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Title: Testing an integrated model of the Theory of Planned Behaviour and Self-Determination Theory for different energy-balance related behaviours and intervention intensities

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Design. Participants (N = 287) completed the baseline measures after randomisation to a 'usual care' or an intervention condition. Both conditions included a medical screening. The intervention condition additionally provided participants with access to a website and coaching. Participants could freely determine their intervention intensity.
Methods. Participants completed measures of exercise behaviour, fat intake, autonomous motivation, attitudes, self-efficacy and intentions at baseline and after the first intervention year. The frequency of coaching was a measure of intervention intensity. Partial Least Squares (PLS) path modelling was used to test the relations.
Results. Changes of autonomous motivation positively predicted changes of self-efficacy ($\beta = .38$; $p < .05$) and intentions towards a healthy diet ($\beta = .38$; $p < .05$). For exercise behaviour, changes of autonomous motivation positively predicted changes of attitudes towards exercising ($\beta = .44$; $p < .05$). The intervention intensity moderated the positive effect of self-efficacy on intentions towards exercising ($\beta = .37$; $p < .05$). Changes in exercise behaviour were positively predicted by changes in intentions ($\beta = .23$; $p < .05$) whereas desired changes in fat intake were positively predicted by the intervention intensity ($\beta = -.18$; $p < .05$).
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Running head: THEORY TESTING IN A RANDOMISED CONTROLLED TRIAL

Testing an integrated model of the Theory of Planned Behaviour and Self-Determination Theory for different energy-balance related behaviours and intervention intensities*

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Conclusions. The significant paths supported the proposed theoretical model and confirmed moderation by behaviour and intervention intensity.

Introduction

Cardiovascular disease can be prevented by an active lifestyle and a healthy diet (Graham et al., 2007). Although vigorous-intensity exercise leads to greater improvements than moderate-intensity exercise, both types should be promoted (Swain & Franklin, 2006). After all, most people are sedentary and are more likely to engage in moderate intensity exercise. For example, brisk walking can reduce the risk of cardiovascular disease and epidemiological research has shown a dose-response effect (Zheng et al., 2009). Zheng et al.'s meta-analysis concluded that an increment of 30 minutes of walking for 5 days a week was associated with a 19% risk reduction. A healthy diet can further lower this risk by reducing or modifying dietary fat intake and increasing fruit and vegetable consumption (Hooper et al., 2001; Mirmiran, Noori, Zavareh, & Azizi, 2009).

Despite the benefits of making positive lifestyle changes, people generally fail to meet exercise and dietary recommendations. Consequently, the literature reports on the psychosocial determinants that can promote or thwart lifestyle changes (Hagger & Chatzisarantis, 2009). Exercise and dietary behaviours are thought to be associated and research has shown that such energy-balance related behaviours tend to cluster (Kremers, de Bruijn, Schalmaa, & Brug, 2004; Pearson, Atkin, Biddle, Gorely, & Edwardson, 2009). Such behaviours can be defined as health promoting or preventive behaviours opposed to behaviours such as smoking and alcohol consumption that are detrimental to health (de Vries et al., 2008).

Research on the psychosocial determinants of both these energy-balance related behaviours has been performed before with integrated models of health behaviour incorporating the Theory of Planned Behaviour (TPB) (Ajzen, 1985) and Self-Determination Theory (SDT) (Hagger, Chatzisarantis, & Harris, 2006b; Ryan & Deci, 2000).

Component Theories

Prior to the explanation of the integrated model, both component theories will be briefly explained. The primary postulate of the TPB is that an individual's intention is the most proximal predictor of his/her behaviour and mediates the effect of three sets of belief-based perceptions on behaviour: attitudes, subjective norms, and perceived behavioural control (PBC) (Ajzen, 1985). Attitudes reflect beliefs as to whether the behaviour (e.g., exercise and dietary behaviour) will lead to desirable outcomes. Subjective norms summarise beliefs about whether salient others want an individual to participate in the behaviour. The concept of PBC is similar to Bandura's concept of self-efficacy (Bandura, 1982; Conner & Armitage, 1998) and reflects whether a person beliefs he/she has the resources or capacity to engage in the behaviour. Cumulative quantitative reviews of research across a wide variety of behaviours (Armitage & Conner, 2001), including exercise (Hagger, Chatzisarantis, & Biddle, 2002b) and research adopting the TPB for dietary behaviours have identified attitudes and PBC as having medium effects on intention with subjective norm demonstrating a substantially weaker effect (Armitage & Conner, 2001; Hagger, Chatzisarantis, & Harris, 2006a).

