EFFECTIVENESS AND IMPLEMENTATION OF HEALTH GAMES TARGETING IMPLICIT ATTITUDES TOWARDS FOOD AND FOOD CHOICE BEHAVIOUR

Behavioural
Science
Institute

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Effectiveness and Implementation of Health Games targeting Implicit Attitudes towards Food and Food Choice Behaviour by Eva E. Alblas

ISBN/EAN: 978-94-6375-324-1

Cover design by: Marianne Alblas-Baghuis
Chapter image by: Dirk-Jan de Adelhart Toorop
Layout and design by: Daniëlle Balk || persoonlijkproefschrift.nl
Printing: Ridderprint BV || www.ridderprint.nl

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PROEFSCHRIFT

Ter verkrijging van de graad van doctor
aan de Radboud Universiteit Nijmegen
op gezag van de rector magnificus prof. dr. F.P.J. Wester,
volgens besluit van het college van decanen
in het openbaar te verdedigen op

donderdag 16 mei om 12:30 uur precies

door

Eva E. Alblas
Geboren op 20 mei 1980
te Utrecht

Promotor:	Prof. dr. M. Buijzen
Copromotoren:	Dr. F. Folkvord Dr. D.J. Anschütz Dr. P.E. Ketelaar
Manuscriptcommissie:	Prof dr. J.C.M. de Weert Prof dr. R.W. Holland Dr. R.C.J. Hermans

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CHAPTER 1

GENERAL INTRODUCTION

In today's Western society, people are presented with an omnipresent array of tasty and affordable foods (Ely, Howard, & Lowe, 2015). Many of these products are energy-dense, with a relatively high sugar and/or fat content (Kessler, 2009). Overconsumption of these energy-dense products is strongly linked with obesity (Bourke, Whittaker, & Verma, 2014), which is in turn associated with many comorbid physical and mental health issues, such as cardiovascular diseases, type II diabetes, various types of cancer, social stress, and isolation (Kaikkonen et al., 2013; World Health Organization, 2018). Contrarily, the intake of fruit and vegetables is associated with healthy weight (Boumtje, Huang, Lee, & Lin, 2005).

Research indicates that both children (CBS, 2017; Herrick, Rossen, Nielsen, Branum, & Ogden, 2015; World Health Organization, 2018) and young adults (Diethelm et al., 2012; RIVM, 2016a) often do not meet the recommended fruit and vegetable intake guidelines, and they consume too much of energy-dense products. Concordantly, the prevalence of overweight and obesity is still increasing (Cheung, Cunningham, Naryan, & Kramer, 2016; Kosti & Panagiotakos, 2006). Therefore, effective interventions stimulating a healthier dietary pattern would be highly beneficial, both to arrest the obesity epidemic and to improve general physical and mental health in the population.

Scholars have found that overweight in childhood is associated with overweight in adulthood (e.g., Cheung et al., 2016; Freedman et al., 2005). Furthermore, overweight is a strong predictor for developing obesity (Field, Cook, & Gillman, 2005), which has been stated to be a chronic disease (Lykouras, 2008). Thus, the benefits of treating an unhealthy eating pattern in childhood are twofold. First, treating overweight during early development may prevent it from progressing to a chronic condition. Second, when these (effectively treated) children become parents themselves, they are postulated to pass on healthy diet habits. Therefore, developing interventions targeting childhood obesity are very important.

However, despite numerous efforts to reduce overweight and obesity, their prevalence is not decreasing (Ebbert, Elrashidi, & Jensen, 2014; Hruby & Hu, 2015). To explain why, a closer look at the methods to curb the problem is warranted. Traditional interventions to improve dietary intake often emphasize caloric restriction, by avoiding or reducing intake of energy-dense, nutrient-low products (Anderson, Luan, & Høie, 2004). However, deprivation of food products has been postulated to increase their reinforcing properties, leading to increased craving (Fisher & Birch, 1999). Therefore, dietary restriction has been postulated to be cognitively demanding, because it requires an active act of self-control, rather than "mere passive inaction" (Muraven & Baumeister, 2000, p. 1). Moreover, self-control appears to depend on limited resources and can be depleted, making dietary restraint increasingly difficult when a person is cognitively taxed or fatigued (Alberts, Martijn, Greb, Merckelbach, & de Vries, 2007; Hofmann, Rauch, & Gawronski, 2007; Muraven & Baumeister, 2000). In line with this, several studies have indeed reported adverse effects of restrictive dieting among children and adolescents (e.g., Bourke et al., 2014) and adults (e.g., Schaefer & Magnuson, 2014).

In sum, currently there is a high prevalence of overweight and obesity. Furthermore, many children do not eat enough fruit and vegetables. Research suggests that interventions that aim to change dietary patterns are often cognitively demanding and craving-inducing, and are not very effective. Therefore, research is needed investigating novel methods to change dietary behaviour.

AUTOMATICITY AS A PREDICTIVE FACTOR FOR (EATING) BEHAVIOUR

Many individuals find it difficult to adhere to a healthy diet, despite being aware of the consequences of their unhealthy eating behaviour. It appears that humans often do not behave rationally; they conduct behaviour in contrast with their personal goals and intentions. Dating back to the writings of Greek philosophers, the term *akrasia* has been coined for this phenomenon (Hupperts & Poortman, 1997), which means a lack of self-control, or to act against better judgement. Akratic behaviour has been observed in many domains of human behaviour, with far-reaching consequences, such as drug abuse (Wiers, Eberl, Rinck, Becker, & Lindenmeyer, 2011), risk taking behaviour (Byrnes, Miller, & D. Schafer, 1999), and poor financial decision making (Schoemaker, 1993).

Also in the food domain, akratic behaviour is observed. As an illustration – for example, when watching an episode of the popular scientific series "Secret Eaters," a British television show about overeating – it is not uncommon to see an obese individual, with the desire to lose weight, indulging in a large *second* lunch at their favourite fast food restaurant. Indeed, when examining the daily caloric intake of (obese) individuals, a consistent daily excess of caloric intake has been observed (Kulesza, 1982; Pearcey & de Castro, 2002; Syrad et al., 2016). This is influenced by increased meal size and meal frequency, but also, as mentioned, by the types of foods and beverages consumed. To explain this dietary behaviour, the term 'hedonic hunger' has been proposed (Michael R. Lowe & Butryn, 2007). Hedonic hunger is the drive to consume food for pleasure rather than simply to resolve energy deprivation. For obese individuals, frequently satisfying this hedonic hunger could be considered akratic because, in most cases, this behaviour conflicts with their goal to lose weight: their diet intentions.

With the purpose to explain (akratic) behaviour, several theories and models have been proposed, such as the 'rational model' by William Dray (Danto, 1958), the 'weakness of the will' theory by Davidson (1969), or, by the hedonists' view, that "knowledge is a slave being dragged around by passion" (Henry, 2002, p. 256). A consensus among these theories is that human behaviour not only is consciously planned and deliberate, based on logic and rational judgements, but also can be instigated on a more unconscious and irrational level (Bargh, 1994). This dichotomy coincides with the proposed dichotomy of the memory system, with rule-based/propositional versus associative processing, that together determine a certain course of action (Schacter & Tulving, 1994).

When further exploring associative processing and its influence on behaviour; how are these well-learned associations and automated behavioural schemata created, and why? When certain sequences of behaviours are executed consistently and over an extended period of time, these behaviours may become automated (Strack & Deutsch, 2004). This allows (human) beings to learn behaviours, which can be carried out efficiently with little or no requirement of attention resources (Bargh, 1994). This has obvious benefits, given the limited attentional capacity that people have to execute behaviour (e.g., Muraven, Tice, & Baumeister, 1998). Such automated or habitual processes are involved in all aspects of food consumption, such as what, when, where and why to eat; when to stop; and with whom to eat (Cruwys, Bevelander, & Hermans, 2015; Van 't Riet, Sijtsema, Dagevos, & De Bruijn, 2011).

Accordingly, based on the proposed dichotomy of the memory system, scholars in various lines of research have adopted reflective impulsive models of behaviour (for a systematic overview see e.g., Smith & DeCoster, 2000). These models make a distinction between deliberate or explicit processes on the one hand, mostly determined by rule-based processing, versus automatic or impulsive processes on the other hand, predominantly based on associative processing. Both types of processes guide everyday behaviour and decision making. Thus, in the case of overconsumption of energy-dense snacks among people who are dieting, akrasia could be explained as behaviour instigated by impulsive processes, for example, in response to appetitive stimuli, which may be contrasting to a person's deliberate goals and intentions.

REFLECTIVE IMPULSIVE MODEL

One influential dual-process model, integrating behavioural (habitual), motivational, and cognitive components of behaviour, is the reflective impulsive model proposed by Strack and Deutsch (2004). According to the reflective impulsive model, reflective (i.e., deliberate) processes are flexible and can rely on new associations, but they are relatively slow and cognitively demanding. The authors refer to this as reasoned action: behaviour instigated after a decision-making process. For example, making a mental calculation of the benefits and costs for health of eating an apple versus the habitual tasty fried snack at the school or company canteen can result in the deliberate choice to buy the apple rather than the fried snack. In contrast to these attention-demanding processes, impulsive (i.e., automatic) processes enable behaviour to be carried out with little or no demand on cognitive attention. These automatic processes rely on well-learned associations and automated behavioural schemata (i.e., habitual behaviour), referred to as impulsive action. These distinct types of processing can be elicited by external cues, such as the sight or smell of food, or internal cues, such as the motivational state of hunger when energy deprived (Strack & Deutsch, 2004).

In line with the functionality of multiple memory system models (e.g., Schacter & Tulving, 1994), Strack and Deutsch (2004) propose that reflective and impulsive processes do not occur exclusively, but they can be activated in parallel and may interact or compete for behavioural output, depending on the cognitive capacity available at that time (Strack & Deutsch, 2004). Therefore, the reflective impulsive model provides a framework that helps to explain behaviour. It helps to explain why people display unhealthy behaviours and execute unhealthy habits.

INCENTIVE-SENSITIZATION MODEL

A model that dives further into automaticity and the mechanisms of habit formation, specifically in relation to maladaptive behaviours, is the incentive-sensitization model by Robinson and Berridge (1993). This theoretical model states that rewarding properties are increasingly attributed to the object(s) of addiction and its associations through classical conditioning, leading to increased liking and wanting of the objects (i.e., termed positive implicit attitudes). The foods become more salient and increasingly attention-grabbing (an effect or process termed attentional bias), and they trigger automatic approach behaviour (i.e., reduced impulse control). These processes elicit motivational activation of approach behaviour (e.g., craving or feelings of hunger while not in nutritionally deprived state), predominantly regulated by the dopaminergic reward system, and occur implicitly (Stice & Yokum, 2016).

These automatic motivational processes triggering food intake are beneficial to reach a homeostatic equilibrium (Denton, McKinley, Farrell, & Egan, 2009). Indeed, research indicates that these processes are more often activated when individuals are in a hungry state, compared to when they are satiated (Stice & Yokum, 2016; Volkow, Wang, Tomasi, & Baler, 2013). However, in overweight and obese individuals, a chronic activation of the automatic processes has been observed, irrespective of satiation (Castellanos et al., 2009; Mogg, Bradley, Hyare, & Lee, 1998; Stice & Yokum, 2016). The motivation to eat thus appears to stay heightened in overweight and obese individuals, postulated to play a role in the maintenance of overweight and obesity (Castellanos et al., 2009; Stice & Yokum, 2016). Therefore, when designing interventions to improve dietary behaviour, it would be beneficial to incorporate techniques to modify automatic processes, treating them as important precursors of eating behaviour.

IMPLICIT ATTITUDES

One automatic component that has been recognized as a possible determinant of behaviour is the affective valence that individuals implicitly assign to (food) product or behaviours. These automatic emotionally valenced associations are also termed ‘implicit attitudes’. Implicit attitudes have been investigated by scholars in multiple domains, and the relation between implicit attitudes and behaviour such as physical activity (Rhodes, Fiala, & Conner, 2009), purchase intention (Strick, van Baaren, Holland, & van Knippenberg, 2009), and organ donation (O'Carroll, Foster, McGeechan, Sandford, & Ferguson, 2011) has been observed. Also in the domain of eating behaviour, consumption has been found to be related with implicit attitudes that children and adults have towards certain food products (e.g., Corsica & Pelchat, 2010; Eschenbeck, Heim-Dreger, Steinhilber, & Kohlmann, 2016; Kiviniemi & Duangdao, 2009; Moira, M., & Richard, 2008; Walsh & Kiviniemi, 2014). This underscores that implicit attitudes can be considered a precursor for behaviour and indicates the potential for behavioural effects through the modification of implicit attitudes towards food products.

A method that has been shown effective in affecting implicit attitudes is evaluative conditioning (e.g., Ebert, Steffens, Stülpnagel, & Jelenec, 2009; Hofmann, De Houwer, Perugini, Baeyens, & Crombez, 2010; Legget, Cornier, Rojas, Lawful, & Tregellas, 2015). In an evaluative conditioning paradigm, stimuli (i.e., conditioned stimuli) are repeatedly paired with emotionally valenced stimuli (i.e., unconditioned stimuli). Through these repeated associations, the emotional valence of the unconditioned stimuli can transfer to the conditioned stimuli, either modifying or strengthening the existing automatic associations with these products (Hofmann et al., 2010).

Studies using an evaluative conditioning paradigm to influence implicit attitudes towards food reported a reduction of craving (Kemps, Tiggemann, Martin, & Elliott, 2013) and an increased likelihood of making healthier food choices (Hollands & Marteau, 2016; Hollands, Prestwich, & Marteau, 2011). These results suggest that targeting implicit attitudes is a promising method to influence eating behaviour through automatic, or subconscious, processes. However, supporting the expression 'old habits die hard', numerous studies suggest that habitual behaviour is resistant to change (e.g., Schaefer & Magnuson, 2014; Webb & Sheeran, 2006). Given that repetition, as mentioned, is often an important component of habit formation, careful consideration of how to deliver an intervention is crucial to maximize exposure time and frequency.

GAMIFICATION AND HEALTH GAMES

Video games are very popular among youth (Willoughby, 2008). Therefore, a promising method to make an intervention more appealing is to add game elements in a non-game context, termed gamification (Deterding, Dixon, Khaled, & Nacke, 2011). Alternatively, a popular approach is to transform an intervention, or a part of the intervention, into a game (Fleming et al., 2017; Van 't Riet, Alblas, Crutzen, & Lu, 2015).

The scientific literature shows an increase in the use of (video) games that have the dual goal of being entertaining and influencing behaviour at the same time. That is, these games aim to "teach, train, and change knowledge, attitudes, and behaviour" (Baranowski, Buday, Thompson, & Baranowski, 2008, p. 2). In the domain of health behaviour, these games are usually referred to as health games (Lu, Kharrazi, Gharghabi, & Thompson, 2013).

It is argued that using health games can have several advantages compared to non-game (digital) health interventions (Garris, Ahlers, & Driskell, 2002; Moyer-Guse, 2008). There are three main advantages of using games (or gamification). First, the element of fun is said to attract, capture, and maintain attention, thus having the capacity to enhance exposure to the intervention (Baranowski et al., 2008). Second, positive attitudes (towards a game) can transfer onto the content and thereby potentially attenuate reactance to the message (Moyer-Guse, 2008; Ritterfeld, Cody, & Vorderer, 2009). Third, educational research suggests that "learning by doing can be superior over learning by listening" (Garris et al., 2002, p. 441). This is because in games, players can practice and perform specific behaviours frequently and enhance their performance and skills through continuous feedback and increasing difficulty in the levels (Bandura, 1986). These advantages suggest a beneficial role of entertainment and entertaining games to educate or train behaviour. Moreover, another advantage is that games often rely on repetition for the player to achieve progress (Ciavarro, Dobson, & Goodman, 2008), making them ideally suited for integrating a repetitive evaluative conditioning paradigm.

Research indeed suggests that health games that aim to treat or train behaviours in a variety of health domains can be very successful, such as when treating children's anxiety (Schoneveld et al., 2016) or adolescent problematic drinking behaviour (Boendermaker, Veltkamp, & Peeters, 2017) or when the aim is to increase (children's) physical (Van 't Riet et al., 2015) or fruit and vegetable consumption (Baranowski et al., 2003). These health games have been designed and developed based on evidence- and science-based theories, paradigms, and techniques, such as exposure therapy and impulse control training to modify, teach, or train specific behaviours. However, at the start of the project, to the best of our knowledge, the effectiveness of a health game that specifically focused on implicit attitudes towards food had not yet been experimentally tested, a gap that the studies belonging to this dissertation aimed to fill.

In sum, given the advantages of video games and the suggested suitability of video games to train implicit behaviours, especially among youth, designing a health game to modify implicit attitudes towards foods would appear to be a promising approach to fill the gap and aid the treatment of overweight and obesity. Therefore, the main focus of this dissertation was to develop and investigate the effectiveness of such a health game.

PLATFORM AND IMPLEMENTATION STRATEGY

When a health game appears effective, it is important also to consider a suitable platform and implementation strategy to ensure (sufficient) exposure to the intervention. Placing a health game online may ensure that a large audience can be reached, with the added benefits that the intervention is available 24/7 and is relatively cost effective. Furthermore, internet-based interventions have the potential to reach individuals who wish to remain anonymous (Tate &

Zabinski, 2004) or those who would otherwise not seek treatment due to physical, geographical, or financial constraints (Ritterband et al., 2003). Due to the internet's many advantages, this is a popular medium to distribute interventions (Casazza & Ciccazzo, 2007; Cushing & Steele, 2010; Stinson, Wilson, Gill, Yamada, & Holt, 2009).

However, to make optimal use of the internet as a platform to offer or distribute the intervention, it should be considered how the target population can find and access the health game. Web-based analytic programs can be used to extract this information. Next, use of tracking usage information can provide an indication whether visitors remain interested in the health game and if advertising campaigns to promote the health game are necessary and effective.

As yet, research investigating usage data of online health games is scarce, even though exploring the usage of health games placed online can provide valuable information about using the internet as a platform. Additionally, usage information can provide an indication about the necessity of advertising and the effectiveness of advertising on stimulating both new and returning visitors to access the health game. Therefore, evaluating this was a secondary focus of this dissertation.

AIMS AND OUTLINE OF THE DISSERTATION

AIMS OF THE DISSERTATION

To treat overweight and obesity, novel approaches to modify eating behaviour are needed. A promising approach is to influence automatic or implicit processes in eating behaviour, for example by targeting implicit attitudes through evaluative conditioning (e.g., Ebert et al., 2009; Hofmann et al., 2010; Legget et al., 2015). In addition, health games have been found to be a suitable tool to train automatic behaviours, and they have several advantages over non-game interventions, especially for youth. Therefore, a health game was developed for the current dissertation, based on an evaluative conditioning paradigm.

The first aim of this dissertation was to examine the effectiveness of a health game based on an evaluative conditioning paradigm. Effectiveness was operationalized by using two outcome measures. First, it was examined whether the evaluative conditioning component could successfully improve implicit attitudes towards foods. Implicit attitudes towards food were assessed at baseline and post-test, after participants finished playing either the health game or a control version, by using an Implicit Association Test (Greenwald, McGhee, & Schwartz, 1998). This test measured the strength of associations between foods (e.g., apple, brownie) and emotionally valenced words (e.g., smile, stupid). In other words, this test compared the subject's ease of combining fruits with positive words and chocolate snacks with negative words (i.e., *healthy implicit attitudes*), versus combining fruits with negative words and chocolate snacks with positive words (i.e., *unhealthy implicit attitudes)*. Second, to test for possible behavioural effects, participants were invited to choose between fruits and chocolate snacks in several digital and/or actual snack choice questions. So, the second outcome measure was food choice behaviour, where the results reflected whether healthier food choices could be stimulated with a health game.

The second aim of this dissertation was to examine whether the effects on implicit attitudes and food choice behaviour would differ between (sub)groups. There were three different (sub)groups. First, the effects of the health game were investigated in two different studies using different samples: adults and children. Second, because of expected ceiling effects for already healthy individuals observed in other research (Hollands et al., 2011), the studies explored whether baseline implicit attitudes would moderate the health game's effectiveness on the two outcome measures. Therefore, a distinction was made between children and adults with healthy implicit attitudes at baseline and children and adults with less healthy implicit attitudes at baseline. So to recap; those with healthy implicit attitudes were substantially faster to combine fruits with positive words and chocolate snacks with negative words, compared to combining fruits with negative words and chocolate snacks with positive words. For participants with less healthy implicit attitudes, this reaction-time difference was smaller. Finally, it was explored whether weight status would moderate the effectiveness of the health game on the two outcome measures. Therefore, in Study 2, a distinction was made between children with under- and healthy weight and children with overweight or obesity.

The third aim of this dissertation was to evaluate using the internet as a platform to distribute a health game and advertising as a strategy to promote this game. Therefore, usage of an existing health game was investigated, in a non-controlled and voluntary setting. The health game was placed online and was promoted through two advertising campaigns. Along with usage information, the effects of advertising on usage were explored and whether advertising would influence usage differently when a distinction was made between new and returning visitors.

OUTLINE

Chapters 2, 3, and 4 report on the three studies that were conducted to investigate the aims of this dissertation. The dissertation concludes with a general discussion in Chapter 5, where the research findings are discussed in relation to the aims, and the implications for the field are considered.

CHAPTER 2: INVESTIGATING THE IMPACT OF A HEALTH GAME ON IMPLICIT ATTITUDES TOWARDS FOOD AND FOOD CHOICE BEHAVIOUR OF YOUNG ADULTS

Chapter 2 describes a randomized controlled trial investigating the effects of a health game in a Dutch student sample (*N* = 125, age: *M* = 20.17, SD = 1.88). This study addressed the first two aims of the dissertation, that is, whether the health game was effective in modifying implicit attitudes and food choice behaviour, and whether the effectiveness differed between subgroups.

To examine the first aim, baseline and post-test implicit attitudes towards food were compared between participants playing either the health game or a control version, to analyse the health game's effects on implicit attitudes. To test for possible behavioural effects, participants were invited to select one snack from several fruits and chocolates in a digital and actual snack choice question. Again, the responses to these two questions were compared between participants playing either the health game or a control version.

To examine the second aim, the sample was split into two groups based on their baseline implicit attitude scores. Specifically, the effectiveness of the health game was examined between children and adults with healthy implicit attitudes and children and adults with less healthy implicit attitudes.

For this study, a novel and challenging health game for the computer was developed, called Sky Islands (see Figure 1). The health game was based on an evaluative conditioning paradigm, with the aim to create or strengthen positive associations with fruits and create or strengthen negative associations with chocolate snacks. To compare the effects of the health game, a control version was developed that was identical to the health game, but rather than pictures of food, pictures of clean and fossil fuels were used, allowing for a comparable story line.

Figure 1. *A screen shot of the first iteration of the health game Sky Islands*

CHAPTER 3: A HEALTH GAME TARGETING CHILDREN'S IMPLICIT ATTITUDES AND SNACK CHOICES

In Chapter 3, building on Chapter 2, a second randomized controlled trial study is described, which aimed to replicate Study 1 in children (*N* = 79, age: *M* = 12.42 y, *SD* = 1.64, BMI: *M* = 25.06, *SD* = 7.40). Thus, this study again addressed the first two aims of the dissertation; whether the health game was effective in modifying implicit attitudes and food choice behaviour, and whether the effectiveness differed between subgroups. The design and research questions were similar to those in Study 1, but with some modifications.

First, an effort was made to include a relatively large proportion of participants who were overweight in the sample, to explore whether body mass index (BMI)[1] would moderate the effects of the health game on the two outcome measures. Second, the children were not physically exposed to the energy-dense snacks, to protect overweight children from possible excess intake of calories. Therefore, only digital snack choices were included, although the participants were given the impression that they could get any snack after the experiment. Third, the health game had some modifications. In this iteration (see Figure 2), players were asked to choose an avatar and enter a name of their choosing. Also, a narrative was incorporated in the game. In this narrative, an adversary was introduced, and the player was asked to help save the inhabitants from this tyrant. These strategies were incorporated because they have been found to increase personal involvement (i.e., character identification) and can aid to contextualize the health message in the game and lead to more reflective processing (Baranowski et al., 2013). Furthermore, the difficulty level was reduced to accommodate younger users, and the graphics were improved.

Figure 2. *A screen shot of the second iteration of the health game Sky Islands*

CHAPTER 4: USER STATISTICS FOR AN ONLINE HEALTH GAME TARGETED AT CHILDREN

In Chapter 4, results from a quantitative study are described, where a web-based analysis program was used to examine usage data of all visits to an online health game. In this study, the third aim of the dissertation was addressed; to evaluate using the internet as a platform to distribute a health game and advertising as a strategy to promote this game. The period of data analyses included the first 31 months following the launch. During this period, the health game was promoted in two advertising campaigns, using television, internet, and radio ads to promote the game. In the period of data analysis, there were 224,859 unique sessions. The descriptives for usage data were reported, including information about the

1 BMI, an abbreviation for body-mass index, is an index score that calculates the ratio between height and weight. It is calculated by dividing the weight in kilograms by the square of a person's height in meters. In this study, BMI was categorised by using the cutoff scores based on sex and age that were established by Cole, Bellizzi, Flegal, and Dietz (2000)

number of first-time versus returning visitors, session time, how the game was found, and which device was used. Furthermore, the relation between advertising and usage was analysed, and the association between advertising and the number of first-time visitors was investigated.

