MASTER

Please remind me to get active
the influence of motivation & triggers on physical activity

van Bon, I.

Award date:
2015

Link to publication
PLEASE REMIND ME TO GET ACTIVE

The influence of motivation & triggers on physical activity

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0829757

In partial fulfilment of the requirements for the degree of

Master of Science
in Human Technology Interaction

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Master’s Program Human Technology Interaction
“Behaviour is our Medium”

Robert Fabricant (2009)
Abstract

Physical activity is well-known to be an important factor for a healthy and balanced lifestyle, whereas physical inactivity increases the chance of noncommunicable diseases. Physical inactivity has therefore been indicated as a major public health challenge (Donaldson, 2004). According to the Fogg Behaviour Model (Fogg, 2009), people can be influenced using technology (e.g. to make them more physically active) if one (1) is sufficiently motivated, (2) has the ability, and (3) is triggered to engage in physical activity. However, despite that the Fogg Behavior Model (Fogg, 2009) has become well-known as a behavioural change model, the proposed interplay between the three key factors on behaviour has barely been investigated empirically. Also, most of the earlier research that has investigated how physical activity can be stimulated, has only utilized a single persuasive strategy as an intervention method (i.e. either motivational, ability-enhancing, or trigger-related) to stimulate physical activity (e.g. Chan et al., 2004; Dantzig et al., 2013; Evans et al., 2012).

The current research made a step toward an empirical assessment of the Fogg Behaviour Model (Fogg, 2009) by investigating two of its key factors, while at the same time investigating the effectiveness of combining two persuasive strategies to stimulate physical activity. That is, we investigated the effect of motivating people or not, and providing triggers or not, on physical activity.

In contrast to our expectations, the findings indicated that participants who were motivated to engage in physical activity did not engage in more physical activity than the participants who were not motivated. Also contrary to our expectations, the physical activity of participants was not greater when they were provided with triggers to remind them to engage in physical activity. However, yet also not confirming the expectations, an interaction effect was found that indicated a significant increase in physical activity when triggers were provided to participants who were not motivated to engage in PA. In contrast, no significant increase in physical activity was found when triggers were provided to participants who were motivated to engage in physical activity.

The current research raises questions with regard to the distinctiveness and independence of the key factors of the Fogg Behaviour Model (Fogg, 2009). That is, in the present study, the triggers could have served as motivational triggers, and the motivational strategies could have served as triggers. Future research should investigate under which conditions it is best to utilize either a single-, or rather multiple manipulations for motivational and trigger-related strategies in order to stimulate PA.

Keywords: physical activity, persuasive technology, fogg behavior model, trigger, motivation, intervention
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1. Introduction

1.1. The need for physical activity

Physical activity is well-known to be an important factor for a healthy and balanced lifestyle. Physical activity (PA) can be defined as “any bodily movement produced by skeletal muscles that results in energy expenditure” (Caspersen et al., 1985). It has been indicated that participation in regular PA include an improved general quality of life, functional ability, and psychosocial health (Powell and Pratt, 1996). On the other hand, insufficient PA increases the chance of noncommunicable diseases, which includes cardiovascular diseases (e.g. heart attacks, stroke), cancers, chronic respiratory diseases (e.g. asthma), obesity, and diabetes (World Health Organization, 2010). For developed countries, physical inactivity has therefore been indicated as a major public health challenge (Donaldson, 2004). The World Health Organization developed global PA guidelines which indicate recommended levels of PA that are needed for the prevention of noncommunicable diseases (World Health Organization, 2010). These PA guidelines state that adults (aged 18-64) should weekly accumulate either at least 150 minutes of moderate-intensity PA, 75 minutes of vigorous-intensity PA, or an equivalent combination of moderate- and vigorous-intensity activity (World Health Organization, 2010). PA for adults includes leisure time PA, occupational (i.e. work), transportation (e.g. walking or cycling), household chores, sports/exercise, or games, in the context of daily, family, and community activities (World Health Organization, 2010). However, despite the serious consequences in health, many people do not comply with these advised PA guidelines (Colley et al., 2011; Butcher et al., 2008; Scheers et al., 2013).

Earlier research has investigated the effectiveness of intervention strategies to increase PA. We will elaborate on these intervention strategies in the following paragraphs. Thereafter, shortcomings of the earlier research will be described. Subsequently, we will investigate how persuasive technology, and in particular the Fogg Behavior Model, can contribute to increasing people’s PA. Finally, the research aims and hypotheses of the current study will be presented.
1.2. Literature overview

1.2.1. Related research on motivation, ability, triggers and physical activity

This section will cover the related research that has investigated the effectiveness of intervention strategies to increase PA, which are categorized into paragraphs of motivational strategies, ability-enhancing strategies, and trigger-related strategies.

1.2.1.1. Motivation & Physical activity

Several research studies have investigated motivational strategies as interventions to increase PA. For instance, Kahn et al. (2002) conducted a systematic review on the effectiveness of interventions to increase PA. Informational approaches addressing risk factors of sedentary behaviour and physical inactivity (through mailings, billboards, television and radio) were indicated to be effective in motivating people to increase their PA (Kahn et al., 2002). Also, Dantzig et al. (2013) asserts that interventions to promote people to get more physically active are likely to be more successful after gaining an established awareness about the adverse health effects of physical inactivity. Moreover, Dantzig et al. (2013) proposes that such an awareness could be gained by presenting information about the adverse health effects of physical inactivity (e.g. all-cause mortality, high blood pressure, increased obesity, and elevated risks of type 2 diabetes). These informational approaches motivate and enable people to alter their behaviour, which also may maintain over time (Dantzig et al., 2013; Heath et al., 2012; Kahn et al., 2002).

Motivation can also be enhanced by enabling self-monitoring of PA in order to increase PA (Chan et al., 2004; Chini et al., 2012; Lin et al., 2006; Michie et al., 2009; Munson & Consolvo, 2012). For instance, PA have shown to increase when participants have the ability to self-monitor their PA using a pedometer (Chan et al., 2004). Also, self-monitoring via diaries have been found to associate with greater increases in PA levels (Conroy et al., 2011). Michie et al. (2009) conducted a meta-analyses on the effectiveness of healthy eating and PA interventions. They found that self-monitoring was the most effective intervention in increasing PA. Moreover, it was indicated that interventions which combined the ability to self-monitor PA with other techniques (e.g. goal setting, providing feedback, rewards) were more effective than interventions without self-monitoring (Michie et al., 2009).

Furthermore, related research on goals has indicated how to motivate people in increasing their PA (e.g. Chan et al., 2004; Lin et al., 2006). A meta-analysis on pedometer-based PA interventions (Kang et al., 2009) indicated that studies with a 10,000 steps/day goal had slightly larger effect sizes (ES = 0.84, 95% CI = 0.43, 1.24) than studies with individual goals (ES =
However, several other studies have suggested that the 10,000 steps/day goal may be too difficult to achieve for some people. For instance, Wilde et al. (2001) indicated that only a few participants (i.e. sedentary women) met this goal, and proposed that the 10,000 steps/day goal might discourage adherence, because the perceived effort might be too great for the benefits. In addition, Wilde et al. (2001) and Sidman et al. (2003) suggested that people with low step counts are especially likely to fail in attaining the 10,000 steps/day goal and may benefit more from individualized goals. Previous pedometer studies that have set individual goals were weekly between +5 to +10%, and indicated an average increase in step count of 2-3000 steps/day (Baker, Mutrie, & Lowry, 2008; Chan et al., 2004; Croteau, 2004; Kaminsky, Jones, Riggin, & Strath, 2013). Also, it can be argued that the effectiveness of goals would be different if it would be set in another unit of PA (e.g. duration instead of steps). Baker et al. (2008) compared the effectiveness of goals set in steps with goals set in minutes, for increasing walking under university students. Results indicated that both goals significantly increased step-counts from the baseline (by ~2266 steps/day), however with no significant difference between the types of goals. Furthermore, Tudor-Locke et al. (2001) suggested that interventions using individual step goals can be effective when it is combined with self-monitoring.

1.2.1.2. Ability & Physical activity

Other earlier research has investigated ability-enhancing strategies as interventions to increase PA. These interventions focussed mostly on recommendation strategies that enhance the ability of people to engage in PA (Gilson et al., 2009; Owen et al., 2011; Plotnikoff & Karunamuni, 2012; Spector & Fox, 2003). Owen et al. (2011) encourages light- to moderate-intensity activities to substitute for sedentary time and increase PA. For instance, people could be recommended to take the stairs more often instead of elevators, stand up and walk while talking on the telephone, or walk/cycle to travel to their work/home/supermarket instead of taking a motorized vehicle (Owen et al., 2011; Plotnikoff & Karunamuni, 2012). Regarding the workplace; promoting the employees’ autonomy has been indicated to influence the employees’ ability to engage in PA by leaving their workstation more often (Owen et al., 2011, Spector & Fox, 2003). In addition, Gilson et al. (2009) have investigated walking strategies to increase the PA of employees. They were recommended to increase their PA, by either brisk route-based walking, or incidental walking (e.g. walk to fellow employees rather than calling or mailing them). Results indicated a significant interaction effect between the interventions- and control
group and PA, in which the route-based walking group reported higher levels of PA (Gilson et al., 2009).

**1.2.1.3. Triggers & Physical activity**

Besides motivational strategies and ability-enhancing strategies, earlier research has also focussed on trigger-related strategies as interventions to increase PA. That is, sending people triggers has been indicated as an effective intervention strategy to increase people’s PA (Bond et al., 2014; Dantzig et al., 2013; Dunstan et al., 2013; Evans et al., 2012). Such interventions may utilize computers or smartphones to send prompts to people to promote PA. For instance, Bond et al. (2014) presented obese individuals with smartphone notifications to evoke breaks in sedentary time and to get them more physically active. The results indicated that prompting frequent short activity breaks (i.e. 3 min. break after 30 min. of sedentary time) was the most effective strategy to decrease sedentary behaviour and increase PA. Dantzig et al. (2013) investigated the effect of timely persuasive reminders on activity breaks. These persuasive reminders were send to the participants’ smartphones each time they performed 30 minutes of continuing computer activity (with max. 3 reminders/day), containing messages which were based on Cialdini’s six social influences strategies (Cialdini, 2001; e.g. “Every day without physical activity is a missed chance to reach a healthier life: Stay active!”). These reminders increased PA, however further analyses indicated no difference between people who read the persuasive messages or not. Dantzig et al. (2013) suggested that receiving a reminder was more important in increasing PA, rather than the persuasive messages of the reminders. Furthermore, Evans et al. (2012) studied if educating office workers about the adverse health effects of sedentary behaviour, and prompting them to take a break from sitting, had a positive effect on sedentary time. The results indicated that both interventions reduced sedentary time, however participants, who received both an education session and prompts to take activity breaks, showed a greater reduction in sedentary time.

**1.2.1.4. Shortcomings of earlier research**

Most of the earlier research has only utilized a single strategy as an intervention method to increase PA. That is, interventions with either a single- or multiple motivational strategies, ability-enhancing strategies, or trigger-related strategies. However, a common assertion of behavioural theories (e.g. Fogg Behavior Model, The Social Cognitive Theory, The Theory of Reasoned Action and Planned Behavior) is that behavioural change is determined by an
interaction between multiple factors (e.g. motivation, ability, and triggers), indicating the importance of investigating the effect of multiple strategies as an intervention method on PA. Also, only a few studies addressed behavioural theories or models in their research, whilst a theoretical base aids in explaining behaviour as well as suggesting how to develop effective interventions to change behaviour (Michie et al., 2014; Michie & Johnston, 2012). Furthermore, earlier research on PA has seriously neglected the university students’ PA, whilst a substantial proportion of university students (i.e. 40 to 50%) have been indicated to be physically inactive (Keating et al., 2010). Moreover, Haase et al. (2004) indicated that the students’ knowledge about the adverse health effects of physical inactivity was low, with only 40% to 60% being aware of the physical inactivity risks to health.

In the following paragraphs we will elaborate on persuasive technology, along with theories and models of behaviour change (in particular the Fogg Behavior Model), and how it can contribute to increasing PA.

1.2.2. Persuasive Technology

Persuasive technology could aid people in increasing their PA. Persuasive technology is a term coined by Fogg (2003) that can be defined as “any interactive intelligent system that is designed to change people’s attitudes and/or behaviours”. Importantly, persuasion is defined as “an attempt to change attitudes and/or behaviours”, in which a voluntary change of attitude and/or behaviour is implied (Fogg, 2003). Thus, if a system would use coercion (i.e. force) or deception (i.e. misinformation) it would fall outside of the realm of persuasive technology (IJsselsteijn et al., 2006). It should be noted that the current research will use the term “persuasion” as a reference to “an attempt to influence people’s behaviour”, thus not attitudes.

In the new era of information technology more and more systems are being designed that allow for persuasion. In addition, persuasive technology could be particularly useful for people in certain areas. For example, health-related applications could motivate people toward healthy behaviour, which subsequently could prevent the onset of medical problems, improve quality of life, and alleviate the economic situation in public healthcare (Intille, 2004; IJsselsteijn et al., 2006). Thereby, technology becomes a powerful tool for changing user attitude and/or behaviour.