In contrast, SDT is a theory of human motivation that distinguishes between the quality of the reasons (i.e. autonomous vs. controlled) that regulate behaviour (Ryan & Deci, 2000). Autonomous motivation reflects engaging in behaviours and activities that are perceived to originate from the self and fulfil personally-relevant goals. Controlled motivation reflects engaging in behaviours for reasons perceived to emanate outside the self. The driving force behind the forms of motivation that people adopt are basic psychological needs. People have the tendency to be attracted to autonomously-motivated activities in order to satisfy three innate psychological needs: the need for autonomy, the need for competence and the need for relatedness. The need for autonomy refers to the need to experience oneself as an initiator and regulator of one's actions. The need for competence refers to the innate need to master one's environment. The need for relatedness refers to people's innate need to seek close and intimate relationships with others. Autonomous motivation is associated with increased psychological well-being and persistence with health-related behaviours. Controlled motivation is associated with negative psychological outcomes and desistance or avoidance of tasks (Deci & Ryan, 2002; Ryan & Deci, 2007). Autonomous or self-determined motivation can also be supported or thwarted by environmental contingencies (Hagger & Chatzisarantis, 2009). Autonomy-supportive environments offer a rationale for the proposed health behaviour, offer choice, take the perspective of the individual and acknowledge difficulties associated with changing behaviour (Ryan & Deci, 2000). SDT is often adopted for tailored behaviour-change intervention programmes as self-determined motives positively affect behavioural engagement (Chatzisarantis, Hagger, Biddle, Smith, & Wang, 2003; Jacobs & Claes, 2008).

Prior Studies

Integrated models of TPB and SDT have been effective in explaining exercise and dietary behaviours (e.g., Hagger & Chatzisarantis, 2009; Hagger, Chatzisarantis, & Harris, 2006a, 2006b). In these models, a motivational sequence is proposed such that the effects of autonomous versus controlled motivation on intentions and behaviour are mediated by the determinants of attitudes and self-efficacy (Hagger, Chatzisarantis, & Harris, 2006a). Although the motivational sequence has been confirmed in several correlational studies, few intervention or experimental studies have tested this sequence (Chatzisarantis & Hagger, 2009; Edmunds, Ntoumanis, & Duda, 2006, 2008; Palmeira et al., 2007) and only one study focusing on exercise behaviour adopted a true intervention or experimental design using randomisation (Chatzisarantis & Hagger, 2009). This school-based SDT intervention that lasted for 5 weeks was designed to change exercise behaviour intentions and levels of exercise by using an intervention that increased the autonomy-supportive behaviours of teachers. Results indicated that exercise behaviour increased in the intervention condition and autonomous motivation and intentions mediated the effects of the intervention on exercise behaviour. Another study used a SDT intervention in the exercise domain as well but used no randomisation (Edmunds, Ntoumanis, & Duda, 2008). These authors tested a SDT teaching style intervention that lasted for 10 weeks. Participants in the intervention condition attended more exercise classes than in the control condition. However, this study was limited as there was no self-reported or actual measure of exercise behaviour included in the latter study. No study to date has adopted an integrated model to evaluate behaviour change in the context of dietary behaviour (Hagger, 2009).

The Present Study and Hypotheses

The aim was to adopt the integrated theoretical approach as a framework for evaluating the effectiveness of an intervention to change exercise and dietary behaviours. Figure 1 shows the integrated health behaviour model that was tested in the present study.

Previous studies have confirmed the effect of self-determined motivation on self-efficacy (or PBC) and attitudes (e.g., Hagger, Chatzisarantis, & Harris, 2006a, 2006b). Self-determined motives were hypothesised to be a distal predictor of attitudes and self-efficacy. Attitudes and self-efficacy were, in turn, proximal predictors of intentions to engage in health-related behaviour in accordance with the TPB. In the present study this motivational sequence was tested with the intervention included as a continuous moderator of the proposed effects of the change scores in the psychological variables across intervention and control groups. Subjective norms were left out of the model because research showed that they have a weaker effect on intention than attitudes and self-efficacy. We hypothesised that the effects of self-determined motivation (autonomous motivation/controlled motivation) on intentions and behaviour would be mediated by the proximal determinants, namely attitudes and self-efficacy (or PBC) (Hagger, Chatzisarantis, & Harris, 2006a). Intentions were hypothesised to mediate the effect of attitudes and self-efficacy on behaviour according to TPB (Ajzen, 1985). The literature is inconclusive with regard to a potential direct effect of self-determined motivation on intention (Hagger & Chatzisarantis, 2009). Therefore, we integrated this path into the model. No direct effect of self-determined motivation on behaviour was hypothesised (Hagger, Chatzisarantis, Culverhouse, & Biddle, 2003).

To evaluate the effectiveness of the intervention, intervention intensity was included as a moderator of every path in the model. We hypothesised that the effect of the independent variables (e.g., change in autonomous motivation) on the dependent variables (e.g., change in attitude) would vary according to the level of intervention intensity (Baron & Kenny, 1986). In prior research the (perceived) characteristics of the environment have been considered as potential factors that attenuate or strengthen the relations in TPB (Rhodes, Courneya, Blanchard, & Plotnikoff, 2007). Our SDT inspired intervention was therefore more or less present in the environment of the participants, depending on their preference. We argue that intervention intensity be viewed as a moderator variable.

The present study is the first randomised controlled trial that tested the relations within an integrated health behaviour model for different behaviours (exercise- and dietary behaviours) and intervention intensities. It will make a unique contribution to the literature by demonstrating the efficacy of the integrated model in evaluating the effectiveness of an intervention targeting appropriate antecedents in energy-balance related behaviours.

Method

Participants

A total of 287 participants, 191 male and 96 female, completed the measures at baseline after randomisation. The mean age of the sample was 40.48 years (SD = 10.55). Seventy percent (N = 202) had a low risk to die from a cardiovascular event in the next 10 years. All participants were highly educated (Master degree). The mean number of minutes of weekly exercise was 237.31 minutes (SD = 178.66) and the daily fat intake (in grams per day) was 106.31 grams (SD = 38.46).

