

MASTER THESIS FEMKE STEEG



Motivating children to eat healthy with a serious game

A STUDY ABOUT THE EFFECT OF THE CONTEXT AND ACHIEVEMENT
TYPE OF REWARDS IN SERIOUS GAMES ON ENGAGEMENT AND
INTRINSIC MOTIVATION FOR HEALTHY FOOD CHOICES IN 8-12 YEAR
OLD CHILDREN

MASTER THESIS COMMUNICATION SCIENCE
Radboud University Nijmegen
in collaboration with Yellow Riders

Motivating children to eat healthy with a serious game

A Study about the Effect of the Context and Achievement Type of Rewards in Serious Games on Engagement and Intrinsic Motivation for Healthy Food Choices in 8-12 year old Children

Femke Steeg - S4360680

Master thesis

Master Communication Science – (Pro)social Communication

Radboud University Nijmegen

Supervisor:

Dr. S. de Droog

9999 words

June 25th, 2018

Preface

I hereby gladly present you the thesis “Motivating children to eat healthy with a serious game”. This thesis was part of the master program of Communication Science at the Radboud University Nijmegen. The writing and research process of this thesis took place from February to June 2018. The study has been conducted on behalf of the company Yellow Riders, a firm specialized in making games for health care objectives. This firm was interested in the effect of different types of rewards in serious games. Together with Ms. Cindy Dekkers from Yellow Riders and my supervisor Ms. Simone de Droog, I formulated the research question of this study.

After obtaining the Master Communication Science, it is my personal plan to enter the labor market. Because of this future perspective, I saw the execution of my master thesis as an opportunity to combine 'theory' (university) and 'practice' (labor market). On the one hand, it seemed very interesting to me to develop myself in the field of theoretical research. On the other hand, I really wanted my research to contribute to the practical field. This has led to the collaboration between the Radboud University in Nijmegen, the organization Yellow Riders and myself as being the executive researcher. Combining theory and practice appeared to be quite a challenge sometimes, but therefore I am extra proud that I successfully completed this thesis.

Fortunately, I had a lot of personal guidance and support from Ms. Simone de Droog during this process. Therefore, I want to thank her in special for her time, help and supportive feedback. I would also want to thank my fellow students from the working group, who supported me and provided me some additional feedback. I want to thank Ms. Cindy Dekkers from Yellow Riders for her time, support and thinking along with my research. Last but not least, I want to thank the game developers from Yellow Riders for not only developing, but also adjusting the game “Yoop Racer” many times for this research.

Summary

This study investigated to what extent different contexts and achievement types of a serious game reward influence game engagement and intrinsic motivation for healthy food choices among 8-12 year-old children. This study also examined whether gender moderates the associations between achievement type and both dependent variables. An experiment was conducted among 178 children on primary schools, in which children were randomly assigned to one of the four serious game reward conditions of the 2 (context: out-game versus in-game) x 2 (achievement type: personal versus social) between-subjects design.

This study did not find a significant effect of game reward context (out-game versus in-game rewards) on game engagement and intrinsic motivation for healthy food choices. Furthermore, this study did not find a significant effect of achievement type (personal versus social rewards) on game engagement. Contrary to expectations, this study did find that personal achievement reward systems significantly lead to more intrinsic motivation for healthy food choices than social achievement reward systems. Finally, the effect of achievement type on intrinsic motivation was not moderated by gender.

Table of contents

§1. Introduction	7
§2. Theoretic framework	9
§2.1 Definition of serious games	9
§2.2 Game attributes: rewards	9
§2.3 Functions of game rewards	9
§2.4 Game reward context	10
§2.4.1 Game reward context and engagement	11
§2.4.2 Game reward context and intrinsic motivation for healthy food choices	11
§2.5 Achievement type of game rewards	12
§2.5.1 Achievement type of rewards and engagement	12
§2.5.2 Achievement type of rewards and intrinsic motivation for healthy food choices	13
§2.6 Gender-based preferences: gender as moderator for achievement type	13
§2.7 Engagement as mediator	14
§3. Method	16
§3.1 Research design	16
§3.2 Participants	16
§3.3 Procedure	17
§3.4 Stimulus materials	18
§3.5 Pre-test	20
§3.6 Measures	21
§3.6.1 Game engagement	22
§3.6.2 Intrinsic motivation	25
§3.6.3 Gender	26
§3.6.4 Control variables	27
§4. Results	28
§4.1 Descriptive findings	28
§4.2 Main effects	28
§4.2.1 Effects of reward context and achievement type on game engagement	28
§4.2.2 Effects of reward context and achievement type on intrinsic motivation for healthy food choices	29
§4.3 Moderating effects	30
§4.3.1 Gender as moderator of the effect between achievement type on engagement	30
§4.3.2 Gender as moderator of the effect between achievement type on intrinsic motivation for healthy food choices	31
§4.4 Engagement as mediator	32

§4.4.1 Engagement as mediator of the association between reward context and intrinsic motivation for healthy food choices	32
§4.4.2 Engagement as mediator of the association between achievement type and intrinsic motivation for healthy food choices	33
§5. Conclusion and discussion	34
§5.1 Conclusion.....	34
§5.1.1 Game reward context and engagement	34
§5.1.2 Game reward context and intrinsic motivation for healthy food choices	34
§5.1.3 Achievement type of rewards and engagement.....	35
§5.1.4 Achievement type of rewards and intrinsic motivation for healthy food choices.....	36
§5.1.5 Moderating effect of gender	36
§5.1.6 Mediating effect of engagement.....	37
§5.2 Strengths and limitations	37
§5.3 Scientific and practical implications	38
References	40
Appendix 1 – Informed consent letter to parents.....	48
Appendix 2 – Instruction about research and serious game “Yoop Racer”	50
Appendix 3 – Complete questionnaire	51
Appendix 4 – Rewards in Yoop Racer before (A) and after pre-test (B)	54

§1. Introduction

Overweight and obesity are major public health concerns (Seidell & Halberstadt, 2015; Williams, Mesidor, Winters, Dubbert & Wyatt, 2015). The Global Burden of Disease study indicated that in 2015, obesity worldwide affected 107.7 million (98.7-118.4) children and 603.7 million (588.2-619.8) adults. Although the prevalence of childhood obesity was lower than in adults, childhood obesity has more rapidly increased in the past few decades (GBD 2015 Obesity Collaborators, 2017). Excessive weight is associated with many health related problems, such as cardiovascular disease, type 2 diabetes mellitus, cancer, osteoarthritis (Guh et al., 2009; Visscher & Seidell, 2001), work disability and sleep apnea (Visscher & Seidell, 2001). It can also lead to psychosocial problems, affecting children's social and emotional well-being, their self-esteem (Sahoo et al., 2015), and their risk of developing mental illnesses (Hatzenbuehler, Keyes & Hasin, 2009; Taylor, Forhan, Vigod, McIntyre & Morrison, 2013).

Giving the growing prevalence of childhood overweight and health related concerns, interventions for both preventing and treating these problems are of great importance (Karnik & Kanekar, 2012; Visscher & Seidell, 2001). Over the past decades, multiple interventions have been implemented, varying from policy to school-based approaches (Williams et al., 2015). Participation in intervention programs showed particularly good results among younger children of 8- to 12- year old, stressing the need for early prevention (Epstein, Valoski, Kalarchian & McCurley, 1995; Reinehr, Kleber, Lass & Toschke, 2010). Although meta-analyses showed positive effects on overall activity levels (Metcalf, Henley & Wilkin, 2012) and cardio-metabolic outcomes (Gonzalez-Suarez, Worley, Grimmer-Somers & Dones, 2009; Harris, Kuramoto, Schulzer, Retallack, 2009; Ho et al., 2013; Oude Luttikhuis et al., 2009; Wilfey et al., 2007), children's lack of motivation can form an important barrier which diminishes positive outcomes (Story et al., 2002).

A promising new area of interventions is provided by computer games. Multiple studies showed that computer-based learning tasks are more engaging for children than instructional methods (Barrera, Rule & Diemart, 2001; Tüzün, Yilmaz-Soylu, Karakus, Inal & Kizikaya, 2009; Wrzesien & Raya, 2010). Computer games in which an educational value is added to the narrative are defined as "serious games" and can have direct or indirect positive psychological and physiological effects on individuals (Susi, Johannesson & Backlund, 2007). Serious games can be applied in a broad spectrum (Susi et al., 2007) and have proven to be effective in healthcare objectives (Zyda, 2005). Serious games appear to be better able to encourage and motivate children to learn about health-related topics than traditional

instructional methods (Yussoff, Crowder, Gilbert & Wills, 2009). Moreover, according to a meta-analysis, games are able to impact motivation and goal setting behavior (Quelly, Norris & DiPietro, 2016). One study even found an effect on actual eating behavior: children were twice as likely to eat breakfast after playing a mobile game app with a virtual pet, compared to children in a control condition (Pollak et al., 2010).

One possible reason that serious games work is because they use rewards: game elements such as badges, points and virtual goods which can be obtained by achieving predetermined performances (Richter, Raban & Rafaeli, 2015). Rewards are able to provoke engagement, by stimulating behavioral and emotional interactivity with the game (O'Brien & Toms, 2010). Engagement is defined as involvement with the task, more time spent on the task, commitment and the sustained effort to pursue goals and challenges (Garris, Ahlers & Driskell, 2002). However, the main goal of game rewards is to motivate children intrinsically, which means engaging in an activity primarily for its own sake (Deci, 1975). Previous research already indicated that game rewards are effective in increasing intrinsic motivation for behavior with low initial interest (Deci, Koestner & Ryan, 1999).

Although consuming healthy foods is considered a low interest task (Cooke et al., 2011; Horne, Hardman, Lowe & Rowlands, 2009), the effect of game rewards on intrinsic motivation for healthy food choices has not been investigated yet. Also, little is known about different characteristics of game rewards. For instance, rewards can vary in the *context* they are obtained: within the gaming context (virtual) or outside the gaming context (real life). Furthermore, the *achievement system* in which rewards are displayed can be personal (visual for the user) or social (visual for all game users) (Hamari & Eranti, 2011). For this reason, the current study investigates the following research question:

“To what extent does the context and the achievement system of a serious game reward have an effect on game engagement and intrinsic motivation for healthy food choices among 8-12 year old children?”

§2. Theoretic framework

§2.1 Definition of serious games

The current literature provides various definitions of serious games. According to Ritterfeld, Ute, Cody and Vorderer (2009, p.6): “a serious game is any form of interactive computer-based game software for one or multiple players to be used on any platform that has been developed for more than entertainment.” Serious games are designed for promoting a predefined and desired action (Susi et al., 2007), by enhancing intrinsic motivation for the target behavior. Serious games are able to do so via various aspects of game design, such as challenge, fantasy, curiosity, choice and control (Lepper & Malone, 1987).

§2.2 Game attributes: rewards

Game attributes are the mechanics of serious games that support engagement and motivation, including interaction, feedback, goals, challenges, and rewards (Wilson, 2009; Yussoff et al., 2009). In this study, game rewards will be the main topic of interest. A game reward is defined as a certain arrangement in the game, which motivates players to keep learning (Yussoff et al., 2009). Game rewards can be gained by completing certain achievements: “game-defined goals whose fulfilment is defined through activities and events within the game” (Hamari & Eranti, 2011, p.4). Examples of game rewards include the possibility of earning points, badges or (virtual) items, playing minigames and monitoring performances through progress-bars or leaderboards (Richter, Raban & Rafaeli, 2015).

§2.3 Functions of game rewards

Engagement

An important function of game rewards is that they can enhance feelings of engagement within the game. To further explain this concept, the user-engagement model for video games and learning environments of O’Brien and Toms (2010) will be discussed. This model states that the intensity of perceived user-engagement is dependent on several system-specific and user-specific attributes. System-specific attributes are related to the usability and usefulness of the system (O’Brien & Toms, 2010): players who form positive judgement about the perceived usability of a computer-based task, will be more actively engaged in gameplay (Wiebe, Lamb, Hardy & Sharek, 2014). User-specific attributes consist of hedonic qualities of players, including interest, satisfaction and focused attention (O’Brien & Toms, 2010). Game rewards can be effectively used to enhance engagement in games, because they improve user

specific attributes of engagement such as concentration and gaming experiences (Ronimus, Kujala, Tolvanen & Lyytinen, 2014).

Intrinsic motivation

Another important function of game rewards is to enhance intrinsic motivation for the target behavior. However, previous research about game rewards on intrinsic motivation shows varying results: while a number of studies show that extrinsic rewards undermine intrinsic motivation (Deci, 1975; Lepper, Greene & Nisbett, 1973), other meta-analyses indicated that rewards enhanced intrinsic motivation under specific conditions (Cameron & Pierce, 1994; Deci et al., 1999). The overjustification hypothesis gives an explanation for the detrimental effect of rewards: when individuals obtain rewards for performing already interesting activities, they will attribute their behavior to the external reward, instead of perceiving it as self-initiated (Lepper et al., 1973; Lepper & Greene, 1975). When taken the initial interest in the target behavior into account, it was found that rewards did not undermine intrinsic motivation for low-interest tasks (Deci et al., 1999) and could even increase intrinsic motivation for these tasks (Cameron, Banko & Pierce, 2001).

The target behavior of the current study – intrinsic motivation for healthy food choices – can be considered a low interest task (Cooke et al., 2011; Horne et al., 2009). Previous research demonstrated that game rewards can be effectively used to motivate children to perform health-related low-interest tasks, such as exercising (Epstein, Beecher, Graf & Roemmich, 2007) and consuming fruit and vegetables (Horne et al., 2011; Lowe, Horne, Tapper, Bowdery & Egerton, 2004; Wengreen, Madden, Aguilar, Smits & Jones, 2013). One possible reason that rewards in health games work, is that the positive feelings of enjoyment in these games can result in implicit, positive associations with healthy food. Consequently, these associations possibly lead to conditioned responses, such as motivation or behavioral intention (Baranowski, Buday, Thompson & Baranowski, 2008). Another explanation is that rewards prime game-achievements which are in line with the goal directed behavior (Papies, 2016), in this case healthy food choices.