Humans can be strong persuaders, since humans have an apparent social presence and impact, have an intuitive sense of social psychological principles of persuasion (e.g. credibility, trust,
reciprocity, authority), and can sense the opportune moment to persuade (i.e. *kairos*) (IJsselsteijn et al., 2006). However, persuasive technology can have several distinct advantages over human persuaders. That is, computers can be more persistent than human beings (i.e. computers don’t get tired), offer greater anonymity (i.e. useful for sensitive issues), and access and manage huge volumes of data (i.e. enables them to retrieve precisely the right information at the right time, and make suggestions) (Fogg, 2003). Also, computers can use many modalities (i.e. text, audio, video) to influence people with a seamless and convincing experience, scale easily (i.e. addressing information to large numbers of people quickly and simultaneously), and can be ubiquitous and embedded by gaining access to areas where humans cannot go (e.g. inside clothing, or implanted in a toothbrush) or may not be welcomed (e.g. in the bathroom or bedroom) (Fogg, 2003).

### 1.2.3. Theories of behaviour change

Many scholars have proposed theories and models that describe how behaviour can be influenced. Among the most prominent are the Social Cognitive Theory, Theory of Reasoned Action and Planned Behavior, and the Transtheoretical (Stages of Change) Model. First, a brief overview of each theory will be given in the upcoming paragraphs, which is followed by a detailed description of the recent Fogg Behavior Model. Thereafter, we will discuss the similarities and differences between the three theories and the Fogg Behavior Model, along with their predictions leading to the performance of PA.

#### 1.2.3.1. The Social Cognitive Theory

According to Bandura’s Social Cognitive Theory (also known as Social Learning Theory, or Efficacy Theory) behavioural change is determined by the reciprocal interaction between environmental, personal, and behavioural factors (i.e. reciprocal determinism; see Figure 1; Bandura, 1997). The environmental factors refer to situational influences that can affect behaviour, which include social (e.g. family and friends) and physical (e.g. sound and temperature) environments. Personal factors refer to a person’s motivational forces (i.e. instincts, traits, drives). These three factors are constantly affecting each other. That is, behaviour is not merely the product of the person and the environment, as well as the environment is not merely the product of behaviour and the person (Glantz et al, 2002). For instance, a person’s environment can influence the person’s behaviour, just as the creation of personal characteristics. Likewise, a person’s characteristics can evoke particular responses
from the environment, as well as a person’s behaviour may alter the person’s environment. Also, congruent with the fundamentals of self-efficacy (i.e. the belief in one’s own ability to achieve a certain outcome), a person’s thoughts and feelings can influence the person’s behaviour, just as the person’s behaviour may alter the manner the person thinks or feels.

Figure 1. Model of the Social Cognitive Theory

1.2.3.2. The Theory of Reasoned Action and Planned Behavior

Although the construct of self-efficacy originated from the Social Cognitive Theory, it was later adopted by other behavioural theories, such as the Theory of Planned Behavior. However, preceding the Theory of Planned Behavior was the Theory of Reasoned Action, which stated that a person’s behaviour is determined by one’s intention to perform the behaviour in question (Ajzen, 1991). Intention is, in turn, determined by a person’s attitude toward the behaviour (i.e. the multiplicative sum of behavioural beliefs on the outcomes of a particular behaviour, and the evaluations of these outcomes), and one’s subjective norm (i.e. the multiplicative sum of normative beliefs about what behaviours other people expect, and the degree of compliance to these expectations). Besides attitudes and subjective norms, the Theory of Planned Behavior expanded upon the Theory of Reasoned Action by adding the component of perceived behavioural control (originating from the construct of self-efficacy; Ajzen, 1991). Perceived behavioural control refers to a person’s perceptions of their ability to perform a particular behaviour. Overall, the greater the attitude toward the behaviour, the more favourable the subjective norm, and the greater the perceived behavioural control, the stronger the intention to perform a particular behaviour. See Figure 2 for a conceptual model of the Theory of Reasoned Action and Planned Behavior.
Figure 2. Model of the Theory of Reasoned Action (i.e. only the light-blue squares) and Planned Behavior (i.e. all blue squares)

1.2.3.3. The Transtheoretical Model

Similar to the Theory of Planned Behavior, the Transtheoretical Model (also referred to as the Stages of Change Model) focuses on a person’s intentional change (i.e. aiming on one’s decision-making), which precedes the ability to change behaviour. Moreover, the model proposes that behaviour change does not occur quickly and decisively, but rather continuously via a recurrent process. The Transtheoretical Model suggests that behavioural change can be achieved by completing a six-step process (see Figure 3; Prochaska, Johnson, & Lee, 1998). The first stage is called precontemplation (i.e. not ready), in which a person may be aware of the problematic behaviour but has no intention to change one’s behaviour. During the contemplation stage (i.e. getting ready), a person begins to recognize the problematic behaviour and considers to make a change. A person creates a plan of action and is intended to take action in the immediate future during the preparation stage (i.e. ready). During the action stage, a person has made the behaviour change, and

Figure 3. The Transtheoretical model
has been able to sustain action in order to prevent relapse during the maintenance stage. Finally, termination represent the stage in which the behaviour change is seen as being fully successful, when a person has 100% efficacy to maintain one’s new behaviour. The last stage is rarely reached, whereby people tend to remain in the maintenance stage.

1.2.3.4. The Fogg Behavior Model

Recently, Fogg introduced a new behaviour change model. Specifically, the Fogg Behavior Model (FBM) provides an understanding of human behaviour and asserts that behaviour is a product of three key factors: motivation, ability, and triggers (Fogg, 2009). That is, the FBM indicates that for persuasive technology to be successful in influencing user behaviour, (1) the user needs to be sufficiently motivated, (2) the user has to have the ability to perform the target behaviour, and (3) the user needs to be triggered to perform the behaviour (Fogg, 2009). Moreover, all three key factors must converge at the same moment in order for the target behaviour to occur (Fogg, 2009; see Figure 4). The vertical axis represents motivation; the more a person is motivated to perform a target behaviour, the higher the person would be marked on the axis. The horizontal axis represents ability; the greater the ability of a person to perform a target behaviour, the more the person would be registered toward the right side of the axis. If a person would have an increased motivation and an increased ability to perform a target behaviour, the greater the likelihood that the person would perform the target behaviour (Fogg, 2009). Also, as one can see from Figure 1, there are no units on the axes. This is due to the conceptual nature of FBM, in which relationships of the components are shown, rather than precise values (Fogg, 2009). In addition, the FBM states that motivation and ability can trade-off (Fogg, 2009). That is, a person with low motivation could perform a behaviour if the particular behaviour is easy enough to perform (i.e. high ability). Likewise, a person who is highly motivated may be able to perform a behaviour, even if the person has a low ability to perform the behaviour. However, people must always have some level of ability and motivation to perform a behaviour (Fogg, 2009). Also, these two factors can be manipulated to increase the likelihood that a target behaviour will be performed (Fogg, 2009). The third factor of the FBM are triggers. A trigger is described by Fogg (2009) as “something that tells people to perform a behaviour”. Fogg (2009) claims that behaviour will not occur if there is no appropriate trigger, even if a person is highly motivated and has a high ability. One can notice from Figure 1 that there is a behaviour activation threshold, asserting that a person would need a sufficient amount of motivation and ability in order to get triggered to perform a target
behaviour (Fogg, 2009). That is, if a person would be above this activation threshold, a trigger would cause the person to perform a target behaviour. In contrast, if a person would be underneath this activation threshold, a trigger would not cause the person to perform a target behaviour.

Furthermore, each of these three key factors have subcomponents. That is, Fogg (2009) suggests that motivation can be influenced with 3 certain core motivators: pleasure/pain (e.g. exercising with energizing music may make exercising more pleasurable to perform), hope/fear (e.g. webshop messages, such as “the best deals you haven’t discovered yet”), and social acceptance/rejection (e.g. entering a weight-loss group to encourage social acceptance). Ability can be increased by six simplicity factors (Fogg, 2009): reduce the time, money, or physical effort to perform a target behaviour. Moreover, matching brain cycles (thinking), matching to people’s routines, and averting social deviance (i.e. going against the norm) also increases the ability to perform a target behaviour. Finally, Fogg (2009) describes 3 types of triggers. (1)
Sparks: triggers with a core motivator, which motivate behaviour (e.g. “Get 20% discount on your next order by subscribing to the newsletter”). (2) Facilitators: triggers with a simplicity factor, which makes behaviour easier to do (e.g. Facebook’s “address book uploader”, which makes one connect with many friends with just a few clicks). (3) Signals: triggers without a core motivator and a simplicity factor, which indicates or reminds (e.g. placing toothpicks next to the toothbrush, reminding one to also clean between the teeth).

However, despite that Fogg’s Behavior Model (Fogg, 2009) has become well-known as a behavioural change model, the proposed interplay between the three key factors on behaviour has, to our knowledge, barely been investigated empirically. The recent study of Basten (2014) assessed the FBM (Fogg, 2009) by investigating the effect of motivation (increased vs. constant) and the location of a trigger (congruent vs. incongruent) on purchasing behaviour. The results were in accordance with the FBM (Fogg, 2009), indicating that a high motivation combined with a well-timed trigger resulted in an increase of purchasing behaviour.

1.2.3.5. Theories of behaviour change & Physical Activity

Several similarities and differences can be noticed between the presented theories of behaviour change, and their predictions leading to the performance of PA. Firstly, all these theories can be regarded as health behaviour theories, which allows the development of interventions to address health problems, such as physical inactivity.

In addition, both the Theory of Planned Behavior as well as the Transtheoretical Model integrate the construct of self-efficacy from the Social Cognitive Theory (Noar & Zimmerman, 2005). That is, the construct of perceived behavioural control in the Theory of Planned Behavior overlaps with the construct of self-efficacy, in the sense that perceived behavioural control is dependent on a person’s perception of one’s ability to perform PA. In the Transtheoretical Model, self-efficacy of PA is regarded as the degree of a person’s confidence to engage in PA, which is hypothesised to be fairly low in the first stages and high in the last stages. However, although ability is one of the three key factors of the FBM, Fogg (2009) does not present self-efficacy as a subcomponent of ability in his model. Instead of self-efficacy, Fogg (2009) addresses “brain cycles” as one of its subcomponents of ability, which focuses more on thinking rather than belief. That is according to Fogg (2009), if PA would be a behaviour that causes one to think hard, one might find it difficult to engage in PA.

Also, the construct of intention, in which a person is intending or planning to perform PA, is similar within the three theories (Noar & Zimmerman, 2005). That is, in line with the Social
Cognitive Theory, a person needs to have a certain extent of self-control (also referred to as self-regulation) to set goals in order to engage in PA. With the Theory of Planned Behavior, it is the construct of behavioural intention that refers to a person’s readiness to engage in PA. With the Transtheoretical model, a person is intending to take action in order to engage in PA during the preparation stage. Fogg (2009) does not explicitly state the construct of intention in his model. However, it can be argued that the construct of intention precedes the moment when one is triggered to engage in PA. That is, according to Fogg (2009), if one is highly motivated and has a high ability, the target behaviour would still not occur if there is no appropriate trigger. In such a case with one’s high motivation and ability to engage in PA, one would have the intention to engage in PA. An appropriate trigger would then transform one’s intention to engage in PA into performance of PA.

Furthermore, similarities as well as differences can be noticed between the theories (excluding the Theory of Planned Behavior) regarding the reinforcement of engaging in PA (Noar & Zimmerman, 2005). With the FBM (Fogg, 2009), triggers can be regarded as reinforcements of PA, in which a trigger precedes the performance of PA. In contrast, the Social Cognitive Theory refers to reinforcements as responses to PA, which follows the performance of PA. However, the Transtheoretical Model includes both types of reinforcements. That is, rewarding PA (i.e. reinforcement management), as well as reminding to engage in PA (i.e. stimulus control), reinforces the performance of PA (Noar & Zimmerman, 2005).

1.3. Research aims

However, despite that the FBM (Fogg, 2009) has become well-known as a behavioural change model, the proposed interplay between the three key factors on behaviour has barely been investigated empirically. Also, most of the related studies on PA have only utilized a single persuasive strategy as an intervention method to increase PA. That is, in terms of the FBM (Fogg, 2009), interventions with either a single- or multiple motivational strategies, ability-enhancing strategies, or trigger-related strategies. In the current research, we investigated two key factors from the FBM (Fogg, 2009), while at the same time investigating the effectiveness of combining two persuasive strategies to stimulate PA. That is, we investigated the effectiveness of triggers and motivation as an intervention combination to increase PA, which led to the following research question:

“What is the effect of motivating people or not, and providing triggers or not, on physical activity?”
However, Fogg (2009) asserts that the performance of a target behaviour is dependent on the motivation and ability of people, and the presence of a trigger. Moreover, Fogg (2009) states that there always needs to be some level of motivation and ability in order for behaviour to occur. In the current research it was safe to assume that the participants (i.e. students, young adults) would have some level of motivation and ability to engage in PA. Also, as compared to the laboratory study of Basten (2014), the current study investigated the FBM (Fogg, 2009) in the field, thereby offering an increase of external validity.

1.3.1. Hypotheses

**H1: Motivation**
Increasing motivation to engage in PA has been indicated as an effective intervention strategy for increasing PA (e.g. Chan et al., 2004; Kahn et al., 2002; Lin et al., 2006). Therefore we expected that the PA of people would be greater when they were motivated to engage in PA than when they were not motivated to engage in PA.

**H2: Trigger**
Presenting people with triggers to remind them to engage in PA has been indicated as an effective intervention strategy for increasing PA (e.g. Bond et al., 2014; Dantzig et al., 2013; Dunstan et al., 2013; Evans et al., 2012). Hence it was hypothesised that the PA of people would be greater when they were provided with triggers to remind them to engage in PA than when they were not provided with triggers.

