which kinds of food to use, and how to build up the usage of the game. Next to that, the child should stay motivated to use the game. Parents indicated that the child may lose his or her interest after playing the game for many times. It is not possible to make a universal solution for this problem, as every child has different interests. To encourage the child to keep playing the game, the parents themselves should find a way to capture the interest of the child. Personalization is also necessary when parents want to involve siblings into playing the game. No family situation is the same, which means that siblings will have different wishes. Siblings who are older than the child with the eating problem will respond differently to the usage of the game than siblings who are younger. Therefore, the parents should see what is the best way to let the children play the game together.

The parents of the child also play an important role in using the game. Even though they are not actively involved in playing the game, there are a lot of decisions which they have to make. The parents should decide how to introduce the game, when to use the game, which kinds of food to use, and how to build up the usage of the game. Furthermore, they have to keep the child motivated to play the game, and phase out the usage of the game once the child eats a more varied diet. These tasks should all be adjusted to the child's specific needs. In succeeding with all these different tasks, the parents' creativity and ingenuity play a key role. The parents should be on the same level of understanding about how they want to approach the usage of the game to ensure that the eating behaviour of their child improves. They should be clear to the child about how the game works and what the child can expect. Therefore, the way that parents approach the usage of the game partly determines whether the game will be effective.

Chapter 7 – Discussion

7.1 Project summary

The goal of this project was to find out to what extent gamification of mealtimes can help children, who have autism and eating problems and cannot make rational choices, to learn to eat new or unpreferred kinds of food. To find an answer to this question, certain steps were taken. A background research was done on literature on autism, eating problems and the state of the art on interventions for children with autism. Then, according to the Creative Technology design method [18], four design phases were used. During the ideation phase, multiple ideas were created and validated by expert opinions. In the specification phase, a final idea was specified with functional and non-functional requirements. Afterwards, during the realisation phase, a prototype was made according to the requirements stated in the specification phase. Finally, to see whether the game could teach children to eat new or unpreferred kinds of food, an evaluation was done.

7.2 Interpretations of results

Now that the evaluation is done, it is time to look back at the project as a whole to discuss its meaning. The main goal of the project was to find out to what extent gamification of mealtimes can help the target group to learn to eat new or unpreferred kinds of food. Before answering the main research question, let's look at the three sub-research questions which support the answer to the main research question. First of all, it was necessary to know what factors play a role when a child with autism refuses to eat a certain type of food. This project focussed on the most common eating problem among children with autism, which is food selectivity. Through literature, it was found that the main reasons for food selectivity were change resistant behaviour and sensory processing difficulties [7, 27]. Secondly, it was helpful to know what kind of technology interventions already exist and have proven to be effective for changing the behaviour of children with autism. Most technology interventions were either an app or a robot, and were designed for children older than this project's target group. Moreover, none of the technology interventions were addressing eating behaviour. Thirdly, it was important to find out how to capture the interest of a child with autism through nudging. Through talks with experts it became clear that children with autism have very specific and restricted interests. Often, children experience pleasure from the simple, sensory perception of the object. The answers to the sub-research questions were important for the continuation of the project.

Based on the answers to the sub-research questions, certain choices were made on how to approach the project. To avoid that the child engages in change resistant behaviour, the game was made as predictable as possible. Every time that the game is played, the same things happen. The only unpredictable thing is which colour the light will be. This was done to try to keep the child interested, as the change of colour is a kind of surprise element. To allow the child to deal with sensory processing difficulties, the decision was made to only ask the child to take a small bite from the food during each round. An intervention mentioned in the state of the art [12], called the teaspoon method, also used this method by asking the child to take a bite from a teaspoon. As this method was tested effectively, it seemed that it was a way to teach the children to eat unpreferred food without overwhelming them. As the existing technology interventions did not fit the target group, the decision was made to take a different approach. To be able to make a game which could be used around the dinner table with the parents, the decision was made to not include a screen, nor a social buddy, such as a robot. Instead, the game would be like more traditional wooden games, with some technology elements added to it. Lastly, the choice was made to capture the interest of a child with the movement of a train. The expectation was that the child would be fascinated by how the train drives, which would be a motivation to eat unpreferred food. All in all, these design choices were expected to contribute to an effective intervention.

When looking back at the design choices and the evaluation results, most design choices seem to have worked out as expected. The predictability of the game makes it easy for the children to understand and get used to playing the game. The change of the colour of the light is seen as something that excites the children. Furthermore, by using technology to facilitate the interactions of the game, the parents do not have to be involved. By doing this, the game always functions in the same way. This allows the children to focus on playing without being annoyed by their parents if they do something which is unexpected or unpreferred. The way technology was incorporated in the game was seen as a creative solution which fits the target group. It is likely that the children's interest will be captured when they see that the train starts driving. Especially for children who are fond of trains, this would be very interesting. Therefore, the main functions of the game can stay unchanged, except for taking a small bite of food.

When looking back at literature, the decision for taking a small bite of food came from the teaspoon

method. The teaspoon method [12] is a method which effectively encourages children with autism and eating problems to take a bite from a teaspoon filled with a new or unpreferred kind of food. The children are only allowed to continue eating a dish with preferred food after taking a bite of an unpreferred kind of food from a teaspoon. If the child refuses to do so, a part of the daily routine of the child is taken away by not eating the dish and by, for example, going to bed without a bedtime story. This unpreferred consequence is something that the children want to avoid. It may be that for this project's concept the unpreferred consequence, the train that stops driving, is not as impactful as taking away a part of the child's daily routine. On the other hand, the teaspoon method was tested on children aged 3 to 14 years old, which means that most of these children can already think rationally. Children of this project's target group are not able to understand consequences that happen at a later point in time, as they cannot think rationally. So, it is not possible to use such a consequence for this project's game. Regarding the processing difficulties, it may be that simply taking a small bite of food, for example from a teaspoon, is too big of a step where children lose their motivation. It may be that allowing the child to look, smell, hear, feel, and taste the food before eating it, is a better way to ensure that child is motivated to eat.

Now, let's look back at the main goal of this project. The main research question was: "To what extent can gamification of mealtimes help children, who have autism and eating problems and cannot make rational choices, to learn to eat new or unpreferred kinds of food?". As stated in the introduction, gamification is the practice of making activities more like games in order to make them more interesting or enjoyable [16]. Points and rewards, a leader board, a digital badge, challenges, and feedback are common elements of gamification [17]. However, not all of these elements are present in the game. First of all, through talks with experts it became clear that the children of the target group do not play together with others. As the game is played alone at home, it is no use to make a leaderboard. Furthermore, points and badges were not included, as those do not fit the target group. The evaluation results indicated that counting the number of rounds is generally not necessary. Some participants even mentioned that it is a bad idea as the child will be focused on how much he or she eats. The game does incorporate challenges, rewards and feedback. The challenge is to eat new or unpreferred kinds of food, the reward is that the train drives, and feedback is given by a speaker, which in some cases also functions as a reward. Overall, the results indicate that the form of gamification of mealtimes has the potential to help the target group to learn to eat new or unpreferred kinds of food. As long as the children are motivated to play the game and the parents approach the learning process in a stepwise manner, it is likely that the children will learn to eat a more varied diet.

7.3 Implications of results

If the game can effectively help children to learn to eat new or unpreferred kinds of food, this would have a big impact on the target group and the family. First of all, the child's health will improve a lot. As stated before, the target group is significantly more at risk for nutrient deficiencies compared to autistic children without food selectivity [6]. Nutrient deficiencies can negatively impact the health and growth of a child. However, a diet which addresses the child's nutritional needs can significantly improve the child's health [35]. This game can be used as a tool to encourage the child to eat a diet which meets his or her nutritional needs. Secondly, the usage of the game can create happier mealtimes for the whole family. Through literature and talks with experts it became evident that mealtimes are unstructured, chaotic and stressful for the family [37]. Some families are not able to participate in mealtimes together because of the problematic behaviour of the child. The game has the potential to tackle these problems. Mealtimes can be fun for the child, where all family members can sit together. This would be very meaningful for the family, as the family dynamics can improve a lot by doing so. Lastly, the game allows for early intervention as it targets children with autism and eating problems with a developmental age of 2 to 4 years old. This is very helpful as it allows parents to take action before the eating problems turn worse. According to experts, parents who do not seek or get help when the eating problems start, see their child's eating habits deteriorate in the years to follow. With an intervention like this one, the eating problems can be addressed in an early phase. All in all, it seems that the child and the family can benefit from using the game.

It may be that the game is not only effective for the target group, but also for children with eating problems but without autism. Half of the participants of the evaluation were parents of such children. They all indicated that the game can be effective for young children without autism too. They would only change the looks of the game but not the way it works. These are really interesting findings, as the game was specifically designed for children with autism. If children without autism can also benefit from using the game, the target

group changes and more children can be helped to overcome their eating problems. The only thing that needs to be done is to see how the looks of the game can easily be adjusted for children without autism. This would be a really great opportunity for Praktijk Forza, the children's practice who came up with this project idea. As they are specialized in dealing with eating problems, they help many children with eating problems. Some of those children have autism, but others do not. As the game is designed for young children, it may also be that there are children with eating problems who do not have a diagnosis with autism yet. If the game would be effective for both of these groups, Praktijk Forza could offer the game to all these children.

7.4 Limitations of the project

The findings of evaluation sessions have to be seen in light of some limitations. The participant sample does not reflect the general population. First of all, the participants were not parents of children of the target group. Next to that, the sample was quite small and participants were not chosen randomly. Therefore, it is not possible to do a statistical analysis to validate the results. Furthermore, the game was not tested by the target group itself. At the moment, the effectiveness of the game is based on the opinion of the parents. Another limitation of the evaluation sessions is that the results are only based on a semi-structured interview. By choosing this data collection method, it was not possible to get the opinion of all participants on all topics. If a participant would introduce a new concept, it was not possible to ask the previously interviewed participants about their opinion. Furthermore, there was a limited time available for the participants to think about their answers to the questions. For example, the majority of the participants indicated that they want to involve siblings into the game, to prevent them from being jealous. However, the question is whether they also took into account the interest of the child, as the involvement of siblings could affect the effectiveness of the game. In the end, the goal of the game is to improve the child's eating behaviour. Therefore, the results need to be validated.

7.5 Recommendations

7.5.1 Practical implementation

There are some changes that can be made to the prototype to improve the user experience and the effectiveness of the game. First of all, a function should be added which allows the user to work through different stages of getting to know a new type of food. These stages are looking, hearing, smelling, feeling, and tasting. Only after going through these phases, the child is able to eat the food. Second of all, the box should look a bit more like a train station. It would be best to add a drawing onto the box, while still keeping the simple look. Another change is to ensure that the colours of the tray and the light are identical, to prevent confusion. Next to that, a timer should be implemented for clicking the buttons, to ensure that the child can only use them as intended. Furthermore, the holes on the speaker side of the box should have a more calm pattern. It would also be helpful to create a manual which explains how the system works and in what ways the usage of the game can be built up. Furthermore, this manual can have suggestions to the parents on what to do if they break or forget the game, and what they can do when the child is not motivated to use the game. Lastly, it would be helpful to see how the game can be produced on a bigger scale, with a better overall quality while still keeping the game affordable.

7.5.2 Future research

There are several interesting options for future research on the topic of this study. One of the most important recommendations for future research is to validate the preliminary results of this study. Once a second prototype version is made based on the recommendations for practical implementation, it would be meaningful to do evaluations with parents of children of the target group. These parents can validate the current results. If these parents think that a game has the potential to help their children, a next step would be to test the game with the target group. While the game has the potential to work effectively after implementing the suggestions for practical implementation, there are two interesting research topics which could increase the effectiveness and usability of the game. First of all, the current concept is made for children with a developmental age of 2 to 4 years old. According to experts, and participants of the evaluation, children with autism need to be guided in order to phase out the usage of the game. Finding an effective method for this process would be very meaningful. Second of all, it may be that parents want to involve siblings when

playing the game with the child with the eating problem. It should be found out to what is the best way to involve siblings, and to what extent the involvement of siblings affects the effectiveness of the game.

Other recommendations for future research are based on the usage and accessibility of the game. As stated before, the game may be effective for children with eating problems without autism too. In order to validate this, an evaluation needs to be done with parents of these children. If the results are positive, the game should be tested with children with eating problems without autism. If the game turns out to be effective, the target group should be redefined. If the game turns out to be effective for the target group, the game can be used in a children's practice, such as Praktijk Forza. Professionals can guide parents with the usage of the game and can help them to resolve problems. Another important topic for future research is to find out how to make sure that the target group uses the game. In order to do so, it should be found out how aware parents are about the existence of eating problems which are not part of phase in the child's development. Furthermore, it is important to know when parents take action, who helps them, and how they get helped. In this way, the game can be made more accessible to the target group.

It is also possible to do future research on topics that are similar to the one of the current project. For this project, the choice was made to focus on children with autism and eating problems who cannot think rationally yet. However, there are still a lot of other children that can be helped. For this project, the main focus was on children with food selectivity. However, there are children with autism who experience eating problems such as pica and rapid eating [3, 25]. These children could also benefit a lot from an intervention. Next to that, it would be interesting to help children with autism and eating problems who can think rationally. These children need to be approached in a different way than the current target group. When designing an intervention, it is also possible to choose another kind of approach. The current project used technology in the form of gamification, but there are a lot of other possibilities around such as video modelling or a reward system. Due to a lack of existing technology interventions which target eating behaviour of children with autism, such new research areas can help a lot of people in future.