The health game examined in Chapter 4 was Monkey Do (short for Monkey See Monkey Do, in Dutch titled Na-Aapje), developed for children from 4 to 8 years of age (see Figure 3). The primary goal of Monkey Do was to be entertaining. The second aim was to expose children to fruits and vegetables in an unobtrusive way, without a didactic component. Monkey Do was developed by the Netherlands Nutrition Centre, in collaboration with the Knowledge Centre for Sport Netherlands, and was part of a broader national campaign aiming to improve dietary lifestyle among Dutch children by increasing their parents' healthy example behaviour (i.e., increase parents' awareness that children learn from and copy their behaviour). The game was freely and easily accessible, without users having to create an account or sign up on the website.

Figure 3. *A screen shot of the health game Monkey Do*

CHAPTER 5: GENERAL DISCUSSION

In Chapter 5, the results from the studies conducted for this dissertation are summarised in a general discussion. In this chapter, the results from the three studies are discussed in relation to the three research aims. Furthermore in this chapter, theoretical and practical implications will be discussed. Moreover, the strengths and limitations, as well as suggestions for future research will be provided. The chapter closes with a general conclusion highlighting the main findings, suggestions and implications.

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CHAPTER 2

INVESTIGATING THE IMPACT OF A HEALTH GAME ON IMPLICIT ATTITUDES TOWARDS FOOD AND FOOD CHOICE BEHAVIOUR OF YOUNG ADULTS

This chapter is published as:
Alblas, E.E., Folkvord, F., Anschütz, D.J. , Van 't Riet, J.P., Granic, I., Ketelaar, P.E. & Buijzen, M. (2018) Investigating the impact of a health game on implicit attitudes towards food and food choice behaviour of young adults. *Appetite,* 128, 94-302
doi: https://doi.org/10.1016/j.appet.2018.05.141

ABSTRACT

Objective: Improving diets by stimulating fruit and vegetable consumption might be beneficial, in particular when they substitute energy-dense products. The aim of present study was to investigate whether a health game can be used to positively affect healthy implicit attitudes (IAs) towards food and subsequent food choice behaviour of young adults.

Design: A 2 (Time: baseline vs. post-test) x 2 (Condition: health game vs. control game) x 2 (Baseline IAs: healthy IAs vs. less healthy IAs) mixed-subjects design was used with 125 participants (age: $M = 20.17$, $SD = 1.88$).

Main Outcome Measures: IAs towards food were assessed at baseline and post-test using an Implicit Association Test (IAT). Additionally, food choice behaviour was assessed after game play.

Results: At baseline, the majority of participants had healthy IAs (i.e., favouring fruit over chocolate snacks). At post-test, significantly less healthy IAs were observed in the control condition, while this reduction was not significant in the health game condition. Regarding food choice behaviour, participants with healthy baseline IAs were more likely to select fruit in the health game condition than participants with healthy baseline IAs in the control game condition. However, participants with less healthy baseline IAs were less likely to select fruit in the health game condition than in the control condition. We found tentative support that health games can be used to influence IAs towards food and positively affect food choice behaviour. However, this influence was only observed for those with healthy baseline IAs.

Conclusion: The current version of the health game would primarily benefit those already healthy and could negatively affect those that need the intervention most, so modifications are recommendable.

The global prevalence of being overweight or obese has reached epidemic proportions (Kosti & Panagiotakos, 2006). Generally, the diet leading to obesity consists of too many energy-dense products and too few fruits and vegetables (RIVM, 2011, 2016b). In addition, eating insufficient amounts of fruits and vegetables is associated with health risks such as cardiovascular disease and several cancers (Kaikkonen et al., 2013). Improving people's diet by stimulating fruit and vegetable consumption might be beneficial, especially when fruits and vegetables replace energy-dense products. The goal of this study is to investigate whether a newly-developed health game can be used to positively affect healthy implicit attitudes (IAs) towards food and food choice behaviour of young adults.

A great number of obesity intervention programs aim to reduce overweight through health education (Anderson et al., 2004), whereby recommendations concerning dietary guidelines are provided. An important assumption in these education-based programs is that increased knowledge positively instigates behavioural change (Van 't Riet et al., 2011). However, knowledge alone does not seem to be sufficient for most individuals to modify and maintain healthy behaviour (e.g., healthy diet and sufficient exercise), especially not in the long term (Schaefer & Magnuson, 2014; Webb & Sheeran, 2006). Therefore, it has been suggested that interventions should not exclusively focus on education (Kirschenbaum & Gierut, 2013). A reason for the limited effectiveness of education-based interventions may be that many processes involved in eating behaviour are not consciously planned and deliberate, but occur on a more automatic level instead (Van 't Riet et al., 2011).

As a consequence, scholars in various lines of research have adopted dual-systems models of behaviour (Strack & Deutsch, 2004). For example, one influential model is the Reflective impulsive model (RIM) by Strack and Deutsch (Strack & Deutsch, 2004). According to this model, deliberate (i.e., reflective) processes are flexible but relatively slow and demand relatively high cognitive effort. In contrast, automatic (i.e., impulsive or implicit) processes enable behaviours to be carried out with little or no cognitive effort. Automatic processes rely on well-learned associations and automated behavioural schemata. These processes are involved in all aspects of food consumption (Van 't Riet et al., 2011). According to the RIM, deliberate and automatic processes do not occur exclusively, but can be activated in parallel and may compete for behavioural output, depending on the cognitive capacity available at that time. As a result, implicit or hedonic desires can be in direct contrast with explicit attitudes and goals (Eschenbeck et al., 2016; Hofmann et al., 2007).

According to the incentive-sensitization theory (Robinson & Berridge, 1993), one of the key processes involved in eating behaviour is the automatic associations triggered by specific food cues, referred to as implicit attitudes (IAs) (Bargh, 1994). Implicit attitudes are formed by (repeated) exposure to food products, whereby parental preferences, feeding styles, and familiarity with foods are important factors that affect implicit attitudes toward food products (Aldridge, Dovey,

& Halford, 2009). Indeed, research indicates that there is a positive relation between unhealthy IAs and energy-dense food purchase intention (Prestwich, Hurling, & Baker, 2011), actual eating behaviour (Corsica & Pelchat, 2010; Eschenbeck et al., 2016; Volkow et al., 2013) and weight (Stice & Yokum, 2016). Additionally, in situations of high distraction (Eschenbeck et al., 2016) or ego depletion (Wang et al., 2015), IAs towards food have been found to better predict soft drinks and chocolate consumption compared to existing explicit attitudes. Thus, IAs could be of importance when targeting unhealthy eating behaviour, treating it as a precursor of eating behaviour.

Research seems to suggest that targeting IAs, for example through an evaluative conditioning (EC) paradigm, can modify automatic associations (Ebert et al., 2009; Legget et al., 2015). During a food EC paradigm, food images (conditioned stimuli) are repeatedly paired with emotionally valenced stimuli (unconditioned stimuli). This can modify or strengthen automatic associations with the conditioned food stimuli (Hofmann et al., 2010), with the degree of modification being relating to decreased craving (Kemps et al., 2013) and with frequency of choices favouring nutrient-dense over energy-dense snacks (Hollands & Marteau, 2016; Hollands et al., 2011), although one study failed to find behavioural effects (Lebens et al., 2011).

Even though there appears to be great potential to change behaviour with interventions using EC paradigms, (habitual) eating behaviour is very resistant to change. Therefore, the current study aimed to tailor the intervention to make it suitable for the general public by transforming the EC paradigm into a health game. There are three main reasons why a health game was chosen as a vehicle for this study. First, the element of fun in games attracts, captures and maintains attention (Ritterfeld et al., 2009), thus having the capacity to enhance exposure to the health intervention (Baranowski et al., 2008). Second, games can be processed on a more automatic level, especially when the message is delivered more implicitly or via a precursor of the behaviour (Baranowski et al., 2016). Third, given the repetitive nature of EC paradigms, games could potentially be highly applicable to target this automatic process since videogames often rely on repetition to progress in the game (Bandura, 1986; Ciavarro et al., 2008). Consequently, “health games” are an increasingly popular tool to instigate behavioural change (Parisod et al., 2014). In particular, health games have been used to train various physical and mental behaviours (Lu et al., 2013; Van ‘t Riet et al., 2015).

The aim of the present study was to investigate whether a ten-minute play session of the health game could positively affect healthy IAs towards food and food choice behaviour of young adults. It was hypothesized that playing the health game would result in more healthy IAs towards food, compared to a control game (H1a). Due to expected ceiling effects of the influence of the game on healthy IAs (Hollands et al., 2011), those with IAs already healthy at baseline were not expected to be as strongly positively affected as those with less healthy IAs at baseline. Therefore, it was hypothesized that the effect of the health game on IAs would be moderated by baseline IAs (H1b). In addition, it was hypothesized that, compared to the control game, playing the health game would result in more participants favouring fruit snacks over chocolate snacks, both as virtual snack choice (H2a) and actual snack choice (H3a). Furthermore, it was expected that this effect would be moderated by baseline IAs, where those with healthy IAs at baseline were expected to be less affected by the health game than participants with less healthy IAs at baseline, due to ceiling effects (H2b and H3b).

MATERIAL AND METHODS

STUDY DESIGN

The study was based on a 2 (Time: baseline vs. post-test) x 2 (Condition: health game vs. control) x 2 (Baseline IAs: healthy IAs vs. less healthy IAs) mixed-subjects design with time as a repeated measures factor and IAs change and food choice behaviour as dependent variables. Participants were randomly assigned to one of the two conditions matched on sex.

PARTICIPANTS

A G*power analysis (Faul, Erdfelder, Lang, & Buchner, 2007) (effect size = 0.30, alpha = .05 and power = .80) indicated a minimum sample size of 126 participants. A total of 128 undergraduate students (> 18 years of age) participated in the study in exchange for a 5-euro gift certificate. A total of 3 participants had IAT data that should be excluded according to the IAT D-score calculations guidelines, because they had ≥ 10% of the trials with a RT < 300 ms, resulting in 125 valid participants (age: $M = 20.17$, $SD = 1.88$). The study took place in the social sciences lab at the Radboud University from March 2015 until May 2015, and was approved by the Ethics Committee of the Faculty of Social Sciences of Radboud University (ECSW2015-2206-324). It was emphasized to the participants that the data would remain confidential and that they could cease participation at any moment without consequence.

MATERIALS

For this study, we developed a novel and challenging health game for the computer, called *Sky Islands* (see Figure 1). In this 2D strategy game, players had to fight an adversary, located at ground level, who was trying to take down floating islands by forcing unhealthy food upon the inhabitants. Too many unhealthy inhabitants would increase the weight of their island, causing it to sink. The goal was to supply the islands with as much healthy food as possible, by dragging the food crates to the islands, to increase the number of healthy inhabitants, resulting in the islands regaining their buoyancy. To win, all islands had to be aligned at the top of the screen. There were three levels in total, with increasing difficulty level.

The health game was based on an EC paradigm, with the aim to create or strengthen positive associations with fruits (i.e., nutrient-dense food) and create or strengthen negative associations with chocolate snacks (i.e., nutrient-low/ energy-dense food). Fruits were associated with positive game advancement, because choosing fruits increased the number of healthy inhabitants. Chocolate snacks on the other hand were associated with negative game advancement, because these snacks decreased the number of healthy inhabitants. The control game was identical to the health game, but rather than pictures of food, pictures of clean and fossil fuels were used, allowing for a comparable story line.

The health game was designed with a built-in time limit of ten minutes. A limited period of playtime was chosen to ensure that all participants would get equal exposure, regardless of players' skills. Participants played the game for ten minutes because the pilot study (*N* = 5) revealed that participants remained focused on playing the game during this time period and it allowed for sufficient evaluative conditioning trials. During an average play session, approximately 100 crates could be dragged to the islands, where in around 10% of the trials, both crates contained energy-dense snacks, to ensure exposure to the negative effects of this food type.

Figure 1. *A screen shot of the health game Sky Islands*

Game evaluation was assessed using a 10-point numeric Visual Analogue Scale, with the anchors labelled as 'not at all' and 'very much'. There was no significant difference (*p* = .372) between the evaluation scores of the health game (*M* = 5.89, *SD* = 1.45) and the control version (*M* = 5.63, *SD* = 1.69). Anecdotal verbal reports suggested that the experienced level of difficulty was quite high in both versions.

The food items used in the health game were based on a pilot study in which 20 students listed their top-two nutrient-dense and energy-dense snacks. The most popular nutrient-dense snacks, as opposed to the most disliked ones, were chosen to maximize possible behavioural effects, given that this was a first test of the health game. This resulted in a list of 10 nutrient-dense and 16 energy-dense snacks, which were ranked by a second group of 14 students. To maximize in-game exposure to the specific food items and thus increase the evaluative conditioning effects (Hofmann et al., 2010), only four popular snacks of both categories were featured in the health game. The items were furthermore comparable in food type to increase generalization within these categories, being four fruits; tangerine, apple, pear, and banana, and four chocolate snacks; peanut chocolate bar, milk chocolate, chocolate muffin, and chocolate brownie, all depicted in a realistic style (see Figure 2).

Figure 2. *The eight snacks used in the health game*

IMPLICIT ATTITUDES

To investigate whether IAs towards food would be influenced by the health game, we administered an Implicit Association Test (IAT) (Greenwald et al., 1998) at baseline and directly after playing the health game or the control game. In the IAT, words appeared on the screen that had to be classified into four categories, representing two attributes (*positive* with the exemplars positive, smile, happy, kind, pleased; and *negative* with the exemplars negative, stupid, pain, sad, sickness) and two targets (*fruits* and *chocolate snacks*, with exemplars being the verbal representations of the eight pictures featured in the health game). Participants had to correctly classify each word before the next stimulus appeared.

We used the standard IAT, containing seven blocks (Greenwald, Nosek, & Banaji, 2003). After two practice blocks with first the attribute words and second the target words, the attributes and targets were presented together in the third and fourth block (i.e., practice and test of the critical block), with 20 and 40 trials, respectively. The participants were asked to respond to *positive* or *chocolate snacks* with the left hand and to *negative* or *fruits* with the right hand (incongruent). After another practice block with the attribute location switched, in the next critical blocks, they responded to *negative* or *chocolate snacks* with the left hand and *positive* and *fruits* with the right hand (congruent). Because performance can be influenced by the order of the two critical blocks (i.e., incongruent first or congruent first) (Greenwald et al., 2003), for half of the participants the order of the critical blocks was reversed for both measurements (evenly distributed in both conditions). A marginally significant order effect was observed *(p* = .057), where those with the congruent block first had healthier IAs scores on both measurements compared to those with the incongruent block first. Therefore, the variable IAT order was included as a covariate in the analyses.

To calculate the IAT score for each participant, the revised scoring algorithm was used (Greenwald et al., 2003), where a positive score was related with IAs favouring fruits over chocolate snacks, referred to as healthy IAs. One outlier was removed from the analysis because the baseline IAT score was over 3 *SD*'s below the mean, resulting in a total of 124 participants with two valid IAT scores. The two conditions did not differ significantly on baseline IAs ($p = .853$).

To categorize the strength of the IAT scores and examine the moderating role, previous research used specific *D* cut-off scores indicating a weak ($D < .35$), moderate ($.35 \leq D \leq .65$) or strong healthy IAs ($D > .65$) (Hahn, Judd, Hirsh, & Blair, 2014). Another study (Hollands et al., 2011) identified participants with a relatively weak (mean z - 1 *SD*), moderate (mean z) or strong healthy IAs (mean z + 1 *SD*). In the present sample however, the data were negatively skewed, with only four participants favouring chocolate snacks over fruit and 76% of the participants having a *D*-score > .65 at baseline (i.e., strong healthy IAs). Therefore, median split-method was used to divide the participants in "healthy" ($n = 61$) vs "less healthy" ($n = 63$) IAs at baseline. The cut-off median value was a *D*-score of .93.

To investigate the effect of condition on time, the IAT *D*-scores at baseline and post-test were examined. The correlation between baseline and post-test IAT scores was .66 ($p < .001$). IAT delta was calculated by subtracting IAT post-test scores – IAT baseline scores.

FOOD CHOICE BEHAVIOUR

Virtual choice and actual food choice were assessed post-test. The snacks used for these questions were identical to the health game and their verbal representations in the IAT (i.e., tangerine, apple, pear, banana and peanut chocolate bar, milk chocolate, chocolate muffin, and chocolate brownie). First, after the second IAT, an image of the eight snacks was shown on the computer screen, with order randomised between participants, with a request to select one of them to take home after the experiment (virtual choice). Second, at the end of the experiment, the same snacks were presented on a platter by the experimenter and participants were offered to take one home. This choice was unobtrusively recorded (actual choice). Participants who refrained from making an actual snack choice were excluded from the corresponding analyses ($n = 9$). In the analyses, the choice questions were transformed to dichotomous variables (i.e., fruit vs. chocolate snack). Fruits were favoured more than chocolate snacks, with 74 out of 125 participants choosing fruits in the virtual choice question, and 78 out of 116 participants in the actual choice question. There was a high positive correlation between the two choices, $r = .79$ ($n = 116$).

ADDITIONAL VARIABLES

HUNGER. Hunger was assessed using a 5-point Likert scale (1 = *not at all* and 5 = *very much;* *M* = 2.70, *SD* = 1.18).

MINUTES SINCE LAST MEAL. Minutes since last meal was assessed using an open recall question (*M* = 95.72, *SD* = 127.31).

BMI. BMI was calculated using self-reported height and weight[1] (*M* = 22.22, *SD* = 2.69), using the cut-off scores reported by the World Health Association (Ulijaszek, 2003). The average BMI fell within the cut-off values of a healthy weight.

DIETARY RESTRAINT. Dietary restraint was assessed using the Concern for Dieting subscale of the Revised Restraint Scale (Herman & Polivy, 1980). This scale contains six 4 to 5-point scale Likert items, such as "Do you eat sensibly in front of others and splurge alone?" and "Do you have feelings of guilt after overeating?", Cronbach's α = .73, *M* = 15.72, *SD* = 4.28.

DIETARY KNOWLEDGE. Dietary knowledge was assessed using the Dutch translation of the general nutrition knowledge questionnaire by Parmenter and Wardle (1999) (*M* = 43.42, *SD* = 6.68).

Given that the last three variables did not correlate with any of the outcome measures, they were not included in the analyses.

PROCEDURE

Each participant read a brief information letter, displayed on a computer screen, informing them that they would play a videogame on the computer, would get a computerized task, and had to fill out some questions. Then, the participant signed the consent form. First, baseline IAs were assessed. Next, participants received the first questionnaire to assess hunger and minutes since last meal, after which the health game or the control version started. Participants were informed that this component had a fixed ten-minute duration. If they had any questions, they could read the game instructions by clicking on the question mark. They were encouraged to keep playing for the full 10-minute duration. After completion of the game, post-test IAs were assessed. Participants then received a second questionnaire, which started with the virtual choice question, recorded game evaluation, and ended with questions assessing demographic information. After completion, the eight snacks were presented on a platter by the experimenter and participants were offered to select one to take home. The experiment lasted approximately 35 minutes.

Given that a non-clinical sample was used, participants were asked to abstain from eating three hours prior to participation to reduce a possible *floor effect* of IAs biased towards energy-dense food, as has been observed in research into other automatic processes involved in eating behaviour (Castellanos et al., 2009; Mogg et al., 1998; Veling, Aarts, & Stroebe, 2013; Veling, van

1 Height and weight were entered by 123 participants

Koningsbruggen, Aarts, & Stroebe, 2014). However, the average time since the last meal was 95.72 minutes (*SD* = 127.31). There was a positive relation between time since last meal and hunger ($p = .008$, $r = .24$). Given the overlap in these constructs, hunger was used in further analyses and time since last meal was not included in the analyses.

STATISTICAL ANALYSES

Randomization checks using a 1-factor analysis of variance were conducted for sex, age, hunger, BMI and baseline IAs. Table 1 shows descriptive information for all variables per condition. No differences were observed ($p > .05$), indicating successful randomization. With respect to the dichotomous moderation variable baseline IAs, the group classified as less healthy did not differ significantly from the group with healthy baseline IAs on all variables ($p > .05$) except sex ($p < .001$). Therefore, sex was added as a covariate.

To examine associations between the variables of interest, correlational analyses were conducted. Table 2 shows Pearson's and Kendall's tau correlations between the variables. Sex was significantly correlated with IAT baseline ($p = .016$), with females ($M = .78$, $SD = .47$) having less healthy IAs than males ($M = .97$, $SD = .29$). IAT order was significantly correlated with IAT baseline ($p = .012$) and post-test IAT ($p = .005$), where those with the congruent block first had healthier IAs scores on both measurements compared to those with the incongruent block first. Furthermore, hunger was significantly correlated with virtual choice ($p = .004$) and marginally significant with actual choice ($p = .052$), where increased hunger was related with higher incidences of chocolate snack choices. Therefore, these variables were included as covariates in the corresponding analyses.

Due to the robustness for violation of normality, to test the effect of condition on IAs, a mixed analysis of covariance (ANCOVA) was conducted, with time (i.e., IAT D-scores at baseline and post-test) as dependent variable and condition as independent variable, controlling for sex and IAT order (H1a). To test whether baseline IAs (i.e., healthy IAs vs. less healthy IAs) moderated the effect of condition on IAs change, the former ANCOVA was repeated twice. First, with baseline IAs added as an independent variable to test the main effect of baseline IAs. Second, to test the three-way interaction between time, condition and baseline IAs (H1b). To test the effect of condition on food choice behaviour (i.e., virtual choice and actual choice), two separate hierarchical logistic regression analyses (based on 1000 bootstrap samples) were conducted, each with four successive models. First, the effect of sex and hunger were tested. Second, condition was entered in the model (H2a and H3a). Third, baseline IAs was entered. Fourth, the interaction effect between condition and baseline IAs was entered (H2b and H3b). Given the directionality of the hypotheses, they were tested using one-tailed analyses. The adjusted *p*-value that was considered significant was 0.05. Within each analysis, effect sizes were reported and Bonferroni-adjusted *p*-values where relevant to correct for multiple comparisons.

Table 1. *Descriptives separated by condition*

		All	Game	Control
Demographics	N (Females)	125 (79)	62 (42)	63 (37)
	Age	20.17 (1.88)	20.16 (1.86)	20.17 (1.92)
	Hunger	2.70 (1.18)	2.66 (1.10)	2.73 (1.26)
	Liking fruit	3.95 (.84)	4.03 (.85)	3.87 (.83)
	Craving fruit	3.31 (1.10)	3.32 (1.16)	3.30 (1.04)
	Liking chocolate	4.05 (1.05)	4.08 (1.12)	4.02 (0.99)
	Craving chocolate	2.84 (1.30)	2.90 (1.34)	2.78 (1.26)
	BMI	22.22 (2.69)	22.18 (2.95)	22.26 (2.43)
	Dietary restraint	15.72 (4.28)	15.48 (4.40)	15.95 (4.18)
	Dietary knowledge	43.42 (6.68)	44.19 (6.84)	42.65 (6.49)
	Time since last meal	95.72 (127.31)	92.02 (114.29)	99.30 (139.60)
Implicit attitudes	Mean initial implicit attitude	0.84 (0.44)	.85 (.41)	.86 (.43)
	Mean implicit attitude post-test	0.73 (0.39)	.78 (.36)	.69 (.41)
Food choices	Number of healthy virtual snack choices (percentage)	74 (59%)	37 (60%)	37 (59%)
	Number of healthy actual snack choices (percentage)	78 (62%)	40 (65%)	38 (60%)

2

Table 2. *Pearson's and Kendall's tau [a] correlations between the variables (N=125)*

	1	2	3	4	5	6	7	8
1. IAT baseline								
2. IAT post-test	.67 **							
3. Virtual choice [a]	.05	.17 *						
4. Actual choice [a]	-.06	.02	.58 **					
5. Hunger	-.09	-.08	-.22 **	-.05				
6. Dietary restraint	-.13	-.07	.06	.07	.03			
7. BMI	-.04	.01	.06	-.08	-.04	.26 **		
8. Sex [a]	-.16 *	-.06	-.16	-.06	-.10	.35 **	-.06	
9. IAT version [a]	.19 **	.22**	.11	.12	.09	-.14	.00	-.01

[a] Kendall's tau
* Correlation is significant at the .05 level
** Correlation is significant at the .01 level

RESULTS

IMPLICIT ATTITUDES

The first hypothesis (H1a) stated that the health game would induce healthier IAs towards food over time, compared to the control version. Remarkably, less healthy IAs were observed in both conditions at the second measurement. However, supporting the hypothesis, a repeated measures analysis of covariance (ANCOVA) revealed a significant interaction between time and condition ($p = .039$, see Table 3). Post-hoc analysis (see Figure 3) revealed that participants playing the control game had a significant reduction ($p < .001$) in healthy IAs from baseline ($M = .86$, *S.E.* = .05) to post-test ($M = .69$, *S.E.* = .05), while for participants playing the health game, the reduction from baseline ($M = .85$, *S.E.* = .05) to post-test ($M = .79$, *S.E.* = .05) healthy IAs was not significant ($p = .081$). A significant main effect of the covariate sex was found ($p = .021$), with males having significantly higher healthy IAs scores than females. A significant main effect of the covariate IAT order was found ($p = .002$), with those with the congruent block first having significantly higher healthy IAs scores than those with the incongruent block first.