**H3: Interaction**
However, Fogg (2009) asserts that in order for behaviour to occur, all three key factors should converge at the same moment. Moreover, according to the FBM (Fogg, 2009) the behaviour activation threshold should be exceeded in order for triggers to succeed. That is, people need to be sufficiently motivated in order for triggers to succeed in increasing PA. Therefore we expected an interaction effect, in which the PA would be greater compared to the three other groups. That is, the PA of people would be greater when they were motivated to engage in PA, as when they were provided with triggers to remind them to engage in PA.
2. Method

2.1. Participants

68 participants were recruited via the universities’ own local database (i.e. JF Schouten) and face to face at the university campus. This sample size was based on a power analysis for a repeated measures ANOVA (within-between interaction) with \( f = 0.2 \), \( \alpha = 0.05 \), and Power = 0.9. A medium effect size of \( f = 0.2 \) was used, because no effect size could be derived from earlier studies that have investigated the same specific combination of persuasive strategies on PA. The population consisted of local students and young adults who did not suffer from physical disabilities and who owned a smartphone with internet and GPS capabilities. Moreover, the sample included 36 men and 32 women, aged 18 to 30, with an average age of 23 (\( SD = 2 \)). In order to stimulate the participants to participate in this field study, we had devised an incentive construction in two parts: (1) all participants received €10 for their participation, and in addition (2) an extra €10 was raffled as a gift certificate for 17 participants (i.e. \( \frac{1}{4} \) of all participants).

2.2. Study design

This study had a 2 (between: motivation increased or not) x 2 (within: triggers provided or not) mixed design (see Table 1). Our hypotheses were tested by conducting an 8-day field experiment, in which triggers and motivation were manipulated. There were two conditions: (1) the increased motivation (IM) condition, in which participants were motivated to engage in PA, and (2) the constant motivation (CM) condition, in which participants were not motivated to engage in PA. Participants in both conditions received triggers (T) on 4 days, which were randomly allocated over the 8 days in order to counterbalance for order effects. That is, in both conditions, half of the participants received the triggers in the first 4 days, and the other half in the last 4 days.

<table>
<thead>
<tr>
<th>Motivation</th>
<th>Triggers</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased</td>
<td>IM + T</td>
<td>IM</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>CM + T</td>
<td>CM</td>
<td></td>
</tr>
</tbody>
</table>

*Table 1. Study design.*
2.3. Interventions

2.3.1. Motivation

In order to increase the motivation to engage in PA, a combination of motivational strategies was used. That is, participants (i.e. in the IM condition) received (1) information on the adverse health effects of physical inactivity to create an awareness about these effects, (2) the ability to self-monitor their PA, and (3) an individual daily goal to achieve. The information on the adverse health effects of physical inactivity were based on the report of the World Health Organization (2010) (see “De negatieve gezondheidseffecten van fysieke inactiviteit” under appendix 6.1. “Motivational strategies”). Also, participants were able to self-monitor their PA using the apparatus Moves (i.e. see ‘Moves” under 2.4.1.1”). Furthermore, the individual daily goal was similar to related research (Chan et al., 2004; Croteau, 2004; Kaminsky, Jones, Riggin, & Strath, 2013), based on an increase of 10% above the baseline measurement of PA (which were assessed with the international physical activity questionnaire, see 2.4.1.2). For instance, if one had an average of 60 minutes/day that one spends physically active, the goal during the experimental period would be 66 minutes/day.

Participants in the CM condition did not receive any of these motivational strategies.

2.3.2. Triggers

In order to trigger participants to get physically active, daily time-based triggers were presented to remind them to engage in PA. In the current research, triggers were regarded as reminders, or in terms of the FBM (Fogg, 2009), “signals”. According to Fogg (2009), a signal serves as a reminder, which contains neither a core motivator as a simplicity factor. These triggers were presented to participants via email, 3 times a day for 4 days (i.e. 09:00, 13:00, and 17:00). The frequency and timing of these triggers were selected in order to avoid the annoyance of too many triggers per day, and to have a sufficient interval between triggers within an acceptable time frame (Dantzig et al., 2013). In order to distinguish between the interventions (motivation vs. trigger), any motivational aspect in the trigger itself should be avoided, so that it would serve purely as a reminder to get physically active. Therefore, the content of triggers were made consistent. That is, all the presented mails had the same sender (i.e. “Get Active”) and subject (“Reminder”) with no further content. See appendix 6.2. “Trigger examples” for examples of a trigger on a smartphone and a computer.
2.4. Measurements

2.4.1. Physical Activity

PA was measured with an objective activity tracker (i.e. Moves), and a questionnaire (i.e. International Physical Activity Questionnaire; IPAQ). Moves assessed PA by measuring walking, cycling, and running, in units of steps, duration, and distance throughout the whole 8-day experiment period. The IPAQ assessed PA by presenting questions about vigorous PA, moderate PA, walking, and sitting, in units of duration. It was regarded as an additional measurement for PA in order to confirm and/or augment the objective PA data of Moves. Moreover, the IPAQ functioned as a baseline measurement for PA, which also determined the participants’ daily goal.

2.4.1.1. Moves

Moves is a smartphone application (app) that automatically monitored PA for walking, cycling, and running (see Figure 5). Smartphone apps like Moves have been indicated to be an ideal tool to monitor and record people in their everyday life (Consolvo et al., 2008; Chini et al., 2012). The app also measured motorized travel (e.g. car, scooter, train), and categorized it under ‘transport’. Moves used sensor information (i.e. accelerometry data) and location information (global positioning system [GPS] data) from the smartphone to measure and categorize PA. The algorithm of the app continuously analyzed the PA data in more detail, in order to present the participant with the most accurate data (unlike many other standalone PA devices or apps). Moreover, the advantages of Moves over other standalone PA devices or apps, were the cost (i.e. free), distinctiveness (i.e. measured different types of PA), platform (i.e. as a smartphone app instead of an extra device), and compatibility (i.e. IOS & Android compatible). However, as Moves made use of sensor and location information, participants were warned about the possible occurrence of battery loss. This was dependent on the age, hardware, and firmware of the smartphone in question. Another disadvantage was the low control over app usage. That is, although participants (who were not motivated to engage in PA) were told not
to open the app, they still had the possibility to open the app and subsequently monitor their PA. In general, however, there are only a few evaluation studies that assessed the validity and reliability of PA trackers as smartphone apps (e.g. Åkerberg, Lindén, & Folke, 2012; Boyce, Padmasekara, & Blum, 2012; Case et al., 2015). In order to ensure the validity and reliability of Moves, a literature study and two short validation studies were performed (see appendix 6.3. “Validity & Reliability of Moves”). We concluded that Moves would be a sufficient measurement tool for the assessment of PA in the current study.

2.4.1.2. International Physical Activity Questionnaire

The IPAQ (short form) assessed PA for vigorous PA (e.g. running, fast bicycling, heavy lifting), moderate PA (e.g. cycling a regular pace, swimming at a regular pace, carrying light loads), walking, and sitting. Also, the questionnaire assessed PA for the last 8 days, and it was applicable for young and middle-aged adults (i.e. 15-69 years; Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire, 2005). In addition, the IPAQ undertook extensive validity & reliability testing, which indicated acceptable validity and reliability results for a self-report questionnaire (Craig et al., 2003). The current study made use of the Dutch variant of the IPAQ (International Physical Activity Questionnaire, 2015; see appendix 6.4. “International Physical Activity Questionnaire”). However, the experiment period consisted of 8 days in order to assess the trigger manipulation on PA at an equivalent level (i.e. 4 days with triggers vs. 4 days without triggers). Hence, the IPAQ was adjusted from the original 7 days to 8 days, under the assumption that this would not substantially decrease the reliability of the IPAQ.

Also, the IPAQ assessed the baseline measurements for PA to determine the participants’ daily goal. However, measuring frequency of PA with an 8-day recall questionnaire does not take certain variations (e.g. illness) in concern. That is, if a participants’ PA in the last 8 days was not similar to a normal 8 days, the measurement of PA and the daily goal would be unreliable. Therefore, one extra question was added that assessed the variability of the participants’ PA in the last 8 days, which should made the measurement of PA more reliable and the daily goal more feasible to achieve.

Furthermore, the post-measurement IPAQ included separate questions for PA in the first 4 days and the last 4 days, in order to distinguish PA between days with triggers and without triggers.
2.4.2. Manipulation checks

2.4.2.1. Motivation

The Exercise Motivation Inventory (EMI-2) was utilized to evaluate if the motivation manipulation increased the participants’ motivation to engage in PA. The questions of the EMI-2 assessed the participants’ motives to engage in PA. In addition, the validity and reliability of the EMI-2 have been indicated as good (Markland and Hardy, 1997). The current study made use of the Dutch variant of the EMI-2 (Exercise Motivation Inventory, 2015; see appendix 6.5. “Exercise Motivation Inventory”). Furthermore, it should be noted that one minor modification was made to the questionnaire. That is, the word “physical training” was replaced with “physical activity”, in order to avoid any misinterpretations of the word “training”, in which case participants could have considered only vigorous exercises (e.g. gym training, running, soccer) as PA and disregarded moderate-to-light exercises (e.g. walking, cycling, gardening).

2.4.2.2. Triggers

In order to evaluate if triggers were noticed by the participants, a short questionnaire had been made (see appendix 6.6. “Trigger Manipulation Check”). The questions assessed if participants had noticed the triggers, the amount of daily triggers, at which times they received the triggers, and what the sender and subject were of the triggers.

2.4.3. Apparatus Questionnaire

A short questionnaire had been made in order to assess the subjective experiences of the apparatus Moves (see appendix 6.8. “Apparatus questionnaire”). The questionnaire included questions that determined if Moves was active throughout the experiment, if participants carried their smartphones with them during PA, if participants monitored their PA with Moves, if participants experienced any problems with Moves, and if participants already monitored their PA before the experiment. Also, participants who were motivated to engage in PA (i.e. IM condition) received two extra questions regarding an evaluation of the individual daily goal (in addition to the manipulation check for motivation, see 2.4.2.1. “Motivation”). These questions determined if participants tried to achieve their daily goal, and the subjective level of feasibility of those daily goals. Finally, the answers on all of these questions were based on a likert-type scaling (Vagias, 2006).
2.5. Procedure

After agreeing to participate, participants were invited for an information session during which we presented them with an informed consent, and informed them about the rationale of the study. In addition, participants were asked to fill in the IPAQ, in order to measure the participants’ baseline PA. Also, they were informed about the apparatus of this study (i.e. Moves), which was installed and set up during this session. Furthermore, participants were assigned to blocks based on gender. Next, within each block, participants were randomly assigned to a condition and a trigger order (i.e. randomized block design). That is, they were either motivated to engage in PA or not, and they received either the triggers in the first 4 days or in the last 4 days.

Participants who were motivated to engage in PA received information on the adverse health effects of physical inactivity. Moreover, they were informed about the ability to self-monitor their PA with Moves. Also, they received their individual daily goal, accompanied with the encouragement to keep track of their PA with Moves, in order to monitor the progress of the daily goal. Participants who were not motivated to engage in PA did not receive any of these motivational strategies. However, they were told not to look on the app during the experiment period. Furthermore, all participants received the daily time-based triggers, which were either on the first– or last 4 days.

PA was tracked with Moves during the whole 8-day experiment period. After those 8 days, participants received an email in which they were asked to follow a link for the post-measurements. These include the same PA questionnaire (i.e. IPAQ), manipulation checks, and the apparatus questionnaire. Also, participants were debriefed, thanked for their participation, and transferred their incentive. The additional incentive was raffled when everybody had finished their experiment.

Table 2. Procedure of the study design.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Pre-measures</th>
<th>Experiment period</th>
<th>Post-measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased Motivation</td>
<td>IPAQ</td>
<td>Increased Motivation Triggers</td>
<td>IPAQ, EMI-2, T-MC, AQ</td>
</tr>
<tr>
<td>Constant Motivation</td>
<td>IPAQ</td>
<td>No Increased Motivation No Triggers</td>
<td>IPAQ, EMI-2, T-MC, AQ</td>
</tr>
<tr>
<td>All</td>
<td>Tracking PA with Moves</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

IPAQ: International Physical Activity Questionnaire  
EMI-2: Exercise Motivation Inventory 2  
T-MC: Trigger Manipulation Check  
AQ: Apparatus Questionnaire
3. Results

PA data was collected from 68 participants. The PA of all participants was measured during an 8-day experimental period with the use of an objective activity tracker (i.e. Moves app) and a questionnaire (IPAQ). Half of the participants were motivated to engage in PA, whilst the other half were not motivated to engage in PA. Also, they each received triggers on 4 days, and on the other 4 days none. The order in which participants received their triggers was counterbalanced. The number of participants per cell can be found in Table 3. Furthermore, all participants received the same pre-, and post measurements (i.e. pre-IPAQ, post-IPAQ, EMI-2, T-MC, and AQ).

Table 3. Number of participants per cell.

<table>
<thead>
<tr>
<th></th>
<th>Increased Motivation (34)</th>
<th>Constant Motivation (34)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Men (36)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T-NT (34)</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>NT-T (34)</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td><strong>Women (32)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T-NT (34)</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>NT-T (34)</td>
<td>8</td>
<td>8</td>
</tr>
</tbody>
</table>

T-NT: Triggers - No Triggers  
NT-T: No Triggers - Triggers

3.1. Data screening

The PA data that was collected with the Moves app consisted of PA (of walking, cycling, and running) in units of duration (i.e. seconds), distance (i.e. meters), and steps (i.e. only for walking and running). The IPAQ scores (of vigorous, moderate, and walking activities) were expressed in duration (i.e. minutes). Several outliers were detected using Z-scores and Tukey’s method (boxplots; Tukey, 1977), which were subsequently removed in the following analyses.