Study Design

E-mails requesting study participation were sent to clients of an insurer (De Onderlinge Ziekenkas) (N = 737). In total, 314 adults signed an informed consent and were randomised to a 'usual care' and an intervention condition using a 1/3 versus 2/3 ratio to be able to study the dose-response effects of the intervention (Claes & Jacobs, 2007). The randomisation was performed by an independent person. The names of the participants were written on papers that were put in sealed envelopes. Next, the envelopes were randomly assigned by hand to baskets for the 'usual care' and intervention condition.

A power calculation with Nquery Advisor 4.0 showed that with 300 participants, a difference of 12 grams daily fat intake (common standard deviation = 34.50 grams) and a difference of 40 minutes of weekly exercise (common standard deviation = 323.00 minutes) could be detected, with a statistical power of 80% and 86%, respectively (2-tailed; $p < .05$). The Hasselt University Ethics Committee approved this study and it was registered (ISRCTN23940498). Figure 2 shows the participants flow diagram for the present study.

After randomisation, 287 adults completed the baseline measures (t = 0) and they were asked to complete the measures again at the end of the first intervention year (t = 1). To examine the intervention effect, however, it is insufficient to merely compare both study conditions because the participants in the intervention could freely determine their own intervention intensity. This freedom enabled participants that were allocated to the intervention condition to choose for an intervention intensity that was comparable to 'usual care'. Focusing on the intervention intensity instead of the original randomisation to 'usual care' and intervention conditions is supported by previous results after 6 months of intervention (Jacobs, Claes, Thijs, Dendale, & De Bourdeaudhuij, 19 May 2009). In the present study, the one year effects of the intervention were studied.

Intervention

The intervention consisted of a website and coaching in addition to the medical screening. In the present study we focus on the impact of the coaching aspect of the intervention. The coaching consisted of several techniques to change the psychosocial determinants from TPB and SDT, exercise and dietary behaviours. The techniques that were used were classical behaviour change techniques included in a recent taxonomy (e.g., providing information on the behaviour-health link, prompt specific goal setting) (Abraham & Michie, 2008; Jacobs, Claes, Thijs, Dendale, & De Bourdeaudhuij, 19 May 2009, unpublished manuscript).

An autonomy-supportive inter-personal style was used to influence the determinants from SDT. This was done by providing positive feedback, providing a rationale, avoiding a controlling language, taking the perspective of the individual, acknowledging difficulties associated with changing health behaviours and enhancing a sense of choice (Chatzisarantis & Hagger, 2009; Deci, Eghrari, Patrick, & Leone, 1994). The sense of choice was enhanced by letting the participants in the study freely determine their own intervention intensity and delivery mode. Before the coaching started, the participants were asked how they wanted it to look like. Several delivery modes were possible: e-mail, post, telephone, and face-to-face (individual and group sessions). How the recommendations derived from SDT were translated into practice was described in detail elsewhere (Jacobs & Claes, 2008).

Measures

Autonomous and controlled motivation for changing exercise and dietary behaviours were measured with the Behavioural Regulation Exercise Questionnaire II (BREQII) (Markland, 2004;

Mullan, 1997) and the Treatment Self-Regulation Questionnaire (TSRQ) (Williams, Gagne, Ryan, & Deci, 2002), respectively.

General-affective attitudes towards changing exercise (4 items) and dietary behaviour (4 items) were assessed using bipolar adjectives (7-point scale). Participants were asked whether changing the behaviour is ‘not pleasant-pleasant’, ‘bad-good’, ‘stressing-relaxing’, ‘unhealthy-healthy’. For self-efficacy for changing exercise (3 items) and dietary behaviour (3 items) respondents were asked to express their confidence in their ability to improve their behaviour (7-point scale). The intentions towards changing exercise (1 item) and dietary behaviour (1 item) were measured on a 7-point scale.

Exercise behaviour was measured with the International Physical Activity Questionnaire (IPAQ) (long version-usual week) (Vandelanotte, De Bourdeaudhuij, Philippaerts, Sjöström, & Sallis, 2005). To correct for over reporting, the household activities (in and outside the house) were left out of the analyses and the scores were multiplied by 0.80 (Rzewnicki, Vanden Auweele, & De Bourdeaudhuij, 2003). Fat intake was measured with a computerised fat intake questionnaire (Vandelanotte, Matthys, & De Bourdeaudhuij, 2004).

The intervention intensity registration for coaching consisted of a registration of the delivery mode, the target behaviour and the frequency of the coaching. The intervention intensity was operationalised as the total frequency of the coaching towards a participant to promote exercise or dietary behaviours, respectively. Change scores were used as outcome measures in the integrated health behaviour model. These change scores were calculated by subtracting the score at baseline from the score after one year of intervention.

Data Analytic Strategies

Preliminary analysis.