§2.4 Game reward context

As mentioned earlier, one form of game rewards is the possibility of granting (virtual) items for certain game-achievements. There are a number of reasons for the motivational aspect of items: they represent past achievements (Gnauk, Dannecker & Hahman, 2012), convey mastery in the game and social status (Cross, 2009; Fu, 2011) and fulfil the desire of

collecting (Gnauk et al., 2012). This study will investigate the different contexts in which virtual items can be granted. When the item-granting system consists of virtual items given within the gaming context, they are defined as *in-game rewards*. An example is a virtual item that can be used by a player or avatar (Fu, 2011). When the item-granting system consists of non-virtual items given external to the gaming context, they are defined as *out-game rewards*. These latter rewards consist of items that are not part of the gaming context and can be obtained in real life (Hamari & Eranti, 2011), for example a discount in a certain shop.

§2.4.1 Game reward context and engagement

Previous research did not focus on the effect of the game reward context on engagement, but expectations about this relation can be formed based on the flow-theory (Csikszentmihalyi, 1990). This theory describes the positive experience of being fully engaged as “flow”: a state in which people are so involved in an activity that nothing else seems to matter” (Anderson, 2011, p. 162). A state of flow can be reached when individuals are optimally challenged, fully focused and so immersed in the game that they lose track of time (Csikszentmihalyi, 1990; Elliot & Harackiewicz, 1994). The degree of immersion in a game is dependent on multiple factors, including control-, sensory-, distraction- and realism factors. Distraction factors relate to the extent to which players are isolated from the external physical environment (Witmer & Singer, 1994, as cited in Garriss et al., 2002). Because in-game rewards are obtained within the gaming context, while out-game rewards are obtained external to the gaming context, players will be more isolated from the external physical environment when receiving in-game rewards. Therefore, it is expected that in-game rewards will be more immersive and thus more engaging than out-game rewards. Consequently, based on the flow-theory of Csikszentmihalyi (1990), the following hypothesis is formed:

H1: In-game rewards will lead to more engagement in the game, compared to out-game rewards (Figure 1).

§2.4.2 Game reward context and intrinsic motivation for healthy food choices

This is the first study to examine the effect of the game reward context (out-game versus in-game) on the intrinsic motivation for healthy food choices. Previous research does not lead to certain expectations about which game reward will be better able to provoke intrinsic motivation. Therefore, the following research question has been formed;

RQ1: To what extent does the game reward context influence the intrinsic motivation for healthy food choices? (Figure 1)

§2.5 Achievement type of game rewards

An achievement system stores information about the achieved goals of a game and the specific reward linked to that achievement (Hamari & Eranti, 2011). The achievement system provides a virtual representation of accomplishments in the personal game profile (Vassileva, 2012). This can have different functions. An achievement system that is only visible for the player itself has a personal function, because it encourages players to break their own records (Wang & Sun, 2011). The information of an achievement system can also be based on the ranking of the user relative to the scores of other players. This has a social function, because other players can form opinions about the player's performances in the game (Vassileva, 2012). In the current study, it will be tested how different achievement types of rewards influence game engagement and intrinsic motivation for healthy food choices.

§2.5.1 Achievement type of rewards and engagement

The achievement types of game rewards (personal versus social) play in on different human desires. While personal achievement systems create a sense of accomplishment and status (Wang & Sun, 2011), reputation can only be earned when achievements are visible for other players (Vassileva, 2012). The ability to compare achievements to other players provokes competition (Medler & Magerko, 2011). Children become sensitive for competition from the age of eight, growing their desire to gain reputation (Erikson, 1959). Although previous research suggested the importance of competition elements in games for engagement (Lepper & Malone, 1987; Richter et al., 2015), this is the first study to investigate the effect of personal versus social achievement systems. Based on the strong preference for competition and reputation of the target group and based on the ability of social achievement systems to provoke competition, the following hypothesis has been formed:

H2: A game reward with a social achievement system will lead to more engagement in the game, compared to a personal achievement system (Figure 1).

§2.5.2 Achievement type of rewards and intrinsic motivation for healthy food choices

In the current literature, many theories provide arguments for the strong effect of status and reputation on intrinsic motivation. Although this is the first study that focuses on the effect of achievement types on intrinsic motivation for healthy food choices specifically, it is expected that the same theories will apply. First, the social comparison theory states that people tend to compare themselves with similar others, in order to evaluate and enhance their beliefs and abilities (Festinger, 1954). Consequently, people strive towards an “unidirectional drive upward”: they constantly wish to improve their position relative to similar others (Wood, 1989). This can explain the motivational aspect of social achievement systems, in which children compete with each other (Vassileva, 2012). Another theory that forms a suitable explanation is the self-efficacy theory (Bandura, 1977). This theory states that high levels of perceived self-efficacy are related to an increase in intrinsic motivation. Perceived self-efficacy is defined as the personal judgement of the ability to perform specific activities. This is influenced by the experience of observing others’ performances (Bandura, 1982), which is possible in social achievement systems. Both theories point out the importance of status and reputation for intrinsic motivation, which are evoked more by a social achievement system. Therefore, the following hypothesis is formed:

H3: A game reward with a social achievement system will lead to a higher intrinsic motivation for healthy food choices, compared to a personal achievement system (Figure 1).

§2.6 Gender-based preferences: gender as moderator for achievement type

There are different motivations to play (serious) games: achievement-, social- and immersion motives. Whereas achievement motives refer to the desire to gain advancement and to challenge and compete with other players, social motives refer more to the desire to develop relationships with other players (Yee, 2006). In general, females appear to be more interested in the social aspects of games while male players tend to be more interested in achievement and competition (Lucas & Sherry, 2004; Yee, 2006). Male players even experience more positive emotions during competitive play than during cooperative game play (Kivikangas, Kätsyri, Järvelä & Ravaja, 2014). Based on their preference for competition elements, it is expected that male players are more engaged and motivated by social achievement systems – in which competition is provoked – compared to female players. Therefore, the following moderation hypotheses have been formed:

H4a: The effect of achievement type on engagement is stronger for boys (Figure 1).

H4b: The effect of achievement type on intrinsic motivation for healthy food choices is stronger for boys (Figure 1).

§2.7 Engagement as mediator

This study investigates to what extent different characteristics of game rewards have an effect on engagement in the game and intrinsic motivation for healthy food choices, because most studies about rewards consider engagement and intrinsic motivation as two non-related outcome variables. However, Csikzentmihalyi's theory of flow (1990) states that people are optimally motivated when they are engaged in a challenging task, suggesting that engagement is an important predictor for intrinsic motivation. This assumption has only been tested in one study. Berkovsky, Coombe, Freyne, Bhandari and Baghaei (2010) showed that player engagement in computer games led to motivation for performing physical activities while playing the game. Therefore, the current study will investigate whether game engagement is a predictor for intrinsic motivation. The last two hypotheses of this study are presented below:

H5a: Engagement in the game mediates the effect of the game reward context on intrinsic motivation for healthy food choices (Figure 1; dotted orange path).

H5b: Engagement in the game mediates the effect of the achievement type on intrinsic motivation for healthy food choices (Figure 1; dotted green path).

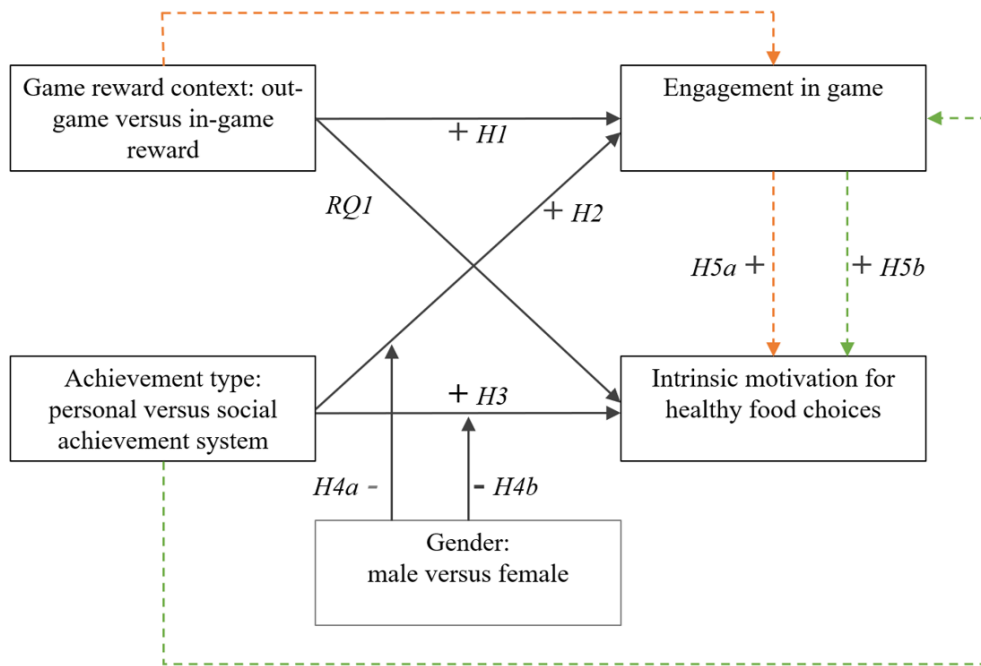


Figure 1. Conceptual model of the research question: “To what extent does the context and the achievement system of a serious game reward have an effect on game engagement and intrinsic motivation for healthy food choices among 8-12 year old children?”

§3. Method

§3.1 Research design

In order to investigate the research question, an experimental research design was used. This made it possible to manipulate the independent variables, while controlling for other possible confounding variables (Field, 2013). This was beneficial for the internal validity. A 2 x 2 between-subjects design with two levels of reward context (out-game reward versus in-game reward) and achievement type (personal versus social achievement) was used. The between subject design avoids interferences between groups and is therefore an eligible research method to investigate the solid effect of the independent variables (Van den Bercken & Voeten, 2002). The participants were randomly assigned to one of the four conditions (in-game reward + personal achievement: $n = 46$, in-game reward + social achievement: $n = 45$, out-game reward + personal achievement: $n = 45$, out-game reward + social achievement: $n = 42$).

§3.2 Participants

The target group of this study consisted of children between 8- and 12- years old. The participants were recruited from five primary schools in Nijmegen (Montessori, $n = 27$; Petrus Canisius, $n = 12$), Uden (Kindcentrum Aventurijn, $n = 43$), Heesch (Emmaus, $n = 79$), Vinkel (Mariaschool, $n = 13$) and one after-school-care in Heesch (Het Beertje, $n = 4$), which gave written consent to participate in the study. Three to two weeks before the research, parents received a letter (written or online) with detailed information regarding the aim and procedure of the research (Appendix 1). It was empathized that all collected data would remain confidential and that children could quit participating at any time. Parents had to respond actively to the enclosed consent statement at least one week in advance. In total, the active consent statement was sent to the parents of 309 children: 183 parents filled in the form and two parents objected. Three participants were excluded from the dataset: one child didn't meet the eligible criteria (age >12) and two children were excluded because the game didn't work properly on the laptop. Eventually, the final sample consisted of 178 children ($M_{age} = 10.225$, $SD_{age} = 1.050$; 54.59% female).

Matching procedures were used to make the experimental groups equal on gender, age and geographical area characteristics (rural area versus city). To avoid any effect of the different schools, the conditions were also randomized within the school. In addition, every

experimental day started off with a different condition to avoid order effects. The distribution of the demographics over the conditions is displayed in Table 1.

Table 1.

Distribution of the demographics over the four experimental conditions (n = 178)

	In-game reward + personal achievement (n = 46)		In-game reward + social achievement (n = 45)		Out-game reward + personal achievement (n = 45)		Out-game reward + social achievement (n = 42)	
		%		%		%		%
Gender (female)	24	52.17	23	51.11	24	53.33	26	61.90
Class/group								
Group 5	11	23.91	4	8.88	4	8.88	5	11.90
Group 6	8	17.39	15	33.33	16	35.56	9	21.42
Group 7	12	26.09	14	31.11	13	28.89	18	42.86
Group 8	15	32.61	12	26.67	12	26.67	10	23.81
Geographical area (city)	27	58.70	19	42.22	23	51.11	13	31.00

§3.3 Procedure

The data collection of this study occurred between April till May 2018. Research indicated that an experiment in small groups of approximately five participants is optimal for children in early middle childhood (ages 7 to 10) (De Leeuw, 2011). Therefore, groups of 4-5 participating children were taken out of the classroom one by one and taken to a quiet room. For each participant, there was a laptop and plug-in ears or a headphone. The researcher then shortly introduced herself and the research assistant (a fellow student of the University). The research assistant helped with general, practical assistance during the experiment and made it possible for the researcher to function as a motivating moderator and to observe the group (Morgan, Gibbs, Maxwell & Britten, 2002). After the introduction, the researcher read out a short and predefined instruction, which included the rules of the game “Yoop Racer” (Appendix 2). The instructions stated that the participants had to move the virtual pet “Yoop” over the streets, by picking up only the healthy foods. It was explained that the participants were able to play the game for ten minutes and that they had to restart the game every time it ended. Before starting the game, the participants filled in their name in the name box on the screen, which enabled them to see their name and corresponding score on the game-screen. Afterwards, the researcher gave a start sign for playing the game.