3.2. Manipulation checks

3.2.1. Motivation

Participants filled in the EMI-2 questionnaire as a manipulation-check for motivation after the experiment period. Higher scores were reported by participants who were motivated to engage in PA ($M = 2.35$, $SD = 0.76$), compared to participants who were not motivated to engage in PA ($M = 2.07$, $SD = 0.86$) on a scale ranging from 0 to 5. However, an independent samples t-test indicated that this difference was not significant ($t(66) = 1.408$, $p = 0.164$). Therefore we cannot evaluate if the motivation manipulation was successful in motivating participants to engage in PA.
3.2.2. Triggers

Nearly all participants (i.e. 63/68) reported to have noticed the daily triggers. Also, results on the follow-up questions about the characteristics of the triggers (i.e. frequency, timing, subject, and sender of the mails) confirmed the participants’ reports that they have noticed the daily triggers. However, 5 participants did not indicate to have noticed the daily triggers during their experiment period. The most common given reason indicated that these mails ended up in their spam inbox. Data of these 5 participants were excluded in the following analyses. Overall, we can conclude that the trigger manipulation was successful. An overview of the results can be found appendix 6.7. “Trigger Manipulation Check answers”.

3.3. Apparatus questionnaire results

Participants reported that they carried their smartphone with them most of the time during PA. It was during certain physical activities (e.g. swimming, gym training, and soccer) that they did not carry their smartphone with them. Also, participants indicated that Moves was always active in the background. Participants who were motivated to engage in PA reported that they had self-monitored their PA with Moves daily, whereas participants who were not motivated to engage in PA did not. In addition, most of the participants who were motivated to engage in PA indicated the feasibility of their daily PA goal as easy, and they often attempted to achieve their daily goal. Moreover, most participants indicated no problems with Moves, however some did indicate experiences with battery loss. An overview of the results of the apparatus questionnaire can be found in appendix 6.9. “Apparatus questionnaire answers”.

Also, no significant correlations were found between the items of the questionnaire. However, a positive medium correlation was found between the feasibility of daily goals and PA in units of duration (i.e. Moves data; \( r = 0.430, p < 0.05, R^2 = 0.185 \)), indicating an association between easier daily goals and an increase in PA.

Furthermore, by comparing the participants’ daily goals with their post-IPAQ scores (i.e. mean daily PA of 8 days), we found that 53% (i.e. 18/34) of the participants managed to achieve their daily goal. Moreover, no differences were found between the achievement of daily goals and days with or without triggers. In addition, correlation analyses indicated no association between the achievement of daily goals and participants’ reports of the feasibility of their daily goal, or to what extent they tried to achieve their daily goal.
3.4. Testing hypotheses

In order to test our hypotheses, 2 x 2 repeated measures ANOVA’s were performed with PA as dependent variable. That is, PA was objectively (i.e. Moves data) and subjectively (i.e. IPAQ data) assessed, and analysed in units of duration (i.e. in seconds, Moves data; in minutes, IPAQ data), distance (i.e. in meters, Moves data), and steps (i.e. Moves data). Moreover, the dependent variable PA was divided in these analyses (i.e. PA of 4 days with triggers, and PA of 4 days without triggers) in order to detect differences on PA between days with triggers and days without triggers. The independent variables were condition (increased motivation vs. constant motivation) and trigger order (triggers – no triggers vs. no triggers – triggers).

3.4.1. Hypothesis 1: increased motivation vs. constant motivation

The first hypothesis focused on motivation and PA, in which an increased motivation to engage in PA should lead to an increase in PA. Using repeated measures ANOVA’s for PA in units of duration (Moves: $F(1, 57) = 0.050, p = 0.824$.; IPAQ: $F(1, 56) = 0.067, p = 0.796$), distance ($F(1, 56) = 0.387, p = 0.536$), and steps ($F(1, 54) = 0.059, p = 0.809$) we found no proof for hypothesis 1. This means that participants who were motivated to engage in PA did not engage in more PA (duration Moves: $M = 15726.77, SE = 1417.06$; duration IPAQ: $M = 86.75, SE = 11.61$; distance: $M = 30725.32, SE = 2756.15$; steps: $M = 14616.09, SE = 1352.85$) than participants who were not motivated to engage in PA (duration Moves: $M = 16171.02, SE = 1394.74$; duration IPAQ: $M = 91, SE = 11.61$; distance: $M = 28258.19, SE = 2849.82$; steps: $M = 14152.38, SE = 1352.85$). Whilst participants who were motivated to engage in PA did show higher scores in distance and steps, lower scores were noticed in duration. An overview of the means and standard errors of these units of PA can be found in Table 4.

The manipulation check for motivation (i.e. EMI-2 questionnaire after the experimental period) indicated no significant difference in motivation between participants who were motivated to engage in PA, and those who were not motivated. This suggests that the motivation manipulation did not successfully increase the motivation of participants, and subsequently had no significant effects on PA.
Table 4. Means and standard errors of PA for increased motivation (IM) and constant motivation (CM).

<table>
<thead>
<tr>
<th></th>
<th>Duration (Moves)</th>
<th>Duration (IPAQ)</th>
<th>Distance</th>
<th>Steps</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std. error</td>
<td>Mean</td>
<td>Std. error</td>
</tr>
<tr>
<td>IM</td>
<td>15726.77</td>
<td>1417.06</td>
<td>86.75</td>
<td>11.61</td>
</tr>
<tr>
<td>CM</td>
<td>16171.02</td>
<td>1394.74</td>
<td>91</td>
<td>11.61</td>
</tr>
</tbody>
</table>

3.4.2. Hypothesis 2: triggers vs. no triggers

Not confirming hypothesis 2, the PA of participants was not significantly greater when they received triggers to remind them to engage in PA. That is, repeated measures ANOVA’s indicated no significant main effects for triggers on PA in units of duration (Moves: $F(1, 57) = 0.750, p = 0.390$; IPAQ: $F(1, 56) = 0.455, p = 0.503$), distance ($F(1, 56) = 0.003, p = 0.960$), and steps ($F(1, 54) = 1.912, p = 0.172$). However, the means are greater for all units of PA when participants received triggers (duration Moves: $M = 16341.28, SE = 1107.02$; duration IPAQ: $M = 91.3, SE = 9.04$; distance: $M = 29540.76, SE = 2001.37$; steps: $M = 15042.73, SE = 1064.03$) than when they did not received triggers (duration Moves: $M = 15556.5, SE = 1394.74$; duration IPAQ: $M = 86.45, SE = 8.88$; distance: $M = 295442.76, SE = 2387.28$; steps: $M = 13725.74, SE = 1073.18$). Moreover, a small trend is noticeable in the latter measure of PA, in which more steps were made by the participants during times when they received triggers. Means and standard errors of the units of PA can be found in Table 5.

Table 5. Means and standard errors of PA with triggers (T) and no triggers (NT).

<table>
<thead>
<tr>
<th></th>
<th>Duration (Moves)</th>
<th>Duration (IPAQ)</th>
<th>Distance</th>
<th>Steps</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std. error</td>
<td>Mean</td>
<td>Std. error</td>
</tr>
<tr>
<td>T</td>
<td>16341.28</td>
<td>1107.02</td>
<td>91.3</td>
<td>9.04</td>
</tr>
<tr>
<td>NT</td>
<td>15556.5</td>
<td>1394.74</td>
<td>86.45</td>
<td>8.88</td>
</tr>
</tbody>
</table>

Furthermore, further repeated measures ANOVA’s were conducted regarding the direct effects of triggers on PA. That is, differences in PA (i.e. in units of duration, distance and steps) were analysed between periods of 2 hours before triggers and periods of 2 hours after triggers compared to the same periods during which no triggers were presented (i.e. 11:00 – 13:00 vs. 13:00 – 15:00). No significant differences were detected that indicated an increase of PA after triggers were presented.
3.4.3. **Hypothesis 3: interaction effect**

We expected an interaction effect, in which the participants’ PA would be greater when they were motivated to engage in PA, as when they were provided with triggers to remind them to engage in PA. A significant interaction effect between motivation (constant motivation vs. increased motivation) and triggers (no triggers vs. triggers) was found for PA in units of steps \( F(1, 54) = 5.643, p < 0.05, \text{partial } \eta^2 = 0.095 \), however not confirming hypothesis 3. That is, these results suggest that PA was greater during the days with triggers for participants who were not motivated to engage in PA \( (M = 15942.21, SE = 1504.76) \), but lesser for participants who were motivated to engage in PA \( (M = 14143.24, SE = 1504.76) \). In contrast, during the days without triggers, PA was greater for participants who were motivated to engage in PA \( (M = 15088.93, SE = 1517.7) \), but lesser for participants who were not motivated to engage in PA \( (M = 12362.55, SE = 1517.7) \). This interaction effect between the levels of motivation and triggers is depicted in Figure 6. Pairwise comparisons revealed that the difference of PA between triggers and no triggers was not significant for participants who were motivated to engage in PA \( (p = 0.486) \). However, the difference of PA between triggers and no triggers was significant for participants who were not motivated to engage in PA \( (p < 0.01) \). Therefore, we can conclude that providing participants with triggers to remind them to engage in PA elicited a significant increase in PA than when they were not provided with triggers, if however they were not motivated to engage in PA.

Furthermore, this interaction effect is also noticeable with PA in units of duration \((\text{Moves}: F(1, 57) = 1.521, p = 0.223; \text{IPAQ}: F(1, 56) = 0.835, p = 0.365), \text{and distance} (F(1, 56) = 1.965, p = 0.166)\), however not significant. Means and standard errors of the units of PA can be found in Table 6.

**Table 6. Means and standard errors of PA with motivation (IM, CM) and triggers (T, NT).**

<table>
<thead>
<tr>
<th></th>
<th>Duration (Moves)</th>
<th>Duration (IPAQ)</th>
<th>Distance</th>
<th>Steps</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std.error</td>
<td>Mean</td>
<td>Std.error</td>
</tr>
<tr>
<td>IM-T</td>
<td>15560.27</td>
<td>1577.94</td>
<td>92.45</td>
<td>12.78</td>
</tr>
<tr>
<td>IM-NT</td>
<td>15893.27</td>
<td>1536.54</td>
<td>81.05</td>
<td>12.56</td>
</tr>
<tr>
<td>CM-T</td>
<td>17122.3</td>
<td>1553.08</td>
<td>90.15</td>
<td>12.78</td>
</tr>
<tr>
<td>CM-NT</td>
<td>15219.74</td>
<td>1512.34</td>
<td>91.86</td>
<td>12.56</td>
</tr>
</tbody>
</table>
3.5. Exploratory analyses

3.5.1. Walking

For further analyses we used the same repeated measures ANOVA’s individually for the different physical activities that were measured with the Moves app (i.e. walking, cycling, and running). No significant results were found for cycling. Also, no analyses could be conducted for running, since only a limited number of participants had running data. Moreover, only 0.6% of the physical activities consisted of running, 12.9% cycling, and 86.5% walking. With regard to walking, similar results were found compared to the results of hypothesis 3. That is, a similar significant interaction effect between motivation and triggers was found for walking in units of steps \( F(1, 53) = 6.356, p < 0.05, \text{partial } \eta^2 = 0.107 \), but also in units of duration \( F(1, 53) = 4.502, p < 0.05, \text{partial } \eta^2 = 0.078 \). Both interaction effects are visualized in Figure 7 and 8. Also, pairwise comparisons revealed significant differences in walking between triggers and no triggers for participants who were not motivated to engage in PA, for both steps \((14968.29 \pm 1465.27 \text{ vs. } 11408.04 \pm 1378.79, \text{respectively}; p < 0.01)\) and duration \((10356.79 \pm 1057.9 \text{ vs.})\).
8372.29 ± 960.67, respectively; \( p < 0.05 \)). No significant interaction effect was found between motivation and triggers for walking in units of distance.

*Figure 7 (left).* Interaction effect of motivation * triggers on mean walking in units of steps.  
*Figure 8 (right).* Interaction effect of motivation * triggers on mean walking in units of duration.

Besides the analyses of walking in units of duration, distance, and steps, we also analysed the frequency of walking (i.e. the number of times participants walked, independent of duration, distance, and steps) with the same repeated measures ANOVA. A similar interaction effect was found for the frequency of walking between triggers and motivation, however not significant \( (F(1, 59) = 2.662, \ p = 0.108) \).

### 3.5.2. IPAQ comparisons

Participants filled in the IPAQ twice; before and after the manipulations. We compared the differences between these questionnaires in a similar repeated measures ANOVA, with time as dependent variable (i.e. IPAQ 1 vs. IPAQ 2) and condition and trigger order as independent variables. A significant main effect between time was found \( (F(1, 54) = 5.032, \ p < 0.05, \ \text{partial } \eta^2 = 0.085) \), indicating that all participants reported lower scores on the IPAQ before the manipulations (\( M = 72.411, \ SE = 5.913 \)) and higher scores on the IPAQ after the manipulations (\( M = 86.210, \ SE = 8.267 \)) (see Figure 9). Pairwise comparisons revealed that the difference between time was significant for participants who were motivated to engage in PA (64.392 ±
8.362 vs. 82.616 ± 11.691, respectively; $p < 0.05$), but not for participants who were not motivated to engage in PA (80.430 ± 8.362 vs. 89.803 ± 11.691, respectively; $p = 0.286$).