Table 3. *Results from a repeated measures analysis of covariance with IAs change as dependent variable, controlling for sex and IAT order*

Variables	**Results ANCOVA**	**Partial Eta Squared**
Time * Condition	$F(1, 120) = 3.14$, $p = .039$	.026
Sex (male = 1, female = 2)	$F(1, 120) = 4.27$, $p = .021$	.034
IAT order	$F(1, 120) = 8.23$, $p = .002$	.064

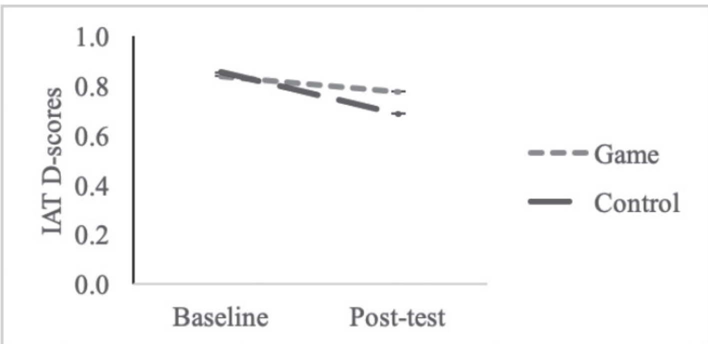

Figure 3. *Average IAT D-scores at baseline and post-test for the game and control condition*

H1b stated that the effect of the health game on IAs change would be moderated by baseline IAs. A second ANCOVA revealed a main effect of baseline IAs (p < .001, see Table 4). A third ANCOVA tested the three-way interaction between time, condition and baseline IA. This interaction was not significant, thus, the hypothesis could not be supported.

Table 4. *Results from two repeated measures analysis of covariance with IAs change as dependent variable, controlling for sex and IAT order*

Variables	**Results ANCOVA II**	**Partial Eta Squared**	**Results ANCOVA III**	**Partial Eta Squared**
Sex (male = 1, female = 2)	F (1, 119) = .34, p = .281	.003	F (1, 118) = .34, p = .282	.003
IAT order	F (1, 119) = 1.90, p = .085	.016	F (1, 118) = 1.85, p = .088	.003
Baseline IA	F (1, 119) = 77.48, p < .001	.394	F (1, 118) = 77.02, p < .001	.395
Time * Condition	F (1, 119) = 3.69, p = .029	.030	F (1, 118) = 3.64, p = .029	.030
Time * Condition * Baseline IA			F (1, 118) = 2.21, p = .070	.018

CHOICE BEHAVIOUR

H2a stated that playing the health game would result in more virtual choices favouring fruit over chocolate snacks. We did not find support for the hypothesis, given that condition did not significantly predict virtual choice (see Table 5). The hierarchical logistic regression analysis showed that sex and hunger were significant predictors of actual choice, whereby the probability to choose chocolate snacks was larger for females than males, and increased when hunger increased.

H2b stated that the effect the health game on virtual choice would be moderated by baseline IAs, where those with healthy IAs at baseline were not expected to be as strongly positively affected than those with less healthy IAs at baseline. The hypothesis could not be supported (p = .975, see Table 5). However, a significant effect in the opposite direction was observed, where individuals with healthy baseline IAs towards food chose fruit more often after playing the health game than participants in the control condition, whereas those with less healthy baseline IAs towards food chose chocolate snacks more often after playing the health game than participants in the control condition.

Table 5. *Hierarchical logistic regression analysis for virtual snack choice, controlling for sex and hunger (n=125)*

Predictors	Model Chi-square (*p*-value)	Nagelkerke's R^2	B	Wald	*p*	Exp(B)
Step 1	13.18 (.001)	.135				
Sex			-.88	4.55	.016	.41
Hunger			-.52	9.01	.001	.59
Step 2	13.23 (.004)	.135				
Sex			-.89	4.59	.016	.41
Hunger			-.52	8.98	.001	.60
Condition			.08	.05	.414	1.09
Step 3	13.23 (.010)	.135				
Sex			-.89	4.30	.019	.41
Hunger			-.52	8.93	.001	.60
Condition			.08	.05	.413	1.09
Baseline IA			-.02	.00	.476	.98
Step 4	17.16 (.004)	.173				
Sex			-.90	4.25	.020	.41
Hunger			-.48	7.29	.003	.62
Condition			.88	2.40	.061	2.42
Baseline IA			.74	1.75	.093	2.09
Condition * Baseline IA			-1.55	3.86	.025	.21

H3a stated that playing the health game would result in more actual choices favouring fruit over chocolate snacks. We did not find support for the hypothesis, given that condition did not significantly predict virtual choice (see Table 6). The hierarchical logistic regression analysis showed that sex and hunger were significant predictors of actual choice, whereby the probability to choose chocolate snacks was larger for females than males and increased when hunger increased.

H3b stated that the effect the health game on actual choice would be moderated by baseline IAs, where those with healthy IAs at baseline were not expected to be as strongly positively affected than those with less healthy IAs at baseline. The hypothesis could not be supported (p = .998, see Table 6). However, the same opposite effects were observed as for the virtual choice question, where individuals with healthy baseline IAs towards food chose fruit more often after playing the health game than participants in the control condition, whereas those with less healthy baseline IAs towards food chose chocolate snacks more often after playing the health game than participants in the control condition.

ADDITIONAL FINDINGS

Interestingly, BMI nor dietary restraint related with implicit attitudes or choice behaviour. However, they were significantly and positively correlated with each other (p = .003). Also, dietary restraint showed a significant positive correlation with sex (p < .001), where females had higher restraint scores than males.

Table 6. *Hierarchical logistic regression analysis for actual snack choice, controlling for sex and hunger (n=116)*

Predictors	Model Chi-square (*p*-value)	Nagelkerke's R^2	B	Wald	*p*	Exp(B)
Step 1	6.75 (.034)	.079				
Sex			-.72	2.70	.050	.49
Hunger			-.38	4.56	.016	.68
Step 2	7.06 (.070)	.082				
Sex			-.75	2.86	.045	.47
Hunger			-.38	4.56	.016	.68
Condition			.23	.31	.289	1.26
Step 3	8.10 (.088)	.094				
Sex			-.86	3.50	.031	.42
Hunger			-.39	4.79	.014	.67
Condition			.24	.33	.284	1.27
Baseline IA			.43	1.03	.155	1.54
Step 4	16.78 (.005)	.188				
Sex			-.89	3.41	.032	.41
Hunger			-.33	3.18	.037	.72
Condition			1.43	5.49	.010	4.16
Baseline IA			1.70	6.90	.004	5.47
Condition * Baseline IA			-2.52	8.15	.002	.08

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DISCUSSION

The aim of this study was to investigate whether a health game could positively influence healthy IAs towards food and food choice behaviour of young adults, where baseline IAs were expected to moderate the effect of condition on IAs change and food choice behaviour. Overall, participants in both conditions showed a decrease in healthy IAs from baseline to post-test. Partially in line with hypothesis H1a, this decrease was not significant in the health game condition, while it was significant in the control condition. Refuting H1b, the effect of condition on IAs change was not moderated by baseline IAs. Furthermore, refuting H2a and H3a, results showed that condition did not affect virtual or actual food choice. However, the effects of condition on both virtual and actual choice were significantly moderated by baseline IAs. The direction of this moderator effect was opposite to what was expected (H2b, H3b), where participants with healthy baseline IAs towards food chose fruit more often after playing the health game than participants in the control conditions, whereas participants with less healthy baseline IAs towards food actually chose chocolate snacks more often after playing the health game than participants in the control conditions. Albeit unexpected, these interesting results call for further discussion and research.

With regard to the observed IAT findings, there are two possible explanations for the overall decrease in healthy IAs. First, the relatively high average IAT score in this sample could point toward a regression to the mean at post-test. While test-retest reliability of the IAT was adequate (Cronbach's Alpha = .80), in a large comprehensive study examining the methodology of the IAT *D*-score calculation (Nosek, Greenwald, & Banaji, 2007), a reduction of extreme scores was observed for those with little or no prior experience with an IAT, which was interpreted as a training effect (Greenwald et al., 2003). Second, it is also conceivable that the exposure to food cues in the first IAT activated processes involved in eating behaviour, since many studies have found a relation with exposure to food cues and increased scores of hunger and craving (Boswell & Kober, 2016) and eating behaviour (Buijzen, Schuurman, & Bomhof, 2008; Folkvord, Anschütz, Nederkoorn, Westerik, & Buijzen, 2014; Folkvord, Anschutz, Wiers, & Buijzen, 2015), thereby possibly resulting in less healthy IAs during the second IAT in the current study. However, the ten additional minutes of food exposure in the health game condition did not amplify the reduction in healthy IAs. In fact, the health game seemed to protect for the training and food exposure effects, given the smaller reduction in healthy IAs at the second measurement, compared to the control condition. However, further research is warranted to disentangle the effects of food exposure in the IAT for individuals with little or no prior experience with the IAT.

Interestingly, it appeared that the health game had a favourable effect on food choice behaviour for those with healthy baseline IAs, while an unfavourable effect was observed for those with less healthy baseline IAs. Assuming that those with healthy baseline IAs value healthy eating, the evaluative conditioning and the implicit health message in the health game could have elicited heightened attention, activating more reflective processes, resulting in subsequent healthier food choice behaviour. This would also be in line with prior findings reporting that evaluative conditioning effects are stronger for those with high contingency awareness (Hofmann et al., 2010). Alternatively, for participants with less healthy baseline IAs, the food cues in the health game may have functioned as priming, primarily activating the hedonic properties of energy-dense food rather than reflective processes, resulting in a larger proportion of individuals choosing the chocolate snacks after playing the health game. This finding has also been observed in a study investigating the effect of fruit depictions in an online memory game (Folkvord, Anschütz, Buijzen, & Valkenburg, 2013).

These findings are also in line with research on persuasion, reporting that those with less healthy attitudes are more resistant to persuasive messages (Rimer & Kreuter, 2006) and findings that interventions are not often (re)visited by the actual at-risk group (Crutzen, de Nooijer, Candel, & de Vries, 2008; Jacobs & Jansz, 2017; Van 't Riet, Crutzen, & De Vries, 2010). This highlights the importance of tailoring the intervention to the target audience, as opposed to 'preaching to the choir' (Van 't Riet, Ruiter, & De Vries, 2011).

While it must be emphasized that the effect of the health game on food intake was unfavourable for the participants with less healthy baseline IAs, it must also be stressed that the average IAs in this group were still moderately healthy according to prior classifications (Hahn et al., 2014). Future research should investigate the effects of the health game in participants with unhealthy IAs or in a clinical sample. However, this should be done with caution given the potential adverse effects found in the study. Building on current findings, a next iteration of the health game should be tested, incorporating strategies to stimulate central message elaboration (e.g., adding narrative and customization). Additionally, when investigating whether the health game can positively influence existing dietary patterns for those that need such an intervention, familiarity and habitual eating behaviour (Aldridge et al., 2009), the influence of expected satiety (Forde, Almiron-Roig, & Brunstrom, 2015), and personality characteristics such as impulsivity (Braet, Claus, Verbeken, & Van Vlierberghe, 2007) and eating style (i.e., external or emotional eating) (Nguyen-Rodriguez, Unger, & Spruijt-Metz, 2009; I. M. T. Nijs, Franken, & Muris, 2009) should be taken into account.

Given the often limited (long-term) success of interventions promoting a healthy diet (Kirschenbaum & Gierut, 2013; Schaefer & Magnuson, 2014; Webb & Sheeran, 2006), novel approaches to target the obesity epidemic are highly needed. The current study aimed to build on two existing fields of research, by targeting a more implicit component of eating behaviour (i.e., automatic positive associations towards energy-dense food), using a digital video game as a vehicle. As a promising alternative to the traditional approach of providing information about healthy eating behaviour, or to augment standard treatment, a novel and challenging health game was developed, aimed at improving immediate eating behaviour. Results suggest that the health game was indeed effective for a sub-group of the sample, those with healthy baseline IAs. As postulated, the effects may have resulted from a more thorough elaboration of the health message in line with personal salience.

The present study also had some limitations. First, our sample consisted of generally lean students. Participants were asked to abstain from eating three hours prior to participation to reduce a possible floor effect of IAs biased towards energy-dense food, as has been observed in research into other automatic processes involved in eating behaviour (Castellanos et al., 2009; Veling et al., 2013; Veling et al., 2014). Additionally, the difference between lean and overweight individuals on automatic processes involved in eating behaviour appears to be minimal when lean participants are hungry (Castellanos et al., 2009; Stice & Yokum, 2016). Given that the attempt to induce hunger in this sample was not totally successful, the results cannot be generalized to a clinical sample (Robinson & Berridge, 1993; Stice & Yokum, 2016). Second, the average game evaluation score was mediocre and anecdotal verbal reports stated that the game was difficult. Possibly the evaluative conditioning effects may have been impeded by eliciting some feelings of frustration rather than experiencing positive emotions and associations with fruits. The next iteration of the health game should therefore also have a reduced difficulty level. Third, though there was no indication, some participants may have correctly guessed the purpose of the study, which could have influenced their eating behaviour. Future studies should include a probe to assess participants' expectations of the purpose of the study, to control for possible confounding effects. Fourth, only immediate effects of a health game were investigated. Future studies should also investigate long-term effects, with repeated exposure to a health game, preferably in a more naturalistic setting, to examine whether the positive effects observed in individuals with healthy IAs would hold over time. Additionally, to examine whether the evaluative conditioning effects would strengthen by repeated exposure, as is found in prior research (Hofmann et al., 2010). Especially given the low rate of weight loss maintenance over time observed in other intervention studies (Schaefer & Magnuson, 2014; Webb & Sheeran, 2006), long-term effects of the game on stimulating the choice of a fruit snack over an energy-dense one, could be beneficial.

CONCLUSIONS AND IMPLICATIONS

The current study, investigating the effect of a health game using evaluative conditioning to affect healthy IAs and food choice behaviour, provides a valuable contribution to the body of research into novel approaches of targeting eating behaviour. The health game appeared rather successful for participants with healthy implicit attitudes towards food at baseline, by inducing healthy food choice behaviour. However, for participants with less healthy attitudes towards food at baseline, those who need such interventions, the health game had an opposite and adverse effect.

Further research should investigate whether improvements to the health game can result in positive effects in overweight or obese participants. For them to benefit from the health game, it would be recommended to adapt the stimuli in the health game to make it tailored to individual needs, for example by using both fruits and vegetables, and include ones favourite energy-dense snacks to maximize its beneficial effects. The health game could then be placed on free game websites and could be distributed by dieticians as an additional playful component of their standard treatment.

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CHAPTER 3

A HEALTH GAME TARGETING CHILDREN'S IMPLICIT ATTITUDES AND SNACK CHOICES

This chapter is submitted for publication as:
Alblas, E.E., Folkvord, F., Anschütz, D.J., Van 't Riet, J.P., Ketelaar, P.E. & & Buijzen, M.
(manuscript under review)
A Health Game targeting Children's Implicit Attitudes and Snack Choices

ABSTRACT

Objective: The present study investigated whether a health game can be used to affect children's implicit attitudes (IAs) towards food and subsequent snack choices.

Design: A between subjects design was used with two conditions (health game vs. control), *N* = 79, 12.42 y ± 1.64, BMI: 25.06 ±7.40.

Main Outcome Measures: IAs towards food were assessed at baseline and post-intervention using an implicit association test (IAT). Baseline IAT scores were used to categorize IAs as healthy (favouring fruits) vs. unhealthy IAs (favouring chocolates). Additionally, three digital snack choices were recorded.

Results: No main effect of condition on post-test IAs was found. However, baseline IAs moderated the effect of condition on post-test IAs; participants with less healthy baseline IAs playing the health game had healthier post-test IAs compared to those playing the control game. Regarding the snack choices, Additionally, participants playing the health game favoured fruit over chocolate in one of the snack choices. Baseline IAs did not moderate the effect of condition on snack choices.

Conclusion: Tentative support was found that health games can be used to improve IAs towards food, an effect found for participants with less healthy IAs.

A dietary pattern characterized by high intake of fruits and vegetables is negatively associated with cardiovascular disease (Kaikkonen et al., 2013) and obesity (Boumtje et al., 2005), which in turn increases the chance of Type II diabetes and various forms of cancer (Kirschenbaum & Gierut, 2013). Yet, children often do not meet the recommendations with regard to fruit and vegetable consumption (World Health Organization, 2018). In contrast, overconsumption of energy-dense products is often observed (Diethelm et al., 2012). One of the postulated reasons for preferring energy-dense over nutrient-dense products is the implicit attitudes that children have towards these food products (Walsh & Kiviniemi, 2014).

In the last decades, spurred by the rapidly increasing prevalence of overweight and obesity (Cheung et al., 2016), a plethora of strategies to improve dietary patterns have been developed (Gidding et al., 2006). Many of which had a strong focus on the reflective decision making processes of eating behaviour, emphasizing calorie reduction by advocating to avoid or restrict the consumption of many energy-dense products (Anderson et al., 2004). However, research indicates that their effectiveness in changing (long-term) eating behaviour among children is low (Bourke et al., 2014). Therefore, novel methods of improving dietary patterns are needed.

Consequently, dual-process models such as the reflective impulsive model (RIM) (Strack & Deutsch, 2004) have been used to review the full spectrum of decision making. In these models, a distinction is made between conscious or reflective processes, for example explicit diet goals, and more unconscious or implicit processes, such as the hedonic associations with food; where the latter type of processes are less cognitively demanding. Both types of processes can be activated in parallel in response to food cues and, depending on the cognitive resources available, determine food consumption. One of the contributing implicit processes influencing eating behaviour, according to the incentive sensitization theory by Robinson and Berridge (1993), involves implicit attitudes (IAs) towards food, which also have been described as the 'affective valence' associated with specific food products (M. R. Lowe et al., 2009; Sheeran, Gollwitzer, & Bargh, 2013).

Implicit attitudes towards foods are formed by (repeated) exposure, whereby parental preferences and feeding styles and are important factors that affect implicit attitudes toward these products (Aldridge et al., 2009). Accordingly, in adults, several studies have found a relation between IAs and eating behaviour (e.g., Nederkoorn, Houben, Hofmann, Roefs, & Jansen, 2010; Volkow et al., 2013), and IAs towards food appear to determine food choices when capacity for reflective and conscious decisions is low (Eschenbeck et al., 2016; Wang et al., 2015).

The effects of evaluative conditioning to modify IAs towards food has shown promising results in adults (e.g., Hofmann et al., 2010; Legget et al., 2015). In such a paradigm, images (conditioned stimuli) are repeatedly paired with emotionally valenced stimuli (unconditioned stimuli). This can modify or strengthen automatic associations with the conditioned stimuli (Hofmann et al., 2010). In addition to modified affective associations, targeting IAs has also been found to lead to behavioural effects, such as direct snack choice (Hollands & Marteau, 2016; Hollands et al., 2011; Kemps et al., 2013) or online food shopping behaviour (Prestwich et al., 2011).

In children, the relation between IAs and weight (Craeynest et al., 2005) and eating behaviour (Bernstein, 1978; Marty et al., 2017) has also been observed. However, there is a gap in the literature with respect to changing IAs to target eating behaviour in children. The promising results in adults warrant further research to explore the potential of using evaluative conditioning to change children's IAs and, ultimately, to improve dietary patterns.

When designing the intervention, it was chosen to incorporate the evaluative conditioning paradigm into a digital game, because so called health games can have several benefits over non-game interventions (Garris et al., 2002; Moyer-Guse, 2008). First, educational research suggests that 'learning by doing' can be superior over 'learning by listening' (Garris et al., 2002, p. 441). This is because in games, players can practice and perform specific behaviours frequently, and enhance their performance and skills through continuous feedback (Bandura, 1986). Second, positive attitudes (towards a game) can transfer onto the content, and thereby may attenuate reactance to the message (Moyer-Guse, 2008; Ritterfeld et al., 2009). Third, the element of fun is said to attract, capture and maintain attention, thus having the capacity to enhance exposure to the intervention (Baranowski et al., 2008). Using health games to train behaviour has become increasingly popular, and their effectiveness has been examined for a range of various physical and mental behaviours (Van 't Riet et al., 2015)

The aim of the present study was to investigate the effects of a health game on IAs towards fruits and chocolate snacks, and subsequent snack choices of children. This health game was designed specifically for children, but its effects were already tested in an adult sample (anonymous, 2018), after which some modifications were made. This will be further discussed in the method section. It was hypothesized that the health game would positively influence IAs towards food, compared to a control version. Specifically, it was expected that the health game would make the affective associations with fruits more positive, relative to the affective associations with chocolate snacks (H1a). Due to expected ceiling effects (Hollands et al., 2011), baseline IAs were hypothesized to moderate the effect of the health game on post-test IAs, where participants with IAs already healthy at baseline were not expected to be as strongly positively affected compared to those with less healthy IAs at baseline (H1b). Second, as a proxy for actual eating behaviour, three digital snack choices were included; (1) a digital snack dispenser; (2) a direct snack choice, and (3) a delayed snack choice. It was hypothesized that playing the health game would be associated with more fruit than chocolate snack choices compared to the control version (H2a). Furthermore, it was expected that the effect of condition on digital snack choices would be moderated by baseline IAs, where participants with healthy IAs at baseline were expected to be less affected by the health game than those with less healthy IAs at baseline, due to ceiling effects (H2b).

MATERIAL AND METHODS

STUDY DESIGN AND PARTICIPANTS

A between subjects design was used to investigate the effect of condition (health game vs. control) on IAs and snack choice. Participants were randomly assigned to either the health game or the control condition by the main investigator.

Data acquisition took place from November 2015 until February 2016. At the end of the predetermined data-collection period, a total of 98 children participated in this study in exchange for a 5-euro gift certificate. Because research indicates that BMI is negatively related with healthy IAs (Stice & Yokum, 2016), the majority of participants were acquired through dietitian and/or sports facilities treating children with overweight. However, this inclusion criterion hampered recruitment. Therefore the minimum age of 12 was changed to ten. Nonetheless, this resulted in a relatively small sample size. The experiment took place at participants' health care facilities, and at two secondary schools in the Netherlands[1].

The study was approved by the Ethics Committee of the Faculty of Social Sciences of Radboud University (ECSW2015-2206-324). A total of 16 participants had IAT data that should be excluded according to the IAT D-score calculations guidelines, because they had ≥ 10% of the trials with a RT < 300 ms. Furthermore, three participants were excluded from the analyses due to outliers on the IAT (n = 2) or a missing IAT score (n = 1), resulting in 79 valid participants included in the analyses (age: M = 12.42, SD = 1.64), of which 43 were girls (54%). A total of 50 children (63%) were overweight or obese. It was emphasized to the participants that the data would remain confidential and that they could cease participation at any moment without consequence. Prior to participation, parental informed consent was acquired.

INTERVENTION

For this study, a second iteration of the health game *Sky Islands* was used (see Figure 1). In this 2D strategy game, players had to fight an adversary, located at ground level, who was trying to take down floating islands by forcing unhealthy food upon the residents. Too many unhealthy residents would increase the weight of their island, causing it to sink. The goal was to supply the islands with as much healthy food as possible, to increase the number of healthy residents, resulting in

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1 These 79 participants were either tested alone or in small groups with a maximum of four at their respective dieticians or sports facility, or in a class setting in groups with a maximum of seven:
- Solo: n = 25; n health game = 13; BMI: M = 26.67, SD = 6.28;
- Groups: n = 27; n health game = 14; BMI: M = 28.35, SD = 7.58;
- Class setting: n = 27; n health game = 11; BMI: M = 20.47, SD = 6.04.

One-factor analysis of variance revealed no differences on baseline IAs for these three groups (p = .558). Also, adding group size as covariate in the analyses did not significantly affect the results.

the islands regaining their buoyancy. To win, all islands had to be aligned at the top of the screen. There were three levels, with increasing difficulty.

There were some improvements to the health game, after the first study was conducted (anonymous, 2018). First, players were asked to choose an avatar and enter a name of their choosing. Second, a narrative was unfolded. In this narrative, the adversary was introduced and the player was asked to help and save the inhabitants from this tyrant. These strategies were incorporated because they have been found to increase personal involvement (i.e., character identification) and can aid to contextualize the health message in the game and can lead to a more central processing (Baranowski et al., 2013). Furthermore, the graphics were improved and the difficulty level was reduced to accommodate younger users.