In the conditions with the in-game reward, participants automatically received the rewards (stickers) in a virtual way within the game. The participants received those rewards after breaking a new high score or when achieving a second or third best score. In the out-game reward conditions, the participants received similar images for exactly the same achievements, but in the form of a sticker in real life. The researcher and research assistant were responsible for handing out these stickers: they watched the screens of the participants and put a sticker on their cardboard when achieving a first, second or best score.

After nine minutes, the researcher gave a sign that the participants had the chance to finish their current game and then had to press the “quit” button. The warning after nine minutes made sure that children did not have to stop abruptly and that the average playing time was approximately ten minutes. When all children finished, the researcher handed out the questionnaires. The participants were instructed to carefully read the questions and to choose only one answer. It was emphasized that there were no right or wrong answers and that they could ask for explanation for difficult words or questions. After each session, the reset button was pressed to erase the high scores and obtained rewards of the previous group. In the time schedule of this experiment, the short attention span of 8- to 12-year old children (Delfos, 2000) was taken into account: the total time of one experimental round was approximately 30 minutes, whereof 20 minutes for listening to instructions and filling in questionnaires and 10 minutes for playing the game.

§3.4 Stimulus materials

The serious game “Yoop Racer” (<http://d54.incourse.eu/343f589bec5e/?view=Start>) was developed by a professional game designer from Yellow Riders, a company specialized in making serious games for health organizations. The Yoop Racer game is a simplified version of the game “Hello Yoop”, a virtual pet that functions as a life style coach for children to eat healthy (Yellow Riders, 2018). The aim of Yoop Racer is to bring *Yoop* as far as possible. The rules for the game were (1) to pick up as many healthy foods to give *Yoop* more energy, and (2) to avoid the unhealthy foods and cars. The unhealthy foods were thrown on the road by villains “*Sugerman*” and “*Transvetje (Trans Fatty)*”. In developing this game, several characteristics that are known to encourage children’s motivation were applied. First, the game is challenging, because the game becomes more difficult with each level: more unhealthy foods appear in the game at a faster pace. Second, fantasy elements were established by creating a cartoonish world with virtual characters (*Yoop*, *Sugerman* and *Transvetje*). Finally, curiosity was provoked because children did not know how the

characters and props would respond in the game (Malone, 1981). Important features that were used to engage children in the game were the aesthetics and sound effects of the game (O'Briens & Toms, 2010): *Yoop* made a pleasant sound when eating healthy food and an unpleasant sound when bumping into a car or eating unhealthy food. Furthermore, *Sugerman* and *Transvetje* made unpleasant laughing sounds.

The game was exactly the same for the four conditions, except for the manipulated independent variables. The type of reward context (out-game versus in-game reward) was manipulated by giving the same rewards for the same achievements in both versions, but provided in a different way. The rewarding system was set up so that participants received: (1) an image of *Yoop* when breaking a new high score, (2) an image of *Sugerman* or *Transvetje* when achieving the second score in ranking, and (3) an image of a healthy food product when achieving a third score in ranking. When not achieving a first, second or third best score, children received no reward. After children finished the game, the score and a corresponding text about whether children earned a reward (e.g. "congratulations.." or "too bad..") popped up on the screen. The rewarding images in the in-game reward condition were given virtual and displayed on the start-screen of the game. In the out-game condition, the images had the form of real life stickers displayed on a cardboard (Figure 2).

The achievement type of the reward (personal versus social achievement) was manipulated by differences in the insight of the scores. In the personal conditions, children were only able to see their *own* top three scores on a progress-bar. In the social conditions, children were also able to see the scores of the other participants in the group. The top three scores were displayed on the screen while playing the game, which made it possible for children to compare their own scores with the ranking of the group. The ranking was reset after each experimental round (Figure 3).

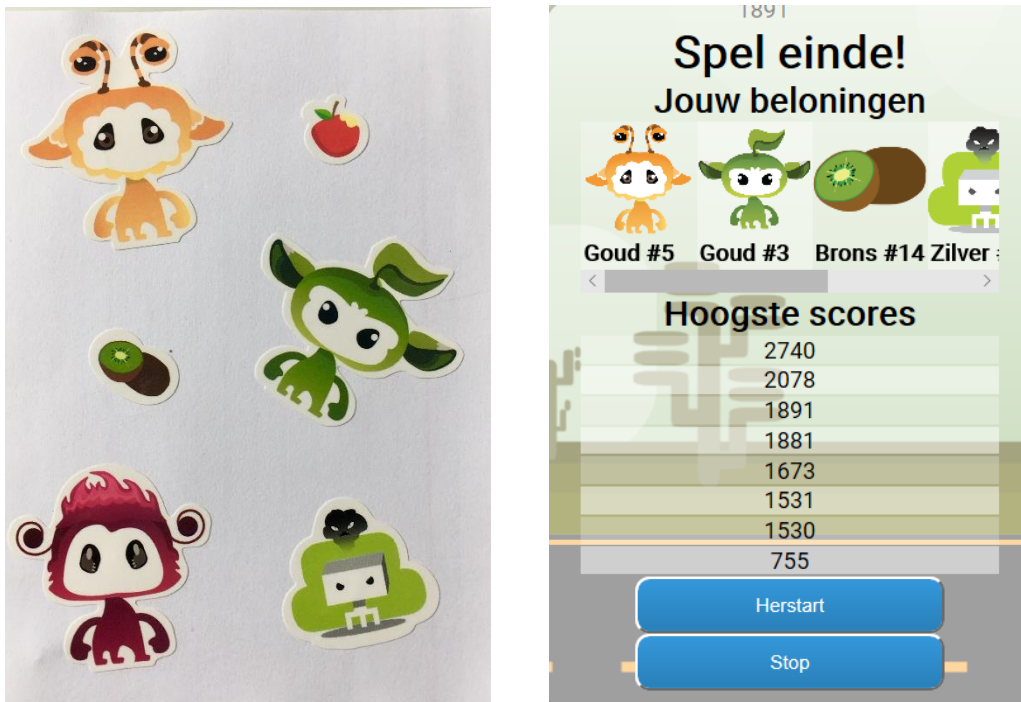


Figure 2. Out-game reward (left) versus in-game reward (right)



Figure 3. Personal progress-bar (left) versus social ranking (children filled in their own name) (right).

§3.5 Pre-test

In the week before the first experiment, a short pre-test was conducted. This pre-test took place in the form of a manipulation check, in which the rewards and the difficulty of the game were evaluated. This manipulation check was important, because the rating of the rewards and the perceived difficulty can influence the game engagement. In order to test these game features, items 30 till 33 of the questionnaire in appendix 3 were used, and additional observations were made during game play. The pre-test was conducted among 12 participants of the Montessori primary school in Nijmegen (58,33% female; $M_{age} = 11.00$, $SD_{age} = .739$). The participants played the game for ten minutes in groups of four persons. Afterwards, the participants filled in questions about the rewards, such as “*Did you like the stickers in the*

game?” (items 30-32), and one question about the difficulty of the game (item 33). The results indicated that children liked the rewards ($M = 3.083$, $SD = .842$, *range 1-4*), and that they thought the game was a little bit easy ($M = 1.417$, $SD = .515$, *range 1-4*).

Observations during game play showed some additional and interesting results. The game did not work properly on the computers. After a few minutes a lag occurred, which caused the game to falter and jam. The participants responded irritated and made some comments about this. After consultation with the game designer, it was concluded that the game only works properly on laptops with a video card and a software program that is supported by the game. Therefore, the researcher brought five suitable laptops to each experiment. Another important observation was that the participants really liked the rewards and were committed in getting an image of *Yoop*, more so than of the villains *Sugerman* and *Transvetje*. In turn, images of the villains were perceived as more appealing than images of food products. This observation implicated that the chosen rewards were already given in a correct order.

Another adjustment that was made after the pre-test is that participants only received a reward after improving their high score, or second and third best score. In the pre-test version of the game, the participants gained engagement-contingent rewards, meaning that children received rewards after each gaming round for simply engaging in the game. This made it very easy for children to gain rewards and – in line with previous research (Cameron & Pierce, 1994; Pierce, Cameron, Banko & So, 2003) – appeared to decrease children’s intrinsic motivation. Therefore, a performance-contingent scheme was implemented in the game, meaning that children only received rewards for first, second or third best scores. This adjustment also made the game a little bit more challenging. Screenshots of the game before and after the pre-test can be found in Appendix 4.

§3.6 Measures

This section describes how the variables were operationalized. The variables were measured with a self-report questionnaire containing 34 questions about engagement, intrinsic motivation and controlling variables. A questionnaire is a suitable research method for the target group, because children are able to complete self-reports from the age of 7 (De Leeuw, 2003; De Leeuw, Borgers & Smits, 2004). However, there are some important survey prerequisites for children aged 8-12: (1) they do not understand negations or indirect questions, (2) the understanding of complex words should be checked, and (3) a neutral

answer category should not be included because children tend to opt out on these (De Leeuw, 2011). For this reason, statements were adapted to simple and concrete questions, complex words were avoided and neutral categories were removed from the response categories. In addition, given children's limited attention span (Delfos, 2000), the scales were shortened. The complete questionnaire with all measured scales can be found in Appendix 3, the item numbers are mentioned per variable.

A principal component analysis (PCA) was executed for all scales used in the questionnaire, in order to determine the scales to be one-dimensional. The criterium for all the factor analyses was that the eigenvalues should not be bigger than 1 (Field, 2013). Because all scales contained more than two items, an Oblique Rotation was applied. After that, reliability analyses were performed for all scales, with a Cronbach's Alpha of .70 considered to be reliable (Field, 2013). For all items that together formed a reliable scale, a new variable was constructed with the average score on this scale.

§3.6.1 Game engagement

Game engagement was measured with a revised version of the User Engagement Scale (UES) (Wiebe et al., 2014, $\alpha = .88$). The UES, developed by O'Brien and Toms (2010) is a tool to measure engagement during video game-play, but the revised UES demonstrated better psychometric properties than the original scale (Wiebe et al., 2014). Multiple adjustments were made to the questionnaire in order to be eligible for this research. First, the subscale 'aesthetics' was removed, because the game versions did not differ in the aesthetical elements. Second, the scale was translated into Dutch, and tailored to the target group in the way discussed above. An equal amount of items were removed from the three remaining subscales to shorten the scale.

A PCA with an extraction based on eigenvalues bigger than 1 showed an uninterpretable pattern matrix that was not corresponding with the current literature. Therefore, another PCA was conducted in which three factors were forced to be extracted. The pattern matrix showed more interpretable results and the three detected components were corresponding to the subscales of engagement in the revised UES (Wiebe et al., 2014). Three items appeared to be problematic, because they loaded on more than one component. Based on common sense and observations during the experiment, the following three items were removed: "*Did you feel you were encouraged during game playing?*" and "*Did you think the content of the game was interesting?*" (observations made clear that children didn't

understand these questions); and “*Did you become tired of playing the game?*” (children only played the game for ten minutes, so this item did not really fit the experimental setting). A new PCA with the removed items showed an improved validity (Table 2). Only three items (about the concept of losing track of time while playing the game) loaded different as expected: in addition to their category ‘focused attention’, they also loaded high on ‘satisfaction’. However, removing these items didn’t seem desirable, because losing track of time is considered an important feature of engagement and there were no logical reasons for removing these items. Removing more items did also not improve the Cronbach’s Alpha.

The adjusted engagement scale consisted of the following subscales: ‘focused attention’ (4 items, e.g.: “*Were you focused while playing the game?*”), ‘perceived usability’ (2 items, e.g.: “*Did you feel irritated while playing the game?*”) and ‘satisfaction’ (4 items, e.g.: “*Would you recommend this game to your friends and family?*”). The three subscales together were expected to measure game engagement and to form one scale (Wiebe et al., 2014). The answer options of the questionnaire were varying from (1) *No, definitely not*, to (4) *Yes, definitely so*. The complete scale for measuring engagement had a medium reliability ($M = 3.393$, $SD = .382$, $\alpha = .636$) and can be found in question 16 to 29 in the complete questionnaire (Appendix 3).

Table 2.

Factor analysis for Engagement

Item	Factor loading		
	1 (Satisfaction)	2 (Perceived Usability)	3 (Focused Attention)
Would you play the game again?	.822	.013	-.108
Did you like the experience of playing the game?	.750	.017	.014
Were you interested while playing the game?	.664	.019	-.009
Would you tell your friends or family this game is fun?	.692	.073	-.069
Did you forget the time while playing the game?	.558¹	-.012	.012
Did you forget the world around you while playing the game?	.369¹	-.419	.215
Did time pass by fast while playing the game?	.271¹	.173	.194
Did you feel irritated while playing the game? ²	.068	.756	.108
Did you feel frustrated while playing the game? ²	.167	.728	.022
Were you concentrated while playing the game?	.095	-.099	.764
Did you get distracted with other things or other classmates?	-.211	.124	.826
Eigenvalue	2.927	1.359	1.185
R ²	26.605	12.350	10.774
KMO	.760		

1: Items loaded high on satisfaction, while originally belonging to focused attention.

2: Items that were reverse coded, so that all items were coded in a positive direction

§3.6.2 Intrinsic motivation

To measure intrinsic motivation for healthy food choices, a selection of 15 items of the Intrinsic Motivation Inventory (IMI) was used (Ryan & Deci, 2000). The IMI was chosen because it covers a broad concept of intrinsic motivation, which can be adopted to specific target behaviors. This shortened version has already been effectively used in a pre- and post-test design for the effect of educational games on intrinsic motivation in younger, Dutch children (Vos, van der Meijden & Denessen, 2011, $\alpha = .73$). The short IMI version originally uses statements with a 5-point likert scale, but was also transformed to a 4-point likert-scale with questions instead of statements.