Chapter 8 - Conclusion

The main goal of this project was to find out to what extent the gamification of mealtimes can help children, who have autism and eating problems and cannot make rational choices, to learn to eat new or unpreferred kinds of food. The evaluation results indicate that the game has the ability to help the target group with learning to eat new or unpreferred kinds of food. This is very meaningful as around 70% of children with autism have eating problems. An interesting result from the evaluation is that the game may also be suitable for children with eating problems but without autism. Future research needs to validate the evaluation results, as the participants of the current study do not represent the general population from the target group nor from children with eating problems without autism. If future evaluation sessions indicate that the game can effectively help children to learn to eat new or unpreferred kinds of food, children's practice Praktijk Forza can use the game for their clients.

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Appendices

Appendix 1 – Literature review

Eating problems in children with Autism Spectrum Disorder: A literature review

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23/04/2021

2149 words
(excluding reference list)

Eating problems in children with Autism Spectrum Disorder: A literature review

Eating problems are common among children with Autism Spectrum Disorder (ASD). A recent study by Van Dijk et al. [1] found that the prevalence of atypical eating behaviour is 70.5% among children with ASD. The same study also found that these children show behaviours that are also present in typically developing children (TDC), but at a higher level. Next to that, studies suggest that unlike in TDC, eating problems do not tend to improve in children with ASD when they grow up. Van Dijk et al. [1] conclude that changes in eating problems in children with ASD are not related to age. Tanner et al. [2] also do not find significant differences in age between children with autism who were selective and non-selective eaters. Zimmer et al. [3] do observe poorer food variety scores among children with ASD compared to TDC. This is problematic as it can lead to nutrient deficiencies, which in turn can potentially harm the child's growth and development [4]. To help these children, my graduation project is about designing a technology intervention that can change their eating behaviour. To do so, it is important to get a better understanding of their eating problems. Therefore, this literature review will discuss the different kinds of eating problems, the underlying reasons for these problems, and the family's influence. Afterwards, a short conclusion and a discussion will be given, with suggestions for future research.

Different kinds of eating problems

Children with autism often refuse or avoid food because they do not want to eat. The most common characteristic of this behaviour is food selectivity. Schreck et al. [5] and Sharp et al. [6] found that over 70% of children with autism were reported to eat a narrow variety of food and show low to moderate food acceptance. Furthermore, Tanner et al. [2] point out that children with autism, who show selective eating, have higher food refusal rates than those who do not. Other reasons for refusing food are a lack of appetite, emotional undereating and food neophobia [4, 7]. There are multiple kinds of problematic behaviour that come along when the child gets presented with a novel or non-preferred food. Sharp et al. [8] point out that children usually push the food away, turn their head away from the food, and start crying. Next to that, they can use negative statements and show aggression towards caregivers, but such behaviours are less common. These behaviours can lead to difficult situations, especially when the caregiver wants to feed the child a varied diet. Thus, it becomes clear that there is a need to tackle the food refusal problem, to improve the mealtimes of the child.

Some children with autism also show eating problems which might be less common. One of those problems is pica. The American Psychiatric Association [9, p. 329] describes pica as the persistent eating of non-nutritive, non-food substances for at least 1 month, which is inappropriate to the developmental level of the individual and not part of cultural practice. They state that ASD and intellectual disability (ID) are most commonly comorbid with pica. According to the American Psychiatric Association, the prevalence of pica is unclear. However, a recent study by Fields et al. [10] found that the prevalence of pica, among children aged 2.5 to 5 years, was 28.1% among those with ASD and ID, and 14.0% among those with ASD without ID. This suggests that pica may be common in young children with ASD, especially in those with ID. Another behaviour that can appear among children with autism, is rapid eating. Van Dijk et al. [1] found that children with autism have shorter meals than typically developing children. Leader et al. [11] confirm this and state that rapid eating is the third most common feeding problem, next to food selectivity and food refusal. Pica and rapid eating can both negatively impact the health of the child, as they can for example lead to gastrointestinal issues [11]. Therefore, it is important to consider these issues when designing an intervention to improve eating behaviour.

Underlying reasons for certain eating behaviour

Many underlying reasons can explain the aforementioned eating problems of children with autism. In most cases, there is not simply one thing that causes the behaviour. A good starting point is to look at the main symptoms of ASD. According to the American Psychiatric Association [12, p. 50], ASD can be characterized by two core symptoms. These are "persistent deficits in social communication and social interaction" and "restricted, repetitive patterns of behaviour, interests, or activities". The refusal of food can be explained by the second core symptom, which can also be seen as a need for sameness. Fisher et al. [13] found that children who engage in change-resistant behaviour, such as refusing new kinds of food, do this to avoid unpredictable consequences. By frequently showing this kind of behaviour, the probability of predictable consequences

increases. Children with autism are found to show more problematic behaviour, such as crying, when they refuse more food [6]. To deal with this problem, one can create a situation where not eating a novel food leads to an unavoidable, very unattractive situation, such as going to bed early [14]. In this case, most children will prefer eating the novel food over the other undesirable situation. Thus, behavioural interventions can be very helpful to improve the eating behaviour of the child.

Children with ASD experience the eating of food differently than typically developing children (TDC). Kral et al. [4] found that children with ASD and TDC differ significantly in oral sensitivity status. This means that these children show different responses to oral stimulation. Hubbard et al. [15], for example, found that 49% of the children with ASD, compared to only 5% of TDC, were reported to avoid certain tastes and smells. Children with ASD commonly experience sensory processing difficulties, which is linked to their oral sensitivity status [16]. A review by Page et al. [17] also concludes that impaired sensory processing is positively associated with feeding difficulties. There are different kinds of food characteristics that can play a role when the child shows problematic behaviour such as food refusal. Hubbard et al. [15], Schreck et al. [5], and Sharp et al. [6] confirm that the food type and texture of the food are the main determinants. According to Hubbard et al. [15], foods that are mixed are also not preferred. Oral sensitivity can lead to food selectivity, a lack of appetite, emotional undereating and other problematic behaviour among children with autism, mainly due to negative emotions about having to eat the food [4, 11]. Therefore, it is important to take oral sensitivity into account when targeting the behaviour of these children.

Children with autism suffer from problems in the stomach and the intestines, which might be the cause of certain eating problems. Marí-Bauset et al. [18] mention that gastrointestinal problems (GI problems) are more common among children with ASD than TDC. The study states that some behaviours that are associated with ASD, are found to be significantly related to GI problems. Marí-Bauset et al. also claim that constipation and abdominal pain are the most frequently reported GI problems. According to Leader et al. [11], GI problems can partly predict rapid eating. Furthermore, Maenner et al. [19] state that abnormal feeding behaviours, such as pica, can appear because of GI problems. The study explains that the actual underlying reason for pica is the inability of the child to communicate the existence of the GI problem with parents or caregivers. This links to the first core symptom of ASD: “persistent deficits in social communication and social interaction” [12, p. 50]. Still, one should wonder what the causal relationship is between pica and GI problems. In contradiction to what Maenner et al. state, Fields et al. [20] say that children and adults who engage in pica, are at increased risk for GI problems. Therefore, one can conclude it is unclear what the actual relationship is between GI problems and eating behaviour.

Other reasons for the eating problems in children with autism are from a wide range of causes. Potential causes for pica, aside from GI problems, are sensory processing difficulties, challenges in understanding the difference between food and non-food objects, and nutrient deficiencies [9, 20]. In case of nutrient deficiencies, the American Psychiatric Association [9] states that usually no specific biological abnormalities are found in the children. This suggests that these nutrient deficiencies can easily be solved through a specific diet or supplements. Lyall et al. [21] found that children with ASD have hyperactivity and deficits in attention, which could lead them to easily lose interest in eating and could potentially explain the rapid eating behaviour. Another cause of rapid eating, and food selectivity and food refusal, could be the occurrence of multiple forms of psychopathology [11]. However, Zickgraf & Mayes [7] do not find a relation between atypical eating behaviours and psychopathology scores. One last unexpected finding is that some children with ASD have higher levels of leptin than TDC, which cause them to not feel hungry [22]. Leptin is a hormone that functions as a feedback mechanism to inhibit food intake [23]. When this feedback is missing, a child will need extrinsic motivation to eat. These different potential causes of eating problems should be considered when designing a behaviour intervention.

Influence of the family

Daily mealtimes can create stressful situations for the family and the child with autism. Curtin et al. [24] state that parents of children with ASD are more likely to report spousal stress at mealtimes than parents of TDC. Marquenie et al. [25] add to this that the child has a profound impact on the family’s routines, rituals and dynamics. Parents try to find ways to encourage the child to eat, where sometimes even the typically developing sibling has a role to model the desired behaviour [26]. Kral et al. [4] found that caregivers of

children with ASD engage in higher levels of prompting and encouragement during mealtimes than caregivers of TDC. The study also highlights that caregivers of children with atypical oral sensitivity engage in more emotional feeding than those of children with typical oral sensitivity. Nevertheless, many families report that having mealtimes together rarely happens [26]. The constant struggle to feed the child usually also causes parents to give up and stop trying to feed the child novel or non-preferred foods [8, 27]. Some families implement a special diet for the child or make use of nutritional supplements to target the eating problems [6, 25]. It would be meaningful to find a routine to improve the child's behaviour and family mealtimes.

Conclusion

The goal of this literature review was to explore the kind of eating problems that arise among children with autism. It can be concluded that there are several eating problems like refusing to eat, rapid eating, eating non-food objects, and showing troublesome behaviour. When looking at the underlying reasons for this behaviour, it becomes apparent that there is often no clear cause, but rather multiple causes that lead to a certain behaviour. To design an effective intervention to target the eating behaviour of a child with autism, it is important to find out what the exact underlying causes are. Furthermore, the role of the family should be taken into account, as they are the feeder of the child and are known to struggle a lot with their child's eating problems.

Discussion

This literature review has several limitations which should be taken into account. Due to the scope of this review, only a relatively small selection of sources has been discussed. There is a lot of literature available on the topic of autism and eating problems. Therefore, a bigger selection of literature might lead to new conclusions about the topic. The articles that were discussed during this review also have limitations on their own. Especially the definitions of certain behaviours, such as food selectivity, were not always the same. This made it difficult to compare findings among different studies. In general, there also seems to be no standard on how research should be done. Sometimes a study does not have a control group, and another time a study does not sufficiently explain how the research has taken place. If one were to make a detailed and extensive literature review about this topic, there would be a lot of challenges in trying to compare studies on a detailed level. Currently, there are still a lot of uncertainties about the prevalence and underlying reasons for specific eating problems among children with autism. Future research will need to focus on giving more clarity about these issues. Another focus area is to find standard, universal definitions for the different kinds of eating problems. The most important area for future research will be interventions that successfully tackle the eating problems of children with autism.

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Appendix 2 – Information brochures

Appendix 2A – Information brochure, English version

Human Media Interaction

Enschede, May 2021

Dinner time! - Information brochure
English version

Dear reader,

In this letter, we would like to inform you about the research you have been invited to participate in. The research will take place in May, June and July of 2021, in an online environment such as Microsoft Teams or Google Meet, or at the house of the participant. In the proposed research, entitled 'Dinner time!', the researcher will talk with you about topics such as the eating behaviour of children with autism, difficulties and challenges during dinner times with a child with autism, but also about ideas and thoughts about ways to help these children with the use of technology. Therefore, for this research we are looking for adults who have expertise and/or experience in this area of knowledge. You may be an expert in advising children and families who struggle with eating problems or symptoms of autism, but you could also be a family member or caregiver of a child who has autism. It is important to highlight that the goal is not to recruit people who have autism themselves. It may be that a participant who, for example, has a child with autism, turns out to also have autism himself/herself. In this case, the participant will only be asked about experiences related to the child. The participant will not explicitly be asked about personal experiences from when he/she was a child. Depending on the participant and the phase of the research, different kinds of research will be done. The research may be a semi-structured interview, but a brainstorm session is also possible. Apart from simply talking to each other, the researcher and/or participant may also share pictures, videos, or other information with each other. At the end stage of the research, an evaluation of a prototype will take place. You will be informed about the specific kind of research that will take place. For every separate research session, you will have to give your consent. This, for example, means that a follow-up session is a choice, and not mandatory. The main goal of the research is to get more clarity on the problems that children, with autism and eating problems, and their caregivers struggle with, and to find a fitting technology solution that can be of help. It is important to take into account that you might have to talk about sensitive topics. The researcher will be patient and give you the time you need. However, you should take into account that participation remains voluntary at all times and that, without giving any reasons, you may refuse to participate in the research. Furthermore, you may also end your participation at any time and may also afterwards (within 24 hours) refuse to allow your data to be used for the research. Your data will be handled in a confidential manner in case you do allow your data to be used. Your data will be stored on the server of the University of Twente and will be secured by a password. The anonymity of the data is guaranteed and will never be disclosed to third parties, unless you give your explicit permission. Personally identifiable information will be deleted after it has been transcribed to text and anonymized. This process is expected to take less than a month after the research has taken place. At the end of the entire research, you may, if you wish to, be informed about the results obtained by means of a debriefing.