Figure 1. *A screen shot of the health game Sky Islands*

Based on an evaluative conditioning paradigm, in the health game fruits were associated with positive game advancement, because choosing fruits increased the number of healthy inhabitants. Chocolate snacks on the other hand were associated with negative game advancement, because these snacks decreased the number of healthy inhabitants. The control game was identical to the health game, but rather than food, pictures of clean and fossil fuels were used, allowing for a comparable story line.

To maximize generalisation, the food items used in the game were comparable in food type, because the literature suggests that implicit attitude change, influenced by evaluative conditioning, can transfer on to other untested but comparable products (Legget et al., 2015). There were four fruits; apple, strawberry, pear and banana, and four chocolate snacks; peanut chocolate bar, milk chocolate, chocolate muffins and chocolate brownies (see Figure 2).

Figure 2. *The eight snacks used in the health game*

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PRIMARY OUTCOME MEASURE: IMPLICIT ATTITUDES

To investigate whether IAs towards food would be influenced by the health game, an implicit association test (IAT; Greenwald et al., 1998) was administered at baseline and directly after playing the health game or the control version. In the IAT, words appeared on the screen that had to be classified into four categories, representing two attributes (*positive* with the exemplars positive, happy, kind and pleased; and *negative* with the exemplars negative, pain, sad and sickness) and two targets (*fruits* and *chocolate snacks*, with exemplars being the verbal representations of the eight pictures featured in the health game). Participants had to correctly classify each word before the next stimulus appeared.

The standard IAT containing seven blocks was used. After practicing with the attribute words and the target words, the attributes and targets were presented together in the *critical blocks* (i.e., practice and test). The participants were asked to respond to positive words or chocolate snacks with the left hand and to negative words or fruits with the right hand (incongruent). Next, the attribute location switched and in the second critical blocks, they had to respond to negative words or chocolate snacks with the left hand and positive words or fruits with the right hand (congruent). Given that previous research (Greenwald et al., 2003) reports that performance can be influenced by the order of the two critical blocks, for half of the participants, the order of the critical blocks was reversed.

To calculate the IAT score for each participant, the revised scoring algorithm was used (Greenwald et al., 2003), where a positive score was referred to as healthy IAs. Thus, participants with healthy IAs were faster in combining fruits with positive words and chocolate snacks with negative words (i.e., healthy IAs) than in combining fruits with negative words and chocolate snacks with positive words (i.e., unhealthy IAs). At baseline, the majority of participants had healthy IAs (M = .78, SD = .35). To examine possible order effects, an independent-samples t-test was conducted to compare IAT baseline scores in both versions. There was a significant difference for congruent-first (*M* = .89, *SD* = .35) and incongruent-first (*M* = .68, *SD* = .33); $t(77) = -2.65$, $p = .010$. Therefore, IAT order was included as a covariate in the corresponding analyses.

SECONDARY OUTCOME MEASURES: DIGITAL SNACK CHOICES

Prior to participation, the participants were informed of a food reward after conclusion of the experiment. In a previous study (anonymous, 2018) digital snack choice was highly correlated with actual snack choice ($p < .001$, $r = .79$, $n = 116$). Therefore, to protect the large number of overweight children in this sample from possible excess calories, the children were not physically exposed to the chocolate snacks. Participants were unaware that only apples would be distributed, regardless of their behaviour in the three digital snack choices.

DIGITAL SNACK DISPENSER

In the digital snack dispenser task (DSD; van Koningsbruggen, Veling, Stroebe, & Aarts, 2013), two dispensers were displayed, one containing apples and the other peanut chocolate bars. The order of exposure to the two dispensers was counter-balanced between subjects. Participants were asked to press the space bar for as short or long as they liked to earn one of these snacks, where the maximum that could be obtained were three snacks. By pressing the space bar, the dispenser opened and snacks fell out, while a grey overlay started to cover the food dispenser to simulate it emptying out. The grey overlay completely covered the dispenser after 60 seconds. The duration of space bar press was recorded, as an indication of their effort to acquire these food items. In general, the space bar was held longer for apples (*M* = 24.84 s, *SD* = 20.82) than for the peanut chocolate bars (*M* = 18.49 s, *SD* = 21.44). There was a strong significant correlation between these two durations ($r = .60$, $p < .001$).

DSD snack choice was calculated by subtracting the space bar press duration of apples minus that of chocolate snacks, with a positive score reflecting a preference for fruit. One outlier was excluded from the corresponding analyses because the DSD snack choice score was > 3 *SDs* below the mean. A total of 53 out of 78 participants pressed longer for apples than for chocolate snacks. An independent-samples t-test was conducted to investigate a possible order effect. There was a significant difference between chocolate first (*M* = 2.57 s, *SD* = 1.70) and apples first (*M* = 11.16 s, *SD* = 18.00); $t(76) = .12$, $p = .034$. Therefore, DSD order was included as a covariate in the corresponding DSD analyses.

DIRECT SNACK CHOICE

Participants were presented with an image of an apple and a chocolate bar, shown next to each other on the computer screen, with order counterbalanced between participants. They were requested to indicate which of the snacks they would like to eat right now. Participants who refrained from making a snack choice were excluded from the corresponding analyses (*n* = 2). Apples were slightly more favoured than chocolate snacks, chosen by 42 out of 77 participants.

DELAYED SNACK CHOICE

Participants were asked which of the two snacks they would like to take home after the experiment. Participants who refrained from making a snack choice were excluded from the corresponding analyses (*n* = 2). Apples were slightly more favoured than chocolate snacks, also chosen by 42 out of 77 participants. Most children (65 out of 77) chose similarly in both snack questions ($r = .74$, $p < .001$).

CONTROL VARIABLES

Several other variables were assessed to examine their relation and possible effects on the outcome variables.

DIETARY RESTRAINT. Dietary restraint was assessed using the Concern for Dieting subscale of the Revised Restraint Scale (Herman & Polivy, 1980). This scale contains six 4 to 5-point scale Likert items, such as 'Do you have feelings of guilt after overeating?', Cronbach's α = .61, *M* = 13.49, *SD* = 3.44).

BMI. Self-reported height and weight was entered by 75 participants and used to calculate BMI[2,3] (*M* = 25.06, *SD* = 7.40). A total of 50 children (63%) were classified as overweight or obese. A total of 24 children (31%) were obese.

HUNGER. Hunger was assessed using a visual analogue scale (0 = *no hunger* and 100 = *extreme hunger; M* = 21.00, *SD* = 24.77).

SNACK EVALUATION. Evaluation (i.e., liking) of fruits and chocolate snacks were assessed using a visual analogue scale (0 = *not at all* and 100 = *very much; M* = 75.86, *SD* = 22.64 and *M* = 54.34, *SD* = 26.24, respectively).

NUTRITION KNOWLEDGE. Nutrition knowledge was assessed with the Nutrition Knowledge Scale (Dickson-Spillmann, Siegrist, & Keller, 2011). This scale contains 20 true-false items, such as 'Brown sugar is much healthier than white sugar', Cronbach's α =.59, *M* = 11.63, *SD* = 3.22).

GAME EVALUATION. Game evaluation was assessed using a 10-point numeric Visual Analogue Scale, asking 'How much did you enjoy playing the game' (1 = *not at all* and 10 = *very much*; *M* = 7.27, *SD* = 1.77).

2 BMI was calculated using cut-off scores based on sex and age that have been established by Cole et al (2002) (Cole et al., 2000)

3 When weight and/or height was not known by the child, this was measured by the experimenter, or requested from their health care provider, parent or caregiver.

PROCEDURE

Before signing a consent form, which was signed already by one of the parents or carer, each child was read aloud a brief information letter. The rest of the components were conducted on the computer. First, baseline IAs were assessed. Next, hunger, snack evaluation and dietary restraint was assessed. Then the health game or the control version started. Participants were informed that the game time was ten minutes. Additionally, they were encouraged to keep playing for the full duration of the game. After completion, post-test IAs were assessed. Participants then responded to the three digital snack choices. Lastly, a second questionnaire assessed game evaluation and nutrition knowledge, and ended with questions assessing demographic information. The experiment took approximately 40 minutes.

STATISTICAL ANALYSES

Preparatory analyses were conducted to examine whether randomization was successful and to examine which additional variables should be used as covariates. One-factor analysis of variance revealed no significant differences for age, dietary restraint, sex, BMI, and hunger between the two conditions ($p > .05$). However, the conditions differed significantly on baseline IAs ($p = .015$) and nutrition knowledge ($p < .001$) (see Table 1).

Because the conditions differed on nutrition knowledge, this variable was included as a covariate in the analyses. Baseline IAs was included as a moderator. Due to the observed order effects, IAT order and DSD order were added as covariates to the respective analyses. Furthermore, correlation analysis was conducted to examine associations between variables. Table 2 shows the significant Pearson's correlations between the variables. Age correlated with post-test IAs ($p = .003$). Chocolate evaluation and dietary restraint correlated with direct snack choice ($p = .003$ and $p = .003$, respectively) and with delayed snack choice ($p = .034$ and $p = .004$, resp.). Therefore, these variables were included as covariates in the corresponding analyses. Baseline IAs and BMI were centred on the mean.

To test the effect of condition on implicit attitudes, a hierarchical regression analysis was conducted (based on 1000 bootstrap samples) with three successive models, with post-test IAs as dependent variable. First, the effects of the covariates IAT order, age and nutrition knowledge were tested. In the second model, the effects of condition and baseline IAs were tested (H1a) and the third model tested the interaction between condition and baseline IAs (H1b). To explore the interaction, simple slopes analysis was conducted.

Table 1. *Descriptives separated by condition*

		Health Game	**Control Game**
Demographics	N (Females)	38 (20)	41 (23)
	Age (SD)	12.66 (1.73)	12.20 (1.54)
	Dietary restraint (SD)	13.39 (1.73)	13.59 (3.54)
	BMI (SD)	25.96 (2.73)	24.27 (7.73)
	Number (percentage) of overweight/ obese	26 (68.42)	24 (58.54)
	Hunger (SD)	21.61 (2.73)	20.44 (23.41)
	Fruit preference (SD)	77.38 (24.55)	75.25 (21.29)
	Chocolate preference (SD)	59.51 (23.61)	49.60 (28.26)
	Food knowledge (SD)	12.89 (1.73)	10.46 (3.29)
	Game evaluation (SD)	7.41 (1.71)	7.15 (1.85)
Implicit attitudes	Baseline IAs (SD)	.88 (.31)	.69 (.37)
	Post-test IAs (SD)	.70 (.26)	.53 (.40)
Snack choices	Latency DSD (SD)	10.37 (22.32)	2.61 (14.69)
	Number (percentage) of apples chosen (direct snack choice)	22 (57.89)	20 (48.78)
	Number (percentage) of apples chosen (delayed snack choice)	23 (60.53)	19 (46.34)

3

To test the effect of condition on DSD snack choice, a hierarchical logistic regression analysis (based on 1000 bootstrap samples) was conducted with three successive models, with DSD snack choice outcome as dependent variable. The first model tested the effect of the covariates nutrition knowledge and DSD order. The second tested the effects of condition and baseline IAs, and the third tested the interaction between condition and baseline IAs. To test the effect of condition on the direct and delayed snack choice questions, two additional hierarchical logistic regression analyses (based on 1000 bootstrap samples) were conducted with three successive models each, with direct or delayed snack choice as dependent variable. The first model tested the effect of the covariates nutrition knowledge, chocolate evaluation and dietary restraint. The second tested the effects of condition and baseline IAs, and the third model tested the interaction between condition and baseline IAs. The hypotheses were tested with one-tailed analyses; the adjusted p-value that was considered significant was 0.05.

Table 2. *Pearson's and Kendall's tau [a] correlations between the variables*

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Baseline IAs															
2	Post-test IAs	.57**														
3	DSD snack choice	.20	.04													
4	Direct snack choice [a]	.06	-.05	.19*												
5	Delayed snack choice [a]	.10	-.07	.24**	.72**											
6	Age	.14	.33**	.11	-.06	.11										
7	Sex [a]	-.08	.07	-.01	.10	.15	-.05									
8	Dietary restraint	.12	.10	-.04	.29**	.28**	-.13	.07								
9	BMI	.06	.14	.19	.12	.14	.13	.04	.31**							
10	Hunger	-.03	-.05	-.01	-.14	-.11	.04	-.04	-.19	-.21						
11	Fruit preference	-.04	-.11	.06	.16	.12	-.25*	.17	.30**	.13	-.11					
12	Chocolate preference	.10	.21	-.01	-.28**	-.20*	.35**	-.05	-.14	.01	.38**	-.08				
13	Nutrition knowledge	.39**	.34**	.11	.03	.09	.36**	.18	-.09	.03	-.01	-.03	.23*			
14	Game evaluation	.07	-.05	-.12	-.04	-.06	-.28**	.03	.15	.21	-.04	.13	-.23*	-.22		
15	IAT order [a]	.26**	.11	.11	.07	.07	.15	-.01	.00	.00	-.16	-.03	.10	.06	-.11	
16	DSD order [a]	.10	-.17	-.15	.09	.14	-.07	-.01	.07	-.13	-.15	.11	-.11	-.01	.04	.08

[a] Kendall's tau
* Correlation is significant at the .05 level
** Correlation is significant at the .01 level

RESULTS

PRIMARY OUTCOME MEASURE

H1a stated that playing the health game would result in healthier IAs towards food, compared to the control version. Condition did not significantly predict post-test IAs (p = .248), refuting the hypothesis. IAT order (p = .120), age (p = .030) and nutrition knowledge (p = .013) were positively related with post-test IAs, see Table 3.

H1b stated that the effect of the health game on IAs would be moderated by baseline IAs. There was a significant interaction between condition and baseline IAs (p = .007). Simple slopes analysis showed that for participants with less healthy baseline IAs, playing the health game was related with significantly higher post-test IAs scores compared to the control condition, b = .24, 95% CI [.05, .43], t = 2.46, p = .008, supporting the hypothesis. For participants with average (b = .08, 95% CI [-.05, .21], t = 1.24, p = .110) or healthy baseline IAs (b = -.08, 95% CI [-.26, .10], t = -.84, p = .201) no significant relation was found between condition and post-test IAs.

SECONDARY OUTCOME MEASURES

H2a stated that participants in the health game condition would favour apples compared to snacks. Condition predicted DSD snack choice (p = .037), see Table 4. On average, participants in the health game condition had a stronger preference for apples over chocolate bars (M = 10.37 s, SD = 22.32) compared to those in the control condition (M = 2.61 s, SD = 14.69). DSD order was negatively related with DSD snack choice (p = .017). Condition did not significantly predict direct (p = .185) or delayed snack choice (p = .060), see Table 5 and 6. Thus, the hypothesis was partially supported. Chocolate evaluation was negatively related with direct (p = .007) and delayed snack choice (p = .033). Nutrition knowledge and dietary restraint were positively related with direct (p = .015 and p = .012, resp.) and delayed snack choice (p = .006 and p = .008, resp.).

H2b stated that the effect of the health game on snack choices would be moderated by baseline IAs. The results showed no significant interactions between condition and baseline IAs (p = .452, p = .484 and p = .429, resp.), refuting the hypothesis.

Table 3. *Linear model of predictors of post-test IAs, with 95% bias corrected and accelerated confidence intervals reported in parentheses. Confidence intervals and standard errors based on 1000 bootstrap samples*

	Predictors	Δ R2	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta with 95% confidence interval	p	Cohen's f2
Step 1		.179					
	IAT order		.13	.07	.09 [-.06, .23]	.120	.031
	Age		.22	.02	.05 [.00, .09]	.030	.121
	Nutrition knowledge		.25	.01	.03 [.00, .05]	.013	.129
Step 2		.213					
	IAT order		-.02	.07	-.02 [-.15, .12]	.410	.031
	Age		.24	.02	-.05 [-.01, .09]	.009	.121
	Nutrition knowledge		.03	.01	-.00 [-.02, .03]	.406	.129
	Condition		.07	.07	-.05 [-.09, .19]	.248	.066
	Baseline IAs		.51	.10	-.50 [-.30, .71]	.000	.477
Step 3		.049					
	IAT order		.00	.07	.00 [-.13, .13]	.487	.031
	Age		.25	.02	.05 [-.01, .01]	.005	.121
	Nutrition knowledge		.01	.01	.00 [-.02, .02]	.466	.129
	Condition		.61	.16	.43 [-.10, .10]	.006	.066
	Baseline IAs		.70	.12	.69 [-.44, .44]	.000	.477
	Condition * Baseline IAs		-.66	.19	.47 [-.84, .84]	.007	.048

Table 4. *Hierarchical regression analysis for DSD snack preference, controlling for nutrition knowledge and DSD order, with 95% bias corrected and accelerated confidence intervals reported in parentheses. Confidence intervals and standard errors based on 1000 bootstrap samples*

	Predictors	Δ R2	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta with 95% confidence interval	p	Cohen's f2
Step 1		.075					
	Nutrition knowledge		.13	.62	.73 [-.50, 1.95]	.121	.015
	DSD order		-.25	3.97	-8.77 [-16.68, -.86]	.015	.061
Step 2		.078					
	Nutrition knowledge		-.02	.68	-.12 [-1.48, 1.23]	.429	.015
	DSD order		-.25	3.88	-9.01 [-16.74, -1.29]	.011	.061
	Condition		.21	4.22	7.64 [-.76, 16.05]	.037	.075
	Baseline IAs		.18	5.99	9.25 [-2.70, 21.20]	.064	.046
Step 3		< .000					
	Nutrition knowledge		-.02	.69	-.13 [-1.50, 1.24]	.427	.015
	DSD order		-.25	3.93	-8.96 [-16.79, -1.12]	.013	.061
	Condition		.22	4.27	7.69 [-.81 , 16.20]	.038	.075
	Baseline IAs		.19	7.62	9.81 [-5.39, 25.01]	.101	.046
	Condition * Baseline IAs		-.02	11.74	-1.41 [-24.81, 21.99]	.452	.014

ADDITIONAL FINDINGS

Because almost two-thirds of the participants in the study were overweight or obese, additional exploratory analyses were performed to examine the relation between weight status and implicit attitude and snack choice.

Four additional hierarchical (logistic) regression analyses revealed that BMI did not predict post-test IAs scores (p = .196), DSD snack choice (p = .335), direct snack choice (p = .155) or delayed snack choice (p = .222). BMI did not moderate the effect of condition on post-test IAs scores (p = .436), DSD snack choice (p = .337) or direct snack choice (p = .478). However, BMI moderated the effect of condition on the delayed snack choice outcome (p = .039). Simple slopes analysis revealed that playing the health game was related with significantly more fruit choices, compared to the control condition, only for participants with high BMI, b = 1.32, 95% CI [-.21, 2.85], z = 1.69, p = .0045. For participants with average (b = .41, 95% CI [-.54, 1.36], z = .84, p = .201) or low BMI (b = -.51, 95% CI [-1.93, .92], z = -.69, p = .244), no significant relation was found between condition and delayed snack choice.

Table 5. *Hierarchical logistic regression analysis for direct snack choice, controlling for nutrition knowledge, chocolate evaluation and dietary restraint, with 95% bias corrected and accelerated confidence intervals reported in parentheses. Confidence intervals and standard errors based on 1000 bootstrap samples*

	Predictors	Model Chi-square (*p*-value)	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta with 95% confidence interval	*p*
Step 1		22.31 (.000)				
	Nutrition knowledge		.22	.10	1.25 [1.02, 1.53]	.015
	Chocolate evaluation		-.04	.01	.96 [.94, .99]	.001
	Dietary restraint		.22	.08	1.25 [1.06, 1.48]	.004
Step 2		22.80 (.000)				
	Nutrition knowledge		.20	.11	1.22 [.98, 1.53]	.038
	Chocolate evaluation		-.04	.01	.96 [.94, .99]	.001
	Dietary restraint		.22	.09	1.25 [1.06, 1.48]	.005
	Condition		-.41	.59	.67 [.21, 2.10]	.244
	Baseline IAs		-.02	.84	.98 [.19, 5.06]	.490
Step 3		22.80 (.000)				
	Nutrition knowledge		.20	.11	1.22 [.98, 1.53]	.038
	Chocolate evaluation		-.04	.01	.96 [.94, .99]	.001
	Dietary restraint		.22	.09	1.25 [1.05, 1.48]	.005
	Condition		-.40	.59	.67 [.21, 2.11]	.246
	Baseline IAs		-.05	1.08	.95 [.11, 7.91]	.482
	Condition * Baseline IAs		.07	1.63	1.07 [.04, 25.99]	.484

Table 6. *Hierarchical logistic regression analysis for delayed snack choice, controlling for nutrition knowledge, chocolate evaluation and dietary restraint, with 95% bias corrected and accelerated confidence intervals reported in parentheses. Confidence intervals and standard errors based on 1000 bootstrap samples*

	Predictors	Model Chi-square (*p*-value)	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta with 95% confidence interval	*p*
Step 1		18.86 (.000)				
	Nutrition knowledge		.27	.11	1.31 [1.06, 1.61]	.006
	Chocolate evaluation		-.03	.01	.97 [.95, .99]	.008
	Dietary restraint		.21	.08	1.23 [1.05, 1.45]	.005
Step 2		19.61 (.001)				
	Nutrition knowledge		.23	.11	1.26 [1.01, 1.58]	.021
	Chocolate evaluation		-.03	.01	.97 [.95, .99]	.006
	Dietary restraint		.21	.08	1.23 [1.05, 1.45]	.006
	Condition		-.47	.57	.62 [.20, 1.91]	.204
	Baseline IAs		.10	.82	1.10 [.22, 5.47]	.453
Step 3		19.64 (.003)				
	Nutrition knowledge		.23	.11	1.26 [1.01, 1.58]	.021
	Chocolate evaluation		-.03	.01	.97 [.95, .99]	.006
	Dietary restraint		.21	.08	1.23 [1.04, 1.45]	.007
	Condition		-.47	.58	.63 [.20, 1.94]	.209
	Baseline IAs		-.02	1.04	.98 [.13, 7.55]	.493
	Condition * Baseline IAs		.29	1.61	1.33 [.06, 31.46]	.429

DISCUSSION

The aim of this study was to investigate the effects of the health game on IAs towards fruits and chocolate snacks, and subsequent digital snack choices of children. Baseline IAs were expected to moderate the effect of condition on post-test IAs and digital snack choices. Results showed no main effect of the health game on post-test IAs, thereby refuting H1a. However, baseline IAs moderated the effect of the health game on post-test IAs, confirming H1b. Playing the health game was related with healthier post-test IAs compared to playing the control game, only for participants with less healthy baseline IAs. Furthermore, participants playing the health game pressed longer for fruit than for chocolate snacks in the digital snack dispenser compared to those in the control condition, while direct and delayed snack choice were not affected by condition, partially confirming H2a. Finally, baseline IAs did not moderate the effect of condition on snack choices, refuting H2b.

IMPLICIT ATTITUDES

With regard to the observed IAs findings, moderation analyses showed that the health game was able to modify the automatic associations with the fruit and chocolate stimuli used, for those with relatively unhealthy baseline IAs. For these children, their implicit attitudes towards fruits, relative to chocolate snacks, became more positive after a single play session. This suggests that a health game can be used for evaluative conditioning, to improve implicit attitudes towards food. This is promising, because using health games can have certain advantages, such as 24/7 availability and access from home (Van 't Riet et al., 2010). Even though the implicit attitudes from children with relatively healthy baseline IAs were not affected by the health game; their baseline IAs scores were already found to reflect strong positive implicit attitudes to the fruits relative to the chocolate snacks (Hahn et al., 2014). Therefore, it is plausible that the absent changes in implicit attitudes in this group were due to the proposed ceiling effects, also observed in other research (Hollands et al., 2011). Further research should explore the proposed ceiling effects and evaluative conditioning in more detail, to evaluate the game's effectiveness for implicit attitude change, and generalizability to other snacks.

DIGITAL SNACK CHOICES

With regard to the digital snack choices; in the digital snack dispenser measure, children had a stronger preference for fruit over chocolate snacks after playing the health game, while direct and delayed snack choice did not seem to be affected by condition. While encouraging, the mixed results warrant caution in interpreting the effects of the health game on snack choice behaviour. It may be that the second IAs measurement session, after the health game and prior to the digital snack choices, attenuated the effects of the health game. However, because the health game aimed to influence an implicit process, the effects may have been too subtle to influence reflective behaviour, corroborating with the dual-process model of behaviour (Strack & Deutsch, 2004). Future research should investigate whether multiple sessions of targeting implicit attitudes can lead to additive effects and cause spill-over effects on more explicit choices or eating behaviour.

ADDITIONAL FINDINGS

It must be noted that an effect on explicit choice behaviour (i.e., delayed choice) was observed for a subset of the sample, where participants with overweight preferred fruit more often after playing the health game compared to the control condition. For leaner participants, no effect of condition on snack choice was observed. It is conceivable that for children with overweight, the implicit health message of the game was salient and activated reflective processes. Possibly, the health game activated diet intentions in this group, resulting in subsequent healthier snack choice behaviour, as other research investigating the effects of priming suggests (Papies & Hamstra, 2010; Price, Higgs, & Lee, 2016).