A PCA showed confusing and uninterpretable components and factor loadings. After multiple attempts of deleting problematic items and running the analysis again, the model did not improve. Therefore, it was decided to look at the reliability of the complete scale first. Although the complete scale already had a high reliability level ($\alpha = .793$), the reliability would increase to $\alpha = .810$ after deleting the item “*Do you think you’ll put much effort in choosing healthy food?*” Because of the large improvement ($>.05$), it was chosen to delete this item. When running a PCA without the removed item, the analysis showed the same three sub-components as in the study of Vos et al. (2011). The item “*Do you think it’s hard to choose healthy food?*”, was deleted because it loaded high on all three components. After repeating the analysis with the deleted variable, the PCA showed that the used scale still consisted of the same three subscales as described in the literature (Table 3): ‘interest’ (6 items, e.g.: “*Do you think you’ll like to eat healthy?*”), ‘perceived competence’ (3 items, e.g.: “*Do you think you’ll be good at eating healthy?*”) and ‘effort’ (4 items, e.g.: “*Do you think you’ll put much effort in eating healthy?*”). The answer options of the questionnaire were varying from (1) *No, definitely not*, to (4), *Yes, definitely* so. The full version of the shortened IMI was still found to be highly reliable ($M = 3.075$, $SD = .395$, $\alpha = .813$) and can be found in question 1 up to 15 in the complete questionnaire (Appendix 3).

Table 3.

Factor analysis for Intrinsic motivation for healthy food choices

Item	Factor loading		
	1 (Initial interest)	2 (Relevance/ effort)	3 (Perceived competence)
Do you think you'll like eating healthy?	.674	.047	.214
Do you think you'll like choosing healthy foods?	.802	-.103	.019
Do you think choosing healthy food is boring? ¹	.488	.287	-0.54
Do you think you'll be skilled to choose healthy food?	.572²	.060	-.016
Do you think choosing healthy food is interesting?	.637	.018	-.150
Do you think healthy eating is fun?	.740	-.101	.227
Do you think you'll try to eat healthy?	.121	.759	-.026
Do you think you'll do your best to eat healthy?	-.002	.769	.110
Do you think it's important to eat healthy?	-.095	.725	-.033
Do you think you'll put much effort in eating healthy?	.161	.451	.185
Do you think you'll be good at eating healthy?	.089	-.039	.807
Do you think you'll be good at eating healthy, compared to your classmates?	-.028	-.006	.692
Do you think you'll be satisfied with how healthy you'll eat?	-.015	.235	.503
Eigenvalue	4.156	1.470	1.031
R ²	31.972	11.310	7.934
KMO	.845		

1: Items that were reverse coded, so that all items were coded in a positive direction

2: Item loaded high on initial interest, while originally belonging to perceived competence.

§3.6.3 Gender

Gender is expected to be a moderator. It was measured with one question, and coded as a dummy variable: "I am a boy/ girl" (boy = 0, girl = 1).

§3.6.4 Control variables

This study included four control variables: age, class/group, liking of the rewards and perceived difficulty of the game. First, it was expected that age influences engagement and intrinsic motivation of children. During the 8-12 years, children develop more reasoning, memory and language skills (De Leeuw, 2011), possibly changing their attitudes as they get older. Because the cognitive development of children might be more dependent on their class/group than their actual age, the class/group of a child was also taken into account. The score 5 was given to children from group 5, etc. ($M = 6.736$, $SD = 1.010$).

Children were also asked questions about the liking of the rewards. It was expected that children who do not like the rewards would show less effect in engagement and intrinsic motivation. The liking of the rewards was measured with the same three items as in the pre-test ($M = 3.375$, $SD = .625$). The final control variable was the perceived difficulty of the game. It was expected that when the game was experienced as easy, children would be easily bored. On the other hand, when children experienced the game as difficult, they could be easily frustrated. Both can diminish the effects of engagement and intrinsic motivation. The same question as in the pre-test was used ($M = 1.815$, $SD = .826$).

A correlation analysis (Pearson r) was conducted to measure the correlations between the control variables and the dependent variables (Table 4). There was a positive significant correlation between the liking of the rewards and engagement. All other control variables did not correlate with the dependent variables. Therefore, only liking of the rewards was included as covariate in the analyses with engagement as dependent variable.

Table 4.

Correlations between control variables and dependent variables

Dependent variables	Control variables			
	Age	Class/ group	Liking of rewards	Perceived difficulty
	r	r	r	r
Engagement	.041	-.001	.316**	-.060
Intrinsic motivation for healthy food choices	-.088	-.106	.055	.007

* $p < .05$, ** $p < .001$

§4. Results

Before testing the hypotheses, randomization checks were conducted with a one-way ANOVA for age, and class/group. No statistical significant difference was demonstrated for age between the four experimental conditions ($F(3,174) = .328, p = .800$). There were also no significant differences for class/group between the experimental conditions ($F(3,174) = .096, p = .962$). For gender, a chi-square test was used to demonstrate that there was no significant difference in gender within the experimental groups ($X^2(3, N=178) = 1.262, p = .738$). This implies that the randomization of participants on gender, age and class/group over the experimental conditions went well.

§4.1 Descriptive findings

In this section, some general and notable results will be discussed. The participants of the experiment really liked the rewards in the serious game ($M = 3.375, SD = .625$). Strikingly, a marginally significant effect of the rewarding context on liking the rewards was found ($F(1,175) = 2.043, p = .052$), implicating that children in the out-game context ($M = 3.467, SD = .067$), might have liked the reward more compared to children in the in-game context ($M = 3.286, SD = .065$). In this experiment, the game was perceived as not really difficult, $M = 1.815, SD = .826$. However, the achievement type of reward was significantly associated with perceived difficulty ($F(1,75) = 4.163, p = .043$), meaning that children in the social achievement conditions perceived the game as more difficult ($M = 1.944, SD = .088$), compared to children in the personal achievement conditions ($M = 1.693, SD = .086$).

§4.2 Main effects

First, the main effects of this study are reported: it was investigated whether there was a direct effect of the reward context (0 = out-game, 1 = in-game) and achievement type of reward (0 = personal, 1 = social) on the dependent variables. These main effects were tested with ANCOVA analyses with engagement and intrinsic motivation for healthy food choices as dependent variables.

§4.2.1 Effects of reward context and achievement type on game engagement

To test the hypotheses of the effect of the reward context and the achievement type of reward on engagement, an ANCOVA was executed. The reward context and achievement type of a reward were the between-subjects factors and liking of the reward was included as covariate.

The first hypothesis (H1) predicted that children who gained in-game rewards would be more engaged in the game, than children who gained out-game rewards. This hypothesis was not supported by the results, $F(3,172) = .037$; $p = .848$. Children who received in-game rewards, did not show higher scores on engagement ($M = 3.397$; $SD = .038$) compared to children who received out-game rewards ($M = 3.387$; $SD = .040$).

The second hypothesis (H2) about the achievement type of reward, expected that children in the social achievement conditions would experience more engagement than children in the personal achievement conditions. The results also did not confirm this hypothesis, $F(3,72) = 3.542$; $p = .062$. Children who played the game with a social achievement system had equal scores on engagement ($M = 3.341$; $SD = .039$) compared to children who played the game with a personal achievement system ($M = 3.443$; $SD = .038$).

Because there were no main effects of the reward context and achievement type on engagement, it was investigated whether there was an interaction effect between the two independent variables on engagement. However, the added interaction term appeared to be not significant, $F(3,72) = .137$; $p = .711$). Therefore, it was concluded that both independent variables as well as the interaction of these variables did not have a significant effect on engagement, and hypotheses 1 and 2 were rejected.

§4.2.2 Effects of reward context and achievement type on intrinsic motivation for healthy food choices

To examine the research question about the effect of the reward context on the intrinsic motivation for healthy food choices (RQ1), and the hypothesis about the effect of the achievement type of reward on the intrinsic motivation for healthy food choices (H3); an ANOVA analysis was carried out. The reward context and achievement type were the between-subjects factors and intrinsic motivation for healthy food choices as dependent variable.

The research question asked whether out-game rewards or in-game rewards would have a bigger effect on the intrinsic motivation for healthy food choices. The results of the ANOVA showed no significant results, $F(3,171) = 1.094$; $p = .279$. Children in the in-game reward condition showed no significant differences on intrinsic motivation for healthy food choices ($M = 3.102$; $SD = .041$), compared to children in the out-game reward condition ($M = 3.041$; $SD = .042$). The hypothesis about the achievement type of a reward, predicted that children who played the game with a social achievement system would be more intrinsically

motivated to eat healthy than children who played the game with a personal achievement system. The results showed a significant effect of achievement type on intrinsic motivation for healthy food choices, $F(3,171) = 5.679$; $p = .018$. However, contrary to the expectations, children in the personal achievement conditions showed significant higher scores on the intrinsic motivation for healthy food choices ($M = 3.142$; $SD = .041$) compared to those in the social achievement conditions ($M = 3.001$; $SD = .043$). Because this significant effect was contrary to the expectations, hypotheses 3 was rejected. After adding an interaction term to the model, there was also no significant interaction effect of reward context and achievement type on intrinsic motivation for healthy food choices, $F(3,171) = 1.050$; $p = .307$.

§4.3 Moderating effects

The theoretic framework discussed that boys might be more sensitive for competition elements compared to girls. Therefore, it was expected that gender would moderate the effects between achievement type and engagement, and between achievement type and motivation for healthy food choices. These hypotheses were tested with PROCESS, a tool in SPSS designed for conducting moderation analyses (Hayes, 2013).

§4.3.1 Gender as moderator of the effect between achievement type on engagement

Although no main effect of achievement type on engagement was found, for completeness, this study also tested the predetermined hypothesis (H4a) that gender moderates the relationship between achievement type on engagement. Therefore a PROCESS model 1 analysis was conducted with achievement type as independent variable, engagement as outcome variable, gender as moderator, and liking of the rewards as covariate. Hypothesis 4a about the moderating effect of gender was found to be not significant, ($\beta = -.020$, 95% CI[-.196 - .236], $t = .186$, $p = .852$) and was therefore rejected.

Table 5.

Linear model for predicting engagement

	<i>B</i>	<i>SE B</i>	<i>t</i>	<i>p</i>
Constant	2.809 [2.504 – 3.115]	.155	18.146	.000**
Achievement type	-.112 [-.272 - .048]	.081	-1.384	.168
Gender	-.083 [-.234 - .068]	.077	-1.084	.280
Achievement type * Gender	.020 [-.196 - .236]	.109	.186	.852
Liking of the reward	.201[.114 - .288]	.044	4.556	.000**

$R^2 = .127$ (* $p < .05$, ** $p < .001$)

§4.3.2 Gender as moderator of the effect between achievement type on intrinsic motivation for healthy food choices

Although the main effect of achievement type on intrinsic motivation for healthy food choices was significant in the opposite direction than assumed, it was investigated whether gender moderated this association. A PROCESS model 1 analysis was conducted, with achievement type as independent variable, intrinsic motivation for healthy food choices as dependent variable, and gender as moderator. The hypothesis that gender moderates the effect between achievement type and intrinsic motivation for healthy food choice (H4b) was not significant, ($\beta = -.085$, 95%CI[-.320 - .150], $t = -.711$, $p = .478$) and was therefore rejected.

Table 6.

Linear model for predicting intrinsic motivation for healthy food choices

	<i>B</i>	<i>SE B</i>	<i>t</i>	<i>p</i>
Constant	3.127 [3.009 - 3.245]	.060	52.363	.000**
Achievement type	-.094 [-.267 - .080]	.088	-1.068	.287
Gender	.028 [-.1340 - .191]	.082	.346	.730
Achievement type * Gender	-.085 [-.320 - .150]	.119	-.711	.478

$R^2 = .035$ (* $p < .05$, ** $p < .001$)

§4.4 Engagement as mediator

The current study investigated the additional hypothesis that game engagement is a mediator in the relation between both independent variables (reward context and achievement type) on intrinsic motivation for healthy food choices. Both hypotheses were tested with PROCESS, which is an eligible research method for mediation models (Hayes, 2013). According to Baron and Kenny (1986), several requirements must be met in order to have a mediation effect. (1) The total effect of the independent variable on the dependent variable should be significant. However, Hayes (2009) revised this criteria and stated that the total effect does not have to be significant in order to have a mediation effect. (2) The independent variable significantly predicts the mediator. (3) The mediator significantly predicts the dependent variable. (4) The relationship between the independent variable and the dependent variable is not significant when the mediator is included in the model. When this effect however is still significant, there is partial mediation (Baron & Kenny, 1986).

§4.4.1 Engagement as mediator of the association between reward context and intrinsic motivation for healthy food choices

The first mediation hypothesis (H5a) stated that engagement mediates the relation between the reward context and intrinsic motivation for healthy food choices. Although no total effect of the reward context on intrinsic motivation for healthy food choices was found, it is still possible that there is a full mediation effect (Hayes, 2013). Therefore, PROCESS model 4 was used to test this hypothesis with reward context as independent variable, engagement as mediator, intrinsic motivation for healthy food choices as dependent variable, and liking of the rewards as covariate (Figure 4). The effect of the game reward context on engagement in the game (path a) was not significant, $\beta = .012$, $t = .206$, $p = .837$. The effect of engagement in the game on intrinsic motivation for healthy food choices (path b) was significant, $\beta = .304$, $t = 3.825$, $p = .002$. The direct effect of the game reward context on intrinsic motivation for healthy food choices (path c') was not significant, $\beta = .072$, $t = 1.242$, $p = .216$. Because only the third criterium for mediation was met, engagement did not mediate the relation between reward context and intrinsic motivation for healthy food choices, so hypothesis 5a was rejected.