Yours sincerely,

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If you have any complaints or concerns about this research, please direct them to the secretary of the Ethics Committee of Computer & Information Science:

Coordinator: Secretary of the Ethics Committee
Zilverling building, P.O. Box 217
Faculty of EEMCS
University of Twente
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Email: ethicscommittee-cis@utwente.nl

Appendix 2B – Information brochure, Dutch version

Human Media Interaction

Enschede, Mei 2021

Dinner time! – Informatiebrochure

Nederlandse versie

Geachte lezer,

In deze brief willen wij u informeren over het onderzoek waarvoor u bent uitgenodigd om mee te doen. Het onderzoek vindt plaats in mei, juni en juli 2021, in een online omgeving zoals Microsoft Teams of Google Meet, of thuis bij de deelnemer. In het voorgestelde onderzoek, getiteld 'Dinner Time!', gaat de onderzoeker met u in gesprek over onderwerpen zoals het eetgedrag van kinderen met autisme, moeilijkheden en uitdagingen tijdens het avondeten met een kind met autisme, maar ook over ideeën en gedachten over manieren om deze kinderen te helpen met het gebruik van technologie. Daarom zijn wij voor dit onderzoek op zoek naar volwassenen die expertise en/of ervaring hebben op dit kennisgebied. U zou misschien een expert kunnen zijn die kinderen en gezinnen adviseert die worstelen met eetproblemen of symptomen van autisme, maar u zou ook een familielid of verzorger kunnen zijn van een kind met autisme. Het is belangrijk om te benadrukken dat het niet de bedoeling is om mensen met autisme te werven. Het zou kunnen dat een deelnemer, die bijvoorbeeld een kind met autisme heeft, zelf ook autisme blijkt te hebben. In dit geval wordt de deelnemer alleen gevraagd naar ervaringen met betrekking tot het kind. Er zal niet expliciet gevraagd worden naar persoonlijke ervaringen uit de tijd dat hij/zij een kind was. Afhankelijk van de deelnemer en de fase van het onderzoek zullen er verschillende soorten onderzoeken worden gedaan. Het onderzoek kan een semigestructureerd interview zijn, maar een brainstormsessie is ook mogelijk. Behalve met elkaar praten, kunnen de onderzoeker en/of deelnemer ook foto's, video's of andere informatie met elkaar delen. In de eindfase van het onderzoek vindt een evaluatie van een prototype plaats. U wordt geïnformeerd over het specifieke soort onderzoek dat zal plaatsvinden. Voor elke afzonderlijke onderzoek sessie moet u uw toestemming geven. Dit betekent bijvoorbeeld dat een vervolgsessie een keuze is, en niet verplicht. Het belangrijkste doel van het onderzoek is om meer duidelijkheid te krijgen over de problemen waar kinderen, met autisme en eetproblemen, en hun verzorgers mee worstelen, en om een passende technologische oplossing te vinden die daarbij kan helpen. Het is belangrijk om er rekening mee te houden dat u mogelijk over gevoelige onderwerpen moet praten. De onderzoeker zal geduld hebben en u de tijd geven die u nodig heeft. U dient er echter rekening mee te houden dat deelname te allen tijde vrijwillig blijft en dat u, zonder opgaaf van redenen, deelname aan het onderzoek kunt weigeren. Verder kunt u uw deelname ook te allen tijde beëindigen en ook achteraf (binnen 24 uur) weigeren uw gegevens te laten gebruiken voor het onderzoek. Uw gegevens worden vertrouwelijk behandeld voor het geval u toestemming geeft voor het gebruik van uw gegevens. Uw gegevens worden opgeslagen op de server van de Universiteit Twente en zijn beveiligd met een wachtwoord. De anonimiteit van de gegevens is gegarandeerd en zal nooit aan derden worden verstrekt, tenzij u hiervoor expliciet toestemming geeft. Persoonlijk identificeerbare informatie zal worden verwijderd nadat deze naar tekst is getranscribeerd en geanonimiseerd. Dit proces zal naar verwachting minder dan een maand duren nadat het onderzoek heeft plaatsgevonden. Aan het einde van het gehele onderzoek kunt u, indien u dat wenst, door middel van een debriefing worden geïnformeerd over de behaalde resultaten.

Hoogachtend,

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Als u eventuele klachten of bedenkingen heeft over dit onderzoek, geef deze dan alstublieft door aan de secretaresse van de Ethische Commissie van Computer en Informatietechnologie:

Coördinator: Secretaresse van de Ethische Commissie
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Appendix 3 – Informed consent forms

Appendix 3A – Informed consent form, English version

Dinner Time! - Informed Consent
English version

Throughout this consent form, the participant is referred to by "I":
"I hereby declare that I have been informed in a manner which is clear to me about the nature and method of the research as described in the aforementioned information brochure 'Dinner Time! – Information brochure'. 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 this consent without the need to give any reason and I am aware that I may withdraw from the experiment at any time. If my research results are to be used in scientific publications or made public in any other manner, then they will be made completely anonymous unless I give my explicit permission to usage of my (full) name. My personal data will not be disclosed to third parties without my express permission. If I request further information about the research, now or in the future, I may contact Sophie Gaastra via email: s.l.gaastra@student.utwente.nl."

If you have any complaints or concerns about this research, please direct them to the secretary of the Ethics Committee of the Faculty of Electrical Engineering, Mathematics and Computer Science at the University of Twente, P.O. Box 217, 7500 AE Enschede (NL), email: ethicscommittee-cis@utwente.nl.

Please fill in the boxes that apply to you:

☐ *I read and understand the consent form.*

☐ *I allow the researcher to audio record the research session.*

☐ *I allow the researcher to video record the research session.*

☐ *I allow the researcher to use my first name in publications related to this research.*

☐ *I allow the researcher to use my last name in publications related to this research.*

Signed in duplicate:

…….	…….	…….
Name participant	*Date*	*Signature*

"The researcher has provided explanatory notes about the research. He/she declares himself/herself willing to answer, to the best of his/her ability, any questions which may still arise about the research."

…….	…….	…….
Name researcher	*Date*	*Signature*

Appendix 3B – Informed consent form, Dutch version

Dinner Time! - Consent formulier
Nederlandse versie

In dit toestemmingsformulier wordt naar de deelnemer verwezen met "ik":
"Hierbij verklaar ik dat ik duidelijk geïnformeerd ben over de aard en methode van het onderzoek, zoals omschreven is in de informatie brochure 'Dinner Time! – Informatiebrochure'. Mijn vragen zijn naar tevredenheid beantwoord. Ik ga ermee akkoord dat ik op vrijwillige basis mee doe aan het onderzoek. Ik heb het recht om te stoppen op elk moment, hiervoor hoef ik geen toelichting te geven. Als mijn onderzoeksresultaten gebruikt zullen worden in wetenschappelijke publicaties of publiek worden gesteld op enig andere manier, dan zullen deze resultaten compleet anoniem verschijnen tenzij ik mijn expliciete toestemming geef voor het gebruik van mijn (volledige) naam. Mijn persoonlijke data zal niet gedeeld worden met derden zonder mijn uitdrukkelijke toestemming. Als ik meer informatie wil aanvragen over het onderzoek, nu of in de toekomst, dan kan ik contact opnemen met Sophie Gaastra via email: s.l.gaastra@student.utwente.nl."

Als u eventuele klachten of bedenkingen heeft over dit onderzoek, geef deze dan alstublieft door aan de secretaresse van de Ethische Commissie van de Faculteit Electrotechniek, Wiskunde en Informatica, Postbus 217, 7500 AE Enschede (NL), email: ethicscommittee-cis@utwente.nl.

Vul de velden in die voor u van toepassing zijn:

☐ *Ik heb het consent formulier gelezen en begrijp wat er staat.*

☐ *Ik geef de onderzoeker toestemming om audio opnames te maken tijdens het onderzoek.*

☐ *Ik geef de onderzoeker toestemming om video opnames te maken tijdens het onderzoek.*

☐ *Ik geef de onderzoeker toestemming om mijn voornaam te gebruiken in publicaties gerelateerd aan dit onderzoek.*

☐ *Ik geef de onderzoeker toestemming om mijn achternaam te gebruiken in publicaties gerelateerd aan dit onderzoek.*

Ondertekend in tweevoud:

……	……	……
Naam deelnemer	*Datum*	*Handtekening*

"De onderzoeker heeft de deelnemer van toelichtingen voorzien over dit onderzoek. Hij/zij verklaart dat hij/zij enige vragen die nog uit het onderzoek zouden kunnen voortkomen zal beantwoorden naar zijn/haar beste vermogen."

……	……	……
Naam onderzoeker	*Datum*	*Handtekening*

Appendix 4 - Parts and tools needed to build the protype

Appendix 4A – Parts and tools of the train station

Main parts:

- Arduino Uno microcontroller
- Arduino Uno usb cable
- Micro SD card reader with SCK, MOSI, MISO and CS connections
- Micro SD card
- Speaker (~ 8Ω)
- Amplifier with volume knob (PAM8403 2-CHANNEL 3W)
- RGB led with common cathode
- 3x 330Ω resistor
- Servo motor
- 2x standard button (12x12mm)
- snap-action switch
- Capacitor of 470µF
- Powerbank (5V, 2A)
- Wires male-female
- Wires female-female
- Wooden train track pieces
- 4mm wood
- 8mm wood
- 4mm non-transparent white acrylic

Tools and other parts:

- A computer or laptop with Arduino software
- A voice recorder
- Soldering iron
- Soldering tin
- Heat shrinks
- Wires
- Laser cutter
- Sand paper
- Wood glue
- Superglue

Appendix 4B - Parts and tools of the electric train

Main parts:

- IKEA LILLABO Battery-operated locomotive
- 1N4148 Diode
- Snap-action switch

Tools and other parts:

- Soldering iron
- Soldering tin
- Wires
- Screwdriver

Appendix 4C – Parts and tools of the plate

Main parts:

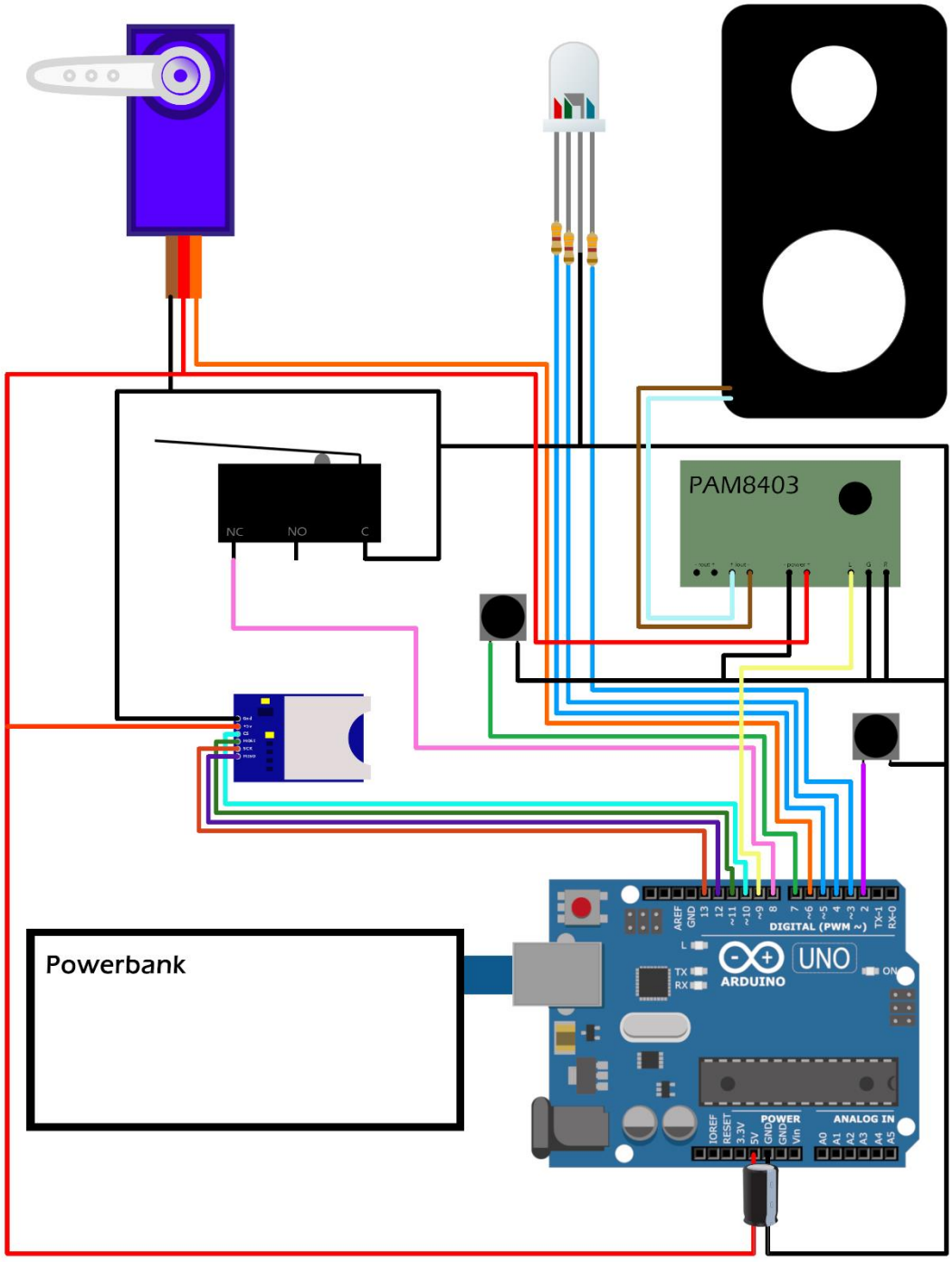
- 3D design for plate
- PLA for 3D printer
- Resin for SLA printer