Interestingly, the present study did not find a relation between unhealthy IAs and BMI that has been observed in previous research (Stice & Yokum, 2016). However, in this sample, most children with overweight were being treated for their eating behaviour. It is plausible that this treatment, as well as the psychological associations with being overweight (Kirschenbaum & Gierut, 2013), had already influenced their IAs towards food to favour fruits over chocolate snacks, making them similar to the IAs of the lean participants in this sample. Using a more tailored approach in terms of favourite snacks, or by incorporating a larger variety of snacks, could have revealed different correlational patterns. Therefore, more research is warranted to disentangle the relation between IAs towards food and BMI, and to investigate the effect of treatment on IAs.

STRENGTHS AND LIMITATIONS

Given the limited (or even adverse) effects of frequently used interventions promoting a healthy diet (Bourke et al., 2014; Havermans, Giesen, Houben, & Jansen, 2011; Schaefer & Magnuson, 2014), novel approaches to lower the prevalence of overweight and obesity are highly needed. Research indicates that targeting eating behaviour through precursors of behaviour, for example by influencing automatic processes such as implicit attitudes, can have promising effects on eating behaviour (Hollands & Marteau, 2016; Veling et al., 2014). Furthermore, using health games as a tool to instigate behavioural change has shown great potential (e.g., Lu et al., 2013). To our knowledge, this is one of the first studies attempting to modify implicit attitudes towards food through videogames; thereby, providing a valuable contribution to the body of research into novel approaches of targeting eating behaviour. Results suggest that the health game was indeed effective for a sub-group of the sample, those with relatively unhealthy baseline IAs. The results suggest that this health game could be used as a playful addition to standard treatment, possibly augmenting the effects.

The current study also had some limitations. First, the results must be treated with caution, given the relatively small sample size. Second, randomization was not completely successful; there were less participants in the health game condition with unhealthy baseline IAs compared to the control condition. Third, a relatively large number of participants had to be excluded from the analyses, mostly due to invalid IAT data. Future studies should include more participants per condition, or match participants in the conditions on baseline IAs, to examine the effects of the health game in more detail. Fourth, multiple locations with different settings (e.g., group sizes) were used to conduct the experiment. Even though the conditions were equally distributed in the different settings, and analyses showed no differences between locations, this may have confounded the results. Although the current study does well on ecological validity, for future studies it would be recommended to use a more controlled setting. Finally, only immediate effects of a single play session were investigated. Future studies should also investigate long-term effects, with repeated exposure to the health game, to examine whether the present effects observed in individuals with less healthy IAs would hold or strengthen over time and how this would relate to reflective processes and snack choices.

Finally, a note of caution must be made with respect to the findings observed in a previous study, where the first iteration of the game was tested on young adults (anonymous, 2018). The data showed that the game appeared successful only for healthy adults, with no effects on the less healthy adults. To explain these mixed findings, first, modifications were made to the health game to increase message elaboration and personal involvement, which may have improved the game's effectiveness. Second, it must be noted that these less healthy participants still were mostly lean adults, in contrast to present sample, with half of the children being overweight or obese. It is therefore plausible that the games' effectiveness is especially strong for those with salient health goals, being either successful at weight control, or currently on a diet trying to lose weight. More research is warranted to examine the effects of the current version of the health game on different populations.

CONCLUSIONS AND IMPLICATIONS

Research indicates that eating behaviour is instigated and influenced by various processes, such as mere exposure to food cues (I. M. Nijs & Franken, 2012), expected satiety (Forde et al., 2015), social norms (Bevelander, Anschutz, & Engels, 2012) and habits (Van 't Riet et al., 2011). The present study, investigating the effect of a health game based on an evaluative conditioning paradigm, provides a valuable contribution to the body of research into novel approaches of targeting children's eating behaviour. Although the present findings were mixed, they indicate potential for targeting implicit processes to improve dietary choices, such as targeted implicit attitudes or implicit approach behaviour (Stice, Lawrence, Kemps, & Veling, 2016). However, it is likely that a multidisciplinary approach, targeting multiple behaviours and processes, may prove most effective, given the multi-faceted origins of initiating eating behaviour and dietary choices. It would therefore be plausible that the health game would be most effective when used in combination with other interventions. Future research should investigate such a combined approach.

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CHAPTER 4

USER STATISTICS FOR AN ONLINE HEALTH GAME TARGETED AT CHILDREN

This chapter is published as:
Alblas, E.E., Folkvord, F., Anschütz, D.J., Ketelaar, P.E., Granic, I., Mensink, F., Buijzen, M. & Van 't Riet, J.P. (2017). User statistics for an online health game targeted at children. *Games for Health journal, 6 (5), 319 - 325*.
doi: https://doi.org/10.1089/g4h.2016.0114

ABSTRACT

Objective*:* Given that many households in Western countries nowadays have home-access to the Internet, developing health promoting online interventions has the potential to reach large audiences. Studies assessing usage data of online health interventions are important and relevant, but as of yet scarce. The present study reviewed usage data from Monkey Do*,* an existing online health game developed specifically for children from 4 to 8 years old. Additionally, the effect of advertising on usage was examined.

Methods*:* In an observational study, a web-based analysis program was used to examine usage data of all visits to the online health game for the first 31 months following the launch. We reported descriptives for usage data. We analyzed the relation between advertising and usage with a Mann-Whitney U-test, and used a Pearson's chi-square test to investigate the association between advertising and the number of first-time visitors.

Results*:* In the period of data-analysis, there were 224,859 sessions. Around 34% of the visitors played the game more than once. Compared to first-time visitors, the average session time of returning visitors was doubled. The game was most frequently accessed via search engine query, on a desktop computer (compared to mobile devices). Advertising was found to be positively related to the number of sessions and the number of first-time visitors.

Conclusions*:* Placing a game online can reach a large audience, but it is important to also consider how to stimulate retention. Furthermore, repeated advertisement for an online game appears to be necessary to maintain visitors over time.

Nutrition during childhood is essential for growth and development, health, and well-being (World Health Organisation, 2009). However, less than 3 out of 10 Dutch children between 4 to 8 years eat sufficient fruit and vegetables (RIVM, 2011, 2016a, 2016b) and they consume too much energy-dense products (Kosti & Panagiotakos, 2006). Therefore, modifying dietary intake by stimulating fruit and vegetable consumption among children is important.

To increase daily fruit and vegetables consumption among children, many educational health interventions have been conducted (Anderson et al., 2004; Geller, Dube, Cruz, Stevens, & Keating Bench, 2015; Lazorick, Fang, & Crawford, 2016). Unfortunately, these interventions often require several face-to-face contact moments and, in terms of effectiveness, show mixed short term results and often limited long term effects on consumption (Gidding et al., 2006; Hampl et al., 2016; Joseph, Gorin, Mobley, & Mobley, 2015; Snethen, Broome, & Cashin, 2006; van den Berg, Mikolajczak, & Bemelmans, 2013). As many households in Western countries have home-access to the Internet (Bernhardt & Hubley, 2001), using internet-based health interventions is a promising approach, also because these health interventions are relatively inexpensive and available at all hours of the day (Van 't Riet et al., 2010). Indeed, various studies show that offering health interventions online can be effective for behavioral change (Casazza & Ciccazzo, 2007; Cushing & Steele, 2010; Stinson et al., 2009). The media that can be used to access online digital interventions (i.e., computers, smartphones and tablets), have become increasingly popular (especially among young people) and user-friendly (Almonani, Husain, San, Almomani, & Al-Betar, 2014; Arteaga, Kudeki, & Woodworth, 2009).

With the plethora of information on the web, accessibility, discoverability, usage and retention of an online health intervention are important to consider when evaluating its effectiveness. A clear name and obvious search terms can increase discoverability, as can referring to the health intervention on other websites using hyperlinks (Bowler, Hong, & He, 2011). Equally important to consider is how retention can be maintained over time, given the high attrition rates of web-based health interventions demonstrated in previous research (Eysenbach, 2005; Verheijden, Jans, Hildebrandt, & Hopman-Rock, 2007). Important factors for these high attrition rates are losing interest and not seeing the immediate benefit of the health intervention (Wu, Delgado, Costigan, MacIver, & Ross, 2005). When a health intervention program is not frequently revisited, total exposure to the health intervention remains low and this may not lead to the intended results as a consequence. One factor that may impact on the access, discoverability and usage patterns is advertising (Buijzen, Valkenburg, & Valdivia, 2012).

Health games are an increasingly popular tool to instigate behavioral change (Parisod et al., 2014). For example the element of fun in games attracts, captures and maintains attention, thus having the capacity to enhance exposure to the health intervention (Baranowski et al., 2008). Additionally, games can be processed on a more automatic level, especially when the message is delivered more implicitly or via a precursor of the behavior (Baranowski et al., 2016). However, until now, the main focus of research on health games has been on effectiveness and little is known about usage of this type of health interventions when placed online. Next to the question of whether the games are played, having insight in the target group's search behavior and their device of choice provides valuable information about changes and improvements to, and future development of health games aimed to reach a specific population.

The first aim of the present study was to assess usage of the online health game Monkey Do (i.e., number of sessions, frequency of sessions, and session time). Based on previous research (Crutzen et al., 2009; Crutzen, Roosjen, & Poelman, 2012; Van 't Riet et al., 2010), this usage information was considered to be an essential prerequisite of effectiveness of online health games. The second aim was to assess how the game was accessed; via what traffic source visitors arrived on the webpage and which types of devices were used to play the game. The third aim was to examine whether there was a relation between advertising and (first-time) usage.

MATERIALS AND METHODS

MONKEY DO

The present study examined the online health game Monkey Do (short for Monkey See Monkey Do, in Dutch titled Na-aapje), developed for children from 4 to 8 years of age. Monkey Do is a game of skill and revolves around a monkey that has to collect fruits and vegetables hanging in a tree, to earn points. Collecting these healthy foods in a specific displayed sequence heightens the score. Controlled by the arrow keys on the keyboard, the monkey swings from branch to branch. Missing a branch causes the monkey to fall down. Falling three times results in game over, after which the player can try again. The primary goal of the game is to be entertaining. The second aim is to expose children to fruits and vegetables in an unobtrusive way, without a didactic component. Based on the principle of evaluative conditioning (Gawronski & Bodenhausen, 2006), the rationale behind this game is to strengthen the association between positive emotions and fruit and vegetables. Consequently, having a more positive attitude towards fruit and vegetable could result in increased fruit and vegetable intake (Greenwald, Poehlman, Uhlmann, & Banaji, 2009; Hofmann et al., 2010).

We selected this game, because it functions as an example for online health games. Monkey Do was featured on the website of the Netherlands Nutrition Centre (NNC) website, the Dutch authority on providing information on diet and nutrition. The NNC website has approximately 9 million visits per year. Monkey Do was developed by the NCC, in collaboration with the Knowledge Centre for Sport Netherlands, and was part of a broader national campaign aiming to improve dietary lifestyle among Dutch children by increasing their parents' healthy example behavior (i.e., increase parents' awareness that children learn from and copy their behavior). The game was freely and easily accessible, without having to create an account or sign up on the website.

The game was advertised by the NCC during two separate periods. The first period of major advertising, lasting 20 days, started on 6/4/2012, seven days after the game was launched. It consisted of a 25-second commercial broadcasted on several television networks during prime time child or family programs; approximately 460 radio commercials aired on 18 different national and regional radio stations; banners on various websites and availability on national websites featuring free games. Continuing after the 20-day period of major advertising were the radio commercials (approximately 230 more commercials for another 10 days) and the online advertising (for several more months). The second period of major advertising, lasting 17 days, started on 12/21/2012 and was online only, with a site-wide banner on the NCC website and on one of the most popular Dutch game websites (www.spele.nl).

DESIGN AND PROCEDURE

In present observational study, we analyzed usage data from all visits to Monkey Do made in natural setting, using Google Analytics. The first 31 months after launch (5/29/2012 to 12/31/2014) were included in the data-analysis period. Google Analytics is a free web-based analytics service with a strict confidentiality policy, that allows you to track visitors' behavior, using cookies, by adding a few lines of program coding on each web page (Dyrli, 2006).

Because this was a retrospective study in naturalistic setting, no informed consent was acquired. However, a few days after the game was launched, the cookie legislation was implemented, based on the European e-Privacy Directive. In the Netherlands, unambiguous consent is required to accept cookies. At the NCC website, this message included a statement that the settings for cookies used for analysis could be adjusted. Therefore, all visitors accepting the cookies gave active consent to track their behavior on this website. Given that the game did not request personal information and no individual characteristics were recorded, we also included the data recorded between 5/29/2012 and 6/5/2012 (6,926 sessions by 5,835 visitors).

With regard to the first aim, to assess usage of the game, we first reviewed the number of sessions, making the distinction between first-time and returning visitors. In addition, session time was reviewed. With regard to the second aim, how the game was accessed, we reviewed via what traffic source visitors arrived on the Monkey Do webpage and which devices were used. With regard to the third aim, we examined whether advertising was positively related with (first-time) usage, by comparing the periods with vs. without advertising on number of sessions and on visitor type (i.e., first-time vs. returning).

MEASURES

In the present study, most variable names were adopted from Google Analytics. Google Analytics registered all views from unique IP addresses, termed 'visits' but in the present study referred to as 'sessions,' and allowed distinction between novel and repeated sessions. Visitors who accessed the website for the first time were labeled as 'first-time visitors.' Multiple sessions from the same IP address within the study period were labeled as 'return sessions,' made by 'returning visitors.' A session ended after 30 minutes without activity or when leaving the website. Resuming or returning to the website then counted as a return session. It must be noted that the number of first-time visitors was an approximation, because visitors could have used multiple devices or shared their device(s) with other users.

Session time, as an approximation of play time, was recorded by subtracting the time in minutes of the last action (i.e., mouse click) on that specific page, minus the time of landing on the page. Periods of inactivity (< 30 minutes) followed by resumed activity on the web-page overestimated session time. Only uninterrupted sessions, without spending time on other (pages of the) website(s), were used to calculate session time.

Traffic source referred to how visitors got to the game website. There were four main categories: direct (i.e., accessing the page directly by entering the exact name or the URL); referral (i.e., through links from another websites); paid search (i.e., via paid text ads or banners) and organic search engine (i.e., finding the page through search engine queries). However, in first instance, traffic source was not included as trackable information. This tracking feature was enabled on 7/25/2013. Thus, the traffic source of all sessions before this date was referred to as 'not available.'

Google Analytics also records whether visitors access the website using a mobile device (i.e., smartphone or tablet), or desktop (with laptops falling in the latter category). Having insight in the device of choice provides valuable information about future game development.

DATA ANALYSES

For number of sessions, frequency of sessions, session time, traffic source, and use of device, group means were reported. No further analyses could be performed because individual data were not provided by Google Analytics. To examine the influence of advertising on usage, we compared the two periods with major advertising (i.e., the 20-day period of advertising with television, radio and internet commercials and the 17-day period of online advertising in December) against the periods with minor to no advertising. A nonparametric Mann–Whitney U tests was conducted to analyze the relation between advertising and the number of sessions. A Pearson's chi-square test was performed to compare the number of sessions of first-time vs. returning visitors during the periods with vs. without advertisement. The statistical software program SPSS 22.0 (IBM Corp. in Armonk, NY) was used to conduct the analyses.

RESULTS

USAGE INFORMATION

To address our first aim, we reviewed the number of sessions, frequency of sessions and session time. In the first 31 months after launch, Monkey Do had 224,859 sessions (see Table 1). Approximately two-third was made by first-time visitors. The average session time increased with number of sessions (see Table 2). Where first-time visitors played for 5:10 minutes, those with two sessions or more doubled this time to 10:50 minutes and for visitors with ten sessions or more, session time almost tripled to 13:42 minutes.

WAY OF ACCESS

To address our second aim, we assessed how the visitors accessed the game and which device they used. The majority of visitors accessed the game through organic search engine, followed closely by direct search (see Table 1). Visitors accessing the game through these sources also had the highest averaged session time. With regard to device, most visitors accessed the website using a desktop (versus mobile devices).

Table 1. *Sessions, Visitors, New visitors, Percentage of new sessions and Average session duration per Traffic source, Device and User type*

	Sessions	Visitors	New visitors	Percentage of new sessions	Average session duration
Total	224,859	160,114	149,944	66.68%	00:07:43
User type					
New visitor	149,944	149,944	149,944	100.00%	00:05:10
Returning visitor	74,915	45492	-		00:12:49
Traffic source					
(not set)	212,477	163,509	141,618	66.65%	00:07:40
Organic Search	5,639	4,376	3,439	60.99%	00:08:49
Direct	4,776	3,765	3,473	72.72%	00:10:31
Referral	1,792	1,540	1,337	74.61%	00:04:24
Paid Search	65	57	24	36.92%	00:03:26
(Other)	51	25	16	31.37%	00:04:49
Email	30	29	23	76.67%	00:01:31
Social	23	23	8	34.78%	00:01:52
Display	6	6	6	100.00%	00:02:13
Device					
Desktop	193,211	146,814	127,579	66.03%	00:08:50
Tablet	18,567	15,516	12,718	68.50%	00:00:48
Mobile	13,081	10,701	9,647	73.75%	00:01:09

Table 2. *Sessions, Visitors, Percentage of visitors and Average dose time per Frequency of sessions*

Frequency of sessions	Sessions	Visitors	Percentage of visitors	Average dose time
1	149,671	149,671	66.75%	0:05:10
2	68,714	34,357	15.32%	0:10:50
3	39,240	13,080	5.83%	0:12:56
4	26,868	6,717	3.00%	0:12:15
5	20,230	4,046	1.80%	0:12:20
6	16,074	2,679	1.19%	0:12:13
7	13,258	1,894	0.84%	0:13:51
8	10,984	1,373	0.61%	0:12:26
9	9,072	1,008	0.45%	0:13:59
10	8,140	814	0.36%	0:13:42

ADVERTISING AND USAGE INFORMATION

To address our third aim, we examined whether advertising for the game would be related to (first-time) usage. Figure 1 shows the total number of sessions per month. The figure clearly reveals two peaks of number of sessions, corresponding to the two periods of major advertising, in June and December 2012 (month 2 and 8, respectively). Due to the large variation in sessions between the periods, we also show the total number of sessions of the first and second major advertising period, ranging from one week prior to, up to one week after advertising (Figure 2 and 3, respectively).

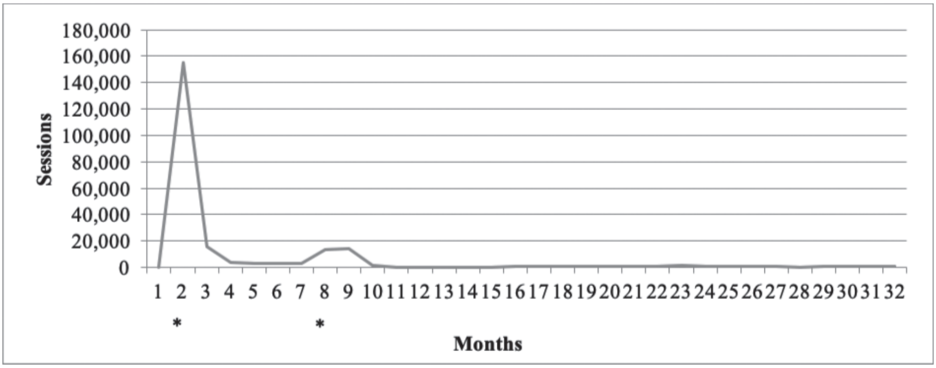

Figure 1. *Total number of Sessions per month for the first 31 months after launch*
** Advertising in June 2012 (month 2) and December 2012 (month 8)*

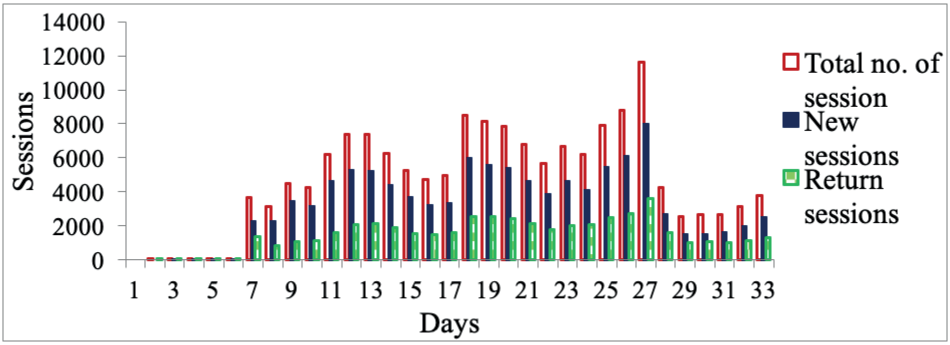

Figure 2. *Total number of sessions, New sessions and Return sessions around the first period of major advertising, starting from day 7 up until day 27.*

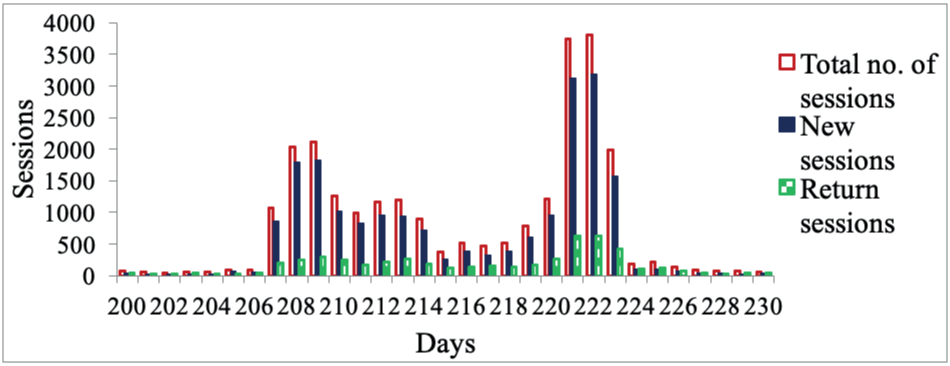

Figure 3. *Total number of sessions, New sessions and Return sessions around the second period of major advertising, starting from day 207 up until day 223.*

We compared usage during major advertising against minor and no advertising. The Mann-Whitney U test showed that advertising was positively related to the number of sessions, U = 34,372.00, z = 10.37, p <.001, r = .34. Furthermore, the Pearson's chi-square test showed a significant association between advertisement and whether visitors were there for the first time or returning, χ^2 (1) = 5823.39, p < .001. Based on the odds ratio, the odds of being a first-time visitor after advertisement was 2.07 times higher than the odds of being a first-time visitor in the periods without advertisement.

DISCUSSION

The aims of this paper were to (1) assess usage of the online health game Monkey Do; (2) to assess how the game was accessed; and (3) to examine the relation between advertising and (first-time) usage of the game.

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With regard to the first aim, examining usage revealed that around one-third of the visitors returned. Returning visitors played more than twice as long as single session visitors. For visitors with 10 sessions or more, session time almost tripled. It is therefore plausible that visitors who returned enjoyed playing the game, whereas non-returning visitors might not have enjoyed the game that much. Results from a qualitative study (KidsVitaal, 2012) that examined attitudes towards the game revealed that especially the older children, between 10 and 12 years of age, thought that Monkey Do was somewhat childish and better suited for younger children. Therefore, it is likely that visitors who played more frequently and with a longer duration were of a younger age, although in the current study it was not possible to determine the age of the users. It might be an undesirable fact that around two-third of the visitors who showed initial interest in the game (developed for young children) did not play for a long time and did not return to the game. Given that session time is a possible moderator of game effectiveness (Gentile, 2011; Johnson, Wyeth, & Sweetser, 2013; Subrahmanyam & Renukarya, 2015), future target population effectiveness studies, should examine if children who play the game more often are affected to a larger extent than children who play the game only once.

With regard to the second aim, during the 31-month period of analyses, Monkey Do had 31,648 sessions (14%) from mobile devices. Because this game did not support using such devices, exposure was low for these sessions. Given that mobile devices gain in popularity and their use increases (Almonani et al., 2014), future game designers will benefit from making the game available for mobile devices.

With regard to the third aim, the results showed that advertising was positively related to number of sessions and with the ratio of first-time vs. returning visitors. Without advertisements usage decreased over time, although this decrease was gradual. Thus, our results suggest that online health interventions seem to benefit from repeated advertisement. Further research is needed to investigate and optimize (online) advertising for this population.

This study presents a valuable addition to studies investigating game exposure in a more controlled fashion in three respects. First, it provides important information about usage data of an online health game in a non-controlled and voluntary setting. Second, in combination with a qualitative component, these findings can be used to further optimize online health promoting games. Third, long-term usage data could be investigated and the two separate periods of advertising allowed for causality testing, indicating a positive relation between advertising and usage.