A preliminary analysis and a main analysis were performed. In the preliminary analysis, we inspected the descriptive statistics and correlation matrix for the relevant variables at both measurement times. Next, the psychometric properties were studied. In line with existing research all multiple item scales used in this study are modelled as reflective constructs. The measurement models for t = 0 and t = 1 were estimated separately for the exercise and dietary constructs. In line with MacKenzie, Podsakoff, and Jarvis (2005), the following psychometric properties merit attention in case of reflective multiple item constructs: unidimensionality, internal consistency reliability, within-method convergent validity, and discriminant validity. Unidimensionality is evidenced as the first eigenvalue of the correlation matrix of the construct items exceeds Karlis, Saporta, and Spinakis' (2003) modified Kaiser-Gutman criterion and the second eigenvalue is below 1. Within-method convergent validity is assessed by evaluating the magnitude and statistical significance of the relationships between the construct and their accompanying indicators (Anderson & Gerbing, 1988) and by examining the amount of average variance extracted (Fornell & Larcker, 1981). Finally, to proceed with the main analysis we computed the first differences of the constructs in our study and assessed whether the underlying assumption of strict endogeneity was met. First differences were defined as $\Delta z_t = z_t - z_{t-1}$ where z_t denotes the variable measured at time t and z_{t-1} denotes the value of that variable one time period ago. The first differences were determined for each indicator variable in our model.

Main analysis.

To assess the relationships within our integrated health behaviour model depicted in Figure 1 and test our hypotheses we used PLS path modelling which is a variance based structural equation modelling (SEM) technique that does not rely on distributional assumptions. The rationale why PLS path modelling was preferred over the ubiquitously used covariance-based SEM techniques for the current study can be explained as follows. First, as will be shown below our data exhibited significant deviations from normality (see below and descriptive statistics). Second, previous studies (e.g., Cortina, 1993; Li et al., 1998) have shown that analysis of continuous moderator variables is extremely problematic using covariance-based SEM techniques. Third, to appropriately estimate the dynamic effects put forward in our model the first differencing approach which relies on least squares estimation is most suitable (see also below). All analyses were conducted with smart PLS. Based on the empirical work of Andrews and Buchinsky (2002) and MacKinnon, Lockwood, and Williams (2004), the significance of the parameter estimates is assessed by constructing 95% bias-corrected percentile confidence intervals based on a bootstrap procedure with J=7,000.

The data collected for this study exhibited a panel structure as for each participant the constructs are measured at two points in time. Moreover, our main research interest was to model how changes in the different constructs were related to one another. Consequently, we estimated the relationships using a first differencing method. Using a first differencing approach offers the following advantages (Wooldridge, 2002). First, the biasing influence of unobserved time-constant individual specific effects is eliminated. Second, just as least squares estimation techniques can be used to estimate the model parameters, a variance-based SEM technique such as PLS Path Modelling can be used to integrally test the relationships in the conceptual framework. Third, under the strict endogeneity assumption the first difference estimator is the most efficient in its class.

To model the hypothesized moderator effects we used the PLS-PS approach suggested by Goodhue, Lewis, and Thompson (2007). According to this approach, the moderator effect is modelled as a latent variable with a single indicator that is the product of the summed indicators of the constructs underlying the hypothesized moderator effect.

Results

Preliminary Analysis

Tables 1a and 1b depict the descriptive statistics and the correlation matrix for the relevant variables for exercise and dietary behaviours respectively. In both tables the lower triangle of the correlation matrix contains the coefficients between the variables measured at t = 0 and the upper triangle contains the coefficients between the variables measured at t = 1.

Running the measurement models with all the available items for each construct revealed inconsistent results for the item “motcon”. More specifically, the loading for this item was low and insignificant thereby indicating a lack of reliability and validity. Consequently, in the remainder of this study the construct controlled motivation will be modelled as a single item scale. The estimation results concerning exercise and dietary behaviour for both measurement periods are presented in Table 2.

Using Jöreskog’s (1971) formula for internal consistency reliability, we concluded that the different items consistently reflected the underlying construct as all values exceed the recommended cut-off level of 0.70 (Nunnally & Bernstein, 1994). The constructs used in this study possessed a sufficient degree of within-method convergent validity as none of the bias-corrected bootstrap intervals contained a value of zero and the amount of average variance extracted for each construct exceeded 0.50. Finally, discriminant validity was supported as for each construct pair the square root of the average variance extracted values exceed the correlation coefficient between the two constructs (Fornell & Larcker, 1981). An initial run of the model revealed that the assumption of strict endogeneity, that is $E(\Delta u_t,\Delta X_t) = 0$ or $\text{cov}(\Delta u_t,\Delta X_t)$ held. Note that Δu_t denotes the vector containing the model’s error terms and ΔX_t denotes the matrix of hypothesized predictor variables.

Main Analysis

Taking into account the modelling considerations outlined in the previous paragraphs, results of the main analysis are presented in Tables 3a and 3b. Table 3a summarizes the relevant model performance statistics. Table 3b provides an overview of the estimates for the different individual model parameters.

Exercise behaviour.