Tools and other parts:

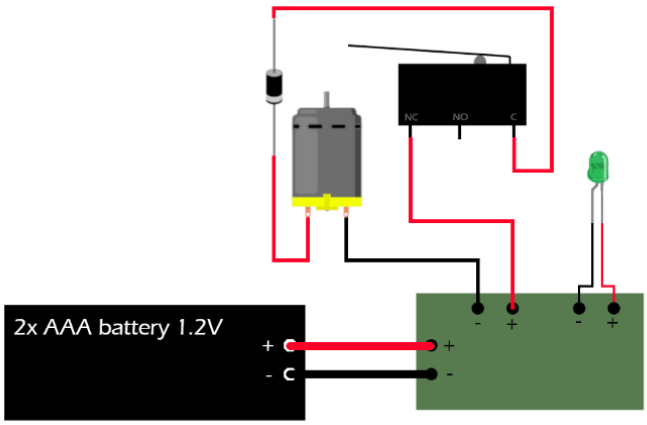
- Ultimaker 3D printer
- Formlabs 3L SLA printer
- Formlabs cleaning machine
- Formlabs cure machine
- Plastic gloves
- Stanley knife
- Wire cutter
- Sanding paper
- Tape
- Primer
- Brushes
- Paint (blue, white and green)
- Vaseline

Appendix 5 - Schematics of electrical circuits

Appendix 5A – Schematic of train station



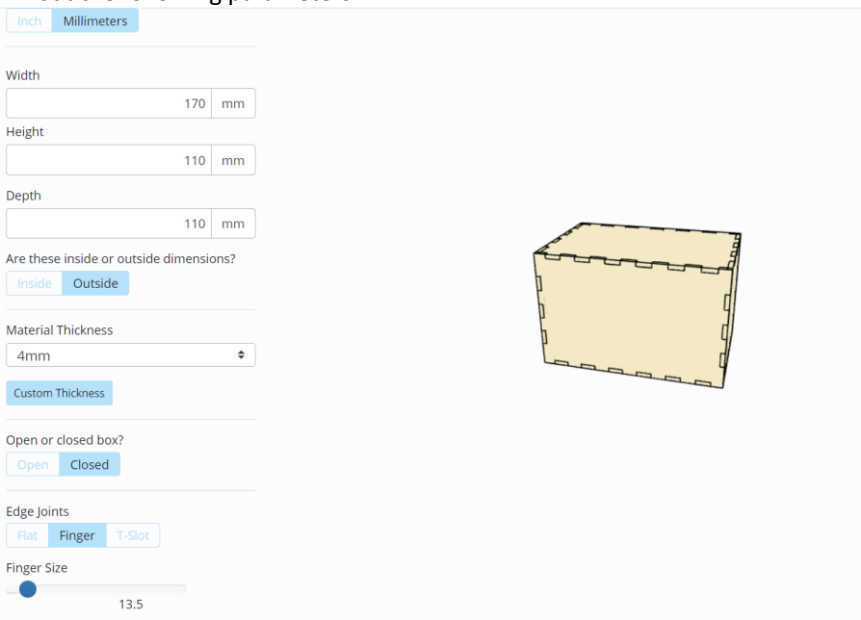
Appendix 5B – Schematic of electrical train



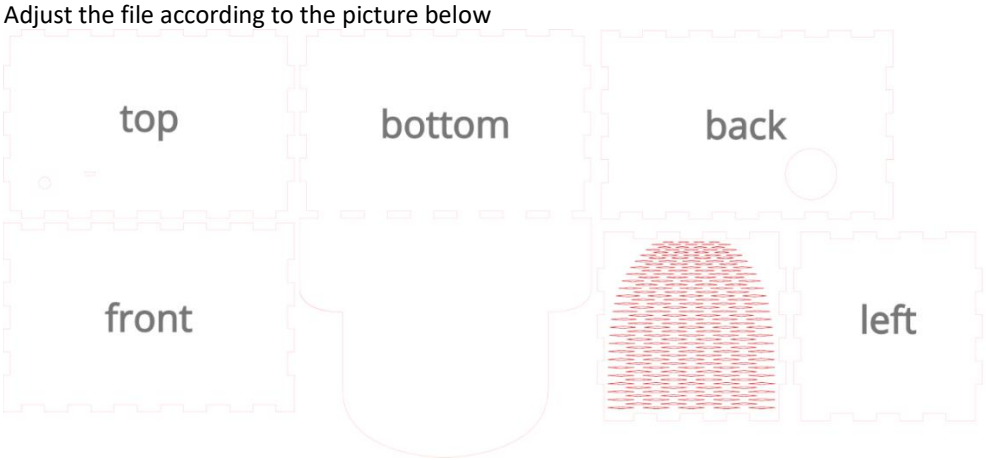
Appendix 6 - Laser cut designs train station

Appendix 6A – Laser cut design main box

- Go to https://en.makercase.com/.
- Choose “Basic box”.
- Fill out the following parameters:



- Download the box plan.
- Adjust the file according to the picture below

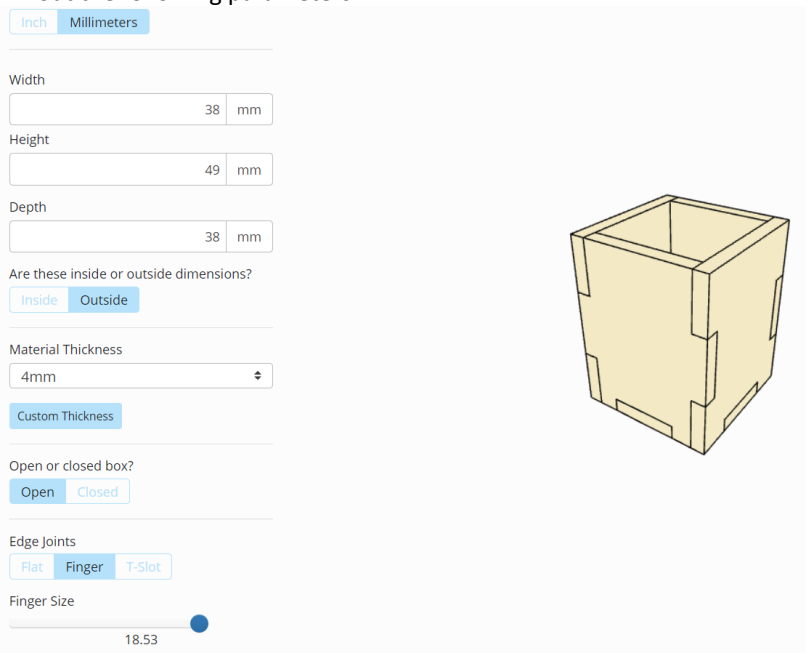


- Tip: Download the parametric kerf # 2 from https://www.instructables.com/Curved-laser-bent-wood/ to make the pattern on the speaker side of the box.
- Use 4mm wood for making the laser cut.

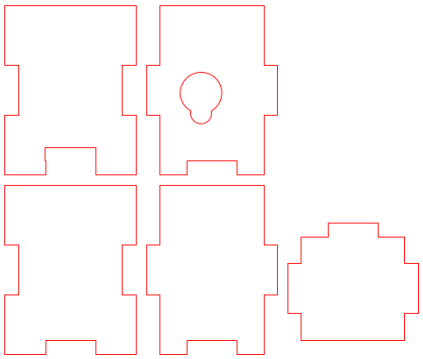
Appendix 6B – Laser cut design servo motor box

- Go to https://en.makercase.com/.
- Choose “Basic box”.

- Fill out the following parameters:



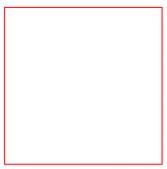
- Adjust the file according to the picture below:



- Use 4mm wood for the laser cut.

Appendix 6C – Laser cut design top servo motor box

- Make a pdf file with a square of 38 x 38 mm.



- Use 4mm white non-transparent acrylic for the laser cut.

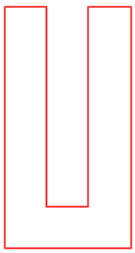
Appendix 6D – Laser cut design button elevation

- Make a pdf file with a square of 20 x 20 mm.

- Use 8mm wood for the laser cut.

Appendix 6E – Laser cut design gate catcher

- Make a pdf file according to the file below:



- Dimensions are:
  - Width: 42 mm
  - Height: 70 mm
- Use 8mm wood for laser cut.

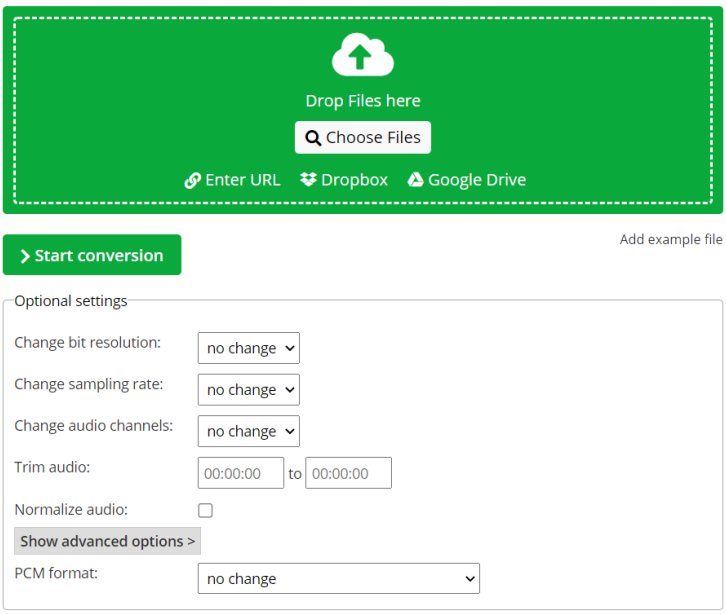
Appendix 7 - Music files for prototype

Appendix 7A – A list of music files to upload on the SD card

- set0.WAV - A recording of someone saying “3 soorten eten.”
- set1.WAV - A recording of someone saying “4 soorten eten.
- set2.WAV - A recording of someone saying “5 soorten eten.”
- eet.WAV A recording of someone saying “Eetsmakelijk!”
- oh.WAV - A recording of someone saying “Oh oh, de trein is gestopt met rijden. Neem je een hapje? Dan rijdt de trein weer verder.”
- goed.WAV - A recording of someone saying “Goed gedaan, je hebt een hapje genomen!”
- groen.WAV - A recording of someone saying “Neem een hapje uit het groene vak van het bord.”
- wit.WAV - A recording of someone saying “Neem een hapje uit het witte vak van het bord.”
- blauw.WAV - A recording of someone saying “Neem een hapje uit het blauwe vak van het bord.”
- paars.WAV - A recording of someone saying “Neem een hapje uit het paarse vak van het bord.”
- rood.WAV - A recording of someone saying “Neem een hapje uit het rode vak van het bord.”
- toet.WAV - A recording of a train honking

Appendix 7B - How to convert mp3 files to WAV files

- Go to https://audio.online-convert.com/convert-to-wav.



- Upload the mp3 file that you want to convert.
- Go to “Optional settings” and fill out the following:
  - Change bit resolution: 8 bit
  - Change sampling rate: 16000 Hz
  - Change audio channels: mono
- Click “Show advanced options” and fill out the following:
  - PCM format: PCM unsigned 8-bit
- Click “Start conversion”.
- Wait for the conversion to be finished.
- Download the WAV file.