*Figure 9.* Main effect of time on mean IPAQ score.

We also investigated if similar results would occur when the same analyse would be conducted with the individual components of the IPAQ questionnaire (i.e. vigorous activities, moderate activities, walking). Indeed, a similar significant main effect between time was found for walking ($F(1, 55) = 4.924$, $p < 0.05$, partial $\eta^2 = 0.082$), in which lower scores were reported for walking on the IPAQ before the manipulations ($M = 22.705$, $SE = 3.641$) and higher scores for walking were reported on the IPAQ after the manipulations ($M = 30.981$, $SE = 3.983$). Also, pairwise comparisons indicated a significant effect of walking between time for participants who were motivated to engage in PA (16.235 ± 5.098 vs. 27.241 ± 5.575, respectively; $p < 0.05$), but not for participants who were not motivated to engage in PA (29.175 ± 5.201 vs. 34.722 ± 5.689, respectively; $p = 0.302$). In addition, a similar main effect between time was found for moderate activities ($F(1, 54) = 3.079$, $p = 0.085$), but this difference was not significant. Also, a non-significant main effect between time was found for vigorous activities.
However interestingly, lower scores of vigorous activities were reported on the IPAQ after the manipulations ($M = 16.453, SE = 2.382$) compared to the IPAQ before the manipulations ($M = 21.135, SE = 2.882$).

Furthermore, sitting time (in hours) was also assessed in these questionnaires. Using the same repeated measures ANOVA but with sitting time as dependent variable, less sitting time was noticeable in the IPAQ after the manipulations ($M = 8.130, SE = 0.382$) compared to the IPAQ before the manipulations ($M = 8.55, SE = 0.395$), however with a non-significant difference ($F(1, 56) = 1.388, p = 0.244$).

### 3.5.3. Trigger order effects

During the experiment, participants were either presented with triggers in the first 4 days or in the last 4 days. However, trigger order effects were noticeable in the IPAQ data when analysing for differences between levels of triggers and motivation. That is, the same repeated measures ANOVA as during the hypotheses testing with PA in units of duration (i.e. IPAQ data) indicated a significant interaction effect ($F(1, 56) = 7.803, p < 0.01$, partial $\eta^2 = 0.122$) between triggers (i.e. triggers vs. no triggers) and trigger order (i.e. triggers – no triggers vs. no triggers – triggers). This interaction effect can be seen in Figure 10. This suggests that participants who received their triggers in the first 4 days reported a higher PA when triggers were present ($M = 106.73, SE = 12.34$) rather than absent ($M = 81.83, SE = 12.31$). In contrast, participants who received their triggers in the last 4 days reported a higher PA when triggers were absent ($M = 91.08, SE = 12.97$) rather than present ($M = 75.86, SE = 13.2$). Pairwise comparisons indicated that the difference in PA between triggers and no triggers was significant for participants who received their triggers on the first 4 days ($106.734 \pm 12.344$ vs. $81.828 \pm 12.131$, respectively; $p < 0.05$). However, this difference was not significant for participants who received their triggers on the last 4 days ($75.864 \pm 13.197$ vs. $91.08 \pm 12.968$, respectively; $p = 0.152$). Moreover, a comparable interaction effect was found between triggers and trigger order for PA in units of distance ($F(1, 56) = 3.601, p = 0.063$), however not significant.
Figure 10. Interaction effect of Time * Trigger order on mean PA in units of duration (IPAQ).
4. Discussion

PA is an important factor for a healthy and balanced lifestyle, whereas physical inactivity increases the chance of noncommunicable diseases. Persuasive technology could aid people in increasing their PA. According to the FBM (Fogg, 2009), PA can be successfully increased when the user is sufficiently motivated, has the ability, and is triggered to engage in PA. However, despite that the FBM (Fogg, 2009) has become well-known as a behavioural change model, the proposed interplay between the three key factors on behaviour has barely been investigated empirically. Also, most of the earlier studies that have investigated the effectiveness of persuasive interventions to increase PA have only utilized a single persuasive strategy as an intervention method (i.e. either motivational, ability-enhancing, or trigger-related).

In the current research, we investigated two key factors from the FBM (Fogg, 2009), while at the same time investigating the effectiveness of combining two persuasive strategies to stimulate PA. That is, we investigated the effect of motivating people or not, and providing triggers or not, on PA. We expected that the PA of people would be greater when they were motivated to engage in PA than when they were not motivated to engage in PA. Also, it was hypothesised that the PA of people would be greater when they were provided with triggers to remind them to engage in PA than when they were not provided with triggers. Thirdly, we expected an interaction effect, in which the PA of people would be greater when they were both motivated to engage in PA, as when they were provided with triggers to remind them to engage in PA.

To investigate these questions, we performed an 8-day field experiment, in which half of the participants were motivated to engage in PA, whilst the other half were not motivated to engage in PA. Also, each participant received triggers on 4 days, and on the other 4 days none. The order in which participants received their triggers was counterbalanced. PA was measured throughout the experimental period with the use of an objective activity tracker (i.e. Moves app), and before as well as after the experimental period with a questionnaire (IPAQ).

4.1. Hypotheses revisited

4.1.1. Motivation

We expected that the participants’ PA would be greater when they were motivated to engage in PA than when they were not motivated to engage in PA. Our results did not confirm this first hypothesis. Moreover, the manipulation check for the motivation manipulation (i.e. EMI-2
questionnaire) indicated no significant difference in motivation between participants who were motivated to engage in PA, and those who were not motivated. This suggests that the motivation manipulation did not successfully increase the motivation of participants, and subsequently had no significant effects on PA.

With regard to the motivational information, earlier research indicated that such information about the adverse health effects of physical inactivity would establish an increased awareness which is regarded as a requisite for the success of other motivational interventions, such as self-monitoring and PA goals (Dantzig et al., 2013). The motivational information should have motivated and enabled people to make a first step toward increasing their PA. However, we did not assess the motivational degree of the motivational information, and therefore we could not measure its individual influence on motivating participants to increase their PA.

With regard to self-monitoring, the qualitative results (of the apparatus questionnaire) indicated that participants who were motivated to engage in PA indeed did self-monitor their PA daily. However, generally it could be that self-monitoring of PA has a delayed effect on the increase of PA. That is, if participants were able to self-monitor their PA for a longer period than 8 days, it might have elicited a greater influence on their motivation and a greater increase in PA (Prochaska, Johnson, & Lee, 1998). Moreover, in accordance to the Transtheoretical Model, it takes time (i.e. months) to successfully go through the stages of change in order to achieve a behaviour change (Prochaska, Johnson, & Lee, 1998). Then again, as the FBM (Fogg, 2009) and the Theory of Planned Behavior (Ajzen, 1991) do not address the element of time in their theories, indicating indistinctness regarding the time frame that should be necessary to achieve behavioural change. Also, similar research on self-monitoring of PA indicated fairly direct improvements in PA levels when individuals had the ability to self-monitor their PA (e.g. Chan et al., 2004; within a week). In general, future research should investigate differences between time frames of intervention periods and the effect on PA, and how long such an effect would endure after intervention periods have ended (Kahn et al., 2002).

With regard to the daily goal, participants reported mixed results regarding the feasibility of their daily goal, ranging from very difficult to very easy with a mode of easy. Also, most of the participants often attempted to achieve their daily goal, and only half of the participants (i.e. 18/34) managed to achieve their daily goal. These results could indicate that the daily goals might not have been challenging enough to achieve. Moreover, participants could have been influenced by a response bias, in which they indicated the attempt to achieve their daily goals as more often than they realistically did. However, no correlations were found between the feasibility of daily goals and their attempt to achieve those goals, suggesting no association
between the feasibility of daily goals (easy or difficult) and their attempt to achieve those daily goals. Moreover, a positive medium correlation was found between the feasibility of daily goals and PA in units of duration (i.e. Moves data), indicating that rather easier daily goals might have been associated with an increase in PA. Then again, no similar significant correlations were found for the other units of PA, suggesting no further association between the feasibility of daily goals and PA level. Despite that these daily goals were individualized goals, which are indicated to be preferred over general goals (i.e. 10,000 steps/day; Wilde et al., 2001; Sidman et al., 2003), they were based on subjective reports (i.e. IPAQ). A more thorough baseline measurement of PA may have generated more tailored and motivating daily goals. That is, daily goals could be calculated from an objective baseline measurement of PA (i.e. Moves) that lasts for a minimum of 3 days (Tudor-Lock et al., 2005), which may lead to a higher attempt rate of achieving daily goals and subsequently a higher PA level.

The utilized motivation interventions are, in terms of the FBM (Fogg, 2009), related to the “Hope / Fear” dimension. According to Fogg (2009), this motivation dimension is identified by anticipation of an outcome, which relates more to extrinsic motivation (e.g. PA enhances weight-loss and appearance; physical inactivity increases the chance of obesity). In contrast, the “Pleasure / Pain” dimension of the FBM (Fogg, 2009) relates more to intrinsic motivation (e.g. engaging in PA satisfies me). Moreover, in line with self-determination theory, intrinsic motivation, rather than extrinsic motivation, is indicated as a key element in promoting PA (Ryan et al., 2009). In this regard, the utilized motivation interventions may have been unilateral. Future research could investigate if the effect of interventions on PA would be more effective when these are related to the “Pleasure / Pain” dimension of the FBM (Fogg, 2009) and focus on the intrinsic motivation of people (e.g. let people develop their own goals by identifying their personal intentions and benefits to engage in PA).

In addition, the extrinsic motivational interventions could have been ineffective in persuading intrinsically motivated participants to engage in PA. Moreover, in line with the self-determination theory, the extrinsic motivational manipulations could have undermined the participants’ intrinsic motivation to engage in PA, due to a decrease in their feelings of self-control and competence (Ryan et al., 2009).
4.1.2. Triggers

Also, the results did not confirm hypothesis 2, indicating that the PA of participants was not significantly greater when they received triggers to remind them to engage in PA. It could be that the triggers were not congruent with the timing to engage in PA. That is, participants could have received the triggers on moments when it was not possible to engage in PA (e.g. during a car ride or work meetings), or when they were already engaging in PA (e.g. during gym training, swimming, cycling). Moreover, no direct effects of triggers were identified that indicated an increase in PA after participants received the triggers. The influence of these triggers could have been greater when they were received during critical moments, in which participants made PA related decisions. For instance, a trigger just before a lunch break could have stimulated participants to go for a walk during their break. The effectiveness of time-congruent or context-aware triggering have been indicated by earlier studies. For example, Basten (2014) indicated that participants were more persuaded to engage in purchasing behaviour when they received location congruent triggers, instead of location incongruent triggers. That is, participants who received a trigger about a specific product near the product in question decided to purchase the product more often than participants who received the trigger far away from that particular product.

Also, as it would be ineffective to remind participants to engage in PA while they recently engaged in PA, providing positive feedback or rewards would be more effective in those situations in order to reinforce PA (i.e. reinforcement management, Transtheoretical Model; Prochaska, Johnson, & Lee, 1998).

In addition, it could be argued that the power of the triggers were suboptimal because they were presented to the participant via email. That is, although participants reported to have noticed a new email within a quarter of an hour (i.e. see Trigger Manipulation Check), they might also have received several other emails, during which the salience of the triggers may have decreased. An independent channel on which the triggers would be presented (i.e. notifications via an independent app) could possibly preserve the salience of the triggers.

4.1.3. Motivation & Triggers

Furthermore, no confirmation was found for hypothesis 3, indicating that the participants’ PA was not greater when they were motivated to engage in PA, as when they were provided with triggers to remind them to engage in PA. However, the interaction effect, found during the analysis of hypothesis 3, indicated a significant increase in PA when triggers were provided to
participants who were not motivated to engage in PA. In contrast, no significant increase in PA was found when triggers were provided to participants who were motivated to engage in PA. Several interpretations can be given with regard to the results, in which triggers did not have an effect on participants who were motivated to engage in PA, yet did have an effect on participants who were not motivated to engage in PA.

The significant increase in PA when triggers were provided to participants who were not motivated to engage in PA is in contradiction with the FBM (Fogg, 2009), because these participants only received triggers but not the motivation manipulation to engage in PA. However, according to the FBM (Fogg, 2009), a trigger persuades people to perform a target behaviour, provided that they both have the ability as are motivated to perform the target behaviour (i.e. above the activation threshold), suggesting that the participants who did not receive the motivation manipulation both had the ability as were motivated enough in order to get triggered to engage in PA.

In line with the results of the current study, Dantzig et al. (2013) indicated no greater decrease in sedentary behaviour (and increase in PA) while utilizing motivational and trigger-related strategies (i.e. triggers which contained motivating messages). In contrast, and in line with the FBM (Fogg, 2009) yet not within the domain of PA, Basten (2014) indicated a higher increase in sales while utilizing motivational and trigger-related strategies (i.e. triggers which contained a motivating message: sparks). However, in both of these studies the motivational and trigger-related strategies were utilized in one manipulation. In this regard, it could be argued that the triggers in the current study might have served as a type of substitute for motivational triggers, and therefore successfully triggering as well as motivating participants who did not receive the motivation manipulation to increase their PA. Then again, the utilized triggers of the current study were regarded as signals, which contained neither a core motivator nor a simplicity factor (Fogg, 2009).

Moreover, one could question the independence of the key factors of the FBM (Fogg, 2009). That is, Fogg (2009) presents the three key factors of the FBM as independent factors, yet indicates triggers as motivation-enhancing (i.e. sparks) or ability-enhancing (i.e. facilitators). In this regard, triggers are not independent of motivation or ability. In line with the results of the current study, this could explain that the use of a manipulation that contains motivational triggers would lead to behavioural change (i.e. Basten, 2014), whereas the combination of an
independent motivation- and trigger manipulation would not lead to behavioural change (i.e. the current study).