Changes in autonomous motivation positively predicted changes in attitudes towards exercising ($\beta = .44$; $p < .05$). Moreover, the effect of changes in controlled motivation on attitude change towards exercise behaviour diminished as the intervention intensity increased ($\beta = -.20$; $p < .05$). Concerning an individual's changes in self-efficacy to exercise the results in Tables 3a and 3b reveal that this construct could not be explained by changes in autonomous motivation ($\beta = .15$; $p > .05$), controlled motivation ($\beta = .08$; $p > .05$) or by the intervention intensity ($\beta = -.11$; $p > .05$). In changing an individual's behavioural intentions towards exercising the impact of changes in his/her level of self-efficacy depends on the intervention intensity ($\beta = .37$; $p < .05$). More specifically, a higher intervention intensity resulted in a higher positive influence of changes in self-efficacy on changes in behavioural intentions. Finally, changes in behavioural intentions towards exercising translated into an increase in actual exercise behaviour ($\beta = .23$; $p < .05$).

Dietary behaviour.

As evidenced in Table 3a an individual's change in attitude towards changing dietary behaviours could not be explained by change in autonomous ($\beta = -.02$; $p > .05$), controlled motivation ($\beta = -.06$; $p > .05$) or the intervention intensity received ($\beta = .04$; $p > .05$). This is further illustrated in Table 3b in which none of the hypothesized independent variables had a significant effect on attitude.

All other structural equations show an acceptable fit to the data and are discussed into greater depth below (see also Table 3a). Again, the results at the level of the individual model parameters are presented in Table 3b.

Table 3b reveals that changes in self-efficacy regarding dietary behaviours were positively related to changes in autonomous motivation ($\beta = .38$; $p < .05$). In a similar vein, changes in behavioural intentions towards changing dietary behaviours were positively predicted by changes in autonomous motivation ($\beta = .38$; $p < .05$) and self-efficacy ($\beta = .36$; $p < .05$). Finally, desired changes in fat intake were positively predicted by the intervention intensity ($\beta = -.18$; $p < .05$).

Discussion

The purpose of the present study was to test the relations within an integrated health behaviour model of TPB and SDT and to compare the results for exercise and dietary behaviours. Different relations were confirmed but varied across behaviours. Another aim of the study was to test whether the relations varied by the intervention intensity. The relations were moderated by the intervention intensity for exercise behaviour but not for dietary behaviour. Nevertheless, the intervention intensity had a direct effect on changes of fat intake. More frequent interventions were effective in changing fat intake.

Different relations between SDT and TPB constructs were confirmed by well-fitting path-analytic models. An increase of autonomous motivation led to more positive attitudes for exercise behaviour and an increase of self-efficacy for dietary behaviour. In the past, studies have identified an effect of autonomous motivation but not of controlled motivation on these TPB constructs (Hagger & Chatzisarantis, 2009; Hagger, Chatzisarantis, & Biddle, 2002a). In contrast, the intervention intensity negatively moderated the relationship of changes in controlled motivation and changes in attitudes towards exercise behaviour. This might be beneficial since research has shown that controlled motivation negatively predicts exercise behaviour (Edmunds, Ntoumanis, & Duda, 2006). A positive association was found between changes of autonomous motivation and intentions for dietary behaviour but not for exercise behaviour. The direct association between autonomous motives and intentions was confirmed in some studies (e.g., Hagger & Chatzisarantis, 2009) but not in others (e.g., Hagger, Chatzisarantis, & Biddle, 2002a).

For the relations between TPB constructs, one would expect an effect of self-efficacy (PBC) and attitudes on intentions (e.g., Chatzisarantis & Hagger, 2009). The present study showed that changes in self-efficacy were associated with changes in intentions for dietary behaviour. For exercise behaviour, more frequent interventions increased the positive effect of self-efficacy on intentions. In contrast, changes of attitudes did not lead to changes of intentions for any behaviour. This is not in line with the literature where the attitude-intention link was confirmed and found to be stable over time (e.g., Chatzisarantis, Hagger, Biddle, & Smith, 2005).

In the present study, the link between changes of intentions and changes of fat intake was not confirmed. Many authors have identified an “intention-behaviour gap” in cross-sectional and prospective studies adopting the theory of planned behaviour (Sheeran, 2002). However, the link between intentions and behaviour is seldom zero, and in most studies a significant intention-behaviour link has been documented (Chatzisarantis & Hagger, 2009; Hagger & Chatzisarantis, 2009; Hagger, Chatzisarantis, & Harris, 2006b; Webb & Sheeran, 2006) and has been corroborated by meta-analyses (Armitage & Conner, 2001; Hagger, Chatzisarantis, & Biddle, 2002b). The problem with the intention-behaviour relationship usually lies in the inconsistency, the modest effect size, and the relatively large variation in behaviour that remains unexplained by intentions. The lack of a significant relationship for fat intake in the present study may have been due to a lack of correspondence between the measures. In the present study, participants reported their intentions to change their diet through the adoption of a healthy low-fat diet including 5 portions of fruits or vegetables per day. Although an explicit reference to fat intake was made in the presentation of the study, participants also considered the adoption of another behaviour, namely their fruit and vegetable intake. This might have caused the lack of prediction of fat intake by intention due to a lack of specificity.

There was, however, a significant intention-behaviour relationship for exercise behaviour. Given the lack of conclusive evidence that intra-individual changes in intention are predictive of behavioural changes the latter finding is very important (Scholz, Nagy, Göhner, Luszczynska, & Kliegel, 2009). Our findings also corroborate previous findings that intention-behaviour link is usually weaker for dietary behaviour than for exercise behaviour (Hagger, Chatzisarantis, & Harris, 2006b). However, it is important to note the caveat regarding the intention and behaviour measurement correspondence which was far greater in the exercise measures than in the dietary measures (Hagger, Chatzisarantis, & Harris, 2006b).