Appendix 8 - Arduino Code prototype

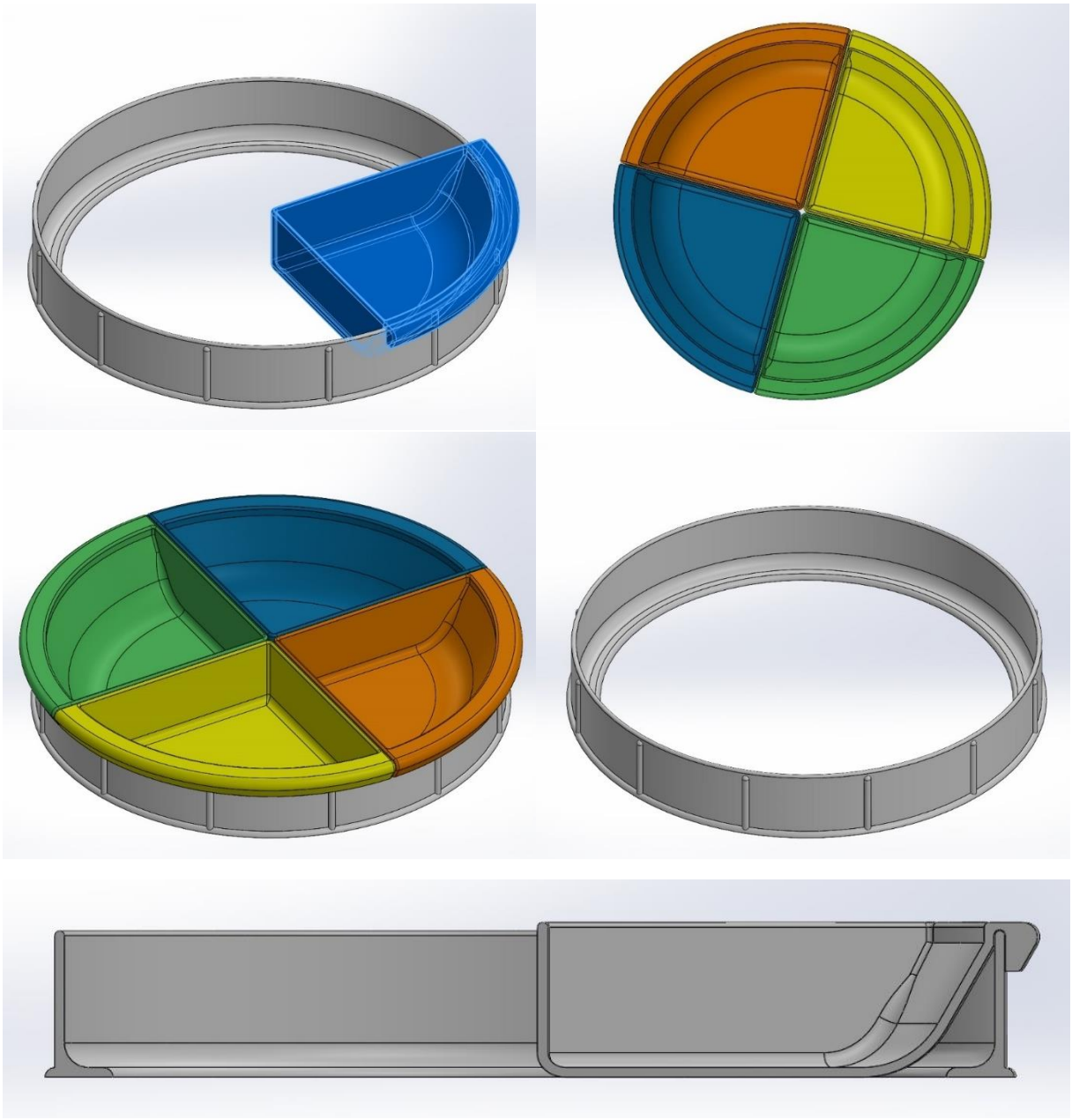
```
// Libraries
#include <Bounce2.h>
#include <SPI.h>
#include <SD.h>
#include <TMRpcm.h>
#include <ServoTimer2.h> // Use this library! The standard servo library does not work
because TMRpcm.h and Servo.h both use timer 1

// Digital pins Arduino
// SD card reader pins 10 - 13 are automatically defined by library
// sdCSK = 13 // CSK connection SD card reader
// sdMISO = 12 // MISO connection SD card reader
// sdMOSI = 11 // MOSI connection SD card reader
// sdCS = 10 // CS connection SD card reader
#define audioPin 9 // Audio input signal
#define trainPin 8 // Pin connected to button which measures if train is at station
#define setPin 7 // Pin connected to button to set settings game
#define servoPin 6 // Servo signal
#define ledRedPin 5 // Pin connected to red LED of RGB LED
#define ledGreenPin 4 // Pin connected to green LED of RGB LED
#define ledBluePin 3 // Pin connected to blue LED of RGB LED
#define foodPin 2 // Pin connected to button to indicate child ate food

// Booleans
bool start; // did game start?
bool childAte; // did child eat?

// Numbers
int traySetting; // setting 0, 1 or 2 correspond to 3, 4 or 5 trays
int servoPosition; // position ranges from 750 (0 degrees) to 2250 (180 degrees)
long servoPreviousTime; // used for measuring the time in between rotations
float servoInterval; // the time interval between rotations
int colorCodes [] = {255, 255, 255, 0, 250, 0, 0, 0, 255, 231, 102, 255, 0, 255, 0}; // →
// RGB values for colours (white, green, blue, purple, red)

// Strings
String colors [] = {"wit.WAV", "groen.WAV", "blauw.WAV", "paars.WAV", "rood.WAV"}; // →
// names of WAV files which state the colour
String currentColor; // one of the colour WAV files mentioned above

// Objects
Bounce2::Button foodButton = Bounce2::Button(); //Initiate food button object
Bounce2::Button setButton = Bounce2::Button(); //Initiate set button object
Bounce trainButton = Bounce(); //Initiate a train button bounce object
ServoTimer2 servo; // Create servo object to control servo
TMRpcm audio;

void setup() {
  randomSeed(analogRead(0)); // initialize the pseudo-random number generator
  servo.attach(servoPin); // attach servo object to the correct pin
  foodButton.attach(foodPin, INPUT_PULLUP); // →
 // attach foodButton object to the right pin and initialize internal pullup resistor
  setButton.attach(setPin, INPUT_PULLUP); // →
 // attach setPin object to the right pin and initialize internal pullup resistor
  trainButton.attach(trainPin, INPUT_PULLUP); // →
 // attach trainButton object to the right pin and initialize internal pullup resistor
  foodButton.interval(25); // assign an interval of 25 ms to the foodButton object
  setButton.interval(25); // assign an interval of 25 ms to the setButton object
  trainButton.interval(25); // assign an interval of 25 ms to the trainButton object
  foodButton.setPressedState(LOW); // set pressed state of foodButton object to low
  setButton.setPressedState(LOW); // set pressed state of setButton object to low
  start = false;
  childAte = false;
  traySetting = 0;
```

```
  servoPosition = 2250; // begin position is 180 degrees
  servoInterval = 0.5; // interval is 50 ms
  servoPreviousTime = 0;
  servo.write(servoPosition); // put servo in starting position
  if (!SD.begin()) {
    while (true); // wait until SD card is successfully initialized
  }
  audio.speakerPin = audioPin;  // set speaker output to correct pin
  audio.setVolume(4);    // Set volume level, ranges from 0 to 7
  audio.quality(1);      // Set 1 for 2x oversampling, Set 0 for normal
}

void loop() {
  updateButtonStatus();
  if (!start) {
    setGame();
  }
  else {
    runGame();
        if (!audio.isPlaying()) {
          digitalWrite(audio.speakerPin, LOW);
        }
  }
}

void updateButtonStatus() {
  foodButton.update();
  setButton.update();
  trainButton.update();
}

void setGame() {
  // Change tray setting when set button is pressed and play audio
  if (setButton.pressed()) {
    traySetting = (traySetting + 1) % 3;
    playAudio("set" + String(traySetting) + ".WAV");
  }
  // Start game if food button is pressed; play audio and turn on light
  else if (foodButton.pressed()) {
    start = true;
    playAudio("eet.WAV"); // play "eetsmakelijk!"
    changeColour(traySetting + 3);
  }
}

void runGame() {
  if (foodButton.pressed()) {
    childAte = true;
    playAudio("goed.WAV");  // play "goed gedaan!"
    openGate();
  }
  else if (setButton.pressed()) {
    playAudio(currentColor);
  }
  else if (trainButton.changed()) {
    // If train is at station
    if (!trainButton.read()) {
      if (!childAte) {
        playAudio("oh.WAV"); // play "Oh oh..."
      }
    }
    // If train leaves station
    else if (trainButton.read()) {
      playAudio("toet.WAV"); // play "toet toet!"
      changeColour(traySetting + 3);
```

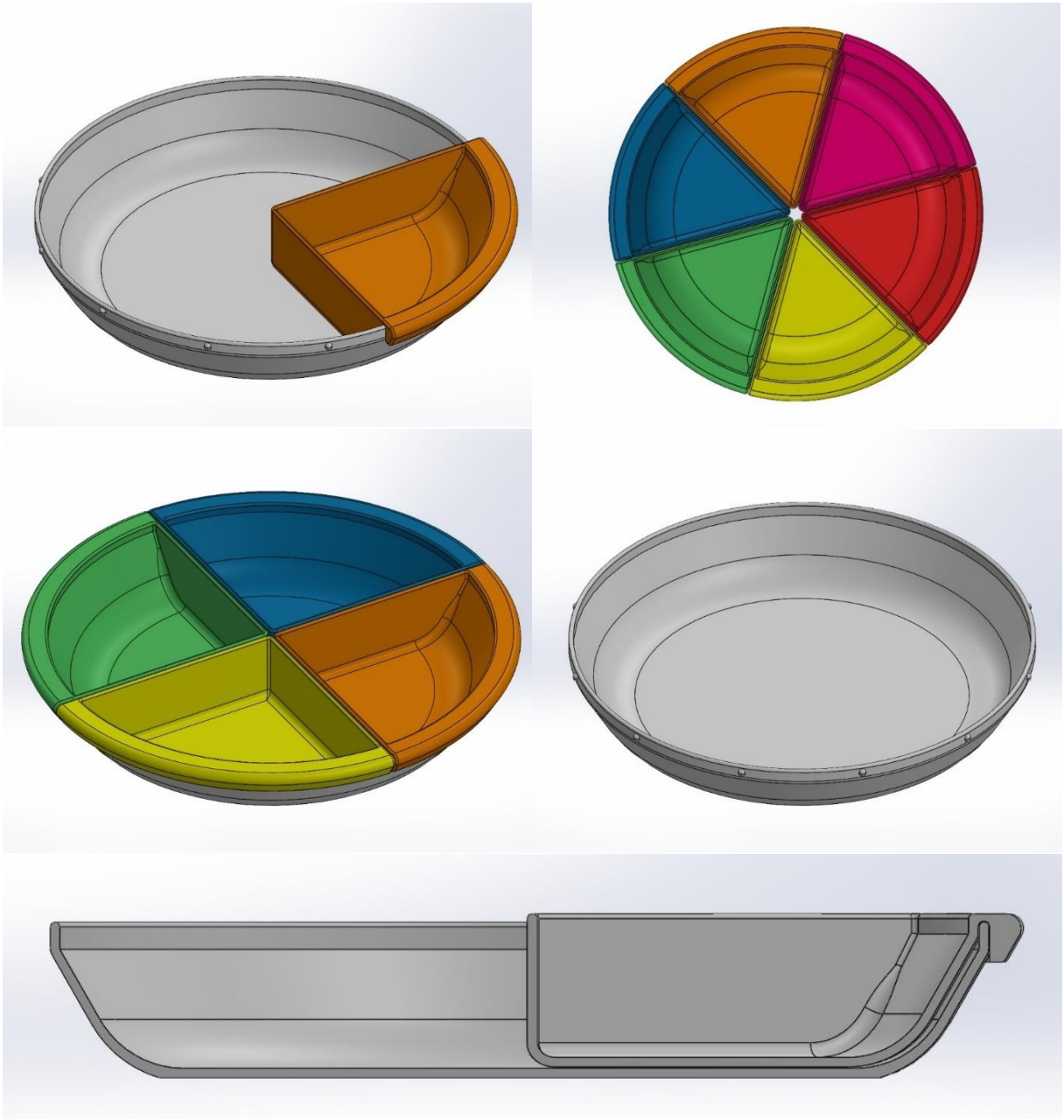
```
      closeGate();
      childAte = false;
    }
  }
}

void openGate() {
  long currentTime = millis();
  while (servoPosition >= 1167) {
    if (millis() - currentTime > 2000) {  // wait 2 seconds before opening the gate
      if (millis() - servoPreviousTime > servoInterval) { // →
      // wait a few milliseconds between every time the position changes
        servoPreviousTime = millis();
        servoPosition -= 1;
        servo.write(servoPosition); // adjust position of gate
      }
    }
  }
}

void closeGate() {
  long currentTime = millis();
  while (servoPosition <= 2250) {
    if (millis() - currentTime > 2000) {  // wait 2 seconds before opening the gate
      if (millis() - servoPreviousTime > servoInterval) { // →
      // wait a few milliseconds between every time the position changes
        servoPreviousTime = millis();
        servoPosition += 1;
        servo.write(servoPosition); // adjust position of gate
      }
    }
  }
}

void playAudio(String filename) {
  audio.play(filename.c_str());
}

void changeColour(int trays) {
  int nr = random(trays); // picks random nr between 0 and (amount of trays - 1)
  currentColor = colors[nr]; // set currentColour to correct WAV file
  // Displays color of the chosen tray
  analogWrite(ledRedPin, colorCodes[3 * nr]);
  analogWrite(ledGreenPin, colorCodes[(3 * nr) + 1]);
  analogWrite(ledBluePin, colorCodes[(3 * nr) + 2]);
}
```

Appendix 9 - Designs of plate

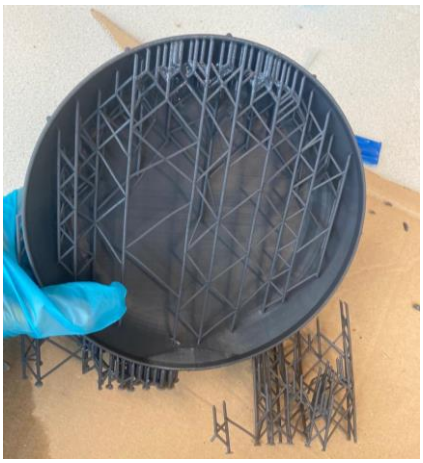
Appendix 9A – Initial design



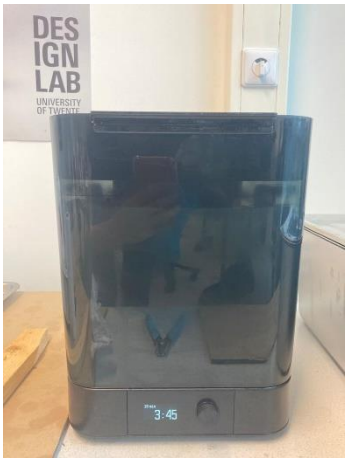
Appendix 9B – Final design



Appendix 10 - Design process plate made by SLA printer




Taking out the parts of the design from the SLA printer.