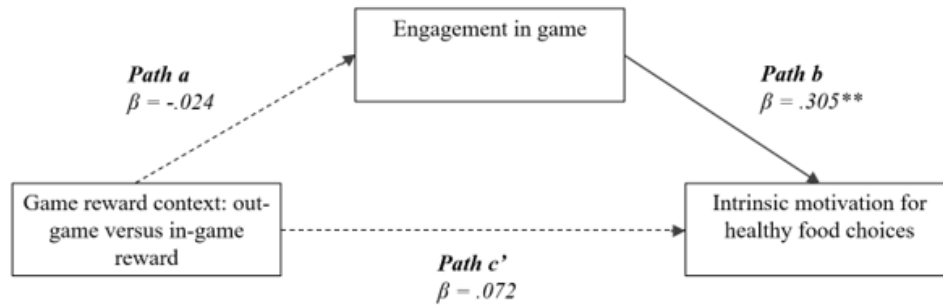


Figure 4. Mediation model with unstandardized beta coefficients, $*p < .05$, $**p < .01$. Significant relationships are displayed in the model with arrows and non-significant relationships are displayed with dotted arrows.

§4.4.2 Engagement as mediator of the association between achievement type and intrinsic motivation for healthy food choices

The second mediation hypothesis (H5b) stated that engagement mediates the relation between the achievement type of reward and intrinsic motivation for healthy food choices. Again, PROCESS model 4 was used with achievement type as independent variable, engagement as mediator, intrinsic motivation for healthy food choices as dependent variable, and liking of the rewards as covariate (Figure 5). The effect of the achievement type on engagement in the game (path a) was not significant, $\beta = -.093$, $t = -1.695$, $p = .092$. The effect of engagement in the game on intrinsic motivation for healthy food choices (path b) was again significant, $\beta = .287$, $t = 3.600$, $p = .004$. The direct effect of achievement type on the intrinsic motivation for healthy food choices (path c') was not significant, $\beta = -.104$, $t = -1.802$, $p = .073$. Because only the third criterium for mediation was met, engagement also did not mediate the relation between achievement type and intrinsic motivation for healthy food choices. Hypothesis 5b was rejected.

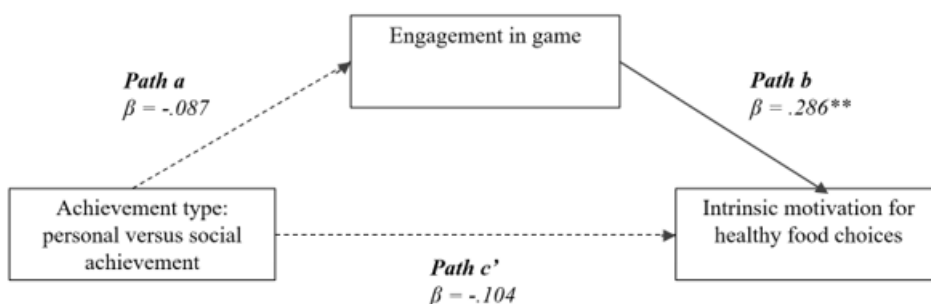


Figure 5. Mediation model with unstandardized beta coefficients, $*p < .05$, $**p < .01$. Significant relationships are displayed in the model with arrows and non-significant relationships are displayed with dotted arrows.

§5. Conclusion and discussion

§5.1 Conclusion

The prevalence of childhood overweight is growing worldwide. A promising new area of interventions is provided by serious games, which are better able to encourage and motivate children to learn about health-related topics. Although previous research demonstrated that serious game rewards can be an effective tool (e.g. Wrzesien & Raya, 2010), little is known about the effects of different characteristics of game rewards. Therefore, this study investigated to what extent different contexts and achievement types of serious game rewards influence the engagement and intrinsic motivation for healthy food choices in 8-12 year old children. In this section, each paragraph will discuss one research question or hypothesis.

§5.1.1 Game reward context and engagement

This study indicated that in-game rewards did not lead to more engagement in the game, compared to out-game rewards (H1). This finding is not in line with the flow-theory of Csikzentmihalyi (1990), which states that engagement is related to immersion in the game. Immersion is dependent on distraction factors: while distraction diminishes game immersion, focused attention benefits this. On beforehand, it was expected that in-game rewards would be less distractive and thus more immersive, compared to out-game rewards. However, according to O'Brien and Toms (2010), engagement is related to multiple factors, including not only focused attention, but also perceived usability, game aesthetics and satisfaction. The satisfaction while playing the game was also measured in this study, and the descriptive results showed that children in the out-game context might have been more satisfied with the game rewards than children in the in-game context. Because there was only a marginally significant effect, no firm conclusions can be drawn about this effect. Future research should focus on both focused attention and satisfaction as distinctive variables. When focused attention indeed appears to be higher in the in-game context, but satisfaction more present in the out-game context, this forms a valid explanation for the equal effect of both game reward contexts on engagement.

§5.1.2 Game reward context and intrinsic motivation for healthy food choices

This was the first study to investigate the effect of the game reward context on the intrinsic motivation for healthy food choices (RQ1). This study indicated that out-game and in-game

rewards were of equal influence on the intrinsic motivation for healthy food choices. However, based on the trend that children in the out-game context marginally significant liked the rewards more than children in the in-game context, that seems somewhat surprising. Previous research showed that positive feelings of enjoyment in health games can result in implicit, positive associations with healthy foods (Baranowski et al., 2008). It would thus have been logical to find that out-game rewards also (marginally) increased the intrinsic motivation for healthy food choices. However, except for the fact that marginally significant results can't be interpreted, there is also a methodological issue. Because assigning positive feelings to associated themes is considered an automatic and unconscious process (Buijzen & van Reijmersdal & Owen, 2010), the study of Baranowski et al (2008) measured the implicit (unconscious) association with healthy food. This study however only measured explicit (conscious) self-reports. Future research should therefore measure intrinsic motivation not only explicitly, but also implicitly (e.g. with implicit association tasks) to draw conclusions about the effect of the reward context on intrinsic motivation.

§5.1.3 Achievement type of rewards and engagement

Based on the desire for competition of the target group (Lepper & Malone, 1987; Richter, Raban & Rafaeli, 2015), it was expected that social achievement systems would lead to more engagement than personal achievement systems (H2). Contrary to expectations, this study did not demonstrate a significant difference between the achievement type on engagement. This is probably due to the fact that children in both conditions already scored high on engagement, leading to little variance in engagement scores. Despite the lack of a significant effect, this study did find a negative trend between achievement type and engagement. Remarkably, this trend contradicts previous research about the effect of competition elements on engagement. This study provides a potential explanation for this (possible) negative effect: children who played the game with a social achievement system, perceived the game as more difficult compared to those in the personal achievement condition. Previous research showed that satisfaction in the game increased with mastery of the game (Holbrook, Chestnut, Oliva & Greenleaf, 1984; Klimmt, Blake, Hefner, Vorderer & Roth, 2009). Given the fact that this trend is not significant, it is possible that a longer playing time is necessary to develop more mastery in both achievement systems to indicate differences in game satisfaction and thus engagement (O'Brien & Toms, 2010). Future research should therefore follow playing

behavior for a longer period of time to explain the possible negative effect of achievement type on engagement.

§5.1.4 Achievement type of rewards and intrinsic motivation for healthy food choices

It was also expected that social achievement systems would lead to more intrinsic motivation for healthy food choices than personal achievement systems (H3). The current study however indicated the opposite: a personal achievement system significantly led to more intrinsic motivation for healthy food choices than a social achievement system. This finding contradicts dominating developmental theories, in which it is stated that children become more sensitive for competition elements from the age of eight (Erikson, 1959). It also contradicts the social comparison theory (Festinger, 1954) and the self-efficacy theory (Bandura, 1982), that both emphasize the motivational effect of status and reputation. However, some other studies about intrinsic motivation and competition showed that competition can both increase and decrease intrinsic motivation. Competition can be perceived as informational, because it provides feedback about one's performance and therefore enhances intrinsic motivation. On the other hand, competition can have a controlling aspect when trying to win "at all costs" becomes a salient part of game playing (Deci, Betley, Kahle, Abrams & Porca, 1981; Epstein & Harackiewicz, 1992). When players focus too much on the goal of winning, competition can diminish intrinsic motivation for the target behavior (Deci et al., 1981). In this study, participants probably felt a lot of pressure to win, because the opponents were present in the same room. This might have caused the competition elements to be a controlling aspect of game playing. Therefore, it would be interesting to repeat this study within a non-pressuring context, for example by dividing opponents over different rooms.

§5.1.5 Moderating effect of gender

This study investigated the moderating effect of gender on the association between achievement type and both dependent variables (H4a-b). Because the direct relationship between achievement type and engagement was not significant, it can be concluded that gender did not moderate this association. Gender did also not moderate the negative, significant effect between achievement type and intrinsic motivation for healthy food choices. This is not in line with previous research about player motives, showing that male players are more interested in achievement and competition, while female players are more interested in

social interaction (Lucas & Sherry, 2004; Yee, 2006). However – besides competition – social interaction was also stimulated in this study, because participants were playing the game within the same room and discussing their game play. This possibly explains why no sex differences were found in the relation between achievement type and engagement. Therefore, this finding also makes it interesting to repeat the study with opponents divided over different rooms.

§5.1.6 Mediating effect of engagement

Finally, this was the first study to investigate whether engagement mediates the effects between both independent variables and intrinsic motivation for healthy food choices (H5a-b). The non-significant effect of reward context on intrinsic motivation for healthy food choices was not explained by a mediated effect of engagement. This study also showed that engagement did not mediate the significant negative effect of achievement type on intrinsic motivation for healthy food choices. However, in both mediation models it was found that engagement significantly predicts engagement. This is in line with the flow-theory, in which it is argued that people are optimally motivated when they are engaged in a challenging task (Csikzentmihalyi, 1990). Future research with other – perhaps more engaging – serious games rewards (e.g. rewards that are applicable within the game), are necessary to confirm whether engagement is just a predictor of intrinsic motivation, or whether engagement can explain relations between serious game rewards and intrinsic motivation.

§5.2 Strengths and limitations

This study has several strengths. This was the first study to examine different characteristics of serious game rewards on engagement and intrinsic motivation for healthy food choices. Furthermore, the sample included children from different schools in different areas of the Netherlands, which makes the study more generalizable to other primary school children aged 8-12. In addition, the matching procedure of this study is a strength, because this leads to more statistical power to identify differences between the conditions (Field, 2013).

This study also has some limitations, which result in improvements and suggestions for follow-up research. First, the game that was used for this study did not always work properly, because sometimes a small lag occurred. This was prevented as much as possible by bringing laptops to the experiment on which the game was tested several times, but did not prevent the game from lagging a few times. This might have influenced especially

engagement outcomes, since it influences the perceived usability of the game (O'Brien & Toms, 2010). Follow-up research should use a game that is demonstrated to work properly on all types of laptops or other game platforms. A methodological limitation of the current study is that the intrinsic motivation for healthy food choices was measured with self-report scales. This enlarged the risk of socially desirable answers (Boeije, 't Hart & Hox, 2009), resulting in the risk of inaccurate reporting. Therefore, future research with implicit measures (e.g. implicit association tasks) is recommended to confirm the results of this study. Additionally, free choice tasks in which children choose one food product over the other might give some extra information, because they measure actual (instead of intended) behavior. Another methodological issue might be that children played the game for only ten minutes, leading to the recommendation to do follow-up studies in which children are able to play the game for a longer period of time.

Finally, there are some limitations about the research design of this study. The research design only makes it possible to draw conclusions about short term effects (Boeije, 't Hart & Hox, 2009). It is possible that the found effects fade out over time. Therefore, it is recommended to conduct a longitudinal follow-up research, in which children play the game for a longer period of time and keep track of eating diaries. This makes it possible to measure long term effects (Field, 2013). Finally, although the sample size was big enough to perform the desirable analyses, it would be recommended for follow-up research to include more children to the sample size to increase statistical power (Field, 2013).

§5.3 Scientific and practical implications

This study has some important scientific and practical implications. When reading these implications, it should be taken into account that (1) they only affect short-term effects and (2) they are only generalizable to children aged 8-12 on primary schools in The Netherlands. This study contributed to the scientific field, because it was the first study to investigate different characteristics of serious game rewards. This study showed that the context of a reward does not influence engagement and intrinsic motivation for healthy food choices. Furthermore, this study showed the interesting result that a personal achievement system leads to more intrinsic motivation for healthy food choices than a social achievement system. This result is conflicting many dominating theories about competition elements aimed at young children, but can be a great starting point for future research about rewards in serious games for health.

The current study also has some practical implications. Because the context of a game reward appears to make no difference, game designers can choose to use both. However, because out-game rewards are probably experienced as more enjoyable, they can form an effective tool for attracting and maintaining children's interest. Furthermore, in order to maximize children's intrinsic motivation for healthy food choices, game developers should be somewhat careful with implementing competition elements. Although long-term effects are not established, this study showed that children are triggered more by a personal scoreboard than a ranking on the short term.