The intervention intensity had no moderating effect on the intention-behaviour relation in the present study. Maybe the present intervention would have benefited techniques designed to convert intentions into behaviour such as implementation intentions and action planning to achieve a moderation effect (Chatzisarantis, Hagger, & Thøgersen-Ntoumani, 2008; Scholz, Schuz, Ziegelmann, Lippke, & Schwarzer, 2008; Sniehotta, 2009; Webb & Sheeran, 2007; Wiedemann, Schüz, Sniehotta, Scholz, & Schwarzer, 2009). However, there is evidence that questions the effectiveness of implementation intentions founding moderating the intention-behaviour relationship (De Vet, Oenema, Sheeran, & Brug, 2009). Perhaps the moderation effect of the intervention on some relations within the model was thwarted by the large number of choice options. SDT recommendations include advice to enhance a feeling of choice. However, letting participants determine their own intervention intensity and delivery mode might undermine the effectiveness of the intervention because participants can opt to be unexposed to the intervention materials and therefore the options would have not been met with sufficient information. Ryan and Deci (2006, p. 1577) stated that “one can have many options and not feel autonomy, but instead feel overwhelmed and resentful at the effort entailed in the decision making”. The number of options is not, by itself, enough to stimulate a feeling of autonomy, they need to be meaningful and informed (Ryan & Deci, 2006). For all that, the intervention had a direct effect on dietary behaviour by decreasing the fat intake. The actual intervention intensity that the participants received plays a fundamental role in interpreting the effects of the present intervention.

The most important strength of this study is its contribution to theory testing in the health behaviour domain using an experimental design. It directly follows the advices dispensed by comparable studies namely to use experimental designs to test the model, preferably for dietary behaviour (e.g., Edmunds, Ntoumanis, & Duda, 2006; Hagger & Chatzisarantis, 2009). Furthermore, the intervention was SDT-inspired in its design. It is the first in which participants could freely determine their own intervention intensity and delivery mode. Furthermore, the present study investigated changes in psychosocial determinants and behaviour on the long-term, namely after one year of intervention. Chatzisarantis and Hagger (2009) succeeded with their intervention based on SDT in changing perceived autonomy support, motivational orientations and self-reported physical activity behaviour. However, these changes were measured 5 weeks after an intervention that lasted for 5 weeks. Lastly, the integrated models were tested using intra-individual change scores in SDT and TPB constructs.

Of course it would be remiss for us not to identify the limitations of the present study and recommendations for future research. Our data are limited because the intervention was conducted on a sample of highly educated adults who were motivated to change their behaviour. The results might therefore not be generalizable to the population. Furthermore, our model may omit a number of potentially valuable constructs (e.g. perceived autonomy support and psychological need satisfaction). Measures for these constructs could have given more insight into the experience of the participants with the many choice options available and the extent to which this might have stimulated or thwarted feelings of autonomy or competence. Other interventions made use of manipulation checks or included measures to gain more information on SDT-related constructs that might have been influenced by an intervention (Chatzisarantis & Hagger, 2009; Edmunds, Ntoumanis, & Duda, 2006).

Despite these limitations, present results support some of the relations embedded in an integrated model of TPB and SDT. The integrated model is useful since it provides a rationale behind the origins of the social cognitive variables of intention, attitude, and self-efficacy within the TPB. The present study showed that this, however, may depend on the type of behaviour and the level of intervention. Future research should be focused on some issues that arise from the current study: the number of options and the actual intervention intensity given to participants. The intervention intensity was found to be a moderator of important relations within the integrated model for exercise behaviour and a direct predictor of decrease in fat intake. In terms of practical recommendations arising from this research, health promotion interventions should be aimed at increasing autonomous motivation to influence the distal and proximal determinants of behaviour. In doing so, they can follow the SDT recommendations, e.g., by enhancing a sense of choice. The health care professional should explain the options available, guide the decision-making process but not leaving the participant alone risking him or her to get overwhelmed by the options available.

References

Abraham, C., & Michie, S. (2008). A taxonomy of behavior change techniques used in interventions. *Health Psychology, 27*(3), 379-387.

Ajzen, I. (1985). From intentions to actions: a theory of planned behavior. In J. Kuhl & J. Beckmann (Eds.), *Action-control: From cognition to behavior* Heidelberg: Springer.

Anderson, J. C., & Gerbing, D. W. (1988). Structural equation modeling in practice: A review and recommended two-step approach. *Psychological Bulletin, 103*(3), 411-423.

Andrews, D. W. K., & Buchinsky, M. (2002). On the number of bootstrap repetitions for BCa confidence intervals. *Econometric Theory, 18*(4), 962-984.

Armitage, C. J., & Conner, M. (2001). Efficacy of the theory of planned behaviour: a meta-analytic review. *The British Journal of Social Psychology, 40*(Pt 4), 471-499.

Bandura, A. (1982). Self-efficacy mechanism in human agency. *American Psychologist, 37*, 122-147.

Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*(6), 1173-1182.