Putting the parts into the cleaning machine, and then into the curing machine.

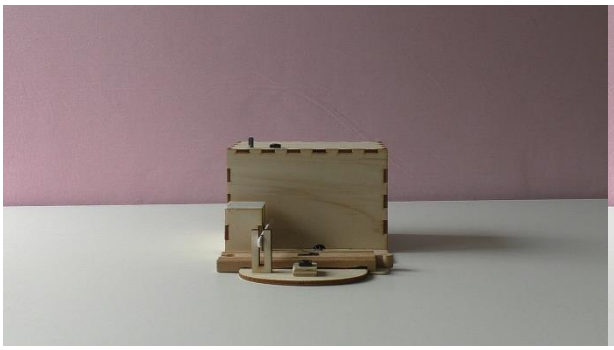
Taking off all the support material.


Sanding the parts to take away the left overs of the support material.

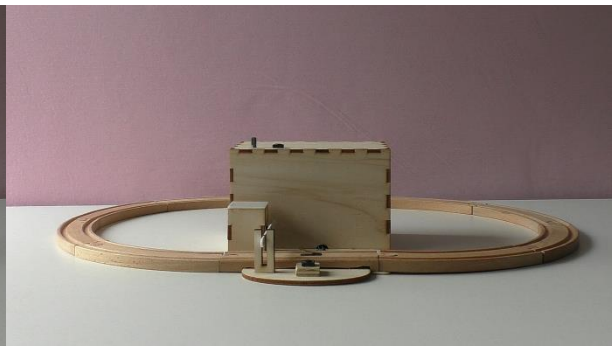

Cover the trays with tape and putting primer onto the edges.

Painting the edges of the trays with blue, green and white paint.

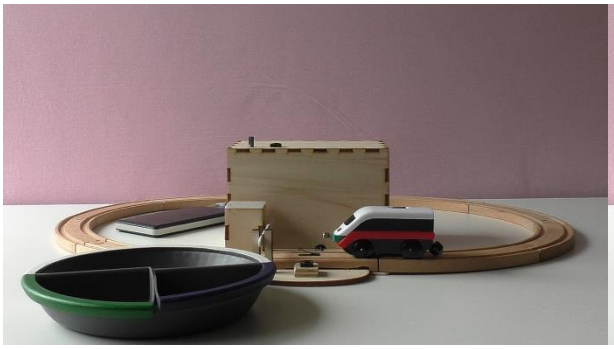
Appendix 11 - Final prototype game



1. Train station basis



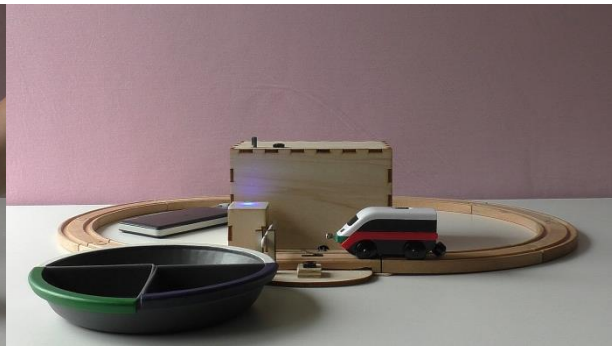
2. Adding the train track



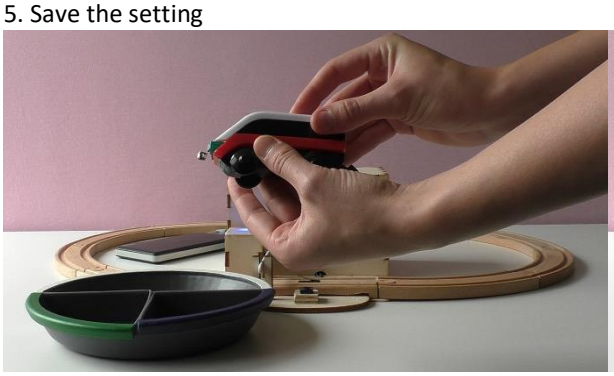
3. Adding the plate, train and connecting the power bank

4. Adjusting the settings for the plate

5. Save the setting

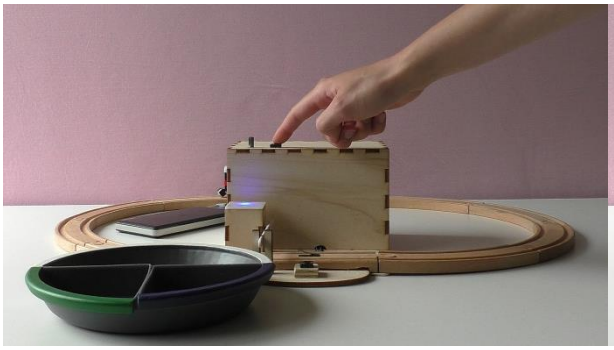


6. The game starts



7. Turning on the electric train

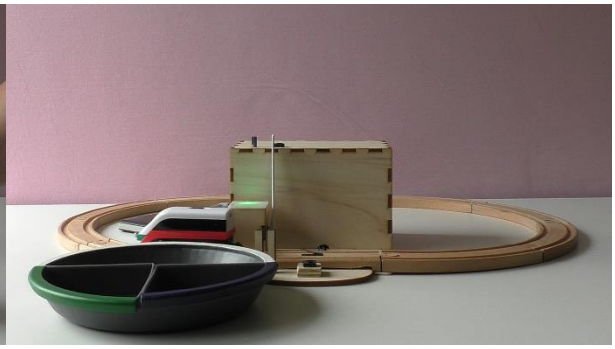
8. Putting the train onto the train track



9. Click the button to hear which coloured tray to eat from

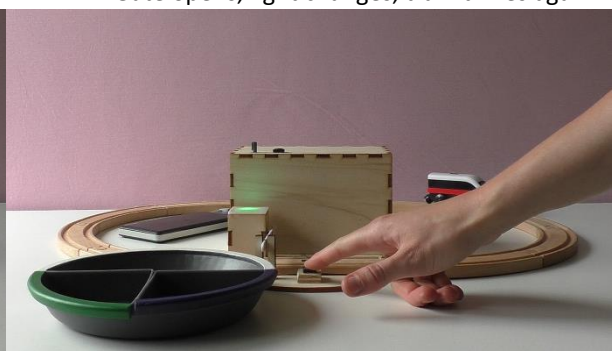
10. The train stops because the child did not eat

11. Press the food button because child ate

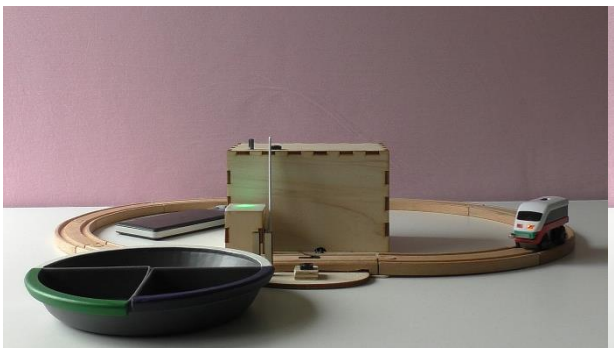


12. Gate opens, light changes, train drives again

13. Gate closes



14. Press food button because child ate



15. Gate opens

16. Train passed, light changed and gate closed

Appendix 12 – Semi-structured interview questions for evaluation

The questions marked in blue are the ones that were added after the second evaluation session. Therefore, four out of six participants answered these questions.

1. What is your first impression of the game?
2. How do you imagine using the game together with your child?
3. How did you experience using the game?
4. The game interacts with the child through sound, compliments and a train that drives. What do you think of this interaction?
5. What do you think of the interaction between the plate and the game?
6. To what extent do you think that the child will understand the game?
7. What do you think the child would think about the game?
8. What kind of effect would the usage of the game have on the eating behaviour of the child according to you?
9. You probably already had certain expectations when you heard that I was bringing a game. Does my game meet your expectations?
10. What do you think of the looks of the game?
11. What would you change about the looks of the game?
12. Is there something missing in the game?
13. Would you add something to the game?
14. Is there a part of the game that, according to you, can be left out?
15. Would you like to change how the game works?
    a. Would playing music when the train drives have added value?
    b. Would counting the rounds of the train have added value?
16. How do you think that siblings would react to the usage of the game?
17. To what extent do you think that the child would become dependent on the usage of the game during mealtimes?
18. What would you do if the game stopped working unexpectedly?
19. What would you do if you forgot to bring the game?
20. Would you like to use the game?
    a. When would you like to use the game?
    b. Where would you like to use the game?
21. Would you recommend the product to other people?
22. Are there parts of the game that you already use during current mealtimes?
23. Are there interventions that you use during mealtimes that are not used in the game?
24. Maybe you already had a certain idea of what kind of game I would bring with me today. If so, what were your thoughts?

Appendix 13 – Overview of feedback of evaluation sessions

An overview of the feedback of the evaluation sessions can be found below. Different colours are used to be able to differentiate between the feedback of 6 participants. The feedback is placed underneath three different sections: look and feel, usage of the game, and the effect on the eating behaviour.

Colours per participant:

Participant 1 (daughter 8 years, no autism)

Participant 2 (daughter 7 years, no autism)

Participant 3 (daughter 4 years, no autism)

Participant 4 (son 8 years, autism and eating problems)

Participant 5 (sons 14 + 17 years, no eating problems)

Participant 6 (sons 14 + 17 years, no eating problems)

Look and feel

- Fun, playful way to work on learning to eat.
- Easy to play the game. Sound and compliments fit the age group.
- In terms of stimuli, I think you are in the good direction. If you would put puppets around the station, that would be very distracting. I think this is good, the fact that it is simple.
- I think some people would describe the look of the game as being boring, but for the target group I think it is good.
- I would not change the looks of the game. I would maybe add some train tracks to allow the train to take longer. The speed of the round is a bit too fast right now, the time in between bites should be longer. And you could change the train into a horse, for example. Then you make it more girly, or personalized. For the daughter it would be a dog.
- I don’t think something is missing. I would not add something, I like it that it’s simple.
- I would not take something out. No, even the function with the button to hear the colour of the tray is useful.
- If I could change how the game works, I would just change the time in between bites. So either using more train tracks, or letting the train move slower. For example, that the train has two speed settings.
- Adding music when the train drives would be too distracting for young children with autism, I wouldn't do it. For my daughter it would be a lot of fun, but she is 8.
- (Counting the rounds useful?) I think it depends on how you would use the amount of rounds. But you could also just use a paper or an abacus. For my daughter it would not have added value.
- Nice, keep it simple, not too many distractions.
- The sounds and compliments are nice, clear and simple. I think that the parents will find their own way in the interaction during playing the game. I also think it depends on the child, how much the child needs. I do not think it is annoying that the game takes over the task of the parents.
- In terms of stimuli, I do not know much about it. I think you should keep it simple. For "normal" children, some trees and other stuff would be interesting. But for children with autism it would be too distracting. You have to adjust also for the specific child.