With regard to the participants who were motivated to engage in PA, it could be that the effect of an intervention strategy (e.g. triggers) loses its power in persuading one to perform a target behaviour (e.g. increase PA) when one is already intervened (e.g. increase motivation) to perform the target behaviour. That is, the effect of manipulating multiple factors (e.g. motivation, ability, triggers) could exceed a certain threshold, in which the persuasion to perform a target behaviour would be reduced. Moreover, even higher PA levels were found during times when no triggers were provided to participants, which possibly could indicate counter-effects of using multiple intervention strategies to increase PA. Those participants could have paid less attention to the triggers than the participants who were not motivated to engage in PA, because they were already spending their attention to the self-monitoring of their PA.

Also, the feasibility of the daily goals could have had an influence on the effect of triggers. That is, participants who were not motivated to engage in PA could indeed have engaged in PA when they were triggered to engage in PA, regardless of their current PA level. In contrast, participants who were motivated to engage in PA could have considered their daily goal as a type of reference point during times when they were triggered to engage in PA. For instance, if those participants had a fairly easy goal, triggers would not have had an effect on them to engage in PA because they would achieve the daily goal without any real effort. Likewise, if those participants had a fairly difficult goal, triggers would also not have had an effect on them to engage in PA because the daily goal was nonetheless impossible to achieve. This could suggest that the unstimulating daily goals may have demotivated participants to engage in PA when they were triggered to engage in PA.

Moreover, the motivation manipulations could also be experienced as triggers. That is, participants could have associated the self-monitoring PA app (perhaps even the sight of the app icon) as a trigger (reminder) to engage in PA. In general, the thought of achieving the daily goal, or even engaging in PA for the purpose of the experiment (i.e. demand characteristics) could have served as a (self-) trigger to engage in PA. In such a case (i.e. when participants were also provided with the initial triggers), the initial triggers could have been suboptimal in persuading participants to engage in PA, and possibly have been experienced as excessive, irritating, or even demotivating.
Furthermore, another variable we should take into account is the third key factor of the FBM (Fogg, 2009), namely the (actual) ability of participants to engage in PA. The ability to engage in PA has not been assessed in the current study. However, it could be that the triggers failed in triggering participants to engage in PA, because they were below the activation threshold. That is, participants who were motivated to engage in PA could have been in fact highly motivated, yet lacked the ability to engage in PA because they found it hard to do. In contrast, participants who were not motivated to engage in PA could have had a greater ability to engage in PA, which subsequently balanced out the slightly lower levels of motivation to engage in PA. However, we assumed that our participants (i.e. students, young adults) always would have some level of motivation and ability to engage in PA. Moreover, with regard to everyday activities such as walking and cycling, all participants should indeed have had the ability to engage in PA.

Similar to ability, the self-efficacy to engage in PA has not been assessed in the current study. However, although the FBM does not specifically addresses self-efficacy as a construct, other theories of behaviour change (the Social Cognitive Theory, the Theory of Planned Behavior, and the Transtheoretical Model), and several studies (e.g. Bauman et al., 2012; French, 2013; Rhodes & Pfaeffli, 2010) have indicated the relevance of self-efficacy in the performance of PA. That is, the participants’ belief in their ability to engage in PA because a greater extent of self-efficacy is typically associated with a greater increase in PA, whereas a lesser extent of self-efficacy is typically associated with a lesser increase in PA (Bauman et al., 2012).

4.2. Discussion of the exploratory analyses

4.2.1. Walking

Further exploratory analyses indicated a similar interaction effect (compared to the interaction effect found during the analysis of hypothesis 3) between motivation and triggers for walking, in which a significant effect was found when triggers were provided to participants who were not motivated to engage in PA. In contrast, no significant interaction effects were found for cycling or running, suggesting that triggers were particularly successful in increasing walking for participants who were not motivated to engage in PA. It could be argued that walking is easier to undertake compared to other, more vigorous physical activities. Moreover, one could easier increase their PA with walking since it would cost less effort than changing other activities (e.g. taking the bicycle instead of the car to work), and walking is also considered as
an everyday PA that has the greatest potential to increase one’s overall activity levels (Hillsdon & Thorogood, 1996).

4.2.2. IPAQ comparisons

Participants reported higher levels of PA on the IPAQ after the manipulations than before the manipulations, indicating that the PA intervention strategies elicited an increase in PA. This difference in PA was however only significant for the participants who were motivated to engage in PA. This suggests that motivating participants to engage in PA, and providing them with (4 days of) triggers to engage in PA results in a significant increase of PA. Also, a similar significant difference was found for solely walking. These results are in contrast with the hypotheses results regarding the use of multiple PA interventions strategies. That is, these findings do suggest that the effect of using multiple PA intervention strategies resulted in a significant increase in PA compared to the effect of using only one intervention strategy. However, the difference in PA between (multiple) PA intervention strategies could only be assessed with the subjective IPAQ data, since we did not have Moves data before the interventions. Overall, there could be potential response biases in the self-report of PA with the IPAQ’s. That is, participants could have overestimated their PA reports due to the awareness of participating in an experiment about PA. Furthermore, participants who were motivated to engage in PA reported lower levels of PA before the manipulations than participants who were not motivated to engage in PA. However, lower levels of PA could be increased more easily than higher levels of PA (Croteau, 2004), which possibly could explain the steep increase in PA of participants who were motivated to engage in PA.

4.2.3. Trigger order effects

Lastly, an interaction effect was found between triggers and trigger order. That is, participants who received their triggers in the first 4 days reported higher levels of PA when triggers were present rather than absent. In contrast, participants who received their triggers in the last 4 days reported a higher PA when triggers were absent rather than present. In the beginning of the experiment participants could have become enthusiastic about the experiment regarding their physical activity, which diminished as their experiment progressed. Thereby higher levels PA were noticeable in the first 4 days rather than the last 4 days of the experiment, regardless of the effects of triggers. Moreover, demand characteristics could also have influenced the performance of participants. That is, in the beginning of the experiment participants could
possibly have formed an interpretation of the study’s purpose and subconsciously changed their behaviour in order to fit that interpretation. In general, however, this significant interaction effect was only noticeable in the analyses of PA in units of duration (i.e. IPAQ). Although a similar trend was seen for PA in units of distance, analyses with other units of PA did not display such an interaction effect.

4.3. Strengths & Limitations

The current research contributed to an empirical assessment of the FBM (Fogg, 2009) by investigating two of its key factors in a field study, while at the same time investigating the effectiveness of combining two persuasive strategies to stimulate PA. The results were overall not in line with the literature. However, the application of Fogg’s Behavior Model (Fogg, 2009) in developing interventions for the stimulation of PA created an understanding of the interplay between motivation and triggers on PA. Several interpretations were given with regard to the current study’s results, by which recommendations can be made for future research in order to create better understanding of the interplay between motivation and triggers on PA, or on behaviour in general (see 4.4. Future Research).

However, several limitations can be noted. Firstly, a general limitation would be the missing third key factor of the FBM in the study design (Fogg, 2009), namely ability. That is, investigation into the effect of ability on PA and its interaction effects with motivation and triggers on PA would have allowed for a full empirical assessment of the FBM (Fogg, 2009). In addition, the current study assessed a baseline for PA using the results of the IPAQ. However, there could have been potential biases in the self-report of PA. The individualized daily goals would have been more reliable if they were based on a quantitative baseline assessment of PA using Moves. Moreover, although a baseline period of 3 days would be sufficient enough for the calculation of reliable daily goals (Tudor-Lock et al., 2005), a baseline period of 8 days would have created the ability to compare objective PA data between periods with PA intervention strategies and periods without any intervention strategies. That is, in the current study this comparison could only be analysed using the subjective IPAQ data.

Moreover, we assumed that PA levels were generally similar across all participants before the manipulations. However, the results of the subjective measurement of PA (i.e. IPAQ) suggests that the PA levels were generally higher for participants who were not motivated to engage in PA than participants who were motivated to engage in PA. Then again, the results of the
objective measurement of PA (i.e. Moves) does not indicate these PA differences between conditions. Overall, lower levels of PA may be increased more easily than higher levels of PA (Croteau, 2004), which could suggest a possible bias in stimulating PA of participants with lower levels of PA.

Furthermore, the motivation manipulation was checked with the results of the EMI-2 questionnaire between the two conditions. However, an additional EMI-2 questionnaire before the manipulations would have created the ability to assess the initial motivational level of participants. Also, this would have provided insights in the changes in motivation to engage in PA within the conditions. Then again, an additional questionnaire would have been an extra burden for the participant to fill out.

4.4. Future research

The current research did not succeed in increasing the motivation to engage in PA with interventions that are related to the “Hope / Fear” dimension of the FBM (Fogg, 2009), which focused on the extrinsic motivation of participants. Future research could investigate if the motivation to engage in PA can be increased with interventions that are rather related to the “Please / Pain” dimension of the FBM (Fogg, 2009) and focus on the intrinsic motivation of people.

Moreover, questions regarding the independence of the key factors of the FBM (Fogg, 2009) were raised in the discussion. Future research should investigate under which conditions it is best to utilize either a single-, or rather multiple manipulations for the FBM’s key factors (Fogg, 2009). That is, Fogg (2009) proposes multiple ways to manipulate the key factors. However, it is unclear under which conditions these key factors should be manipulated independently from each other, or rather be merged into a single manipulation. For example, one can utilize a combination of a motivation manipulation and a trigger manipulation, yet also a single manipulation with a trigger that contains a core motivator. Likewise, one can utilize a combination of an ability manipulation and a trigger manipulation, yet also a single manipulation with a trigger that contains a simplicity factor.

In general, in order to achieve a full empirical assessment of the FBM (Fogg, 2009), future research should investigate into the effect of ability on PA, and its interaction effect with motivation and triggers. Moreover, self-efficacy should be taken into account as it could also have an influence on the performance of PA. Additionally, in order to further investigate the
applicability of the FBM on behavioural change, the model could aid and be applied in changing other behaviours besides PA and purchasing behaviour (i.e. Basten, 2014). Also, several other recommendations for future research can be given that are more methodological in character. That is, future research may focus on a single PA in order to induce more specific results. In addition, an extended and quantitative baseline assessment period of PA would allow for more reliable daily goals, as the ability to compare PA levels between periods with PA intervention strategies and periods without any intervention strategies. Moreover, an additional post-questionnaire or interview could identify in which ways participants increase their PA. Lastly, in the current study subjective PA data did not always confirm the objective PA data. Therefore it could be interesting to investigate the differences between objective and subjective PA data in future research.

4.5. Practical implications

With the emerging possibilities of smartphone apps to track different types of behaviour (e.g. PA, sleeping, eating), research into the reactivity effects of tracking behaviour is of great importance. The current research addressed intervention strategies which are also incorporated in numerous PA apps, such as the ability of self-monitoring PA, provision of PA goals, and reminders to engage in PA. However, the results of the current research suggests that these motivational and trigger-related functions may not be successful in stimulating PA. As is discussed, self-monitoring of PA and the provision of PA goals may not enhance one’s motivation to engage in PA, and reminders may be experienced as irritating or demotivating, which may not be beneficial for increasing PA.

4.6. General conclusion

The current research made a step toward an empirical assessment of the FBM (Fogg, 2009) by investigating two of its key factors, while at the same time investigating the effectiveness of combining two persuasive intervention strategies to stimulate PA. That is, we investigated the effect of motivating people or not, and providing triggers or not, on PA.

No differences were found in motivation, indicating that participants who were motivated to engage in PA did not engage in more PA than participants who were not motivated. Also, no differences were in triggers, indicating that the PA of participants was not greater when they received triggers to remind them to engage in PA. However, an interaction effect was found, in which a significant increase in PA was identified when triggers were provided to participants
who were not motivated to engage in PA. In contrast, no significant increase in PA was identified when triggers were provided to participants who were motivated to engage in PA. The utilized motivational interventions may have been unilateral in only focussing on the participants’ extrinsic motivation, which could have been ineffective in motivating them to engage in PA. Future research could investigate if it would be more effective to motivate participants to engage in PA by focussing on their intrinsic motivation. Also, the triggers to remind participants to engage in PA could have been incongruent with the timing to engage in PA. However in general, the distinctiveness and independence of the key factors of the FBM (Fogg, 2009) were questioned. That is, the triggers could have served as motivational triggers, and the motivational manipulations could have served as triggers. Future research should investigate under which conditions it is best to utilize either a single-, or rather multiple manipulations for motivational and trigger-related strategies in order to stimulate PA. Although Fogg’s Behaviour model (Fogg, 2009) is portrayed as simple and elegant in understanding how behavioural change can be achieved, the findings of the current research may suggest it to be more complex. However, the FBM (Fogg, 2009) is still fairly young, as is the domain of persuasive technology itself. Regardless, persuasive technologies are growing rapidly, and bit by bit it becomes part of our everyday lives. Therefore, research into the interdisciplinary field of persuasive technology and the theories of behaviour change becomes of great importance, in order to develop a mature understanding of persuasive technology and its effects on behaviour, and ultimately to enhance quality of life.
5. References


Heath, G. W., Parra, D. C., Sarmiento, O. L., Andersen, L. B., Owen, N., Goenka, S., Montes, F., &


6. Appendices

6.1. Motivational strategies

Participants who were motivated to engage in PA (IM condition) received the following text on a printed A4 sheet, which they subsequently could take home with them.