Chatzisarantis, N. L., & Hagger, M. S. (2009). Effects of an intervention based on self-determination theory on self-reported leisure-time physical activity participation. *Psychology and Health, 24*(1), 29-48.

Chatzisarantis, N. L., Hagger, M. S., Biddle, S. J., & Smith, B. (2005). The stability of the attitude-intention relationship in the context of physical activity. *Journal of Sports Sciences, 23*(1), 49-61.

Chatzisarantis, N. L., Hagger, M. S., Biddle, S. J. H., Smith, B., & Wang, J. C. K. (2003). A meta-analysis of perceived locus of causality in exercise, sport, and physical education contexts. *Journal of Sport and Exercise Psychology, 25*, 284-306.

Chatzisarantis, N. L., Hagger, M. S., & Thøgersen-Ntoumani, C. (2008). Effects of implementation intentions and self concordance on health behavior. *Journal of Applied Biobehavioral Research, 13*, 198-214.

Claes, N., & Jacobs, N. (2007). The PreCardio-study protocol--a randomized clinical trial of a multidisciplinary electronic cardiovascular prevention programme. *BMC Cardiovascular Disorders, 7*, 27.

Conner, M., & Armitage, C. J. (1998). Extending the theory of planned behavior: a review and avenues for further research. *Journal of Applied Social Psychology, 28*(15), 1429-1464.

Cortina, J. M. (1993). Interaction, nonlinearity, and multicollinearity: Implications for multiple regression. *Journal of Management, 19*(4), 915-922.

De Vet, E., Oenema, A., Sheeran, P., & Brug, J. (2009). Should implementation intentions interventions be implemented in obesity prevention: the impact of if-then plans on daily physical activity in Dutch adults. *International Journal of Behavioral Nutrition and Physical Activity, 6*, 11.

de Vries, H., van 't Riet, J., Spigt, M., Metsemakers, J., van den Akker, M., Vermunt, J. K., et al. (2008). Clusters of lifestyle behaviors: results from the Dutch SMILE study. *Preventive Medicine, 46*(3), 203-208.

Deci, E. L., Eghrari, H., Patrick, B. C., & Leone, D. R. (1994). Facilitating internalization: the self-determination theory perspective. *Journal of Personality, 62*(1), 119-142.

Deci, E. L., & Ryan, R. M. (2002). Self-determination research: Reflections and future directions. In E. L. Deci & R. M. Ryan (Eds.), *Handbook of self-determination research* (pp. 431-441). Rochester, NY: University of Rochester Press.

Edmunds, J., Ntoumanis, N., & Duda, J. L. (2006). A test of self-determination theory in the exercise domain. *Journal of Applied Social Psychology, 36*(9), 2240-2265.

Edmunds, J., Ntoumanis, N., & Duda, J. L. (2008). Testing a self-determination theory-based teaching style intervention in the exercise domain. *European Journal of Social Psychology, 38*, 375-388.

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research, 39-50*.

Goodhue, D., Lewis, W., & Thompson, R. (2007). Research Note–Statistical Power in Analyzing Interaction Effects: Questioning the Advantage of PLS with Product Indicators. *Information Systems Research, 18*(2), 211-227.

Graham, I., Atar, D., Borch-Johnsen, K., Boysen, G., Burell, G., Cifkova, R., et al. (2007). European guidelines on cardiovascular disease prevention in clinical practice: executive summary. Fourth Joint Task Force of the European Society of Cardiology and other societies on cardiovascular disease prevention in clinical practice (constituted by representatives of nine societies and by invited experts). *European Journal of Cardiovascular Prevention and Rehabilitation, 14 Suppl 2*, E1-40.

Hagger, M. S., & Chatzisarantis, N. L. (2009). Integrating the theory of planned behaviour and self-determination theory in health behaviour: a meta-analysis. *British Journal of Health Psychology, 14*(Pt 2), 275-302.

Hagger, M. S., Chatzisarantis, N. L., & Biddle, S. J. (2002a). The influence of autonomous and controlling motives on physical activity intentions within the Theory of Planned Behaviour. *British Journal of Health Psychology, 7*(Part 3), 283-297.

Hagger, M. S., Chatzisarantis, N. L., & Biddle, S. J. H. (2002b). A meta-analytic review of the theories of reasoned action and planned behavior in physical activity: Predictive validity and the contribution of additional variables. *Journal of Sport and Exercise Psychology, 24*, 3-32.

Hagger, M. S., Chatzisarantis, N. L., Culverhouse, T., & Biddle, S. J. H. (2003). The processes by which perceived autonomy support in physical education promotes leisure-time physical activity intentions and behaviour: a trans-contextual model. *Journal of Educational Psychology, 95*, 784-795.

Hagger, M. S., Chatzisarantis, N. L., & Harris, J. (2006a). From psychological need satisfaction to intentional behavior: testing a motivational sequence in two behavioral contexts. *Personality and Social Psychology Bulletin, 32*(2), 131-148.

Hagger, M. S., Chatzisarantis, N. L., & Harris, J. (2006b). The process by wich relative autonomous motivation affects intentional behavior: comparing effects across dieting and exercise behaviors. *Motivation and Emotion, 30*, 307-321.

Hooper, L., Summerbell, C. D., Higgins, J. P., Thompson, R. L., Clements, G., Capps, N., et al. (2001). Reduced or modified dietary fat for preventing cardiovascular disease. *Cochrane Database Syst Rev*(3), CD002137.