- If I could change something, I would maybe make a station out of the box (with for example a window and a person behind the window). But I would not add any other details.
- No, nothing is missing.
- I would add a Station, and maybe a tunnel.
- I would not take something out. No, speaker function and colours are useful too.
- Speed of the train is fine. You can just take a bite when the train has stopped and is at the station.
- I would not add music for when the train is driving. I think it is fine like this, the train already makes some noise.
- (counting rounds?) It may be helpful, but you can do that by yourself as a parent. I do not think the system needs to do that, it does not have to be implemented in the game.
- It is fun, the children can play by themselves. Waiting for the colour is exciting.
- I was surprised by the game. With the colours and the light, that's very smart. Then, there's something else that tells what she needs to eat, instead of that I have to tell her. That's very helpful.
- I think the sounds and compliments are very nice for the child. It's an external factor, the parents are not involved, and I think this can be very pleasant for a child. Because parents are annoying and only complain, while this game is a rewarding system. So I think the child will take the message in a more positive way.
- The volume knob is very important, especially in terms of stimuli for children with autism. In terms of colours, the colours of the trays and the light should be identical, otherwise they do not understand. Wood is always a good choice. And in terms of colours of the game, that really depends per person, also for the children with autism.
- I think the game looks quite boring. But I like colours and stuff. I would paint a station onto the box. A simple one, but that it has the appearance of a station, that it looks more realistic. I would change the station, the light (identical colours) and the plate.
- I was thinking, you could add wagons behind the train, so that there's food in the wagons.
- Nope, I would not add something, otherwise there's too much distraction from the food. The focus should be on the food, it should not be a game on its own. I would maybe put the settings button on the right side, because I am right handed.
- I would not change how the game works. No, I think the order makes sense.
- No, I think adding music when the train drives would be distracting. And I think the rest of the family would not be able to stand it.
- (Useful to count rounds?) Maybe, if you can set a limit for the amount of bites. Then the child knows how much she needs to eat. Then you could let the system say: "Well done, this is the second bite!".
- I do think it is a really nice idea, a playful way to learn how to eat. Clicking the button is also a lot of fun.
- I think it’s good. The sounds and compliments are fine.
- The link between the plate and game is very nice. In this way you can allow them to try different kinds of food. The link is clear.
- The game looks fine. You could give the box some more colour, make a station out of it. To give the experience of a real train station.
- You could always add things to make it more fun. Such as a railroad crossing. But the point is that the game is about eating, it should not become a game by itself. So I think it is better to not add new things, because then the game wouldn't focus anymore on eating. So no.
- I think I would take two trains, one for each child. Both children have difficulty with eating. The food that one of them likes, the other one dislikes. (after telling about the option of two stations) No, I would like two trains. Because otherwise, you get a fight between the children. Oh, I also want blue…. So I would give them

the same assignment, but with two trains. Then you also get the competition element. Then I would just put the train to the other side, if one of them has eaten. Because if you push the button, then both trains will start to drive. When you were building up the game, I expected you would have wagons and that the food would go in there. My son has once been at a place where there were automatic trains driving, and he was allowed to take a lollipop from one of the wagons. Nowadays, he is still talking about how cool that moment was. Even though you say that eating from a wagon would be something that is difficult to unlearn, I think it is most important that they are first motivated to eat. And who cares if the child learns to eat from a wagon. Some children can also only eat from one kind of plate. For the transition you could first go from the train wagons to the plate.

- No, I would not take something out.
- If I could change how the game works, I would enable that children can play together. For example by splitting the tracks. I would prefer not to have to play a part of the game, I think I should not do that.
- Adding music when the train drives…. I do not know. Maybe it is more clear that the train is driving, but I am not sure if it is necessary. Maybe it is too busy. Also because maybe one child does not like the music.
- (Useful to count rounds?) Uhm, difficult. I do not think you should think in numbers. You should be happy if he ate anything at all. Otherwise, you get fights, that one has more rounds than the other one.
- Because of the simplicity, the idea is very powerful. It is easy to remember and it is clear how to play the game. It's something that the target group can understand
- Very easy, does not cost much time to understand. You can even teach the kid to build up the game, while the parent is preparing the food. You can do it together, you can involve your kid really easily. It is very user friendly.
- I like the feedback, it is not too loud. Of course you can also adjust that with the volume knob.
- (about the plate) Calm, not too many colours. As a foundation, three trays are good.
- The game is "stimuli poor", as I said, because of the colours. It's nature colour, wood colour.
- I would not change the train into a car. A train is predictable, a car is not because it can move in different directions. You can also do wagons with names with stickers, but let the train stay.
- No, there's not necessarily something missing. But it's up to the parent to find some extra additions, up to the parent's creativity.
- No, I don't think I would take something out. Just the compliment feedback, because our sons don't take compliments well. The button with the colour of the plate is useful. But I would maybe put a setting that they can only hear the setting twice. Otherwise, clicking the button will become a game on its own. (You could put a timer. Allowing to first click 2 times, and then a timer of 30 seconds) Yeah, that would be perfect.
- No, I would not change how the game works.
- No, don't think you should add music when the train drives.
- (Count the rounds?) I think you should not do it. I think that the child would not want to eat anymore after taking an x amount of bites.
- A train and autism, that fits really well together. A train is very predictable: it drives on a track and the train follows this track.
- The game is "stimuli poor", also in terms of colours, which is important
- The idea is really creative
- I think that this idea would work just as well for young children who do not have autism.

- Easy to understand. You can also include a reward when the child has done four rounds. For example by adding a wagon. One of our sons is very fond of trains. Or another kind of reward that fits with the game.
- It (the compliments and sound) is very decent. The language is short and clear. You are actually just giving an assignment to the child. And then a small "thank you" message follows.
- (about the plate) Calm. If you would use red, yellow and orange, they would get too many stimuli, that would not work for children with autism.
- The game is "stimuli poor". Even though I would change the holes of the speaker, that could be a bit more calm, it might trigger the children.
- I think the same, do not change the train into a car. You can do a wagon behind the train with for example a horse. You could make the train track a bit bigger, and for example adding a tunnel, something simple. But as a reward. (could you include some "level ups" automatically in the system?) That's really difficult to do. Put 100 children with autism next to each other, and none of them are the same.
- I agree. Nothing is missing but it is up to the parents to find additions. The parents know the interests of the child better than anyone else.
- No, I would not know what to take out. For us specifically I would take out the compliment feedback.
- No, I would not change how the game works.
- No, I do not think you should add music when the train drives. At most a train sound of a train driving.
- (Counting rounds?) Ehm, that could be useful…. Or well, on the other hand, he could then say, yeah wait a second, I already did x number of rounds… I do not want to anymore. No, I wouldn't do it. In the end the goal is that the plate is empty, not the amount of bites.

Usage of the game

- Maybe not using it during dinner time but at a moment for learning trying new kinds of food
- I think when my daughter was younger, she would have liked the game a lot, also for a longer time. But right now she would be done with it after 2 or 3 times, but that's just the age. I would not use it every day, because the level that my daughter is at is simply one teaspoon of a certain kind of food. During the week, everyone is busy and there is no time to try a lot of new things. It would also be too much work to prepare everything, because you know you will not get enough out of it. Instead, I would use it for a session where the goal is to try new kinds of food. Only at home. Daughter does not like others to be around when they are working on eating new things.
- Yes, I think the child will understand the game. You can involve the child in the game by asking him/her to push the button. The child has to eat food that he does not like, so this game creates a kind of positive distraction.
- In the beginning I am sure the child is motivated by the game. It also depends on how the child deals with eating. It depends on the child whether it stays fun. My 8 year old daughter would not like it when other friends are present, but when she is alone, I'm sure she would find it fun to do it a few times.
- I do not think that the children are aware that they have to finish eating the food. Because of this, I think they will actually eat. I think the child gets motivated to eat, but is not aware of the link between the game and eating the food. In terms of stimuli, I think you are in the good direction. If you would put puppets around the station, that would be very distracting. I think this is good, the fact that it is simple.
- (Reaction siblings?) I don't know. I do not have that situation. But I think it is good to involve the siblings in the game in some way. For example, that they also

take a bite when the train departs. It would be a weird situation when you do not involve them at all. It depends on the family, how they interact with each other.
- (Recommend to others?) Yes, it is not extremely difficult, it is easy. And it's another way to be working on eating. Also with the distraction from the food, to motivate the child to eat.
- I am wondering whether it is fun enough for my daughter, for daily usage she would be too old (7 years).
- For my daughter it would not work. There is not enough motivation. She is not interested in trains and is simply too old. But I think that for young children, it would work well. For my son it would work really well, but in the end he does not have food that he really does not like. He sometimes just does not open his mouth, then this game would be very helpful. If I had a younger child with eating problems, I would use it during dinner times. But maybe also during lunch if that is possible. Maybe I would put an extra table next to the dinner table to put the game there. I would use it every day if it works, or just on "problem days". I would take it to other places if it's easy to take with me and does not break easily. If it helps with eating, you want to take it with you.
- I would not use it for my daughter, not because it is not fun, but just because my daughter will not be motivated enough, she is not interested in trains. She will not be rewarded enough if she eats. I would use it for my younger son, but luckily he does not have eating problems so it is not necessary.
- For young children it would be very suitable.
- I think the children understand the game very quickly. For young children the parents will have to guide them a bit more. The more the children understand the game, the more easily they can play the game themselves.
- (Reaction siblings?) I think that really depends on the children. If I were to play the game with my son, my daughter would find it interesting and would also like to try. But the other way around, with younger siblings, they probably would like to play together. As a parents you just have to see how you would like to do it.
- I think you should see the game as a tool, as foundation. You can adjust the game according to your own wishes and experience as a parent. I think it should not matter in what way the parent thinks it works best.
- (Recommend to others?) Yes, if I think it could help them.
- Takes up a lot of space on the dinner table, so not very practical for a normal eating moment
- I am wondering how long my daughter would like it (4 years, no autism). She either finds it so much fun that she asks me if she can play the game for food which she does not like, or she stops playing after having played the game for 3 or 4 times.
- Most of all, the game takes away the focus from eating the food. The game has potential.
- I can also imagine that it would be nice to use the game during dinner times. In that case, the whole family would be sitting at the dinner table.
- Yes, in the end I would use the game. I am really curious to see what it would do during dinner times. Solely for that reason, I would like to buy it to test what would happen. I also think to make eating a positive success experience. I would use it when I think that there's a food that my daughter really does not like. I always include my daughter in what we are going to eat, so then I can indicate what the plan is for the evening. I would not take the game with me, only if I would go on a holiday. But not when we go out to eat.
- In terms of how much the children can decide for, they do have a lot to choose. Especially because I have learned that you cannot force children to eat. However, they have to eat what I serve. They cannot choose to eat something else. So if they do not eat anything at all, they go to sleep being hungry. But I would let them decide whether they want to use the game, or let them choose between two kinds of vegetables for the trays. But not more than two options, because that would be too difficult for the child.

- Oldest son would get jealous if we eat together at the dinner table and my daughter is allowed to play with the game. To make sure that siblings do not get jealous, you could involve them in playing the game. For example, you could buy two stations, one for each child.
- My daughter would understand the game very well.
- Yes, my daughter would probably be motivated by the game. But it has to work to her advantage. If she finds out that it does not work to her advantage, she will not want to play anymore. So, as parents, we would have to be careful with when and how we use it. It should be a luxury product for her, because then she won't like to use it anymore. If she finds out that the game is actually a kind of manipulatory way to get her to eat, once she links those things, then she doesn't want to anymore. If I were to use it, I would have to tell her "Hey! We're going to play a game during dinner". I should not talk with my husband about that "it worked" or that "it is so nice she finally eats". We should not say those things out loud when she is around, because then she is done with the game. I think she would then quit with everything, she probably will not play any games anymore. I think it would have a negative effect, because she would not like to eat or play games anymore.
- I think that the process of learning how to play the game is difficult for children with autism. Because there are so many different things that the child has to do or that are happening. But I think that you can do that step by step. Once it is in their system, I think it will work alright.
- Child would be quite dependent of the game. She would not like to eat unpreferred food without using the game. I do not think that this is a problem for my daughter. But a child with autism might not grow out of it, the child will not indicate very quickly that he/she does not need the game anymore. I think that, as a parent, you have a role to make sure that you phase out the usage of the game. Maybe you also need a manual for doing this, that there are options for how you can phase out the usage of the game. Maybe you could take out the train, but keep the light. Because the train is the motivation, but the light chooses what you need to eat. So if you would have a light with a button, it could just indicate that you have to eat from the green tray. I'm not sure if you then still need the feedback, maybe not because they have already learned it. And maybe feedback can then also be given by a caregiver or parent. I do think that for children with autism and eating problems, you will often stay with the plate with three divisions. Because mixed food is just a no go.
- What do you do if they do not take a bite? You would wish that if the child pushes the button that the systems says: "You did not take a bite yet, so the gate will not open yet". Because if that function is not there, you would have to intervene yourself as a parent, and then you would ruin the game. Because if there is no one stopping the children from just pushing the button, they will not eat anymore once they find out.
- If the game stops working I would be there for my child, because she would go crazy. At that point you won't be able to fix the game. Maybe I would drive the train myself, and do the voice myself. And if the child gets angry, then we put it away and we stop. I do realize that I am now taking over the part that the game normally does, and that's dangerous. But I think many parents would tend to do this. So I think it is important to put an advice in the manual that you should not do so if the game stops working. But in the end, you as a parent know your child best, and you know best what does and doesn't work. So I think that the parent will make the choice that works best.
- If I forgot the game, I would drive back, if I remember on time. And I don't have the game, then I think I would get really creative. I would work with colouring pens or with icons. I would just come up with something. But if I was on holidays in the Netherlands, I would drive back to get it.
- I think that if you, as a parent, continually have fights over eating with the child, this could be a really good option. And it gives you some time to rest as a parent.

It's always about what the child needs, but this can also be about the parent, that he/she can also have a normal dinner.