References

- Anderson, S. P. (2012). *Seductive interaction design, creating playful, fun, and effective user experiences*. New Riders Press
- Bandura, A. (1982). Self-efficacy mechanism in human agency. *American psychologist*, 37(2), 122-147. <http://dx.doi.org/10.1037/0003-066X.37.2.122>
- Bandura, A. (1977). Self-efficacy: toward a unifying theory of behavioral change. *Psychological review*, 84(2), 191-215. <http://dx.doi.org/10.1037/0033-295X.84.2.191>
- Baron, R. M. & Kenny, D. A. (1986) "The Moderator-Mediator Variable Distinction in Social Psychological Research – Conceptual, Strategic, and Statistical Considerations". *Journal of Personality and Social Psychology*, 51(6), 1173–1182.
- Barrera, M.T., Rule, A.C. & Diemart, A. (2001). The effect of writing with computers versus handwriting on the writing achievements of first-graders. *Information Technology in Childhood Education*, 2001(1), 215-228.
- Baranowski, T., Buday, R., Thompson, D.I. & Baranowski, J. (2008). Playing for real: video games and stories for health-related behavior change. *Am J. Prev. Med*, 34(1), 74-82. <https://doi.org/10.1016/j.amepre.2007.09.027>
- Berkovsky, S., Coombe, M., Freyne, J., Bhandari, D. & Baghaei, N. (2010, April). Physical activity motivating games: virtual rewards for real activity. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 243-252). ACM.
- Boeije, H. 't Hart, H. & Hox, J. (2009). *Onderzoeksmethoden*. Den Haag: Boom Lemma Uitgevers.
- Buijzen, M., Van Reijmersdal, E. A. & Owen, L. H. (2010). Introducing the PCMC model: An investigative framework for young people's processing of commercialized media content. *Communication Theory*, 20(4), 427-450.
- Cameron, J., Banko, K. M. & Pierce, W. D. (2001). Pervasive negative effects of rewards on intrinsic motivation: The myth continues. *The Behavior Analyst*, 24(1), 1-44. <https://doi.org/10.1007/BF03392017>
- Cameron, J. & Pierce, W. D. (1994). Reinforcement, reward, and intrinsic motivation: A meta-analysis. *Review of Educational research*, 64(3), 363-423. <https://doi.org/10.3102/00346543064003363>
- Cooke, L. J., Chambers, L. C., Añez, E. V., Croker, H. A., Boniface, D., Yeomans, M. R. & Wardle, J. (2011). Eating for pleasure or profit: the effect of incentives on children's

- enjoyment of vegetables. *Psychological science*, 22(2), 190-196.
<https://doi.org/10.1177/0956797610394662>
- Csikszentmihalyi, M. (1990). *Flow: The psychology of optimal performance*. NY: Cambridge University Press.
- Cross, C. (2009). Making games seriously: Creating a peer designed video game for use in library promotion and instruction. *Library Review*, 58(3), 215-227.
<https://doi.org/10.1108/00242530910942063>
- Deci, E. L., Betley, G., Kahle, J., Abrams, L. & Porac, J. (1981). When trying to win: Competition and intrinsic motivation. *Personality and social psychology bulletin*, 7(1), 79-83. <https://doi.org/10.1177/014616728171012>
- Deci, E. L. (1975). *Intrinsic motivation*. New York: Plenum Press
- Deci, E. L., Koestner, R. & Ryan, R. M. (1999). A meta-analytic review of experiments examining the effects of extrinsic rewards on intrinsic motivation. *Psychological bulletin*, 125(6), 627-668.
- De Leeuw, E. (2011). *Improving data quality when surveying children and adolescents: cognitive and social development and its role in questionnaire construction and pretesting* (Report prepared for the Annual Meeting of the Academy of Finland: Research Programs Public Health Challenges and Health and Welfare of Children and Young People May 10-12, 2011 in Naantali). Accessed at May 7th, 2018 from http://www.aka.fi/globalassets/awanhat/documents/tiedostot/lapset/presentations-of-the-annual-seminar-10-12-may-2011/surveying-children-and-adolescents_de-leeuw.pdf
- De Leeuw, E. (2003). *Questioning children in surveys* (Report to the statistical information and monitoring programme on child labour of the International Labour Office's internal programme on the elimination of child labour). Utrecht: Department of methodology and statistics.
- De Leeuw, E., Borgers, N. & Smits, A. (2004). Pretesting questionnaires for children and adolescents. In: Presser, S. Rothgeb, J.M., Couper, M.P., Lesler, J.T., Martin, E., Martin, J. & Singer, E. (2004). *Methods for testing and evaluating survey questionnaires* (pp. 409-429). New York: Wiley.
- Delfos, M.F. (2000). *Luister je wel naar mij? Gespreksvoering met kinderen tussen vier en twaalf jaar*. Amsterdam: SWP, WESP-publicatiereeks.

- Elliot, A. J. & Harackiewicz, J. M. (1994). Goal setting, achievement orientation, and intrinsic motivation: A mediational analysis. *Journal of personality and social psychology*, 66(5), 968-980. <http://dx.doi.org:10.1037//0022-3514.66.5.968>
- Epstein, J. A. & Harackiewicz, J. M. (1992). Winning is not enough: The effects of competition and achievement orientation on intrinsic interest. *Personality and Social Psychology Bulletin*, 18(2), 128-138. <https://doi.org/10.1177/0146167292182003>
- Epstein, L. H., Valoski, A. M., Kalarchian, M. A. & McCurley, J. (1995). Do children lose and maintain weight easier than adults: a comparison of child and parent weight changes from six months to ten years. *Obesity*, 3(5), 411-417. <https://doi.org/10.1002/j.1550-8528.1995.tb00170>
- Epstein, L. H., Beecher, M. D., Graf, J. L. & Roemmich, J. N. (2007). Choice of interactive dance and bicycle games in overweight and nonoverweight youth. *Annals of Behavioral Medicine*, 33(2), 124-131. <https://doi.org/10.1007/BF02879893>
- Erikson, E. (1959). Identity and the life cycle. *Psychological Iss*, 1, 1-71
- Festinger, L. (1954). A theory of social comparison processes. *Human relations*, 7(2), 117-140.
- Field, A. (2013). *Discovering statistics using IBM SPSS statistics*. London: Sage.
- Fu, Y. C. (2011). The game of life: Designing a gamification system to increase current volunteer participation and retention in volunteer-based nonprofit organizations.
- Garris, R., Ahlers, R., & Driskell, J. E. (2002). Games, motivation, and learning: A research and practice model. *Simulation & gaming*, 33(4), 441-467. <https://doi.org/10.1177/1046878102238607>
- GBD 2015 Obesity Collaborators. (2017). Health effects of overweight and obesity in 195 countries over 25 years. *New England Journal of Medicine*, 377(1), 13-27. <http://dx.doi.org: 10.1056/NEJMoa1614362>
- Gnauk, B., Dannecker, L. & Hahmann, M. (2012, March). Leveraging gamification in demand dispatch systems. In *Proceedings of the 2012 Joint EDBT/ICDT workshops* (pp. 103-110). ACM.
- Gonzalez-Suarez, C., Worley, A., Grimmer-Somers, K. & Dones, V. (2009). School-based interventions on childhood obesity: a meta-analysis. *American journal of preventive medicine*, 37(5), 418-427. <https://doi.org/10.1016/j.amepre.2009.07.012>
- Guh, D. P., Zhang, W., Bansback, N., Amarsi, Z., Birmingham, C. L. & Anis, A. H. (2009). The incidence of co-morbidities related to obesity and overweight: a systematic review

- and meta-analysis. *BMC public health*, 9(1), 1-20. <https://doi.org/10.1186/1471-2458-9-88>
- Hamari, J., & Eranti, V. (2011, September). Framework for Designing and Evaluating Game Achievements. In *Digra Conference*.
- Hatzenbuehler, M. L., Keyes, K. M. & Hasin, D. S. (2009). Associations between perceived weight discrimination and the prevalence of psychiatric disorders in the general population. *Obesity*, 17(11), 2033-2039. <https://doi.org/10.1038/oby.2009.131>
- Harris, K. C., Kuramoto, L. K., Schulzer, M. & Retallack, J. E. (2009). Effect of school-based physical activity interventions on body mass index in children: a meta-analysis. *Canadian Medical Association Journal*, 180(7), 719-726. <https://doi.org/10.1503/cmaj.080966>
- Hayes, A. F. (2009). *Beyond Baron and Kenny: Statistical mediation analysis in the new millennium. Communication monographs*, 76(4), 408-420. <https://doi.org/10.1080/03637750903310360>
- Hayes, A. F. (2013). *Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based Approach*. Guilford Publications, New York.
- Ho, M., Garnett, S. P., Baur, L. A., Burrows, T., Stewart, L., Neve, M. & Collins, C. (2013). Impact of dietary and exercise interventions on weight change and metabolic outcomes in obese children and adolescents: a systematic review and meta-analysis of randomized trials. *JAMA pediatrics*, 167(8), 759-768. <http://dx.doi.org:10.1001/jamapediatrics.2013.145>
- Holbrook, M. B., Chestnut, R. W., Oliva, T. A. & Greenleaf, E. A. (1984). Play as a consumption experience: The roles of emotions, performance, and personality in the enjoyment of games. *Journal of consumer research*, 11(2), 728-739. <https://doi.org/10.1086/209009>
- Horne, P. J., Hardman, C. A., Lowe, C. F. & Rowlands, A. V. (2009). Increasing children's physical activity: a peer modelling, rewards and pedometer-based intervention. *European Journal of clinical nutrition*, 63(2), 191-198. <http://dx.doi.org:10.1038/sj.ejcn.1602915>
- Horne, P. J., Greenhalgh, J., Erjavec, M., Lowe, C. F., Viktor, S. & Whitaker, C. J. (2011). Increasing pre-school children's consumption of fruit and vegetables. A modelling and rewards intervention. *Appetite*, 56(2), 375-385. <https://doi.org/10.1016/j.appet.2010.11.146>

- Karnik, S. & Kanekar, A. (2012). Childhood obesity: a global public health crisis. *International journal of preventive medicine*, 3(1), 1-7.
- Kivikangas, J. M., Kätsyri, J., Järvelä, S. & Ravaja, N. (2014). Gender differences in emotional responses to cooperative and competitive game play. *PloS one*, 9(7), e100318. <https://doi.org/10.1371/journal.pone.0100318>
- Klimmt, C., Blake, C., Hefner, D., Vorderer, P. & Roth, C. (2009, September). Player performance, satisfaction, and video game enjoyment. In *International Conference on Entertainment Computing* (pp. 1-12). Springer, Berlin, Heidelberg.
- Lepper, M. R., & Greene, D. (1975). Turning play into work: Effects of adult surveillance and extrinsic rewards on children's intrinsic motivation. *Journal of personality and social psychology*, 31(3), 479-468. <http://dx.doi.org/10.1037/h0076484>
- Lepper, M. R., Greene, D. & Nisbett, R. E. (1973). Undermining children's intrinsic interest with extrinsic reward: A test of the "overjustification" hypothesis. *Journal of Personality and social Psychology*, 28(1), 129-137. <http://dx.doi.org/10.1037/h0035519>
- Lepper, M. R. & Malone, T. W. (1987). Intrinsic motivation and instructional effectiveness in computer-based education. *Aptitude, learning, and instruction*, 3, 255-286.
- Lowe, C. F., Horne, P. J., Tapper, K., Bowdery, M. & Egerton, C. (2004). Effects of a peer modelling and rewards-based intervention to increase fruit and vegetable consumption in children. *European journal of clinical nutrition*, 58(3), 510-522. <http://dx.doi.org:10.1038/sj.ejcn.1601838>
- Lucas, K. & Sherry, J. L. (2004). Sex differences in video game play: A communication-based explanation. *Communication research*, 31(5), 499-523. <https://doi.org/10.1177/0093650204267930>
- Malone, T. W. (1981). Toward a theory of intrinsically motivating instruction. *Cognitive science*, 5(4), 333-369. [https://doi.org/10.1016/S0364-0213\(81\)80017-1](https://doi.org/10.1016/S0364-0213(81)80017-1)
- Medler, B. & Magerko, B. (2011). Analytics of play: Using information visualization and gameplay practices for visualizing video game data. *Parsons Journal for Information Mapping*, 3(1), 1-12.
- Metcalf, B., Henley, W. & Wilkin, T. (2012). Effectiveness of intervention on physical activity of children: systematic review and meta-analysis of controlled trials with objectively measured outcomes (EarlyBird 54). *Bmj*, 345, e5888. <https://doi.org/10.1136/bmj.e5888>

- Morgan, M., Gibbs, S., Maxwell, K. & Britten, N. (2002). Hearing children's voices: methodological issues in conducting focus groups with children ages 7-11 years. *Qualitative Research*, 2(1), 5-20. <http://dx.doi.org/10.1177/1468794102002001636>
- O'Brien, H.L. & Toms, E.G. (2010). The development and evaluation of a survey to measure user engagement. *Journal of the American Society for Information Science and Technology*, 61(1), 50-69. <http://dx.doi.org/10.1002/asi.21229>
- Oude Luttikhuis, H., Baur, L., Jansen, H., Shrewsbury, V. A., O'Malley, C., Stolk, R. P. & Summerbell, C. D. (2009). Cochrane review: Interventions for treating obesity in children. *Evidence-based child health: A Cochrane Review Journal*, 4(4), 1571-1729. <https://doi.org/10.1002/ebch.462>
- Papies, E.K. (2016). Goal priming as a situated intervention tool. *Curr. Opin. Psychol.*, 12, 12-16. <https://doi.org/10.1016/j.copsyc.2016.04.008>
- Pierce, W. D., Cameron, J., Banko, K. M. & So, S. (2003). Positive effects of rewards and performance standards on intrinsic motivation. *The Psychological Record*, 53(4), 561-578. <https://doi.org/10.1007/BF03395453>
- Pollak, J.P., Gay, G. , Byrne, S., Wagner, E., Retelny, D. & Humphreys, L. (2010). It's time to eat! Using mobile games to promote healthy eating. *IEEE Pervasive Computing*, 9(3), 21-27. <http://dx.doi.org/10.1109/MPRV.2010.41>
- Quelly, S.B., Norris, A.E. & DiPietro, J.L. (2016). Impact of mobile apps to combat obesity in children and adolescents: A systematic literature review. *Journal of Specialists in Pediatric Nursing*, 21(1), 5-17. <https://doi.org/10.1111/jspn.12134>
- Reinehr, T., Kleber, M., Lass, N. & Toschke, A. M. (2010). Body mass index patterns over 5 y in obese children motivated to participate in a 1-y lifestyle intervention: age as a predictor of long-term success. *The American journal of clinical nutrition*, 91(5), 1165-1171. <https://doi.org/10.3945/ajcn.2009.28705>
- Richter, G., Raban, D. R. & Rafaeli, S. (2015). Studying gamification: the effect of rewards and incentives on motivation. In *Gamification in education and business* (pp. 21-46). Springer, Cham.
- Ritterfeld, U., Cody, M. & Vorderer, P. (Eds.). (2009). *Serious games: Mechanisms and effects*. Routledge.
- Ronimus, M., Kujala, J., Tolvanen, A. & Lyytinen, H. (2014). Children's engagement during digital game-based learning of reading: The effects of time, rewards, and challenge. *Computers & Education*, 71, 237-246. <https://doi.org/10.1016/j.compedu.2013.10.008>