**De negatieve gezondheidseffecten van fysieke inactiviteit**

Te weinig lichaamsbeweging is geïdentificeerd als de vierde voornaamste risicofactor voor globale mortaliteit (6% van de globale sterfgevallen). Fysieke inactiviteit kan leiden tot hart- en vaatziektes, diabetes mellitus type 2, kanker, en hen risicofactoren zoals een verhoogd bloeddruk, verhoogd bloedsuikerspiegel, en overgewicht. Daarnaast wordt fysieke inactiviteit geschat als de belangrijkste oorzaak voor ongeveer 21-25% van de borst- en darmkanker gevallen, 27% van diabetes, en ongeveer 30% van coronare hartziekte gevallen. Ongeacht van iemands sport- en beweeggedrag, heeft langdurig zitten tevens risico’s voor de fysieke en mentale gezondheid (bv. overgewicht, diabetes, en depressies).

Onderzoek heeft aangetoond dat jong volwassenen in een levensperiode zitten waarin hun fysieke activiteit snel afneemt. Sterker nog; 40-50% van de universitaire studenten blijkt te weinig te bewegen.

Regelmátig bewegen kent daarentegen diverse gezondheidsvoordelen, en bevordert de kwaliteit van leven. Matig intensieve fysieke activiteiten (bv. stevig wandelen en fietsen) hebben al een gunstig effect op gezondheid en verlagen (direct of indirect) het risico op het ontstaan van ziekten, mits deze regelmatig worden verricht. Intensieve fysieke activiteiten (bv. hardlopen en snel fietsen) bevordert bovendien de conditie van hart en longen.

**Zelf-monitor van fysieke activiteit**

Vanaf nu kun je je eigen fysieke activiteit bijhouden! Download hiervoor de app “Moves”.

Registreer met het onderstaande account:

**E-mailadres:** get.active.reminder+ _____ @gmail.com

**Wachtwoord:** getactive

Met deze app wordt je fysieke activiteit automatisch onderverdeeld in lopen, fietsen, en rennen. Door op de “bolletjes” te klikken wordt je fysieke activiteit weergegeven in afstand,
tijd, of stappen. Om de accu te besparen worden korte afstanden niet altijd gemeten. Daarnaast wordt niet alle data correct weergegeven wanneer je nog beweegt: alle data wordt later in meer detail geanalyseerd (bijv. wanneer stappen worden gemeten tijdens een hobbelige auto/trein rit). Je zult altijd kleine meetproblemen ondervinden, maar in het algemeen zou de gemeten dagelijks fysieke activiteit overeen moeten komen met de werkelijke dagelijkse fysieke activiteit.

**Dagelijkse doel**
Probeer voor de komende 8 dagen dagelijks minstens _____ uur _____ minuten fysieke actief te zijn! Je kunt m.b.v. de app je dagelijkse fysieke activiteit bijhouden, en zien hoeveel minuten je nog eventueel mist om je dagelijkse doel te behalen.
6.2. Trigger examples

**Top left:** example of the trigger shown as a notification on a smartphone (i.e. Android)

**Top right:** example of the trigger shown inside an email inbox on a smartphone (i.e. IOS)

**Bottom:** example of the trigger shown inside an email inbox on a computer (i.e. Outlook)
6.3. Validity & Reliability of Moves

The developers of Moves indicated that the app is sufficiently accurate to distinguish day-to-day changes in PA levels. However, very short walks (i.e. less than 30 seconds) are not always counted in order to conserve battery. Moreover, bumps during bumpy car/train rides could sometimes be indicated as steps, but the data should eventually be improved when it is analyzed in more detail.

Generally, there has been little evaluation research on universal PA trackers, whereas much evaluation research is found on pedometers in particular (e.g. Schneider et al., 2003; Park et al., 2014). However, nearly all of those studies are regarded to pedometers as stand-alone devices instead of smartphone applications. Earlier studies that investigated the accuracy of pedometer apps have indicated mixed results from low- to moderate- to high accuracy (Åkerberg, Lindén, & Folke, 2012; Boyce, Padmasekara, & Blum, 2012; Case et al., 2015). For instance, Åkerberg et al. (2012) evaluated the accuracy of six different pedometer apps for three different smartphones compared with direct observation of step counts. 10 participants were instructed to walk 200 steps in their normal walking speed with each app and each of the smartphones outdoors on a flat, straight road. Only one app and smartphone combination indicated a good accuracy with a low standard deviation (195 ± 28.4), whilst the majority of combinations showed low or moderate accuracy. Boyce et al. (2012) measured step count with three popular pedometer apps compared with a conventional pedometer. A single participant walked on a treadmill set at 3 different intensity speed settings, with the apps set at 3 different sensitivity settings. Also, the participant walked a 1 km distance over a pre-planned route, with the apps set at moderate sensitivity. Only one pedometer app showed valid and reliable results for step counts, at however moderate sensitivity settings for moderate and high intensity activity. Moreover, distance and speed estimate were accurately recorded, if however an app used the GPS functionality. Similar to Åkerberg et al. (2012), the recent study of Case et al. (2015) evaluated the accuracy of different smartphone apps and wearable devices compared with direct observation of step counts. However, Case et al. (2015) are the only scholars, at least to our knowledge, that measured the reliability of the Moves app, which were used on an Apple iPhone 5s (IOS) and a Samsung Galaxy S4 (Android). 14 participants were instructed to walk 500 and 1500 step trials on a treadmill. Across all devices and apps, 552 step count observations were recorded in 56 walking trials. Case et al. (2015) found that the data from smartphone apps were only slightly different than the observed step counts, which could be higher or lower. That is,
the relative difference in mean step count ranged from -6.7% to 6.2% for the smartphone apps compared with direct observation.

However, all the latter studies had only measured PA for walking, whereas the current study also assessed PA for cycling. It should be noted that we focused on walking and cycling as main physical activities, and running as an additional measure of PA, due to the assumption that most of the data would be from walking and cycling. Also, the latter studies had only measured PA in units of steps, and disregarded the duration and distance. In addition, subjective experiences of Moves could identify, and potentially anticipate, possible problems and errors of using Moves as a PA tracker. Therefore, two short validation studies were performed to ensure the validity and reliability of Moves.

A short validation study with Moves was assessed by the experimenter (male; 24 years) for walking and cycling with two different smartphones; in one pants pocket an iPhone 4s with iOS, and in the other pants pocket a Galaxy S5 with Android. A 10 minute walk and a 10 minute bicycle ride were performed, in which time was measured with a stopwatch, distance with Google Maps, and steps by direct observation of step counts. The time, distance, and steps which were recorded by Moves was then compared with the observed time, distance, and steps. The results indicated small differences in PA measurements between the smartphones and direct observations (See Table 7 for the results).

Table 7. Differences of PA measurements (i.e. duration in seconds, distance in meters, and steps) between the iPhone, Galaxy, and direct observations.

<table>
<thead>
<tr>
<th></th>
<th>Walking</th>
<th></th>
<th>Cycling</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Duration (s)</td>
<td>Distance (m)</td>
<td>Steps</td>
<td>Duration (s)</td>
<td>Distance (m)</td>
</tr>
<tr>
<td>Observations</td>
<td>600</td>
<td>850</td>
<td>736</td>
<td>600</td>
<td>2800</td>
</tr>
<tr>
<td>iPhone</td>
<td>623</td>
<td>869</td>
<td>724</td>
<td>588</td>
<td>2615</td>
</tr>
<tr>
<td>Galaxy</td>
<td>611</td>
<td>856</td>
<td>719</td>
<td>596</td>
<td>2627</td>
</tr>
</tbody>
</table>
In addition, a second qualitative validation study was assessed for a further exploration with Moves as a measurement tool for PA. 2 participants (both male; $M_{age} = 27$) tested Moves on their smartphone (an Apple iPhone 4 with IOS, and a HTC One M7 with Android) for two weeks. They were asked to let the app run on the background to track their PA. In addition, both were asked to check on their recorded PA a few times to determine differences in accuracy compared to their actual PA.

In general, the participants seemed to like the app, and were surprised about its accuracy. They indicated that they daily checked on their recorded PA. However, a couple problems emerged. Battery loss was indicated as a noticeable problem. Moves described that their app will use approximately 10% of the battery life. However, the participants’ experiences differed; one reported a significant decrease of battery life, while the other did not seem to notice any difference. Moreover, it was indicated that the more physical active they were, the quicker battery life depleted. The other problems were indicated as smaller problems, and were not applicable for both participants. These problems included tracking errors (i.e. small activities were not always tracked), categorisation errors (e.g. walking categorised as cycling), and mapping errors (i.e. route differed from the recorded route). The latter error did not seem to affect PA time. That is, even if the route of an activity was falsely reported on the map, the distance and duration of the route corresponded with the actual route. The tracking errors were minimal, in which only very small activities were not measured (e.g. walking inside the house). However, categorization errors could affect PA measurement. That is, if for instance walking were to be categorized as cycling, it would not be a problem since both activities are physical activities. However, if cycling were to be categorized as transportation, the PA would not be assessed.

Furthermore, the experimenter also tested Moves for a month in order to qualitatively assess the accuracy of Moves to measure PA for a longer period of time. This subjective experience was similar to the participants’ experiences.

We concluded that Moves would be a sufficient measurement tool for the assessment of PA. The advantages of this smartphone app outperformed the disadvantages. However, the battery loss could irritate participants, and subsequently affect PA assessment. Despite that this problem is dependent on the age, hardware, and firmware of the smartphone, participants should be informed about possible battery loss, in order for them to anticipate on this problem.
6.4. International Physical Activity Questionnaire

**Vragenlijst Over Fysieke Activiteiten**

Wij zijn geïnteresseerd in de verschillende fysieke activiteiten die mensen ondernemen in hun dagelijkse leven. De vragen gaan over de fysieke activiteiten die u in de **laatste 8 dagen** heeft ondernomen. Er zitten vragen bij over de fysieke activiteit op uw werk, over uw verplaatsingen, over uw werk in huis en in de tuin, en over uw vrije tijd in verband met ontspanning, lichaamsbeweging en sport.

Denk na over alle **zwere** fysieke activiteiten die u in de **laatste 8 dagen** heeft ondernomen. **Zwere** fysieke activiteiten verwijzen naar activiteiten die een **zware** lichamelijke inspanning vereisen en waarbij u veel sneller en dieper ademt dan normaal. Denk **alleen** aan de fysieke activiteiten die u **gedurende minstens 10 minuten aan één stuk** heeft gedaan.

1. In de **laatste 8 dagen**, op hoeveel dagen heeft u **zware** fysieke activiteiten gedaan (bijv. zwaar tilwerk, spitten, aerobics, hardlopen, of snel fietsen)?
   _______ dagen
   □ Geen  (Ga naar vraag 3)

2. Hoeveel tijd heeft u normaliter op zo’n dag besteed aan **zware** fysieke activiteiten?
   _____ uur _____ minuten /dag

Denk na over alle **matige** fysieke activiteiten die u in de **laatste 8 dagen** heeft ondernomen. **Matige** fysieke activiteiten verwijzen naar activiteiten die een **matige** lichamelijke inspanning vereisen en waarbij u iets sneller en dieper ademt dan normaal. Denk **alleen** aan de fysieke activiteiten die u **gedurende minstens 10 minuten aan één stuk** heeft gedaan.

3. In de **laatste 8 dagen**, op hoeveel dagen heeft u **matige** fysieke activiteiten gedaan (bijv. het dragen van lichte lasten, fietsen op een middelmatig tempo, zwemmen op een middelmatig tempo, of andere activiteiten met een matige intensiteit)? Lopen hoort hier **niet** bij!
   _______ dagen
   □ Geen  (Ga naar vraag 5)

4. Hoeveel tijd heeft u normaliter op zo’n dag besteedt aan **matige** fysieke activiteiten?
   _____ uur _____ minuten /dag
Denk na over de tijd die u heeft **gewandeld** in de **laatste 8 dagen** op het werk, studie, thuis, om te reizen van plaats naar plaats, en al het andere wandelen dat u uitsluitend heeft gedaan voor ontspanning, sport, of in uw vrije tijd.

5. In de **laatste 8 dagen**, op hoeveel dagen heeft u **gewandeld** gedurende minstens 10 minuten aan één stuk?

   _______ dagen

   □ Geen  *(Ga naar vraag 7)*

6. Hoeveel tijd heeft u normaliter op zo’n dag **gewandeld**?

   _____ uur _____ minuten /dag

De volgende vraag gaat over de tijd die u in de **laatste 8 dagen zittend** heeft doorbracht op het werk, thuis, tijdens studiewerk of in uw vrije tijd. Hierbij hoort ook de tijd dat u achter een bureau zat, bezoek kreeg, zat te lezen, of naar de televisie zat of lag te kijken.

7. In de **laatste 8 dagen**, hoeveel tijd heeft u dagelijks gemiddeld **gezeten**?

   _____ uur _____ minuten /dag

**Vergelijkbaarheid:**

8. Was je fysieke activiteit in de **laatste 8 dagen** anders dan normaal?

   □ Minder
   □ Vergelijkbaar *(einde vragenlijst)*
   □ Meer

9. Hoeveel procent **minder** of **meer**?

   □ □ □ □ □ □ □ □ □
   10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

10. Kwam dit door een-, of meerdere, unieke situatie(s)? *(bijv. door een blessure, of een hardloopwedstrijd)*

    Ja: ___________________________________________________________

    □ Nee
6.5. Exercise Motivation Inventory

Hieronder volgen een aantal antwoorden die mensen geven wanneer men hen vraagt naar de redenen waarom ze fysiek actief zijn. Gelieve elke reden zorgvuldig te lezen en aan te duiden in hoeverre deze reden voor u persoonlijk geldt, door het geschikte nummer te omcirkelen.