- For my son, simply taking a bite would be too big of a step. You should include looking, feeling, hearing and smelling before you get to the tasting part.
- We would sit on the dinner table: me, my husband (if he is not working), and my two children (8 year autism son, 4 year son). There would be pans on the table too. I would involve my son a lot in playing the game. I would ask him from the beginning what he wants to have in the trays. That he can make his own choice and there should be at least one kind of food that he likes, because otherwise the game is no fun. And then I would build it up, giving him a choice with more difficult food. But even if my son would only take a really small bite, I would be happy. Because that is something that he would normally never do.
- My son would understand the game, also when he was 4 years old. Also understands the interaction.
- Yes, I think the child would be motivated by the game, but I do think you have to build it up. You start on a really low, easy level. Because otherwise it is no fun anymore. So you start in a really playful way, to get used to the system.
- I'm sure that my son would be depending on the usage of the game once he is used to using it.
- I think it has to be silent on the table. The child wants to hear what the speaker says. So all of us have to be silent.
- Yes, I would like to use the game. I am always open to trying something new. At the moment it is also not working, so we can profit from everything new we try. And he likes trains a lot, so that's also a reason why. The game is meant for home usage, to learn to eat and taste more. To be able to recognise more flavours. When you are going out, you should just eat something that you like, there shouldn't be fights then. At home, I would use it really at a low level, to see how it goes. I am talking about the kind of food then, not the frequency of using the game. So for example during the lunch every day, or for eating fruit. But not directly for eating warm food, that step is too big. I would also just start by looking at the food then. I would have to guide the child. Saying: okay, you will only have to look at the broccoli today. And for the spinach: You can try to taste it. I think in such a way we will be able to work it out. Or each colour indicates a stage (looking, feeling, smelling, etc). The big difference between this game and the plate that I talked about before, is that there is a surprise element. Because you do not know what you are going to eat. The usage of the game also really depends on the mood of the child. My son has to feel good in order to play the game. But maybe you can encourage him to eat by making it more attractive, for example by using this game. I would find it the most difficult to start with using the game for warm meals. Because those meals are the most difficult to my son.
- (Siblings reaction?) Siblings would get jealous. At our family, it would not be possible not to involve the younger brother. Maybe if the son with autism would have an older brother without autism, you might be able to explain why the game is there. But for younger children, you cannot explain why it is like that. Maybe, however, there are children that do not care and are able to eat without using the game. I would give the choice to the sibling whether or not he/she wants to play or not.
- I think that at a certain point I think they do not want to play the game anymore. All new things are attractive. But this game would return every single day, so they start to know that they will play the game and what will happen. I am not sure if you could add something to make it more fun. You first will have to try to see what will trigger the child, that differs per child.
- If the game would stop working I think I would ask my son what he would like to eat, and then I would give it to him. Yeah, sad, but never mind. Then he will have to eat what he prefers. I would not tell this possibility in advance. We would put it on the table, notice that it is not working, and then we would see. He is quite creative so maybe he would start playing by himself. He might choose the colours

he prefers, but still. And otherwise we would not play and we would eat something he likes.

- If I forgot to take the game, Then the child would not eat or try unpreferred food, but that's not such a problem. If you eat somewhere else, they will just eat what they like, that's what I think.
- What happens if one of the plates is empty? (nothing…) Well, then the choice is whether the child wants more food, or that he stops playing the game. About the random choice of colour, the food should probably not be 4 times the same. At least, not from the unpreferred food. It is best to say that the same food can be chosen by the system a maximum of 2 times after each other.
- Yes, I would recommend it to others, but first I would want to try it myself. And I don't know other people's problems, it depends on what is difficult for you. For children without autism who just need to taste more food, I think this game would be very fitting. Those children do not have to go through all those steps. I think that for children without autism, it would work better. But you can change the game for the children with autism.
- (about the compliments + sounds) And the child experiences it as that they do it (play the game) by themselves, that encourages the child too. Our children cannot really deal well with compliments when we give them to them. They are actually have an aversion to it. But maybe if the system gives the compliment, they are able to take them. Because it is part of the game, they interpret it differently.
- I would choose to only sit down with the child, not with the whole family. Just to build a bit of structure, so that you can then afterwards build up to using it together with the family. Otherwise they would feel so pressured and would feel more stimuli.
- (about the fact that the game takes over the function of the parents) I do think it is good to start out like this, then it is clear, the child knows what is expected. If the parents steps in, the message might come across differently, or is told differently. I think that this sound be the foundation. When you notice that it is going well, and there is structure, then you could start to build up on the foundation. But first the foundation should be the game, to not let the parents be involved. I think that as parents this is not a problem, because by that time you already will have tried so many things. Maybe the game would be the thing that can finally help them, so they wouldn't care that they are not involved.
- The child would understand the game really quickly. Yes, the assignment is simple, the target group will understand.
- You can add more things to the game as a reward. (about being involved in the game as a parent) That depends on the child whether that is a problem once you start making your own rules as a parent. Some children are sensitive to it and others are not. For our sons, at a certain point I would come up with new ideas once they are more used to things. Because at a certain point it will turn boring. So I would maybe add some traffic signs. But it shouldn't be too much, and the materials should be natural. (could you include some "level ups" automatically in the system?) I do not think that would work. I think you should leave the system like you have it right now. But in the manual you could put a text like "Do you notice that the child finds the game boring? Here are some options to make it more fun". In this way the parents can adjust the game in a way that fits their child. I think you should not make it too complicated. As parents you should have a clear goal, and if you can reach those basic things, then you are already really happy.
- I think the same. Depending on the sibling's age he/she will get jealous. That's also why I think it is important to first work with the child one o one. Imagine that you have children of 2 and 4, and the child of 2 year old also wants to play. Even though it is not "gezellig" to only be eating together with the child with autism, in the end it is better for the whole family, everyone benefits more from it.

- Yeah I think the child would be depending on the game. But I think you should play the game for a while until there is a pattern (system). During that time, the child depends a lot on the game. But then, as a parent, you have to say that the game will only be used during dinner times. You go from 3 times a day, to two times a day, to one time a day. You have to phase it out. And you can make that visual, with icons for example. - It depends on the child whether the dependence is a problem. You can make a week schedule showing what the plan is, by working with crosses or something, or with icons every day if they do not understand the weeks yet.
- If the game stops working I would manually play the game. (would a child accept that?) I think so. I would do that to keep the pattern. (about coming up with something else) Yeah alright, but we are quite creative, not every parent is like that ability or the energy for that. (asking whether it would be smart to be involved as a parent, when you are still building up the system) No, it is not smart. If parents take over, that could also turn into a pattern, and that's not smart. Maybe you could do something with a dice. So that you can always still use it as an escape, throwing the dice to decide the colour. I do think that giving the child a choice is too difficult.
- If I would forget the game, Yeah, that's then how it is. (about emergency set) But there are always unexpected situations for which you cannot be prepared. But we personally are really organised, and we have not forgotten important things for our sons. But we do have stuff that we need to carry with us.
- Yeah, I would use the game, I think as a parents you are open to anything if it can make sure that the kid eats the necessary food. (for nutrients and vitamins) I would probably start in the morning, because the children are then more awake and focused compared to the end of the day. At the end of the day they can deal worse with stimuli. We would only use it inside the family situation. Grandparents would be possible, but that's it. Otherwise, the child might feel bad about it, especially after the age of four. And, being realistic, it is not possible to sit one o one when you're not home.
- Yeah, I would recommend it to others.
- I am not really sure if our boys would accept the compliments or not. I am not sure how they would take it. But it wouldn't hurt, at most they wouldn't do something with the compliment. The train that is driving is by itself already enough as a compliment or reward for eating. The compliment is extra and less important.
- I agree that you should sit one on one with the child. I also think it is important because of the reactions of people, to be able to follow those. If you, as a parent, are just together with the child, it is easier to respond to what he does. You allow yourself to be more structured. If you are with more people on the table, there are more stimuli, there is more chaos and the system would work less well.
- It is a choice to let the game take over the function that the parent normally has. But by taking steps you can also make a shift to that the parent can take over this function again. Then you can play together eventually. (about not involvement parents) I think that as a parent you are already happy if your child is eating by using the game. Then finally you do not have fights anymore over eating, no stress, no worries.
- The child would understand the game just fine, the child will understand very quickly.
- It's just like with a dog, you teach him tricks. The upbringing of a dog you can almost copy for the upbringing of children. If you are clear, the child knows what he needs to do. You have to be clear and directly, it is more as if you are giving a command to the child. But it is clear, and especially for children with autism this is necessary
- (Reaction siblings?) I think in the beginning a bit jealous. Also depends on the age of the children. Especially for young children. (about eating only with the child with autism) I think so too that it is better to work just with one child first. I think

that an older child would get annoyed if he would not be involved. And the child with autism would get too much stimuli. So then the goal cannot be reached.
- (About dependence) I have wondered the same before, thinking: What if? (responding to participant 5) I think there are moments where the child will eat without using the game. Then you could ask, hey, at that time you were able to eat without using the game, could you do that at home too? You should not force the kid, but ask him if he could. You have to phase it out, not do everything at once. The child indeed depends a lot on the game while being in the phase of building up a system. - I would also reward the child. Not with something big like an electric car to play with, but more something like going for ice cream. (But would the child understand such a consequence? because they are very young) Participant 6 doubts, participant 5 says no. Participant 6: But you should not make any illusions, the child will not play the game for just half a year to then be done with it. Probably, it will take multiple years, maybe the child still plays the game when he is 7 years old. If it is necessary that the child is still playing the game at the age of 8, because the phasing out does not work, yeah, what do you do then? What should you do? At some point they will visit someone else, and they see that it can go differently, and then they might want to change. But well, I think it should not be such a problem if it takes longer than expected. At some point it will work, we have had the same with our sons, for example with sleeping alone.
- If the game stops working I would say: Oops, it doesn't work… That may also be the trigger to not need the game anymore. I would first try to fix it. I think it depends on the child whether or not he would accept it. And well, if it doesn't work, you should be creative. Maybe creating another kind of game. But yeah, at the moment you cannot do much about it. It depends on the child how he will take it. (about dice) Yeah for 3 kinds of food --> 2 blue, 2 green, 2 white. Maybe for 5 --> one free choice. Then you can find out really quickly what they like.
- Yeah, if I would forget the game, I don't know what we would do. You could have an extra emergency set in the car. We would probably have a 'crisps' day then. Or eat something that he likes.
- Yes, I would always try the game out. If you don't shoot, you always miss. I would start using them for dinner, that's the most important meal. I agree, only at home. And at school is definitely not an option, because everyone would look at them.
- I would definitely recommend it to others. From my point of view it could work, even though nobody knows at this point.

Effect on eating behaviour

- I think it has a positive effect. You have a time limit, for when the child should eat, so that is nice. Maybe you could put more train tracks in the beginning, to give the child more time.
- I think it will improve, especially when they are motivated by the game. I do not think that the driving of the train distracts too much from the eating part. When they are eating, the train is not moving. And then after they ate, the train will drive again.
- I think my daughter could get really enthusiastic by playing the game. And that it could make the dinner time more enjoyable for everyone, instead of always having this fight over eating.
- My daughter is also competitive, so she wants to do exactly what she is told to do. So when she pushes the button, and it says "well done!", then you got her, that's what makes her the most happy. So I was surprised by how those things were linked, and I think it could work really well.
- You can use this well for a moment where the goal is to teach the child to eat. For practicing it would be very fun and work nicely.

- In the beginning it will work well, because everything new is awesome. But at a certain point the children will not feel like playing anymore, and then they won't eat anymore.
- It takes time to make it work, but I think you can make a system out of it over time. (about the food that the child will eat) I think as a parent you should be on one line about what you want your child to eat. For example, if the child does not eat potatoes but does eat mashed potatoes, then at least he gets the nutrients and vitamins that he needs. But as parents you have to agree on that, you should be clear about what the goal is that you want to reach. You should not put your expectations too high, not for yourself and also not for the child.
- But you should not have the illusion that the child will suddenly start to eat everything. There will always be certain kinds of food that they will not eat. Our children have the same. For example, red vegetables is something they do not eat.

Appendix 14 – Table with overview opinions participants

	p1	p2	p3	p4	p5	p6
Look and Feel						
Easy to play the game	x	x	x	x	x	x
Fun to play the game	x	x	x	x	x	x
Game is simple / boring but fits the target group	x	x	x		x	x
Train driving too fast?	YES	NO				
Change train into horse, car or dog	YES				NO	NO
Do not add music, too distracting	x	x	x	x	x	x
Add counting rounds?	NO	NO	YES/NO	NO	NO	NO
Sound and compliments fit the target group	x	x	x	x	x	x
Parents will find their own way to adjust for the specific child		x		x	x	x
Annoying that game takes over task of parents?		NO	NO		NO	NO
Add station		x	x	x		
Volume knob is important			x			
Add wagons			x	x	x	
Add train or station for sibling			x	x		
Put a setting: only hear the setting twice (avoid gaming)					x	
Add a reward when train has driven 4 rounds (eg adding a wagon)					x	x
Integrate plate in game			x			
More steps before tasting				x		
Change holes of speaker (stimuli poor)						x
Usage of the game						
Use it now?	NO	NO	YES	YES	YES	YES

Use it during dinner time?	NO	YES	YES/NO	YES/NO	YES/NO	YES
Use it for learning trying new food?	YES	YES	YES	YES	YES	YES
Does child understand the game?	YES	YES	YES	YES	YES	YES
Does child like the game?	YES	YES/NO	YES/NO	YES	YES	YES
Is child motivated by the game?	YES	YES	YES	YES	YES	YES
Should siblings be involved?	YES	YES	YES	YES	NO	NO
Use it during lunch?		YES		YES	YES	
Do you take the game to other places?	NO	YES	YES	YES	NO	NO
Is child dependent on the game			YES	YES	YES	YES
Parents will find a solution when game is not working / missing			YES	YES	YES	YES
Effect of game on eating behaviour						
Does the game have a positive effect?	YES	YES	YES	NO	YES	YES