The current study also had some limitations. First, no detailed information about engagement, immersion, and motivation to play (and re-play) the game was recorded. This could have provided useful information for further development of Monkey Do to make it more appealing to a larger audience. Second, no information on age and sex of the players was recorded. Future studies examining characteristics of returning visitors might provide information that can be used to tailor future advertisements and media choices. There were also some limitations related to Google Analytics. First, visitors are identified based on unique IP address, thus, the number of unique visitors is an approximation. Second, periods of inactivity (< 30 minutes), followed by resumed activity on the web-page overestimate session time. Third, it was only possible to determine access of the visitors to the webpage, not their actual playing behavior. Fourth, for the period of data-analysis, Google Analytics did not yet provide individual data or standard deviations, which limited statistical testing. Fortunately for future research, a feature to extract data based on IP address has been added to Google Analytics in 2016. This will enable researchers to better examine the data and perform statistical analyses for data from 2016 onwards.

CONCLUSIONS AND IMPLICATIONS

This quantitative analysis, reviewing usage over time in a natural setting, provides a valuable contribution to the body of research investigating the effectiveness of health games in a more controlled fashion. Using a web-based analysis software program such as Google Analytics facilitates such usage research. However, careful consideration of required coding is recommended to maximize its full potential, especially when the game is part of a larger website. To our knowledge, no previous study has examined usage data of online health games in a naturalistic setting. Research investigating health promotion (Crutzen et al., 2009; Crutzen et al., 2008; Van 't Riet et al., 2010) and safe driving (Jacobs & Jansz, 2017) indicates that (returning) visitors are often already motivated to change behavior (Crutzen et al., 2008), or don't fall in the highest risk group (Jacobs & Jansz, 2017; Van 't Riet et al., 2010). Because around 66 percent of the visitors did not return, the focus of future online health games should lie on making the game more appealing to those that need the intervention most, to increase retention and reach, and to become more effective as an intervention.

This study also clearly shows that advertising stimulates usage and attracts new visitors. Therefore, we recommend that funds for advertising should be allocated in the budget, when designing and developing online health games aimed to reach large audiences. Without some form of promotion it is likely that exposure to the online interventions will decrease over time. Advertising via different platforms is necessary to maintain the number of visitors, both new and returning.

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CHAPTER 5

GENERAL DISCUSSION

To reduce the high prevalence of overweight and obesity, novel approaches to modify eating behaviour are needed to improve general physical and mental health in the population. A promising approach is to influence automatic or implicit processes in eating behaviour, for example by targeting implicit attitudes through evaluative conditioning (e.g., Ebert et al., 2009; Hofmann et al., 2010; Legget et al., 2015). Because the degree of implicit attitude change through evaluative conditioning appears positively related with repetition (Hofmann et al., 2010), careful consideration of how to deliver an intervention is crucial to maximize both duration and frequency of exposure. Because games often rely on repetition to progress in the game (Ciavarro et al., 2008), a health game could be ideally suited to integrate a repetitive evaluative conditioning paradigm, with the aim to influence eating behaviour.

For the current dissertation, a health game based on an evaluative conditioning paradigm was developed and its effectiveness was investigated. Additionally, usage of an existing health game was investigated, to evaluate the effectiveness of placing a health game online and examine the effects of advertising on usage. The research in the dissertation addressed three research aims. This chapter discusses the results in relation to the research aims and places these findings in a wider framework according to the current literature in the field.

AIMS AND REFLECTION ON THE MAIN FINDINGS

AIM 1: EFFECTIVENESS OF A HEALTH GAME WITH AN EVALUATIVE CONDITIONING COMPONENT

The first aim of the dissertation was to examine the effectiveness of a health game based on an evaluative conditioning paradigm. There were two outcome measures to assess effectiveness, which were (a change of) implicit attitudes and food choice behaviour. Specifically, it was examined whether the health game could successfully influence implicit attitudes towards food (i.e., positively influence the ease of combining fruits with positive words and chocolate snacks with negative words relative to the ease of combining fruits with negative words and chocolate snacks with positive words) and whether the health game could stimulate choosing fruit over chocolate snacks. It must be emphasized that the two outcome measurements assessed different aspects or components of behaviour. Because it is conceivable that different mechanisms underlie the effects of the health game, the two outcome measures will be discussed separately.

FINDINGS AND REFLECTION ON IMPLICIT ATTITUDES

In the study described in Chapter 2, the effects on implicit attitudes observed for adults playing the health game were different from the effects observed for adults playing the control game. The implicit attitudes of adults playing the health game remained equally healthy, whereas the implicit attitudes of adults playing the control game became less healthy (i.e., these adults became slower to combine fruits with positive words and chocolate snacks with negative words relative to combining fruits with negative words and chocolate snacks with positive words). However, in the study in Chapter 3, it was found that children's implicit attitudes were not differently affected after playing the health game versus the control game.

In both studies, the baseline implicit attitude scores were very high (i.e., healthy). While a large comprehensive study examining the methodology of the Implicit Attitude Test score calculation (Nosek et al., 2007) reported adequate test-retest reliability (Cronbach's Alpha = .80), a reduction of extreme scores was observed for those with little or no prior experience with the Implicit Attitude Test. This has been interpreted as a training effect (Greenwald et al., 2003). For the adults, the health game appeared to protect for these training effects, since their implicit attitude scores remained the same.

For the children, the health game did not show this protective influence on their implicit attitude scores. It is possible that children's exposure to the health game was too short, given that the effectiveness of evaluative conditioning appears to be related with the frequency of pairings/associations (Hofmann et al., 2010). Possibly, due to their developmental state, stronger evaluative conditioning effects could have been observed when exposing the children to more pairings. This suggestion about developmental state will be discussed in more detail in the section concerning the results with respect to the second aim.

However, before discussing the results of the main effects of the game on implicit attitudes in more detail, it must be noted that the results regarding the second aim of this dissertation suggest that the effectiveness of the game depends on individual characteristics of the players. This might be the most important explanation for the absence of clear, consistent, and interpretable main effects of the game. The moderation effects will be discussed in the section concerning the results with respect to the second aim.

FINDINGS AND REFLECTION ON FOOD CHOICE BEHAVIOUR

In the study described in Chapter 2, it was found that the health game did not influence adults' actual or digital food choice behaviour. Overall, fruits were chosen more often than chocolate snacks by the adults, and there was no difference between the two game conditions. In contrast, in the study described in Chapter 3, it was found that the health game influenced children's food choice behaviour in a digital food choice question. After playing the health game, children chose fruits more often than chocolate snacks, compared to children who had played the control game.

These results indicate that a 10-minute play session of a health game with pictures of food can positively influence food choice behaviour for some people. This is promising, because exposure to pictures of food has been found to increase selection of energy-dense food products in other research (Buijzen et al., 2008; Folkvord et al., 2014; Folkvord et al., 2015). In that light, the health game countered these observed effects of exposure to food cues on food selection, and it actually caused more healthy choices instead. This provides support for the notion that health games can be used to treat unhealthy eating behaviour. Furthermore, this suggests that games can be employed for beneficial purposes, as a growing body of literature also shows (Granic, Lobel, & Engels, 2014; Lu et al., 2013; Van 't Riet et al., 2015).

However, the results regarding the second aim of this dissertation suggest that the effects of the health game on food choice behaviour also depend on individual characteristics. Therefore, the findings on the (sub)group level will first be described, before the discussion moves to the results considered in a wider framework.

AIM 2: DIFFERENTIAL EFFECTS OF A HEALTH GAME ON DIFFERENT (SUB)GROUPS

The second aim of this dissertation was to examine whether the effects of the health game on implicit attitudes and food choice behaviour would differ between different (sub)groups. First, the effects of the health game were investigated in two different studies using different samples; adults and children. Second, in both samples, a distinction was made between participants with healthy implicit attitudes at baseline versus those with less healthy implicit attitudes at baseline, because baseline implicit attitudes were expected to moderate the effects of the health game on the outcome measures. Third, due to the expected moderation effects of weight status on the health game's effectiveness, in the children's sample, a distinction was made children with under- and healthy weight versus children with overweight and obesity.

ADULTS AND CHILDREN

Interesting contrasts were found between adults and children in terms of how they responded to the health game. Specifically, a favourable effect on implicit attitude change was found only in the adult sample, whereas the intended effects on food choice behaviour were found only in the children's sample. Considering that the health game was designed for children, with use of a more tailored approach for this population (e.g., Lustria et al., 2013), some differences between the samples could be expected. However, the question remains as to how the observed differences could be further explained.

With respect to the effects on implicit attitude change, the results of a meta-analysis indicated that evaluative conditioning effects tend to be smaller in children compared to adults (Hofmann et al., 2010). The authors proposed that, due to their developmental stage, children display contingency awareness less often than adults. This refers to the awareness of the associations between the unconditioned and conditioned stimuli (i.e., in the health game, the associations between positive and negative game events, associated with fruits and chocolate snacks, respectively). Contingency awareness has been found to moderate the effectiveness of evaluative conditioning on implicit attitudes change. The authors additionally proposed that the observed different evaluative conditioning effects between adults and children may result from a less developed capacity for conceptual learning in children, which is also presumed to underlie evaluative conditioning effects (Hofmann et al., 2010). Taken together, younger age or developmental stage is likely to have attenuated the health game's effects on implicit attitudes.

With respect to the effects on food choice behaviour, a factor possibly contributing to the mixed findings is average game evaluation. Although the individual studies did not show a correlation between game evaluation and the outcome measures, it was found that the children liked the game more than the adults did. This may have differentially influenced the results for two reasons. First, in other research, positive attitudes towards health games or health interventions have been found to attenuate reactance to persuasive messages (e.g., Moyer-Guse, 2008; Ritterfeld et al., 2009). Second, the literature suggests that being immersed while playing health games (i.e., implying a deep mental involvement) can lead to better persuasion and more favourable outcomes (e.g., Lu, Thompson, Baranowski, Buday, & Baranowski, 2012). This could explain why children, having a more favourable attitude towards the health game, chose fruits more often after playing the health game, whereas the adults were less persuaded by the health game's message. In sum, it is plausible that how much the game was liked on a meta-level either promoted or interfered with immersion and consequently promoted or interfered with effective persuasion of behaviour. However, the exact mechanism behind this proposed assumption is yet unclear.

To further elucidate why the samples may have responded differently on the outcome measures, a closer look at the samples is warranted. In the first study, the sample consisted of young adults. The majority of these adults were in their early twenties, with lean BMI status, and were studying at university. The second study concerned a sample composed of children. The children were at the developmental stage around the onset of puberty (ranging from 10 to 16 years of age). Furthermore, approximately two-thirds of the children were classified as overweight or obese, and a larger range in educational level was observed than in the adult sample. Thus, the samples differed not only in developmental stage but also in average BMI status and educational level. Further research should explore the influence of these individual characteristics on the health game's effectiveness in more detail.

MODERATION OF BASELINE IMPLICIT ATTITUDES

First, the moderation of baseline implicit attitudes on the game's effects on implicit attitude change are discussed. As described in Chapter 2, it was found that implicit attitudes were not differently affected by the game conditions for adults with healthy implicit attitudes at baseline compared to those with less healthy implicit attitudes at baseline. In contrast, as described in Chapter 3, only for children with less healthy implicit attitudes at baseline, playing the health game was related with healthier post-test implicit attitudes compared to playing the control game. Children with healthy implicit attitudes at baseline were not differently affected by the two game conditions.

In the adult sample, baseline implicit attitudes did not moderate the effect of the health game on implicit attitude change. It is plausible that the adults were more similar to each other compared to the two sub-groups in the children's sample, because of a different underlying construct that differentiated the samples, such as the range of average BMI values. This will be further discussed in the section regarding the moderation of BMI. Interestingly, in the children's sample, for children with less healthy implicit attitudes at baseline, the results suggest that the health game was able to modify the children's implicit associations with the fruit and chocolate stimuli used. This indicates that a health game can be used to affect implicit attitudes towards food, specifically for those who need such interventions most, supporting the idea that an evaluative conditioning paradigm is suited to gamification. Furthermore, this observed finding suggests that at least from age 10 (the minimal age in this sample) some children are in a developmental stage that enables them to be influenced by this type of evaluative conditioning (Smits & Vandebosch, 2012).

Second, whether baseline implicit attitudes moderated the effect of the health game on food choice behaviour; as described in Chapter 2, when adults had healthy implicit attitudes at baseline, they chose fruit more often after playing the health game compared to the control version. However, when adults had less healthy implicit attitudes at baseline, they chose chocolate snacks more often after playing the health game compared to the control version. In contrast, as described in Chapter 3, for children with healthy compared to less healthy implicit attitudes at baseline, their food choices did not differ between the two game conditions.

A possible explanation for the mixed behavioural effects, both in terms of effects of the health game and the moderating effect of baseline implicit attitudes, is priming. Research suggests that priming can be very effective in changing behaviour (Papies & Hamstra, 2010; Price et al., 2016). Through priming, (subtle) reminders can influence behaviour by activating corresponding behavioural schemata associated with the reminders. In the health game that was used, the implicit message was that fruits are good and chocolate snacks are not. Because research indicates that the effects of priming increase when the primed concepts are salient for the recipient (Papies, 2016), it is conceivable that playing the health game activated schemata corresponding to healthy eating, specifically for those participants with salient health goals.

Activation based on salience could therefore explain why the healthiest individuals in the two samples, i.e., mostly lean adults with healthy implicit attitudes, were positively affected. This is because they are speculated to value a healthy lifestyle and are apparently successful at maintaining their weight, given their lean average weight status. Also, in the children's sample, where the health game instigated healthier choices compared to the control version, priming is a likely mechanism through which behavioural effects occurred. In this sample, the majority was overweight or obese and was under treatment by a dietitian or sports instructor. In this treatment, a healthy diet is promoted. Regardless of their actual (habitual) eating behaviour or weight status, it can be inferred that, for these children, healthy eating, or health goals, are salient and easily accessible.

Furthermore, priming can also offer an explanation for the finding that mostly lean adults with less healthy implicit attitudes chose fruit *less* often after playing the health game. For these participants, it is plausible that, rather than health goals, the pictures of food in the health game activated the hedonic rewarding properties of the chocolate snacks, resulting in a larger proportion of individuals choosing energy-dense foods after playing the health game. This effect of exposure to food cues has also been observed in a study investigating the effect of fruit depictions in an online memory game, where exposure to both pictures of fruit and energy-dense snacks increased consumption of energy-dense foods (Folkvord et al., 2013). Taken together, it is postulated that through priming, the health game's message and pictures of food activated either health goals or the hedonic rewarding properties of food.

MODERATING EFFECT OF WEIGHT STATUS (BMI)

As described in Chapter 3, for children, BMI did not moderate the effects of the health game on implicit attitudes. However, BMI moderated the effects of the health game on food choice behaviour. For children with higher BMI values, playing the health game was related with more frequent fruit choices compared to playing the control game. On the other hand, for children with low or average BMI values, the game they played did not influence their food choices.

In terms of implicit attitude change, children with high compared to low BMI values were not differently affected by the two game conditions. This may be the result of an absent significant relation between baseline implicit attitudes and BMI. In this sample, most children with high BMI values were being treated by dietitians or sports instructors for their overweight. It is plausible that, because of this treatment, the children with high BMI values already associated energy-dense food less positively. Possibly, these children had learned to associate energy-dense foods with their overweight, and the stigma this holds (Kirschenbaum & Gierut, 2013), making their implicit attitudes more similar to those of the children with lower BMI values in this sample.

With regard to food choice behaviour, the results described in Chapter 3 suggest that children classified as overweight or obese chose fruit more often after playing the health game, compared to children with a healthy weight status. Again, given that many children with overweight or obesity were being treated by health care providers, it is plausible that the majority of these children were motivated to lose weight. Additionally, it can be expected that most children with high BMI values had formulated health goals and diet intentions. Following this assumption, it is conceivable that priming is a likely mechanism underlying the effect, where the implicit health message in the game (implying that fruits are good and chocolate snacks are not) functioned as a prime to activate diet intentions, specifically in those participants with a desire to lose weight (Forwood, Ahern, Hollands, Ng, & Marteau, 2015; Papies, 2016; Papies & Hamstra, 2010).

Weight status may also provide an additional explanation for the observed differences between adults and children on the behavioural measure. In the adult sample, the majority of participants were lean and had healthy implicit attitudes. In other words, the majority was not in need of a dietary intervention. In the children's sample, the average baseline implicit attitudes scores in this sample were also healthy. However, in contrast, a larger range and variation with regard to weight status were observed. Relatively many children were categorized as being overweight or obese. Therefore, this makes it likely that in the children's sample, a larger proportion had salient, clearly accessible health goals, compared to the adult sample. Concordantly, this may have led to better activation of these goals, primed by the health game's implicit message.

Taken together, the results suggest that the first two research aims can be cautiously answered. The data suggests that a health game can modify implicit attitudes, where an activation of healthy diet intentions through priming is a plausible mechanism underlying the immediate behavioural effect. However, for individuals without active or salient healthy diet intentions, the health game may instead activate the associations of the hedonic rewarding properties of food, resulting in less healthy food choices.

AIM 3: IMPLEMENTATION STRATEGY FOR A HEALTH GAME

The third aim of this dissertation was to evaluate using the internet as a platform to distribute a health game, and advertising as a strategy to promote this game. The health game that was used to address this aim was placed online on various Dutch websites, and there were two separate campaigns to promote the game. First, usage data were examined to explore the potential of using the internet as a medium to distribute an intervention. Second, to examine the effects of advertising, the relation between advertising and (first-time) usage was explored. To extract this information, a web-based analysis software program was used.

USAGE DATA AND THE EFFECTS OF ADVERTISING ON (FIRST-TIME) USAGE

In the study described in Chapter 4, usage data indicated that by using the internet as a platform, a large audience was exposed to the intervention. The data showed that advertising was effective to attract visitors to the health game. Additionally, usage data during the second advertising period indicated that advertising not only attracted new visitors but also stimulated visitors to return, thereby serving as a valuable tool for retention. However, the data also showed that usage gradually decreased over time.

Because many households have a computer and internet access, placing a health game online has the potential to reach a large audience (de Nooijer, Veling, Ton, de Vries, & de Vries, 2008; InternetLiveStats, 2016). This is one of the clear advantages of online interventions and was underscored in the current study. However, in the current landscape, health games need to compete with a plethora of commercial games in a competitive multi-billion-dollar market (Granic et al., 2014). Therefore, how people discover the intervention needs to be carefully scrutinized, as well as how to stimulate people to return, given that this will influence the degree of exposure to the intervention.

Advertising is a powerful method to reach and influence people (Cairns, Angus, Hastings, & Caraher, 2012; Eisend & Tarrahi, 2016). A successful ad can boost sales, for example, by transference (i.e., a finding that advertisement liking highly correlates with brand preference) or by using repetition to increase recall (Vakratsas & Ambler, 1999). Data from the present study indicated that advertising was effective to stimulate new and returning visitors to access the website. However, the effects of advertising appeared to dissipate within a few months, as has been observed in other research (e.g., Vakratsas & Ambler, 1999). This suggests that regular advertising is needed to ensure (repeated) exposure to an online intervention.

With regard to the web-based analysis software program that was used to extract the data, using an analytical tool can be highly beneficial when placing a health game online. Such a tool can provide insight into the behaviour of the visitors, such as how they discover the intervention, how they access it (through which device), and how long they play the health game (or when they stop). Thus, an analytical tool can provide valuable information that can aid further development and fine-tuning of both the intervention and the advertising or campaign material, aiming to stimulate discoverability and retention.

In sum, using the internet as a medium for distribution can be effective to reach a large audience. However, advertising appears necessary to stimulate visitors to access or return to play the health game. Continuous monitoring of usage is important to assess exposure to the online intervention. Due to the competitive market, it is of the utmost importance to see children as media consumers (Konijn, Veldhuis, Plaisier, Spekman, & den Hamer, 2015) and to tailor both the health game and the advertising campaigns to suit their interests, to ensure adequate exposure.

IMPLICATIONS

This dissertation aims to contribute valuable knowledge for scholars, health care providers, and those in need of dietary intervention. First, scholars may use the results from this research as a starting point to further explore the use of health games to modify implicit attitudes towards food and eating behaviour. However, individual differences need to be taken into account, given that this and other research suggest that not all individuals will be equally affected by one intervention (Nguyen et al., 2017; Valkenburg & Peter, 2013). It could be valuable to pin-point specific individual characteristics that indicate whether such an intervention will be successful or not.

Another important issue for scholars is to consider how to implement a health game for the target population. A promising avenue is to use the internet as a platform to distribute the intervention. However, this dissertation provides a substantiated suggestion that advertising appears to be a necessary component to increase discoverability and maintain retention. Therefore, it is recommended to allocate a portion of the research budget to advertising, and to examine the optimal type of advertising. Furthermore, the data suggest that using an analytical tool can be highly beneficial when placing a health game online. Thus, when placing a health game online, selecting and using an analytical tool would be highly recommended, with careful consideration of the required information that needs to be tracked.

Second, for health care providers, this dissertation indicates that a health game targeting implicit attitudes towards food could be a valuable addition to their treatment. First, it can provide an entertaining addition to their often cognitively based, and thus reflective, treatment (e.g., Foster, Farragher, Parker, & Sosa, 2015; Kumar & Kelly, 2017; Sbruzzi et al., 2013). Second, research has shown that positive feelings towards an object, game, or even a commercial can positively influence feelings towards another object, product, or message by transference (e.g., Hofmann et al., 2010; Moyer-Guse, 2008; Ritterfeld et al., 2009; Vakratsas & Ambler, 1999). Therefore, it is also plausible to assume that potential positive attitudes towards a health game could transfer onto other components of the treatment. Moreover, this could potentially also result in less reactance to the practitioner. Thus, adding an entertaining component to the treatment can positively influence the rapport between health care providers and their clients. However, the results also suggest that actively and frequently promoting the game to clients is recommended to ensure adequate exposure.

There is another implication for both scholars and health care professionals who have an interest in methods to *prevent* overweight and obesity. The studies conducted for this dissertation suggest that the health game can have adverse immediate effects for lean individuals without the postulated easily accessible healthy diet intentions. For these individuals, playing the health game may instead activate the hedonic rewarding properties of food, resulting in (increased) selection of energy-dense food products. This would suggest that the health game, in its current form, should preferably be used for treatment of (childhood) overweight and obesity, rather than also for prevention purposes.

Third, children with overweight or obesity could greatly benefit from the health game investigated, because games can function as an entertaining component that can be offered together with treatment. A game can be a fun and easy accessible tool to work on children's treatment by targeting implicit attitudes. Moreover, successful evaluative conditioning could ensure that their implicit attitudes are more in accordance with a healthy diet (i.e., positive towards nutrient-dense foods and negative towards energy-dense foods) and with their healthy diet intentions (i.e., consume predominantly nutrient-dense foods and restrict or avoid energy-dense foods). In accordance with the dual-system models (e.g., Strack & Deutsch, 2004), changing automatic processes should result in behavioural change when cognitive capacity is low. When there is time pressure, fatigue, or ego depletion, deliberate and reflective processes are less likely to occur or are less elaborate. Consequently, in these instances automatic processes more strongly influence behaviour (Alberts et al., 2007; Hofmann et al., 2007; Muraven & Baumeister, 2000). Therefore, when such automatic processes are more tuned towards healthy foods, this could make the 'healthy choice' the 'automatic choice'.

STRENGTHS AND LIMITATIONS OF THE DISSERTATION

STRENGTHS

Novel interventions targeting eating behaviour are highly needed because of the still growing prevalence of (childhood) obesity. For this dissertation, a science- and evidence-based health game was developed, integrating an evaluative conditioning paradigm that showed promising results in the literature (e.g., Ebert et al., 2009; Hofmann et al., 2010; Legget et al., 2015). While health games are becoming increasingly popular for training behaviours (e.g., Baranowski et al., 2003; Boendermaker et al., 2017; Schoneveld et al., 2016; Van 't Riet et al., 2015), this is one of the first health games that has specifically focused on implicit attitudes as a precursor for eating behaviour.

The first strength of this dissertation is that the effectiveness of a health game has been tested among two different samples. First, as proof of principle, the effects of the health game were investigated by using a student sample. Second, the effects were explored among the target population (i.e., children with overweight or obesity). Moreover, in this second study, an adequate number of children and adolescents with overweight or obesity were found to participate, whereas this target population generally shows increased reactance to participation (Boyd & Bee, 2012). This was underscored by anecdotal reports from dietitians who aided with acquisition of the overweight and obese children.

The second strength relates to the inclusion of different measurements, both cognitive and behavioural, to investigate the health game's effectiveness. The measurements were non-invasive and included various questions to assess food choice behaviour. Because results from the first study indicated a significant positive correlation between virtual and actual food choice, the researchers chose to use several virtual food choices in the second study. This was to protect the large number of overweight and obese children from possible excess calories, while still gaining insight into their food choice behaviour. Even though virtual food choices could be considered a proxy of behaviour, the children were under the impression that they could get the snack of their choice after the experiment. This makes it plausible that their virtual choices would have reflected their actual food choice behaviour.