- Ryan, R.M. & Deci, E.L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well begin. *American Psychologist*, 55(1), 68-78.
<http://dx.doi.org/10.1037/0003-066X.55.1.68>
- Sahoo, K., Sahoo, B., Choudhury, A. K., Sofi, N. Y., Kumar, R. & Bhadoria, A. S. (2015). Childhood obesity: causes and consequences. *Journal of family medicine and primary care*, 4(2), 187-192. <http://dx.doi.org/10.4103/2249-4863.154628>
- Seidell, J. C. & Halberstadt, J. (2015). The global burden of obesity and the challenges of prevention. *Annals of Nutrition and Metabolism*, 66(2), 7-12.
<http://dx.doi.org/10.1159/000375143>
- Story, M. T., Neumark-Stzainer, D. R., Sherwood, N. E., Holt, K., Sofka, D., Trowbridge, F. L., & Barlow, S. E. (2002). Management of child and adolescent obesity: attitudes, barriers, skills, and training needs among health care professionals. *Pediatrics*, 110(1), 210-214.
- Susi, T., Johannesson, M. & Backlund, P. (2007). Serious Games : An Overview (IKI Technical Reports). Skövde: Institutionen för kommunikation och information. Retrieved from <http://urn.kb.se/resolve?urn=urn:nbn:se:his:diva-1279>
- Taylor, V.H., Forhan, M., Vigod, S.N., McIntyre, R.S. & Morrison, K.M. (2013). The impact of obesity on quality of life. *Best Practice & Research Clinical Endocrinology & Metabolism*, 27(2), 139-146. <http://dx.doi.org/10.1016/j.beem.2013.04.004>
- Tüzün, H., Yilmaz-Soylu, M., Karakus, T., Inal, Y. & Kizilkaya, G. (2009). The effects of computer games on primary school students' achievement and motivation in geography learning. *Computers & Education*, 52(1), 68-77.
<https://doi.org/10.1016/j.compedu.2008.06.008>
- Van den Bercken, J.H.L. & Voeten, M.J.M. (2002). *Variantieanalyse: De GLM-benadering*. Groningen: Stenfert Kroese
- Vassileva, J. (2012). Motivating participation in social computing applications: a user modeling perspective. *User Modeling and User-Adapted Interaction*, 22(1-2), 177-201. <http://dx.doi.org/10.1007/s11257-011-9109-5>.
- Visscher, T.L.S. & Seidell, J.C. (2001). The public health impact of obesity. *Annual Review of Public Health*, 22, 355-375. <https://doi.org/10.1146/annurev.publhealth.22.1.355>
- Vos, N., Van Der Meijden, H. & Denessen, E. (2011). Effects of constructing versus playing an educational game on student motivation and deep learning strategy use. *Computers & Education*, 56(1), 127-137. <https://doi.org/10.1016/j.compedu.2010.08.013>

- Wang, H. & Sun, C. T. (2011, September). Game reward systems: Gaming experiences and social meanings. In *DiGRA Conference*.
- Wengreen, H. J., Madden, G. J., Aguilar, S. S., Smits, R. R. & Jones, B. A. (2013). Incentivizing children's fruit and vegetable consumption: Results of a United States pilot study of the Food Dudes Program. *Journal of nutrition education and behavior*, 45(1), 54-59. <https://doi.org/10.1016/j.jneb.2012.06.001>
- Wiebe, E. N., Lamb, A., Hardy, M. & Sharek, D. (2014). Measuring engagement in video game-based environments: Investigation of the User Engagement Scale. *Computers in Human Behavior*, 32, 123-132. <https://doi.org/10.1016/j.chb.2013.12.001>
- Wilfley, D. E., Tibbs, T. L., Van Buren, D., Reach, K. P., Walker, M. S. & Epstein, L. H. (2007). Lifestyle interventions in the treatment of childhood overweight: a meta-analytic review of randomized controlled trials. *Health Psychology*, 26(5), 521-532. <http://psycnet.apa.org/doi/10.1037/0278-6133.26.5.521>
- Williams, E. P., Mesidor, M., Winters, K., Dubbert, P. M. & Wyatt, S. B. (2015). Overweight and obesity: prevalence, consequences, and causes of a growing public health problem. *Current obesity reports*, 4(3), 363-370. <https://doi.org/10.1097/00000441-200604000-00002>
- Wilson, K. A., Bedwell, W. L., Lazzara, E. H., Salas, E., Burke, C. S., Estock, J. L., ... & Conkey, C. (2009). Relationships between game attributes and learning outcomes: Review and research proposals. *Simulation & gaming*, 40(2), 217-266. <http://dx.doi.org:10.1177/1046878108321866>
- Wood, J. V. (1989). Theory and research concerning social comparisons of personal attributes. *Psychological bulletin*, 106(2), 231-248.
- Wrzesien, M. & Raya, M.A. (2010). Learning in serious virtual worlds: evaluation of learning effectiveness and appeal to students in the E-junior project. *Computers & Education*, 55(1), 178-187. <https://doi.org/10.1016/j.compedu.2010.01.003>
- Yee, N. (2006). Motivations for play in online games. *CyberPsychology & behavior*, 9(6), 772-775. <http://doi.org/10.1089/cpb.2006.9.772>
- Yusoff, A., Crowder, R., Gilbert, L., & Wills, G. (2009, July). A conceptual framework for serious games. In *Advanced Learning Technologies, 2009. ICALT 2009. Ninth IEEE International Conference on* (pp. 21-23). IEEE.
- Zyda, M. (2005). From visual simulation to virtual reality to games. *Computer*, 38(9), 25-32. <http://dx.doi.org:10.1109/MC.2005.297>

Appendix 1 – Informed consent letter to parents

Faculteit der Sociale Wetenschappen
Communicatiewetenschap
Postbus 9104
6500 HE Nijmegen

Telefoon: (0)24 361 2372
Fax: (0)24 361 3073

Datum
25 juni 2018

www.ru.nl/fsw

Subject
Toestemming voor deelname experiment naar game-app

Beste ouders/verzorgers,

In 2018 voert de Radboud Universiteit een onderzoek uit naar de effecten van een game op de motivatie voor gezond eetgedrag bij kinderen. Deze brief bevat informatie over dit onderzoek.

Invloed van games op gezond gedrag

Eén op de zeven kinderen in Nederland is te zwaar. Kinderen met overgewicht zitten vaak niet lekker in hun vel en zijn minder fit dan leeftijdgenoten. Het aannemen en behouden van een gezonde levensstijl kan echter lastig zijn voor kinderen. Om kinderen hierbij een handje te helpen is in 2017 de game-app 'Hello Yoop' ontwikkeld door Yellow Riders (www.yellowriders.com). Yoop is een virtueel huisdiertje om gezond te leren leven. Informatie in de game-app is gebaseerd op advies van kinderartsen, diëtisten en gedragswetenschappers in Nederland en België.

De game vormt nog een prototype en is nog niet officieel gelanceerd. Hoewel uit eerdere testen bleek dat kinderen de game leuk en uitdagend vinden, is nog niet bekend of kinderen door het spelen van deze game daadwerkelijk een verhoogde motivatie krijgen voor het vertonen van gezond gedrag. Om deze reden gaan we dit voorjaar onder een grote groep kinderen de game Hello Yoop testen. De resultaten van dit onderzoek zullen bijdragen aan het optimaliseren van deze game, zodat hij op grote schaal ingezet kan worden onder basisschoolkinderen.

Wat houdt het onderzoek in?

Op xxxxx 2018 kom ik, Femke Steeg, langs bij de basisschool van uw kind. Tijdens deze dag zal uw kind in een groepje van ongeveer 5 kinderen de klas uit worden genomen voor een experimentje van maximaal een half uur. In dit half uur krijgen de kinderen een korte introductie, waarna zij met behulp van iPad 's de gelegenheid krijgen om de game te spelen. Daarna stel ik ook wat vragen aan uw kind over hun motivatie voor gezond gedrag met behulp van vooraf opgestelde vragenlijsten. Na afloop van het experiment wordt uw kind weer teruggebracht naar de klas.

Gegevens onderzoeker

Dit onderzoek wordt uitgevoerd door masterstudente Femke Steeg. Zij voert dit onderzoek uit ten behoeve van haar afstudeerproject van de masteropleiding Communicatiewetenschap. Femke heeft door haar studieachtergrond in Pedagogiek ervaring met het begeleiden en testen van kinderen.

Vertrouwelijkheid

Wij benadrukken dat alle gegevens anoniem worden verwerkt. Er wordt niet over individuele informatie gerapporteerd naar uw kind of de basisschool, maar er wordt alleen naar de onderzoeksgroep als geheel gekeken. De resultaten van de studie zullen niet gebruikt worden voor commerciële doeleinden. De kinderen zullen nooit aangesproken worden op hun antwoorden of gameprestaties, zodat zij niet het gevoel krijgen beoordeeld te worden of te moeten presteren. Ook kunnen de kinderen te allen tijde stoppen wanneer ze niet meer mee willen doen.

Deelname

De basisschool van uw kind heeft ingestemd om mee te werken en staat achter het doel en de opzet van het onderzoek. Echter krijgt iedere ouder zelf de gelegenheid om wel of geen toestemming te geven voor deelname aan het onderzoek. Daarom verzoeken wij u om het wel of niet mogen deelnemen van uw kind aan ons onderzoek via onderstaand strookje kenbaar te maken, en dit uiterlijk xxxxxx 2018 terug te mailen naar de leidster van uw kind. Ik hoop natuurlijk dat alle kinderen mee mogen doen en dank u alvast voor uw medewerking!

Verdere informatie

Mocht u over het onderzoek vragen hebben, stuur mij dan gerust een e-mail (f.steeg@student.ru.nl). Ik probeer dan zo snel mogelijk te antwoorden.

Vriendelijke groet,

Femke Steeg

Masterstudente aan de Radboud Universiteit Nijmegen

Toestemming deelname kind

Hierbij verklaar ik dat (voor- en achternaam kind)

.....

Wel/ niet deel mag nemen aan het onderzoek.

Eventuele opmerkingen:

.....

Datum:.....

Handtekening ouder/verzorger:.....

Appendix 2 – Instruction about research and serious game “Yoop Racer”

Hallo allemaal,

Mijn naam is Femke en ik ben een studente van de Universiteit. Ik kom vandaag een klein onderzoekje bij jullie afnemen. We gaan vandaag een game spelen en daarna een vragenlijst invullen. Ik heb vandaag xxxx met mij meegenomen, hij/zij gaat mij helpen en er samen met mij voor zorgen dat jullie weer op tijd terug naar de klas kunnen.

We beginnen zo met het spelen van een game. Dit is Yoop ,< laten zien Yoop > en in het spel moet je Yoop proberen zo ver mogelijk te brengen! Dit kan je doen door hem gezond te laten eten en door ongezond eten juist niet op te eten. Daarnaast moet je ook de auto's op de weg proberen te ontwijken. Je kan Yoop bewegen door de pijltjes op je toetsenbord en springen doe je met de spatiebalk.

Voor we beginnen met het spel mag iedereen zijn of haar naam invullen onder het balkje “jouw naam”. Wij zullen straks even iedereen helpen met het starten van het spel en daarna krijgen jullie 10 minuten de tijd om de game te spelen. Als de tien minuten voorbij zijn geef ik een seintje dat jullie mogen stoppen. Belangrijk is dat je dan het spel nog niet weg klikt.

Conditie met in-game reward: iedere keer wanneer jouw Yoop af is en het spel eindigt krijg je een beloning voor hoe goed je het hebt gedaan: brons, zilver of goud. Hier horen stickers bij: deze stickers horen bij de brons, deze bij zilver en deze bij goud. Je krijgt de stickers gewoon in het spel en je kan ze in het startscherm bekijken. Na het spelen van het spel klik je gewoon op “herstart” om het spel opnieuw te spelen. Dan heb je dus weer opnieuw de kans om je prestatie te verbeteren.

Conditie met out-game reward: iedere keer wanneer jouw Yoop af is en het spel eindigt krijg je een beloning voor hoe goed je het hebt gedaan: brons, zilver of goud. Hier horen stickers bij: deze stickers horen bij de bronzen beker, deze bij de zilveren en deze bij goud. Elke keer wanneer het spel eindigt krijg je van ons een sticker op het kartonnen scorebord geplakt dat naast je ligt. Je mag ook je vinger opsteken als we het niet meteen zien. Daarna klik je gewoon op “herstart” om het spel opnieuw te spelen. Dan heb je dus weer opnieuw de kans om je prestatie te verbeteren.