Als u vindt dat een reden helemaal niet waar is voor u, omcirkel dan het cijfer ‘0’. Als u vindt dat de uitspraak helemaal voor u van toepassing is, omcirkel dan het cijfer ‘5’. Als u vindt dat de reden slechts deels voor u geldt, omcirkel dan het cijfer ‘1’, ‘2’, ‘3’ of ‘4’, al naar gelang de uitspraak voor u geldt.

Let wel, we willen weten of deze uitspraken voor u persoonlijk gelden, niet of het in het algemeen goede redenen zijn voor mensen die fysiek actief zijn!

<table>
<thead>
<tr>
<th>Persoonlijk doe ik aan fysieke training</th>
<th>Niet waar voor mij</th>
<th>Helemaal waar voor mij</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Om slank te blijven</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>2. Om een zwakke gezondheid te vermijden</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>3. Omdat ik me er goed door voel</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>4. Om er jonger uit te zien</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>5. Om mijn waarde aan anderen te tonen</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>6. Om me de ruimte te geven om te denken</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>7. Om een gezond lichaam te hebben</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>8. Om mijn fysieke kracht op te bouwen</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>9. Omdat ik het plezierig vind mezelf in te spannen</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>10. Om tijd met vrienden te spenden</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>11. Omdat mijn dokter me heeft aangeraden om te trainen</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>12. Omdat ik graag win in fysieke activiteiten</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>13. Om lenig te worden/bleven</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>14. Om mezelf doelen te verschaffen om naar toe te werken</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>15. Om gewicht te verliezen</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>16. Om gezondheidsproblemen te voorkomen</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>17. Omdat ik vind dat trainen me kracht geeft</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>18. Om een mooi lichaam te hebben</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>19. Om mijn bekwaamheid met anderen te vergelijken</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
</tbody>
</table>
### Persoonlijk doe ik aan fysieke training

<table>
<thead>
<tr>
<th>persoonlijk doet</th>
<th>niet waar voor mij</th>
<th>helemaal waar voor mij</th>
</tr>
</thead>
<tbody>
<tr>
<td>20. Omdat trainen helpt om spanning te verminderen</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>21. Omdat ik een goede gezondheid wil behouden</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>22. Om mijn uithoudingsvermogen te vergroten</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>23. Omdat trainen op zich me voldoening geeft</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>24. Omdat ik plezier beleef aan de sociale aspecten van trainen</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>25. Om een familiale ziekte te vermijden</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>26. Omdat ik hou van het competitieve aspect van trainen</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>27. Om mijn soepelheid te behouden</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>28. Om mezelf persoonlijke uitdagingen te stellen</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>29. Om me mijn gewicht te helpen controleren</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>30. Om een hartkwaal te vermijden</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>31. Om mijn batterijen opnieuw op te laden</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>32. Om mijn uiterlijk te verbeteren</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>33. Om erkenning te krijgen voor mijn bekwaamheid</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>34. Om stress te helpen beheersen</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>35. Om me meer gezond te voelen</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>36. Om sterker te worden</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>37. Voor het plezier van de belevenis van het trainen</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>38. Om plezier te hebben in het samen met andere mensen actief te zijn</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>39. Om me te helpen herstellen van een ziekte/blessure</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>40. Omdat ik van fysieke competitie hou</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>41. Om soepel te worden/blijven</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>42. Om mijn persoonlijke bekwaamheden te ontwikkelen</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>43. Omdat trainen helpt om calorieën te verbranden</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>44. Om er aantrekkelijker uit te zien</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>45. Om dingen tot stand te brengen die anderen niet kunnen</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>46. Om spanning te verminderen</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>47. Om mijn spieren te ontwikkelen</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>48. Omdat ik me op mijn best voel als ik train</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>49. Om nieuwe vrienden te maken</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>50. Omdat ik fysieke activiteiten leuk vind, vooral wanneer er competitie bij betrokken is</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>51. Om mezelf te meten tegenover mijn persoonlijke standaarden</td>
<td>0 1 2 3 4 5</td>
<td></td>
</tr>
</tbody>
</table>
6.6. Trigger Manipulation Check

Uitleg
Probeer de volgende vragen uit uw hoofd te beantwoorden zonder terug te kijken in uw mail.

1. Binnen welk tijdsbestek merkt u meestal een nieuwe mail op tussen 09:00 & 18:00? Waarbij minstens de titel en afzender van de mail wordt opgemerkt; dus niet per se het lezen van de inhoud.
   1 = Direct; 2 = binnen een kwartier; 3 = binnen een half uur; 4 = binnen een uur; 5 = binnen 2 uur; 6 = binnen 4 uur; 7 = binnen 6 uur; 8 = binnen 8 uur; 9 = binnen 10 uur; 10 = langer dan 10 uur

2. Hebt u de dagelijkse mails (reminders) van dit experiment opgemerkt?
   1 = Ja
   2 = Nee [waarom niet?] {verplicht} [skip alle volgende vragen]

3. Op hoeveel dagen hebt u deze mails opgemerkt?
   [vul aantal in]

4. Op deze dagen, hoeveel mails hebt u dagelijks opgemerkt?
   [vul aantal in]

5. Op welke tijd(en) kwamen deze dagelijkse mail(s) meestal binnen?
   [vul tijden in]

6. Wat was de titel en afzender van deze mail(s)? (de naam, niet het e-mailadres)
   [vul titel in]
   [vul afzender in]
6.7. Trigger Manipulation Check Answers

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Mode</th>
<th>Correct answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Binnen welk tijdsbestek merkt u meestal een nieuwe mail op tussen 09:00 &amp; 18:00? [1 = Direct; 2 = binnen een kwartier; 3 = binnen een half uur; 4 = binnen een uur; 5 = binnen 2 uur; 6 = binnen 4 uur; 7 = binnen 6 uur; 8 = binnen 8 uur; 9 = binnen 10 uur; 10 = langer dan 10 uur]</td>
<td>3.43</td>
<td>1.863</td>
<td>2 (binnen een kwartier)</td>
<td>≤ 6 (binnen 4 uur)</td>
</tr>
<tr>
<td>2 Hebt u de dagelijkse mails (reminders) van dit experiment opgemerkt? [1 = Ja; 2 = Nee]</td>
<td>1.07</td>
<td>0.263</td>
<td>1 (Ja)</td>
<td>1 (Ja)</td>
</tr>
<tr>
<td>3 Op hoeveel dagen hebt u deze mails opgemerkt?</td>
<td>5.08</td>
<td>1.429</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>4 Op deze dagen, hoeveel mails hebt u dagelijks opgemerkt?</td>
<td>2.87</td>
<td>1.264</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>5 Op welke tijd(en) kwamen deze dagelijkse mail(s) meestal binnen?* [1 = correct; 2 = half correct; 3 = incorrect]</td>
<td>2.33</td>
<td>0.741</td>
<td>3 (incorrect)</td>
<td>1 (correct)</td>
</tr>
<tr>
<td>6 Wat was de titel van deze mail(s)?** [1 = correct; 2 = incorrect]</td>
<td>1</td>
<td>0</td>
<td>1 (correct)</td>
<td>1 (correct)</td>
</tr>
<tr>
<td>7 Wat was de afzender van deze mail(s)?*** [1 = correct; 2 = incorrect]</td>
<td>1.13</td>
<td>0.336</td>
<td>1 (correct)</td>
<td>1 (correct)</td>
</tr>
</tbody>
</table>

*Answers were categorized under 1 (correct), 2 (half correct), or 3 (incorrect). 1 (correct) equalled “09:00, 13:00, and 17:00”. 2 (half correct) equalled 1 (correct) with deviations of one hour (e.g. “10:00, 13:00, and 16:00). 3 (incorrect) equalled 1 (correct) with deviations of more than one hour, or other answers.

**Answers were categorized under 1 (correct) or 2 (incorrect). 1 (correct) equalled “Reminder”. 2 (incorrect) equalled other answers than “Reminder”.

***Answers were categorized under 1 (correct) or 2 (incorrect). 1 (correct) equalled “Get Active”. 2 (incorrect) equalled other answers than “Get Active”.
6.8. Apparatus questionnaire

Uitleg
De volgende vragen gaan over uw smartphone en de app Moves.

1. Ik had …… mijn smartphone bij me wanneer ik fysiek actief was tijdens de laatste 8 dagen.
   1 = nooit, 2 = zelden, 3 = soms, 4 = vaak, 5 = altijd.
   → antwoord 1, 2, 3, 4: Waarom niet altijd?
   [antwoord veld]

2. De app Moves heeft …… op de achtergrond gedraaid (d.w.z. stond aan) tijdens de laatste 8 dagen.
   1 = nooit, 2 = zelden, 3 = soms, 4 = vaak, 5 = altijd.
   → antwoord 1, 2, 3, 4: Waarom niet altijd?
   [antwoord veld]

3. Ik heb …… op de app Moves gekeken tijdens de laatste 8 dagen.
   1 = nooit, 2 = zelden, 3 = soms, 4 = vaak, 5 = altijd (dagelijks).
   For participants who were motivated to engage in PA (IM condition):
   → antwoord 1, 2, 3, 4: Waarom niet altijd (dagelijks)?
   [antwoord veld]

4. Ik vond de haalbaarheid van mijn dagelijkse doel ……
   1 = heel moeilijk, 2 = moeilijk, 3 = neutraal, 4 = gemakkelijk, 5 = heel gemakkelijk.

5. Ik heb …… geprobeerd om mijn dagelijkse doel te behalen.
   1 = nooit, 2 = zelden, 3 = soms, 4 = vaak, 5 = altijd (dagelijks).
   → antwoord 1, 2, 3, 4: Waarom niet altijd (dagelijks)?
   [antwoord veld]

For all participants:

4./6. Voordat u aan dit experiment deelnam, monitorde u doorgaans uw fysieke activiteit?
   (bijv. m.b.v. een dagboek of een smartphone applicatie).
   Ja
   Nee

5./7. Hebt u enige problemen ondervonden met betrekking tot de app Moves?
   Ja [antwoord veld]
### 6.9. Apparatus questionnaire answers

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  Ik had …… mijn smartphone bij me wanneer ik fysiek actief was tijdens de laatste 8 dagen. [1 = nooit, 2 = zelden, 3 = soms, 4 = vaak, 5 = altijd]</td>
<td>3.97</td>
<td>0.88</td>
<td>4</td>
</tr>
<tr>
<td>↠ antwoord 1, 2, 3, 4: Waarom niet altijd (i.e. 5)* “Smartphone-loze” sport (e.g. fitness, roeien, zwemmen, voetbal); kleren zonder zakken; vergeten mee te nemen; opladen</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2  De app Moves heeft …… op de achtergrond gedraaid (d.w.z. stond aan) tijdens de laatste 8 dagen. [1 = nooit, 2 = zelden, 3 = soms, 4 = vaak, 5 = altijd]</td>
<td>4.59</td>
<td>0.553</td>
<td>5</td>
</tr>
<tr>
<td>↠ antwoord 1, 2, 3, 4: Waarom niet altijd (i.e. 5)* Smartphone uitgevallen / vastgelopen; (per ongeluk) afgesloten; GPS problemen</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3  Ik heb …… op de app Moves gekeken tijdens de laatste 8 dagen.*** [1 = nooit, 2 = zelden, 3 = soms, 4 = vaak, 5 = altijd (dagelijks)]</td>
<td>1.71</td>
<td>0.906</td>
<td>1</td>
</tr>
<tr>
<td>3  Ik heb …… op de app Moves gekeken tijdens de laatste 8 dagen.** [1 = nooit, 2 = zelden, 3 = soms, 4 = vaak, 5 = altijd (dagelijks)]</td>
<td>4.71</td>
<td>0.676</td>
<td>5</td>
</tr>
<tr>
<td>↠ antwoord 1, 2, 3, 4: Waarom niet altijd (i.e. 5)* Soms vergeten; geen tijd om dagelijks te volgen</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4  Ik vond de haalbaarheid van mijn dagelijkse doel …** [1 = heel moeilijk, 2 = moeilijk, 3 = neutraal, 4 = gemakkelijk, 5 = heel gemakkelijk]</td>
<td>3.26</td>
<td>1.163</td>
<td>4</td>
</tr>
<tr>
<td>5  Ik heb …… geprobeerd om mijn dagelijkse doel te behalen.** [1 = nooit, 2 = zelden, 3 = soms, 4 = vaak, 5 = altijd (dagelijks)]</td>
<td>3.38</td>
<td>1.349</td>
<td>4</td>
</tr>
<tr>
<td>↠ antwoord 1, 2, 3, 4: Waarom niet altijd (i.e. 5)* Ging meestal vanzelf; druk / geen tijd</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6  Voordat u aan dit experiment deelnam, monitorde u doorgaans uw fysieke activiteit? [1 = Ja; 2 = Nee]</td>
<td>1.72</td>
<td>0.452</td>
<td>2</td>
</tr>
<tr>
<td>7  Hebt u enige problemen ondervonden met betrekking tot de app Moves?* Nee; verbruikte veel batterij; soms niet secuur gemeten</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Answers are ordered by frequency of occurrence.
**These questions were only presented to participants who were motivated to engage in PA (IM condition).
***This question was only presented to participants who were not motivated to engage in PA (CM condition).