The third strength relates to the final study, that evaluated the internet as a platform to distribute a health game. In this study, long-term usage information (i.e., 31 consecutive months), was available for analysis. Because there were two separate periods of advertising during this period, this allowed for causality testing, improving generalisability. Additionally, because this was an observational study, where usage of the health game Monkey Do was examined in a non-controlled environment, it provides insight into the actual voluntary behaviour of the general population after a health game is placed online.

LIMITATIONS

There are also some general limitations to discuss. First, even though the effects of the health game appeared promising, especially among the target population, both experiments tested only the immediate effects after a single play session. Implicit attitudes towards food are typically formed through classical conditioning, which results in an emotional valence (e.g., pleasure or disgust) being attributed to certain food products by association. Research suggests that these conditioning effects tend to increase or strengthen with repeated pairings of the stimuli (e.g., Hofmann et al., 2010). This is in line with the incentive sensitization theory posited by Robinson and Berridge (1993), which postulates that repeated exposure to pleasurable stimuli can lead to a 'hyper-sensitized' motivational approach system, resulting in magnified attention (i.e., incentive salience) and increased craving (i.e., compulsive wanting) towards these and associated stimuli (Robinson & Berridge, 2008). For future studies, it would therefore be suggested to use a longitudinal design, with prolonged exposure to the health game, to examine its effects on implicit attitudes and behaviour in more depth and over time.

The second limitation relates to the Implicit Association Test as a measuring tool. In prior research, training effects have been observed. Training effect refers to a reduction of extreme scores for subjects with little or no prior experience with this test (Greenwald et al., 2009). A training effect was also observed in the two experiments that were conducted for this thesis. Because both experiments had a between-subjects design, this methodological constraint did not hinder the comparison of the two conditions. However, to better identify effects on implicit attitudes, future studies could include an additional training session prior to the experiment, to reduce these training effects (Nosek, Greenwald, & Banaji, 2005). An additional limitation pertaining to the Implicit Association Test was that both experiments used a test version that assessed the preference for fruits *relative* to chocolate snacks, rather than to a neutral condition. To disentangle the game's effects on implicit attitudes towards fruits versus chocolate snacks in more detail, it would be recommended to use two single-target Implicit Association Tests instead. An additional advantage of this approach would be that this enables further correlational analyses to examine the respective influences on eating behaviour.

The third limitation concerns the food stimuli in the two health games. Both health games had a limited and fixed set of food products. Neither game tailored its stimuli to individual needs, for example, by including the participant's favourite energy-dense snacks to maximize its beneficial effects. Even though the literature suggests that implicit attitudes, influenced by evaluative conditioning, can result in generalization on to other (untested) comparable products (Legget et al., 2015) or can transfer on to concepts such as healthy eating in general (Bui & Fazio, 2016), the mechanisms or ideal circumstances concerning generalization are not yet fully understood (Hofmann et al., 2010). Therefore, future health games might benefit from a more tailored approach. A low-cost option would be to make different versions, for example, by offering a version with sweet snacks and one with savoury snacks, which could be (self) selected by the user. Another option would be to dynamically adjust the presentation of specific food stimuli from an extensive in-game database, based on the player's response pattern. Given the proposed benefits of a tailored approach, tailoring will also be discussed in the next section concerning guidelines for future research.

GUIDELINES FOR FUTURE RESEARCH

Changing eating behaviour by targeting implicit attitudes appears to be a promising strategy. Concordantly, the health game appeared capable of positively influencing implicit attitudes and food choice behaviour for certain individuals. However, there are still gaps in the understanding of the health game's effectiveness. In the next section, new research questions building on the present findings are proposed.

The first suggestion for further research also relates to tailoring. It would be interesting to examine the effects on implicit attitudes and food choice behaviour when using specific versions of the health game tailored to the individual. For example, as was also discussed in the section concerning the limitations, would a health game featuring a person's favourite food products be more effective compared to a version with fixed stimuli? Moreover, the health game that was used in the present experiments aimed to make implicit attitudes towards fruits more positive and implicit attitudes towards chocolate snacks more negative. It would be interesting to separate these two categories, by making two separate versions, in order to examine their respective influences on eating behaviour in more detail. It is possible that some individuals would benefit most from getting a more positive attitude towards nutrient-dense foods, whereas other individuals may benefit more from getting a more negative attitude towards energy-dense foods. Taken together, it could be valuable to investigate the effects of health games using a tailored approach, based specifically on individual needs and characteristics, to see whether this personalised approach would be more effective in changing implicit attitudes and food choice behaviour.

As a second suggestion for future research, it would be interesting to explore the possible added benefits of using a multifaceted approach, because there are also other (implicit) processes that instigate overconsumption or consumption in the absence of hunger (Bourke et al., 2014). Interventions that simultaneously target dietary habits, such as habitual plate-clearing or portion size (Sheen, Hardman, & Robinson, 2018; Syrad et al., 2016), could have additional beneficial effects on changing (long-term) eating behaviour. Also, using health games that target implicit attitudes as a home-based addition, together with dietary knowledge-based interventions could be a very promising strategy to target both reflective and impulsive processes (e.g., Strack & Deutsch, 2004). Therefore, for future studies, it would be interesting to use a multifaceted approach by targeting several influential components causing or preceding eating behaviour, to examine the possible additive effects of such a combined approach.

A third suggestion relates to the challenges of how to ensure repeated exposure to the health game. This health game aimed to change (habitual) eating behaviour, but habitual behaviour is often resistant to change (Neal, Wood, Wu, & Kurlander, 2011; Van ‘t Riet et al., 2011; Wood & Neal, 2007). Therefore, continued exposure would appear important. In accordance with this notion, session time has been found to moderate the effectiveness of health games (Gentile, 2011; Johnson et al., 2013; Subrahmanyam & Renukarya, 2015). To maximize play time, an option could be to make a (health) game interesting by using different levels with increasing difficulty. This allows players to grow in the game by increasing their skill set and overcoming challenges, resulting in feelings of competence and mastery (Baranowski, Belchior, Chamberlin, & Mellecker, 2014). The health game used in the first two studies had three levels. However, it would be interesting to explore the effects on play time when more levels are incorporated, or, alternatively, when players are allowed to choose a difficulty setting.

A final suggestion also relates to how to maximize repeated exposure to a health game. When placed online, exposure and retention can be challenging due to the plethora of information found on the internet. As was observed in the third study, advertising appeared to be an effective strategy to stimulate people to visit and return to the website. Effective marketing strategies designed specifically for the target population could be further examined. Moreover, it would be interesting to explore the effects on retention when using a combined approach of advertising that is simultaneous with the release of new levels or new features of the game.

GENERAL CONCLUSION

For the current project, a health game was designed, based on science- and evidence-based theories, targeting implicit attitudes towards food and food choice behaviour. The studies conducted for this dissertation have broadened understanding of the use of health games to train automatic behaviour, as well as of the benefits of using the internet and advertising to make such a game available for the public. Therefore, this dissertation provides a valuable contribution to the body of research into novel approaches of targeting eating behaviour.

What has been learned? The health game investigated in the first two studies appeared to be successful in modifying implicit attitudes, although the results indicate that its effectiveness depends on individual characteristics. It is plausible that with extended exposure, stronger effects on implicit attitudes can be expected, and through the principles of the incentive sensitization model, these changes are expected subsequently to influence food choice behaviour. With regard to food choices, it is proposed that individuals with salient health goals will benefit most from playing the game. This effect is postulated to be the result of successfully activated health goals due to priming. This, however, also indicates possible adverse effects. When an individual has relatively weak positive associations with fruits compared to chocolate snacks and does not have strong healthy diet intentions, it is possible that pictures of food in health games will activate the hedonic rewarding properties of (energy-dense) foods instead.

The authors' main suggestions for further research are to explore the effectiveness of a health game that uses a multidisciplinary approach, due to the multifaceted origins of eating behaviour. Furthermore, due to individual differences, it is suggested to tailor the health game to suit individual needs in order to maximize effectiveness. Last, it is recommended to allocate a portion of the budget for marketing purposes and to explore effective marketing strategies designed specifically for the target population.

To conclude, modifying automatic processes to improve eating behaviour holds great promise to treat (childhood) overweight and obesity. The results from the studies in this dissertation suggest that targeting implicit attitudes can be effective, at least for some individuals. Furthermore, because video games are very popular among youth and have certain advantages over non-game interventions, using a health game as an intervention tool to modify implicit attitudes appears to be a promising strategy. Further research is warranted to fully exploit the effectiveness.

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APPENDIX

AUTHOR CONTRIBUTIONS AND DATA MANAGEMENT
NEDERLANDSE SAMENVATTING (DUTCH SUMMARY)
DANKWOORD (ACKNOWLEDGEMENTS)

AUTHOR CONTRIBUTIONS AND DATA MANAGEMENT

AUTHOR CONTRIBUTIONS

STUDY 1

The two versions of the game Sky Islands were developed by E. van den Berge. E.E. Alblas, J.P. van ‘t Riet, P.K. Ketelaar, I. Granic, and M. Buijzen developed the study concept and contributed to the study design. A. van Helvoort collected the data. E.E. Alblas analysed and interpreted the data under supervision of F. Folkvord, D.J. Anschütz and M. Buijzen. E.E. Alblas drafted the manuscript, F. Folkvord, D.J. Anschütz, J.P. van ‘t Riet, I. Granic, P.K. Ketelaar and M. Buijzen provided critical revisions. All authors approved the final version of the manuscript for submission. The Behavioural Science Institute, Radboud University funded this research.

STUDY 2

The two versions of the game were developed by E. van den Berge. E.E. Alblas, J.P. van ‘t Riet, P.K. Ketelaar and M. Buijzen developed the study concept and contributed to the study design. E.E. Alblas analysed and interpreted the data under supervision of F. Folkvord, D.J. Anschütz and M. Buijzen. EA drafted the manuscript, F. Folkvord, D.J. Anschütz, J.P. van ‘t Riet, P.K. Ketelaar and M. Buijzen provided critical revisions. All authors approved the final version of the manuscript for submission. The Behavioural Science Institute, Radboud University funded this research.

STUDY 3

The game Monkey Do and its advertising were developed by the Netherlands Nutrition Centre, in collaboration with the Dutch Institute for Sport and Activity. The air time (television, radio and online bannering) was funded by KidsVitaal. E.E. Alblas, J.P. van ‘t Riet, P.K. Ketelaar, I. Granic, and M. Buijzen developed the study concept and contributed to the study design. E.E. Alblas analyzed and interpreted the data under supervision of J.P. van ‘t Riet , F. Folkvord, D.J. Anschütz and M. Buijzen. E.E. Alblas drafted the manuscript, F. Folkvord, D.J. Anschütz, J.P. van ‘t Riet, I. Granic, P.K. Ketelaar, F. Mensink and M. Buijzen provided critical revisions. All authors approved the final version of the manuscript for submission. The Behavioural Science Institute, Radboud University funded this research.

DATA MANAGEMENT

The Radboud University has set strict conditions for the management of research data (Radboud University, 2018). The data from the studies conducted for this dissertation will be treated in accordance with the research data management protocol (https://www.ru.nl/rdm/).

NEDERLANDSE SAMENVATTING (DUTCH SUMMARY)

In de hedendaagse Westerse maatschappij wordt men dagelijks veelvuldig blootgesteld aan een grote diversiteit aan smakelijke en relatief goedkope producten (Ely et al., 2015). Veel van deze producten bevatten relatief veel vet, suiker, of een combinatie hiervan, en hebben hierdoor een hoge calorische waarde (Kessler, 2009). Inname van dit soort hoogcalorische producten is positief geassocieerd met obesitas (Bourke et al., 2014), wat fysieke en mentale gezondheidsproblemen teweeg kan brengen, zoals: Cardiovasculaire aandoeningen, type II diabetes, verscheidene soorten kanker, sociale stress en isolatie (Kaikkonen et al., 2013; World Health Organization, 2018). Daarentegen is de inname van groente en fruit geassocieerd met een gezond gewicht (Boumtje et al., 2005).

Echter, onderzoek wijst uit dat zowel kinderen (CBS, 2017; Herrick et al., 2015; World Health Organization, 2018) als (jong) volwassenen (Diethelm et al., 2012; RIVM, 2016a) onvoldoende groente en fruit consumeren en juist teveel hoogcalorische producten nuttigen. Hiermee samenhangend is de prevalentie van overgewicht en obesitas extreem hoog in veel landen en lijkt het aantal mensen met overgewicht en obesitas wereldwijd nog steeds toe te nemen (Cheung et al., 2016; Ebbert et al., 2014; Hruby & Hu, 2015). Vandaar dat nieuwe interventies om gezond eetgedrag te bevorderen noodzakelijk zijn.

Een innovatieve en veelbelovende strategie om eetgedrag te beïnvloeden legt nadruk op onbewuste, automatische processen betrokken bij eetgedrag. Gedrag is namelijk niet enkel gebaseerd op logische en bewuste redenaties, maar wordt ook beïnvloed door onbewuste en automatische processen (Bargh, 1994). Deze automatische processen ontstaan door herhaling van (gecombineerde) handelingen, waardoor gedrag efficiënt uitgevoerd kan worden (Muraven & Baumeister, 2000; Strack & Deutsch, 2004). Met betrekking tot eetgedrag zijn veel verschillende handelingen, processen of gewoontes te onderscheiden die dit gedrag sturen. Zo kunnen deze automatische processen of gewoontes mede beïnvloeden wat er wordt gegeten, wanneer, met wie, de hoeveelheid die wordt geconsumeerd en om welke reden (Cruwys et al., 2015; Van ‘t Riet et al., 2011). Vaak worden deze automatische processen door externe cues geactiveerd, zoals in reactie op het zien of ruiken van een smakelijke snack, of enkel het zien van de (etens)tijd.

Het reflectieve-impulsieve model, voorgesteld door Strack and Deutsch (2004), maakt inzichtelijk waarom mensen soms irrationele beslissingen met betrekking tot eetgedrag lijken te maken, zoals bijvoorbeeld het eten van een broodje frikandel speciaal terwijl iemand een strikt dieet volgt om af te vallen. Dit komt doordat het zien, of aangeboden krijgen van een frikandel leidt tot de activatie van verschillende processen. Enerzijds kunnen reflectieve processen leiden tot een bewuste gedachte, zoals: “Ik ben op dieet” en daaropvolgend gedrag zoals het kiezen voor een salade. Anderzijds worden ook de meer automatische impliciete processen geactiveerd, zoals de gewoonte van iemand om op ‘vrijdag-frituurdag’ met de lunch een broodje frikandel speciaal te nemen. Beide typen processen kunnen simultaan geactiveerd worden, maar enkel als er voldoende aandacht is, worden reflectieve processen verder uitgewerkt. Als we echter vermoeid zijn, of emotioneel, dan is er minder cognitieve capaciteit beschikbaar voor reflectieve processen, en is de kans groter dat gedrag sterker wordt beïnvloed door impliciete processen (bijv. Alberts et al., 2007; Hofmann et al., 2007; Strack & Deutsch, 2004). Vandaar dat het richten op impliciete processen betrokken bij eetgedrag een veelbelovende strategie zou kunnen zijn om eetgedrag te beïnvloeden, ter behandeling van overgewicht en obesitas.

Onderzoek heeft aangetoond dat impliciete associaties die kinderen en volwassenen hebben met bepaalde voedselproducten - dus de emotionele lading die geassocieerd wordt met deze producten - voorspellend kunnen zijn voor het consumeren van deze voedselproducten (bijv. Corsica & Pelchat, 2010; Eschenbeck et al., 2016; Kiviniemi & Duangdao, 2009; Moira et al., 2008; Walsh & Kiviniemi, 2014). Hierop voortbouwend lijkt onderzoek tevens aan te tonen dat een vermindering van trek (Kemps et al., 2013) en het vergroten van gezondere voedselkeuzes (Hollands & Marteau, 2016; Hollands et al., 2011) kunnen worden gestimuleerd door het beïnvloeden van deze impliciete associaties ten aanzien van voedsel (hierna afgekort tot impliciete associaties).

Er is gevonden dat impliciete associaties beïnvloed kunnen worden middels evaluatieve conditionering (bijv. Ebert et al., 2009; Hofmann et al., 2010; Legget et al., 2015). Bij evaluatieve conditionering worden stimuli (bijvoorbeeld voedsel), geassocieerd met emotionele stimuli (bijvoorbeeld emotionele woorden, zoals blij of verdrietig). Door deze emotionele woorden herhalend te associëren met specifieke voedselproducten kan de emotionele lading van de woorden overslaan naar de producten. Hierdoor kunnen de impliciete associaties met deze voedselproducten aangepast of versterkt worden (Hofmann et al., 2010). Echter, de auteurs stellen dat de effectiviteit van evaluatieve conditionering wordt versterkt door herhaling. Vanwege deze herhaling is het van belang om zorgvuldig te overwegen op welke manier, afhankelijk van de doelgroep, de evaluatieve conditionering het best aangeboden kan worden om zoveel mogelijk blootstelling hieraan te waarborgen.

Een strategie die regelmatig gebruikt wordt om interventies aantrekkelijk(er) te maken, is het toevoegen van game-elementen (Deterding et al., 2011), of het integreren van een interventie in een videogame (Fleming et al., 2017; Van ‘t Riet et al., 2015). Het spelen van videogames is namelijk erg populair onder de jeugd en (jong) volwassenen (Willoughby, 2008). Vandaar dat videogames al langer ingezet worden om gedrag te beïnvloeden, zoals het tegengaan van alcoholgebruik onder jongeren (Boendermaker et al., 2017), het promoten van fysieke activiteit (Van ‘t Riet et al., 2015) en om de consumptie van groente en fruit te stimuleren (Baranowski et al., 2003). In de context van gezondheid bevorderende interventies worden dit soort videogames meestal aangeduid als ‘health games’ (Lu et al., 2013). Daar het gebruikelijk is om in videogames repeterende handelingen uit te voeren (Ciavarro et al., 2008), lijkt dit een medium dat bij uitstek geschikt is om een evaluatief conditioneringsparadigma mee aan te bieden. Desalniettemin, bij de start van dit project was er nog geen literatuur te vinden over de ontwikkeling van en onderzoek naar health games met het specifieke doel om impliciete associaties te beïnvloeden.

Samengevat, onderzoek heeft aangetoond dat health games gedrag kunnen beïnvloeden. Tevens is een game bij uitstek geschikt om een evaluatief conditioneringsparadigma in te integreren. Daarom zou het ontwikkelen van een health game die zich richt op impliciete associaties een veelbelovende tactiek kunnen zijn om eetgedrag te beïnvloeden. Vandaar dat de primaire focus van deze dissertatie lag op de ontwikkeling van en onderzoek naar de effecten van een health game gebaseerd op een evaluatief conditioneringsparadigma.

Als secundaire focus lag de aandacht van deze dissertatie op het evalueren van het gebruik van internet als distributiemedium voor een health game. Dit aangezien het ook belangrijk is om een geschikt platform te gebruiken en een implementatiestrategie te hebben om (voldoende) blootstelling aan de interventie te waarborgen. Het internet als platform heeft veel potentie omdat: Veel mensen bereikt kunnen worden; de interventie altijd beschikbaar is; het relatief kostenbesparend is; mensen bereikt kunnen worden die anoniem willen blijven en mensen bereikt kunnen worden die niet in staat zijn om op locatie te komen (Ritterband et al., 2003; Tate & Zabinski, 2004). Echter, vanwege de grote hoeveelheid aan informatie die op internet te vinden is, lijkt het tevens van belang om de health game actief te promoten. Omdat hier nog relatief weinig onderzoek naar is gedaan, lag de secundaire focus van de dissertatie op het evalueren van het gebruik van het internet als platform, waarbij reclames werden gebruikt als strategie om blootstelling aan de health game te verhogen. Hiervoor werd met een online dataverwerkingsprogramma bekeken hoeveel (nieuwe) gebruikers een bestaande online health game bezochten, waarbij tevens de invloed van reclame op de gebruikersgegevens werd geanalyseerd.

DOEL VAN DEZE DISSERTATIE

Om de primaire en secondaire focus te adresseren, zijn drie doelstellingen geformuleerd, die onderzocht zijn in drie studies beschreven in deze dissertatie. Eerst volgt een uiteenzetting van de doelstellingen, waarop een korte beschrijving van de studies zal volgen die zijn uitgevoerd om deze te onderzoeken. Hierna zullen de bevindingen van de studies besproken worden binnen het kader van de doelstellingen.

De eerste doelstelling van deze dissertatie was om de effectiviteit van een health game te onderzoeken. Hiervoor werd onderzocht of een health game, gebaseerd op een evaluatief conditioneringsparadigma, effectief verandering teweeg kon brengen op twee uitkomstmaten. Deze waren (1) een verandering van impliciete associaties en (2) voedselkeuze na het spelen van de game. Impliciete associaties werden gemeten met de Impliciete Attitude Test (IAT: Greenwald et al., 1998), die vaststelde of er een impliciete voorkeur was voor fruit, dan wel voor chocolade snacks. Deze impliciete voorkeur werd vastgesteld door te meten hoe snel positieve woorden met fruit; en negatieve woorden met chocolade snacks konden worden geassocieerd (combinatie A), in vergelijking met de snelheid van het associëren van negatieve woorden met fruit; en positieve woorden met chocolade snacks (combinatie B). Voedselkeuze werd gemeten door de deelnemers te laten kiezen tussen een appel en een chocolade snack. De eerste doelstelling werd onderzocht in de eerste twee studies, beschreven in hoofdstuk 2 en 3.

De tweede doelstelling van deze dissertatie was te onderzoeken of de effectiviteit van een health game verschilde tussen subgroepen. Hierbij werd onderscheid gemaakt tussen (1) volwassenen en kinderen (2) deelnemers met een sterke impliciete voorkeur voor fruit (deelnemers die veel sneller waren met betrekking tot combinatie A dan combinatie B) ten opzichte van deelnemers met een minder sterke impliciete voorkeur voor fruit (deelnemers die een minder groot verschil in reactietijden lieten zien tussen combinaties A en B) en (3) kinderen met overgewicht/obesitas en kinderen met normaal-/ondergewicht. Deze classificatie van gewicht werd gemaakt op basis van de afkapwaardes van de BMI[1] score. Ook deze doelstelling werd onderzocht in de eerste twee studies.

De derde doelstelling van deze dissertatie was het evalueren van het internet als distributiemedium om een health game op te plaatsen, waarbij reclame werd gebruikt als promotiestrategie. Hierbij werd met name onderzocht hoeveel mensen de website bezochten, wat de invloed was van twee reclamecampagnes op de bezoekersaantallen, en of reclame voornamelijk nieuwe gebruikers aantrok, of ook mensen stimuleerde om terug te keren. Deze doelstelling werd onderzocht in de derde studie, beschreven in hoofdstuk 4.

SAMENVATTING VAN DE STUDIES

STUDIE 1

In dit onderzoek werden de eerste twee doelstellingen (gedeeltelijk) onderzocht bij (jong) volwassenen (N = 125, leeftijd: M = 20,17, SD = 1,88) in een gerandomiseerd within-between subjects design. Specifiek werd onderzocht wat het effect van een health game was op de twee uitkomstmaten en of deze effecten verschilden tussen deelnemers met een sterke of minder sterke impliciete voorkeur voor fruit.

1 BMI, een afkorting voor body-mass index, is een score die de ratio berekent tussen lengte en gewicht. Deze wordt berekend door het gewicht (in kilogram) te delen door het kwadraat van de lengte (in meters). Om BMI bij kinderen te classificeren zijn de afkapwaardes van Cole et al. (2000) gebruikt.

De health game ontwikkeld voor en onderzocht in deze studie kreeg de naam *Sky Islands*. Deze game is gebaseerd op een evaluatief conditioneringsparadigma, met het doel om positieve associaties met fruit te creëren of te versterken en negatieve associaties met chocola te creëren of te versterken. Om de effectiviteit van de health game te onderzoeken, werd deze vergeleken met een controlegame. In deze game zaten geen afbeeldingen van voedsel, maar waren het afbeeldingen van duurzame versus fossiele brandstoffen.

Om de invloed van de health game op impliciete associaties te onderzoeken, werden direct vóór en na het spelen van de health game of de controlegame de impliciete associaties gemeten met de IAT. Om de invloed van de health game op voedselkeuze te onderzoeken, werden de deelnemers na de tweede meting van hun impliciete associaties gevraagd om te kiezen tussen acht voedselproducten; vier vruchten en vier chocoladesnacks. Deze acht producten waren ook opgenomen in de health game en in de IAT. Ook werden de deelnemers na afloop van het experiment dezelfde snacks aangeboden door de onderzoeker, waarbij hun keuze onopvallend werd genoteerd.