Na de game zullen jullie een korte vragenlijst invullen. Hierover zal ik straks meer vertellen. Is het allemaal duidelijk voor jullie?

Na het spelen van de game (9 minuten):

De tijd is voorbij, jullie mogen het laatste spelletje waar jullie mee bezig zijn nog afmaken en daarna op stop klikken. We komen daarna de vragenlijsten uitdelen. < uitdelen vragenlijsten > Lees de vragenlijst goed door. Jullie hebben voldoende tijd om de vragenlijst in te vullen. Je kan geen foute antwoorden geven en je krijgt er ook geen cijfer voor. Ik ben benieuwd naar jouw mening, wat jij vindt. Als jullie ergens vragen over hebben, dan kunnen jullie bij mij of xxxx terecht. Als je klaar bent mag je de vragenlijst op de hoek van je tafel leggen. Het zou fijn zijn als jullie nog even stil kunnen blijven tot iedereen klaar is.

Na het afnemen van de vragenlijsten:

Ik wil iedereen heel erg bedanken voor het meedoen aan dit onderzoek. Jullie mogen met mij mee terug lopen naar de klas.

Appendix 3 – Complete questionnaire

Vragenlijst bij Yoop game

Yoop-NR:

Op de volgende pagina vind je een vragenlijst. In deze vragenlijst worden een paar vragen gesteld over de game die je gespeeld hebt en over het maken van gezonde eetkeuzes. Lees de vragen goed door en geef bij iedere vraag je mening:

1 = Nee, zeker niet

2 = Nee, ik denk het niet

3 = Ja, ik denk het wel

4 = Ja, zeker wel

Er zijn geen goede of foute antwoorden!

De volgende vragen gaan over hoe gemotiveerd jij vanaf nu gaat zijn voor het maken van gezonde eetkeuzes:

	1. Nee, zeker niet	2. Nee, ik denk het niet	3. Ja, ik denk het wel	4. Ja, zeker wel
1. Denk je dat je goed zal zijn in gezond eten?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. Denk je dat je het leuk zal vinden om gezond te eten?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. Denk je dat je veel moeite zal steken in het kiezen van gezond eten?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. Denk je dat je goed zal zijn in gezond eten, in vergelijking met je klasgenoten?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. Denk je dat je het leuk zal vinden om gezond eten te kiezen?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. Denk je dat je zal proberen om gezond te eten?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. Denk je dat je tevreden gaat zijn met hoe gezond je zal eten?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8. Denk je dat het kiezen van gezond eten saai is?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9. Denk je dat je je best gaat doen om gezond te eten?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10. Denk je dat je handig zal zijn in het kiezen van gezond eten?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
11. Denk je dat het kiezen van gezond eten interessant is?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12. Vind je het belangrijk om gezond te eten?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
13. Denk je dat het moeilijk is om gezond eten te kiezen?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
14. Denk je dat gezond eten leuk zal zijn?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
15. Denk je dat je veel energie gaat steken in gezond eten?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

De volgende vragen gaan over wat jij vond van de game:

	1. Nee, zeker niet	2. Nee, ik denk het niet	3. Ja, ik denk het wel	4. Ja, zeker wel
16. Was je geconcentreerd tijdens het spelen van de game?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
17. Zou je de game nog een keer willen spelen?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
18. Voelde je dat je werd aangemoedigd tijdens het spelen van de game?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
19. Liet je je afleiden door andere dingen of klasgenoten?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
20. Vond je het een leuke ervaring om de game te spelen?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
21. Voelde je je geïrriteerd toen je de game speelde?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

22. Vergat je de tijd tijdens het spelen van de game?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
23. Was je geïnteresseerd tijdens het spelen van de game?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
24. Werd je moe van het spelen van de game?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
25. Vergat je de wereld om je heen tijdens het spelen van de game?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
26. Zou je tegen vrienden of familie vertellen dat deze game leuk is?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
27. Voelde je je gefrustreerd tijdens het spelen van de game?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
28. Ging de tijd snel voorbij tijdens het spelen?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
29. Vond je de inhoud van de game interessant?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

De laatste vragen gaan over wat jij vond van bepaalde delen van de game:

	1. Nee, zeker niet	2. Nee, ik denk het niet	3. Ja, ik denk het wel	4. Ja, zeker wel
30. Vond je de stickers in de game leuk?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
31. Had je plezier in de game door de stickers?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
32. Vond je de stickers saai?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
33. Vond je de game moeilijk?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
34. Bij sommige versies van de game kon je alleen je eigen scores zien. Bij andere versies van de game kon je ook de scores zien van anderen. Welke game- versie heb jij gespeeld?	<input type="radio"/> Ik zag alleen mijn eigen scores		<input type="radio"/> Ik zag de scores van de andere spelers	

Leeftijd:

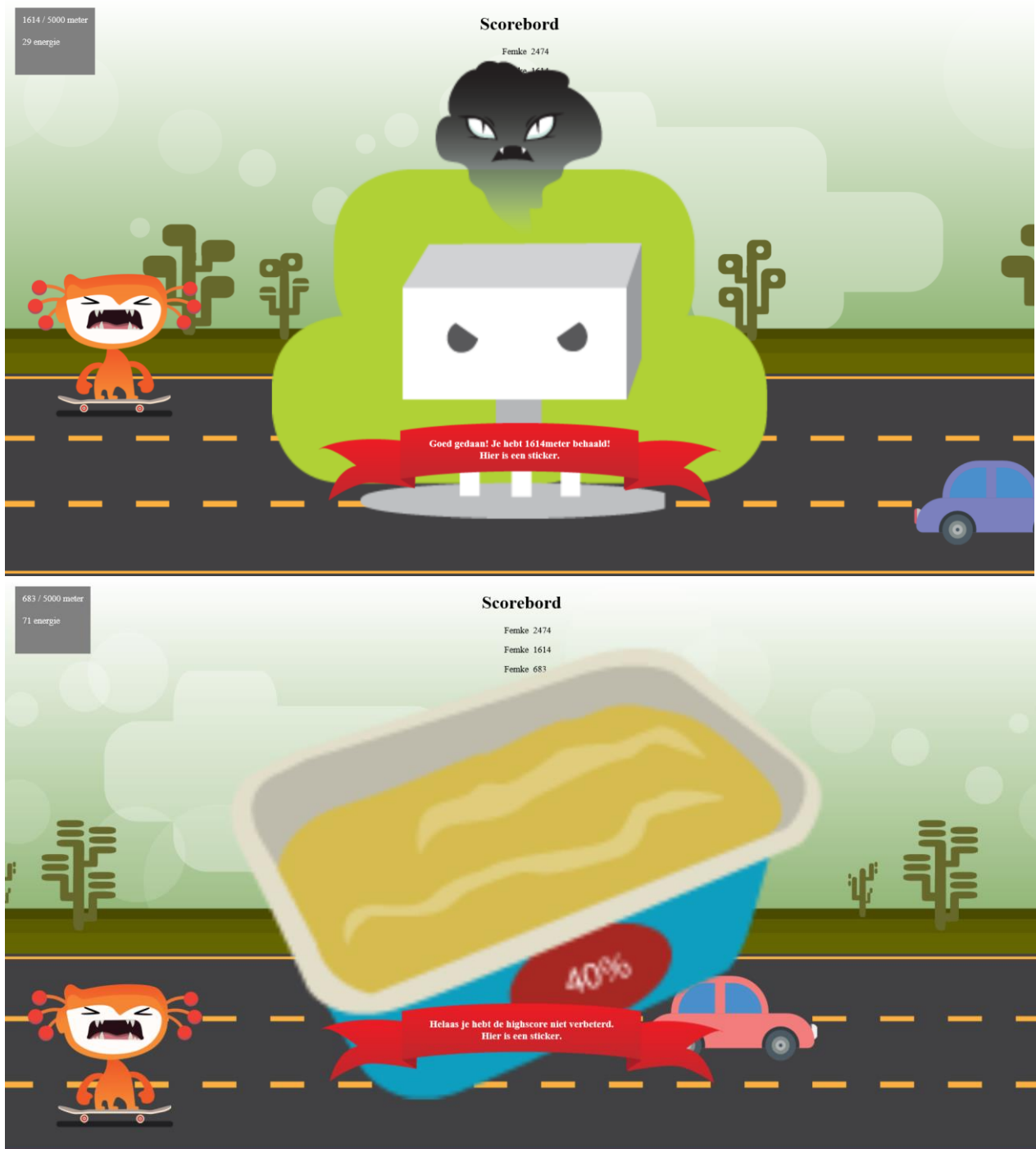
Ik ben een: jongen / meisje

Naam basisschool:

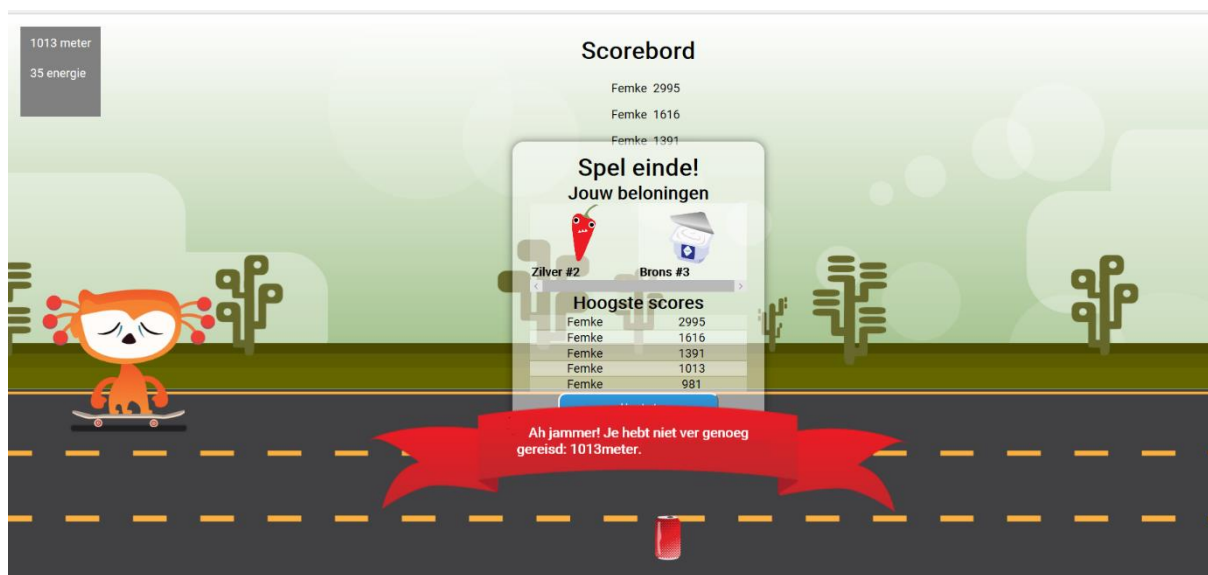
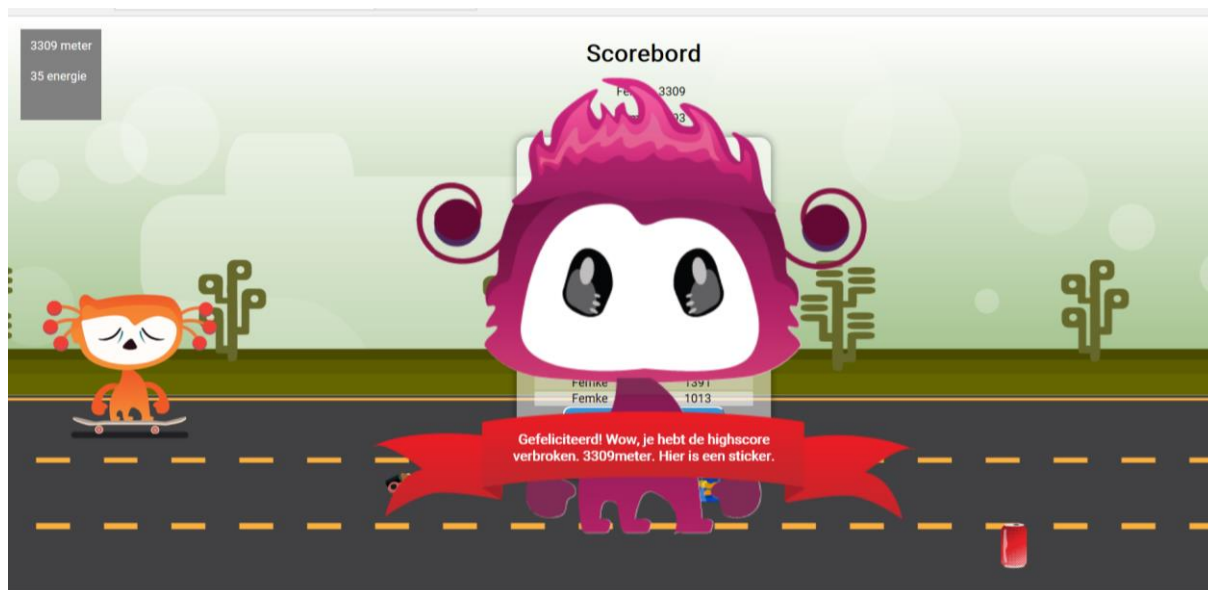
Groep:

Bedankt voor het invullen van de vragenlijst!



Appendix 4 – Rewards in Yoop Racer before (A) and after pre-test (B)

A. Engagement-contingent rewards in Yoop Racer before pre-test (after each experimental round)



B. Performance contingent rewards in Yoop Racer after pre-test (rewards only after achieving a high-score or second or third best score)