STUDIE 2

Dit onderzoek had een vrijwel identieke opzet als de eerste studie, met een paar uitzonderingen. Ten eerste werd dit onderzoek uitgevoerd bij kinderen, waarvan bijna een derde (63%) overgewicht had (N = 79, leeftijd: M = 12.42, SD = 1.64, BMI: M = 25.06, SD = 7.40). Ten tweede werd hiernaast ook gekeken naar het modererende effect van BMI, oftewel, of de effecten van de health game verschilde tussen kinderen met overgewicht/obesitas ten opzichte van kinderen met normaal-/ondergewicht. Ten derde kregen de kinderen enkel digitale voedselkeuzes, als proxy voor voedselkeuze. De laatste uitzondering betrof de games; de kinderen speelden een tweede versie van de games, waarbij enkele verbeteringen waren aangebracht. Zij kregen in deze versies bijvoorbeeld de mogelijkheid om hun eigen avatar en naam te kiezen, en er was een verhaallijn toegevoegd. Deze spelopties/spelcomponenten worden verondersteld meer betrokkenheid te creëren (Baranowski et al., 2013).

STUDIE 3

In de derde studie werd de laatste doelstelling onderzocht; het evalueren van het internet als distributiemedium om een health game op te plaatsen, waarbij reclame werd gebruikt als promotiestrategie. Om dit te onderzoeken werden gebruikersgegevens van een bestaande online health game geanalyseerd met behulp van een online dataverwerkingsprogramma. In deze studie werd gekeken naar de gebruikersgegevens van de eerste 31 maanden vanaf het moment dat de game beschikbaar was gesteld, waarbij het aantal bezoeken aan de website op een totaal van 224.859 uitkwam. Tijdens deze periode waren er twee reclamecampagnes. Hierdoor konden de effecten van reclame op gebruik geanalyseerd worden, waarbij tevens werd bekeken of reclame invloed had op de proportie van nieuwe - en terugkerende gebruikers.

De health game in deze studie betrof *Na-aapje*. Deze game was ontwikkeld door het Voedingscentrum, in samenwerking met het Nederlandse Instituut voor Sport en Bewegen, specifiek voor kinderen tussen de vier en acht jaar oud. Het doel van deze health game was om kinderen op een leuke en vermakelijke manier kennis te laten maken met groente en fruit, zonder een duidelijke gezondheidsboodschap te verkondigen. Na-aapje was onderdeel van een grote campagne met als voornaamste doel om ouders en verzorgers bewust te maken van hun voorbeeldfunctie; namelijk dat kinderen leren door hun gedrag te na doen. De health game stond op verscheidene websites, zoals de website van het Voedingscentrum en op Spele.nl, en was gratis toegankelijk zonder dat het nodig was om een account aan te maken of ergens in te loggen.

RESULTATEN EN DISCUSSIE

DOELSTELLING 1: DE EFFECTIVITEIT VAN EEN HEALTH GAME

Allereerst moet er worden benadrukt dat er twee uitkomstmaten waren, waarbij twee verschillende aspecten of componenten van gedrag werden bekeken. Aangezien het hierdoor waarschijnlijk is dat verschillende mechanismes de effecten van de health game verklaren, zullen de twee uitkomstmaten afzonderlijk besproken worden.

EFFECTEN VAN DE HEALTH GAME OP IMPLICIETE ASSOCIATIES

In de eerste studie, beschreven in hoofdstuk 2, was te zien dat impliciete associaties van volwassenen verschillend werden beïnvloed door de health game ten opzichte van de controleversie. Voor volwassenen bleven de impliciete associaties ten aanzien van fruit na het spelen van de health game even positief bleven. Dit terwijl de impliciete associaties ten aanzien van fruit minder positief werden bij de volwassenen in de controleconditie. Echter, de analyse van de tweede studie, beschreven in hoofdstuk 3, wees uit dat de impliciete associaties van kinderen niet verschillend werden beïnvloed na het spelen van de health game ten opzichte van de controleversie

Voor zowel volwassenen als kinderen waren de impliciete associaties ten aanzien van fruit erg positief. Dat deze associaties minder positief werden, zou verklaard kunnen worden door een zogeheten trainingseffect. Het trainingseffect is een daling van extreme scores en wordt vaker gevonden bij mensen die IAT nog niet of niet vaak hebben gedaan (Greenwald et al., 2003). Onze resultaten lijken aan te geven dat een health game, in ieder geval bij bepaalde deelnemers, een beschermend effect op impliciete associaties kan hebben, aangezien deze trainingseffecten niet werden gevonden na het spelen van de health game.

Echter, de bevindingen van beide studies zijn niet consistent met elkaar. Zo werden de impliciete associaties van kinderen niet of nauwelijks beïnvloed. Mogelijk was voor hen de blootstelling aan de health game te kort. Het lijkt daarentegen waarschijnlijker dat de effectiviteit

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van de health game afhankelijk is van individuele verschillen. De resultaten van de health game op impliciete associaties zullen daarom verder worden besproken bij de sectie behorende bij doelstelling 2.

EFFECTEN VAN DE HEALTH GAME OP VOEDSELKEUZE

In de studie beschreven in hoofdstuk 2, was te zien dat de voedselkeuze van volwassenen niet verschillend werd beïnvloed door de health game ten opzichte van de controlegame. Echter, de analyse van de studie beschreven in hoofdstuk 3 wees uit dat de voedselkeuze van kinderen wel werd beïnvloed door de health game. Zij kozen in deze conditie vaker voor fruit dan de kinderen die de controlegame hadden gespeeld.

Deze resultaten geven wederom een indicatie dat de health game, voor sommige deelnemers, in staat is om positieve effecten teweeg te brengen. Dit is veelbelovend, aangezien dit het idee ondersteunt dat games ingezet kunnen worden voor positieve doeleinden (Granic et al., 2014; Lu et al., 2013; Van 't Riet et al., 2015). Echter, daar er ook met betrekking tot voedselkeuze inconsistente bevindingen zijn gevonden tussen de twee studies, nodigde dit uit om verder in te zoomen op individuele verschillen. Vandaar dat de effecten van de health game op voedselkeuze verder besproken zullen worden bij de sectie behorende bij doelstelling 2.

DOELSTELLING 2: DE EFFECTIVITEIT VAN EEN HEALTH GAME PER SUBGROEP

Bij het onderzoeken van de tweede doelstelling werd onderscheid gemaakt tussen (1) volwassenen en kinderen, (2) deelnemers met een sterke impliciete voorkeur voor fruit en deelnemers met een minder sterke impliciete voorkeur voor fruit en (3) kinderen met overgewicht/obesitas en kinderen met normaal-/ondergewicht.

VOLWASSENEN EN KINDEREN

Er werden interessante verschillen waargenomen tussen volwassenen en kinderen met betrekking tot de effecten van de health game. Terwijl enerzijds een wenselijk effect op impliciete associaties enkel bij volwassenen werd waargenomen, was anderzijds het beoogde effect op voedselkeuze enkel aanwezig bij de kinderen.

Allereerst, met betrekking tot de impliciete associaties; onderzoek suggereert dat evaluatieve conditioneringseffecten kleiner zijn bij kinderen, aangezien zij zich minder bewust zijn van de impliciete associaties in het paradigma (Hofmann et al., 2010). Hierdoor zou de emotionele lading van de woorden dus minder sterk overslaan naar de afbeeldingen van de voedselproducten. Vandaar dat leeftijd een mogelijke verklaring kan bieden voor de gevonden verschillen tussen volwassenen en kinderen.

Ten aanzien van voedselkeuze; een aspect wat de verschillende bevindingen mogelijk kan verklaren, is hoe leuk het spel werd bevonden door de deelnemers. Eerder onderzoek geeft aan dat een positieve houding jegens een interventie kan leiden tot minder weerstand tegen de inhoud (bijv. Moyer-Guse, 2008; Ritterfeld et al., 2009). Ook met betrekking tot health games is gevonden dat meer immersie, dat wil zeggen diepe mentale betrokkenheid, leidt tot sterkere beïnvloeding (bijv. Lu et al., 2012). Aangezien de kinderen het spel leuker vonden dan de volwassenen, zouden de kinderen wellicht sterker beïnvloed zijn door het spelen van de health game bij het maken van hun voedselkeuzes.

Echter, omdat de volwassenen en kinderen op meer aspecten van elkaar verschilden dan enkel leeftijd (zoals opleidingsniveau en gemiddelde BMI status), is meer onderzoek nodig om de verschillende effecten van de health game te verklaren.

DEELNEMERS MET EEN STERKE OF MINDER STERKE IMPLICIETE VOORKEUR VOOR FRUIT

Met betrekking tot de impliciete associaties vonden we dat deze niet verschillend werden beïnvloed door conditie bij volwassenen met een sterke dan wel minder sterke impliciete voorkeur voor fruit. Daarentegen werd gevonden dat kinderen met een minder sterke impliciete voorkeur voor fruit vaker voor fruit kozen na het spelen van de health game dan na het spelen van de controlegame. Kinderen met een sterke impliciete voorkeur voor fruit werden niet verschillend beïnvloed door conditie.

Deze resultaten geven een indicatie dat de health game de impliciete associaties kan beïnvloeden, specifiek bij kinderen die de minst positieve associaties hadden met fruit. Dit geeft tevens aan dat in ieder geval al vanaf tien jaar (de minimum leeftijd van de deelnemers aan dit onderzoek), sommige kinderen wel degelijk beïnvloed kunnen worden door een subtiele vorm van evaluatieve conditionering (Smits & Vandebosch, 2012).

Met betrekking tot voedselkeuze, vonden we dat wanneer volwassenen een sterke voorkeur voor fruit hadden, zij vaker voor fruit kozen na het spelen van de health game dan degenen in de controleconditie. Echter, wanneer zij een minder sterke voorkeur voor fruit hadden, kozen ze vaker voor chocolade na het spelen van de health game dan de volwassenen in de controleconditie. De voedselkeuze van kinderen met een sterke of minder sterke voorkeur voor fruit werd niet verschillend beïnvloed door conditie.

Een mogelijke verklaring voor de effecten van de health game op voedselkeuze is priming. In de context van de twee studies kan worden verondersteld dat de impliciete boodschap van de health game, 'fruit is goed, chocolade niet', als prime heeft gefungeerd, waardoor gezondheidsdoelen bij sommige deelnemers zijn geactiveerd. Onderzoek lijkt aan te tonen dat priming het beste werkt bij mensen waarbij de te activeren doelen belangrijk zijn (Papies, 2016). Onze bevindingen lijken dit te bevestigen, aangezien de health game het beoogde effect op voedselkeuze veroorzaakte bij enerzijds zeer gezonde deelnemers (volwassenen met sterke impliciete voorkeur voor fruit, waarvan het merendeel geen overgewicht had), en anderzijds de meest ongezonde deelnemers (kinderen waarvan het merendeel overgewicht had). Er kan dus worden gesteld dat beïnvloeding op voedselkeuze werd gevonden bij de twee extreme groepen op het gezondheidsspectrum, namelijk zij die gezond *zijn*, en zij die naar alle waarschijnlijkheid gezonder *willen* zijn.

Priming kan tevens verklaren waarom de volwassenen met een minder sterke impliciete voorkeur voor fruit vaker voor chocolade kozen na het spelen van de health game. Er wordt verondersteld dat bij hen de gezondheidsdoelen niet erg belangrijk waren, waardoor de afbeeldingen van voedsel juist de hedonische belonende associaties met hoogcalorisch voedsel activeerden, zoals is gevonden in eerder onderzoek (Folkvord et al., 2013).

MODERATIE VAN GEWICHT (BMI)

Bij kinderen maakte BMI status, dus het al dan niet hebben van overgewicht, niet uit bij het effect van conditie op impliciete associaties. Echter, dit was wel het geval bij voedselkeuze. Kinderen met overgewicht/obesitas kozen vaker voor fruit als zij in de health game conditie zaten, dan de kinderen overgewicht/obesitas in de controlegroep. Voor kinderen met normaal-/ondergewicht was er geen verschil tussen de condities op voedselkeuze.

Het gevonden effect van de health game op voedselkeuze voor kinderen met overgewicht/obesitas past wederom binnen het hierboven voorgestelde mechanisme priming als mogelijke verklaring. Aangezien het merendeel van de kinderen met overgewicht/obesitas onder behandeling was bij een diëtist of sportinstructeur, kan aangenomen worden dat voor hen de wens om gezonder te eten saillant zal zijn. Inderdaad juist voor de kinderen met deze verwachte saillante gezondheidsdoelen gaf de health game het beoogde effect en stimuleerde meer fruitkeuzes dan de controleversie (Forwood, Ahern, Hollands, Ng, & Marteau, 2015; Papies, 2016; Papies & Hamstra, 2010.

Samenvattend, de eerste twee doelstellingen kunnen met enige voorzichtigheid worden beantwoord. De bevindingen suggereren dat de health game in staat is om impliciete associaties en voedselkeuze positief te beïnvloeden, waarbij priming wordt voorgesteld als onderliggend mechanisme voor de gevonden effecten op voedselkeuze. Zo wordt verondersteld dat de health game enerzijds resulteert in een activatie van gezondheidsdoelen bij mensen waarvoor gezondheid belangrijk is, en anderzijds de hedonische belonende associaties met hoogcalorisch voedsel activeert bij mensen zonder saillante gezondheidsdoelen.

DOELSTELLING 3: EVALUATIE VAN HET INTERNET ALS DISTRIBUTIEMEDIUM

In studie 3 werd de derde doelstelling onderzocht, betreffende het evalueren van het internet als distributiemedium om een health game op te plaatsen, waarbij reclame werd gebruikt als promotiestrategie. De health game die hiervoor werd onderzocht, was op meerdere Nederlandse websites geplaatst en was gepromoot tijdens twee campagnes. De gebruikersgegevens lieten zien dat deze online health game een relatief groot publiek had weten te bereiken. Interessant was dat reclame zowel mensen stimuleerde om de site voor het eerst te bezoeken, alsook mensen stimuleerde om terug te keren. De gebruikersgegevens lieten liet wel zien dat het aantal bezoekers langzaam af nam na afloop van iedere reclamecampagne.

Aangezien veel mensen toegang hebben tot het internet, heeft een online interventie de potentie om een groot publiek te bereiken (de Nooijer et al., 2008; InternetLiveStats, 2016). Echter, deze zal moeten concurreren met een overvloed aan beschikbare gezondheid bevorderende interventies en commerciële games (Granic et al., 2014). Om mensen geïnteresseerd te krijgen in producten of diensten, en deze onder de aandacht te brengen, kan het maken van reclame effectief zijn (Cairns et al., 2012; Eisend & Tarrahi, 2016). Evenwel, er is ook gevonden dat de invloed van reclame snel af lijkt te nemen (e.g., Vakratsas & Ambler, 1999). Dit wordt ondersteund door onze data, waarbij het aantal bezoeken aan de website na beide reclamecampagnes al binnen een paar maanden sterk was gereduceerd. Hierdoor lijkt het regelmatig maken van reclame noodzakelijk, om blootstelling aan een online interventie te blijven waarborgen.

Om inzicht te krijgen in het gebruik van een website, kan het waardevol zijn om data-analyse software te gebruiken. Hierdoor wordt bijvoorbeeld inzichtelijk hoe vaak, maar ook hoe lang en op welke apparaten, de website wordt bezocht. Deze informatie kan bijdragen om nog effectiever health games te ontwikkelen en reclame hiervoor te maken in deze competitieve markt (Konijn et al., 2015).

Kortom, het internet kan geschikt zijn om een groot publiek te bereiken. Het maken van reclame lijkt echter noodzakelijk om gebruikers te stimuleren om de website te bezoeken. Hiernaast is het van belang om de gebruikersgegevens te monitoren om de blootstelling te controleren. Vanwege de competitieve markt is het tevens van belang om de doelgroep als mediaconsument te behandelen, en zowel de health game als de reclamecampagne(s) goed aan te laten sluiten bij hun interesse (Konijn et al., 2015).

PRAKTISCHE IMPLICATIES

Deze dissertatie draagt bij aan de bestaande kennis in het veld, daar deze inzichten geeft aan wetenschappers, zorgaanbieders en cliënten. Allereerst, voor wetenschappers is het van cruciaal belang te onderkennen dat de effectiviteit van interventies die zich richten op impliciete associaties, afhankelijk is van individuele verschillen (Nguyen et al., 2017; Valkenburg & Peter, 2013). Daarom kan het waardevol zijn om nader te onderzoeken welke individuele kenmerken de effectiviteit van dit soort interventies kunnen voorspellen. Ook geeft de derde studie aan dat het belangrijk is om reclame te maken voor online health games, om blootstelling hieraan te waarborgen. Om deze reden zou het waardevol zijn om onderzoek te doen naar effectieve vormen van reclame om een online health game te promoten.

Ten tweede, voor zorgaanbieders geeft deze dissertatie een indicatie dat het nuttig kan zijn om aan hun veelal cognitief-gebaseerde behandeling een game toe te voegen die zich juist richt op de automatische aspecten van eetgedrag (e.g., Foster et al., 2015; Kumar & Kelly, 2017; Sbruzzi et al., 2013). Door middel van emotionele overdracht is er tevens een mogelijkheid dat een positieve houding naar de game overslaat naar andere behandelcomponenten, of naar de behandelaar zelf (e.g., Hofmann et al., 2010; Moyer-Guse, 2008; Ritterfeld et al., 2009; Vakratsas & Ambler, 1999). Dit zou de effecten van de behandeling ten goede kunnen komen. Verder is het wel van belang dat de behandelaar de health game regelmatig onder de aandacht brengt van cliënten, om voldoende blootstelling te waarborgen.

Ten derde, cliënten met overgewicht kunnen ook profiteren van de onderzoeken gerapporteerd in deze dissertatie. Door middel van een game kunnen de kinderen laagdrempelig en op een ontspannen manier bezig zijn met de behandeling. Tevens kan de evaluatieve conditionering ervoor zorgen dat hun impliciete associaties ten aanzien van voedsel meer overeen gaan komen met hun intenties tot gezond eten, oftewel, het eten van méér groente en fruit en minder hoogcalorische producten. Vanuit het reflectieve-impulsieve model (Strack & Deutsch, 2004), zouden deze 'gezondere' impliciete associaties er vervolgens voor kunnen zorgen dat de gezonde keuze de automatische keuze wordt.

CONCLUSIE

Voor het huidige promotietraject is een health game ontwikkeld, gebaseerd op theoretische en wetenschappelijk ontwikkelde modellen. Er werd in twee studies onderzocht of deze health game impliciete associaties ten aanzien van voedsel en voedselkeuze positief kon beïnvloeden. Ook werd in een derde studie geëvalueerd of het internet als distributiemedium geschikt is om een interventie op te plaatsen en wat de effecten van reclame zijn op het spelen van de health game.

De eerste twee studies lieten zien dat de health game een positieve invloed kon hebben op beide uitkomstmaten, hoewel de effectiviteit afhankelijk was van individuele eigenschappen. Het is aannemelijk dat bij herhaalde blootstelling aan de evaluatieve conditionering, de effecten van de health game op impliciete associaties sterker zouden kunnen worden. Vervolgens, volgens het principe van het reflectieve-impulsieve model, zouden de gevolgen hiervan op gedrag ook sterker zichtbaar kunnen worden. Met betrekking tot voedselkeuze veronderstellen wij dat mensen waarvoor gezond eten belangrijk is, dus mensen die gezond eten maar ook zij die gezonder willen eten, geprimed worden door de boodschap van de health game, waardoor hun intenties om gezond te eten geactiveerd worden. Bij mensen waarvoor gezond eten niet erg belangrijk is, lijken juist de hedonische belonende associaties van (hoogcalorisch) voedsel geactiveerd te worden, waardoor de health game een averechts effect teweeg kan brengen. Tot slot, de resultaten van laatste studie geven aan dat het internet een waardevol distributiemedium kan zijn om een interventie op te plaatsen omdat veel mensen hier toegang toe hebben. Daarnaast is het van belang om te onderzoeken hoe de interventie het best gepromoot kan worden.

Naar aanleiding van deze dissertatie kunnen een aantal aanbevelingen voor vervolgonderzoek gemaakt worden. Drie interessante suggesties voor vervolgonderzoek zijn: Leidt frequentere blootstelling aan de health game in een longitudinaal onderzoek tot sterkere beïnvloeding van impliciete associaties en voedselkeuze? Geeft een gecombineerde aanbieding van een health game met een meer reflectieve interventie sterkere beïnvloeding op voedselkeuze? Is een health game die meer gepersonaliseerd is met betrekking tot voedselproducten effectiever dan een 'one size fits all' aanpak?

Samengevat, het beïnvloeden van impliciete associaties ten aanzien van specifieke voedselproducten lijkt een veelbelovende methode om eetgedrag te beïnvloeden en daarmee overgewicht te behandelen. Vanwege de voordelen van videogames, onder andere de geschiktheid ervan om evaluatieve conditionering te integreren en de populariteit van videogames onder de jeugd, lijkt het gebruik van een health game als interventievorm een passend medium. Verder onderzoek wordt aangeraden om deze veelbelovende strategie verder uit te diepen, zodat leuke en effectieve health games in de toekomst gebruikt kunnen worden bij de behandeling van overgewicht.

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DANKWOORD (ACKNOWLEDGEMENTS)

Het ei is gelegd, de figuurlijke bevalling achter de rug. Dit weerspiegelt de afrondende fase van mijn project. Ik ben heel erg dankbaar voor alle steun, waardoor ik dit project tot een goed einde heb kunnen brengen.

Allereerst wil ik mijn promotor, Moniek Buijzen, bedanken voor de vele uren die je in mijn werk hebt geïnvesteerd en voor je vertrouwen die je in deze laatbloeier hebt getoond. Je constructieve, kritische feedback heeft mij geholpen om zaken vanuit een ander perspectief te bekijken en om meer uit mezelf te halen.

Ook wil ik Jonathan van 't Riet, Paul Ketelaar en Isabela Granic bedanken. Zonder jullie was het plan 'iets met games tegen obesitas' niet van de grond en tot bloei gekomen. Ik heb veel geleerd van onze meetings en van jullie inhoudelijk sterke input. Ook ben ik erg dankbaar voor het genereuze budget van Paul, waardoor het mogelijk is geweest dat ik zoveel kinderen heb kunnen laten meedoen.

Uiteraard ben ik jullie, Frans Folkvord en Doeschka Anschütz, ook zeer dankbaar dat jullie mij hebben opgenomen in 'team F & D'. Het is niet eenvoudig om halverwege een project in te stappen, maar dat hebben jullie in mijn ogen zeer succesvol gedaan. Als ik soms door het bos de bomen niet meer zag dan waren jullie er voor het aanreiken van handvatten om hier mee om te gaan. Frans, dank voor je nuchtere blik. En Doeschka, jij bent een bekwame people-manager. Hierdoor is er ruimte geweest voor zowel persoonlijke als vakinhoudelijke groei. Ik ben door jullie onder andere een betere schrijver geworden.

Aan alle collega's in Nijmegen, bedankt voor het creëren van een fijne en vertrouwde omgeving. Ik kijk met plezier terug naar de gesprekken met mijn kamergenoten en naar de gesprekjes in de pantry, bij het kopieerapparaat, tijdens (GeMH) meetings of de sporadische game night. Specifiek ook een bedankje aan Susanne, mijn paranimf. Dank voor de vele fijne en goede gesprekken die we tijdens onze tochten, door weer en wind, met elkaar hebben gehad.

Graag wil ik ook stilstaan bij de leden van de beoordelingscommissie. Hartelijk dank voor de tijd en moeite die jullie hebben genomen om dit proefschrift te beoordelen.

Daarnaast wil ik de diëtistes, sportcoaches en docenten bedanken bij wie ik langs heb mogen komen. Jullie hebben mij geholpen om deelnemers te vinden en hebben het mogelijk gemaakt om hen mee te laten doen aan het onderzoek in jullie (kantoor)ruimtes. Mijn dank gaat ook uit naar alle proefpersonen, hartelijk dank dat jullie mee hebben willen doen.

Dan wil ik ook nog mijn vrienden bedanken. Dankzij de gezellige avonden (veel te weinig vanwege mijn zelfverkozen semi-kluizenaarschap) en de leuke festivalweken kon ik even loskomen van alles en genieten van het leven. Nog eventjes en dan mogen jullie mij eindelijk dr. Eva noemen, soms dan.

En dan niet op de laatste plaats maar wel tot slot, lieve familie, dank voor jullie onvoorwaardelijke liefde, steun en interesse. Specifiek wil ik verder de volgende familieleden bedanken: Bul, dank voor je positieve kijk op het leven en de vreugde die je bracht, je wordt zeer gemist. Eileen, bedankt voor de vele leuke en fijne momenten, we hebben veel plezier met elkaar maar je weet me ook af te leiden van veel zaken die deze stresskip bezig houden. Je bent mijn rots in de branding. Mam en (papa) Jerry, bedankt voor jullie steun en het altijd klaar staan voor mij. Jullie hebben mij geleerd om door te zetten, ergens je tanden in te zetten en te blijven doorgaan. Ook erg gewaardeerd zijn de vele lekkere maaltjes (behalve één!) die jullie voor mij hebben gemaakt. Verder gaat mijn dank uit naar Heleen, Daan, Lucas en Feline. Jullie hebben mij, zeker gedurende de afgelopen paar maanden, veel geborgenheid en warmte gegeven. Door de vele goede gesprekken en kinderknuffels ben ik een sterker mens geworden.

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