Jacobs, N., & Claes, N. (2008). An autonomy-supporting cardiovascular prevention programme: practical recommendations from self-determination theory. *The European Health Psychologist, 10*, 74-76.

Jacobs, N., Claes, N., Thijs, H., Dendale, P., & De Bourdeaudhuij, I. (19 May 2009). Effect of a tailored behaviour change programme in highly educated adults: a randomised clinical trial. Unpublished manuscript.

Jacobs, N., Claes, N., Thijs, H., Dendale, P., & De Bourdeaudhuij, I. (unpublished manuscript). Effect of a tailored behaviour change programme in highly educated adults: a randomised clinical trial.

Jöreskog, K. G. (1971). Statistical analysis of sets of congeneric tests. *Psychometrika, 36*(2), 109-133.

Karlis, D., Saporta, G., & Spinakis, A. (2003). A simple rule for the selection of principal components. *Communications in Statistics-Theory and Methods, 32*(3), 643-666.

Kremers, S. P. J., de Bruijn, G. J., Schalmaa, H., & Brug, J. (2004). Clustering of energy balance related behaviours and their intrapersonal determinants. *Psychology and Health, 19*, 595-606.

Li, F., Harmer, P., Duncan, T. E., Duncan, S. C., Acock, A., & Boles, S. (1998). Approaches to testing interaction effects using structural equation modeling methodology. *Multivariate Behavioral Research, 33*(1), 1-39.

MacKenzie, S. B., Podsakoff, P. M., & Jarvis, C. B. (2005). The problem of measurement model misspecification in behavioral and organizational research and some recommended solutions. *Journal of Applied Psychology, 90*(4), 710-729.

MacKinnon, D. P., Lockwood, C. M., & Williams, J. (2004). Confidence limits for the indirect effect: Distribution of the product and resampling methods. *Multivariate Behavioral Research, 39*(1), 99-128.

Markland, D., Tobin V. (2004). A Modification to the Behavioural Regulation in Exercise Questionnaire to Include an Assessment of Amotivation. *Journal of Sport and Exercise Psychology, 26*(2), 191-196.

Mirmiran, P., Noori, N., Zavareh, M. B., & Azizi, F. (2009). Fruit and vegetable consumption and risk factors for cardiovascular disease. *Metabolism, 58*(4), 460-468.

Mullan, E., Markland D, Ingledew DK. (1997). A graded conceptualisation of self-determination in the regulation of exercise behaviour: Development of a measure using confirmatory factor analytic procedures. *Personality and Individual Differences, 23,* 745-752.

Nunnally, J. C., & Bernstein, I. H. (1994). *Psychometric theory* (3rd ed. ed.). New York ; London: McGraw-Hill.

Palmeira, A. L., Teixeira, P. J., Branco, T. L., Martins, S. S., Minderico, C. S., Barata, J. T., et al. (2007). Predicting short-term weight loss using four leading health behavior change theories. *International Journal of Behavioral Nutrition and Physical Activity, 4*, 14.

Pearson, N., Atkin, A. J., Biddle, S. J., Gorely, T., & Edwardson, C. (2009). Patterns of adolescent physical activity and dietary behaviours. *International Journal of Behavioral Nutrition and Physical Activity, 6*, 45.

Rhodes, R. E., Courneya, K. S., Blanchard, C. M., & Plotnikoff, R. C. (2007). Prediction of leisure-time walking: an integration of social cognitive, perceived environmental, and personality factors. *International Journal of Behavioral Nutrition and Physical Activity, 4*, 51.

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *The American Psychologist, 55*(1), 68-78.

Ryan, R. M., & Deci, E. L. (2006). Self-regulation and the problem of human autonomy: does psychology need choice, self-determination, and will? *Journal of Personality*, *74*(6), 1557-1585.

Ryan, R. M., & Deci, E. L. (2007). Active human nature: Self-determination theory and the promotion and maintenance of sport, exercise, and health. In M. Hagger & N. Chatzisarantis (Eds.), *Intrinsic motivation and self-determination in exercise and sport* (pp. 1-20). Champaign: Human Kinetics.

Rzewnicki, R., Vanden Auweele, Y., & De Bourdeaudhuij, I. (2003). Addressing overreporting on the International Physical Activity Questionnaire (IPAQ) telephone survey with a population sample. *Public Health Nutrition, 6*(3), 299-305.

Scholz, U., Nagy, G., Göhner, W., Luszczynska, A., & Kliegel, M. (2009). Changes in self-regulatory cognitions as predictors of changes in smoking and nutrition behaviour. *Psychology and Health*, *24*(5), 545-561.

Scholz, U., Schuz, B., Ziegelmann, J. P., Lippke, S., & Schwarzer, R. (2008). Beyond behavioural intentions: planning mediates between intentions and physical activity. *British Journal of Health Psychology, 13*(Pt 3), 479-494.

Sheeran, P. (2002). Intention—Behavior Relations: A Conceptual and Empirical Review. *European Review of Social Psychology, 13*, 1-36.

Sniehotta, F. F. (2009). Towards a theory of intentional behaviour change: plans, planning, and self-regulation. *British Journal of Health Psychology, 14*(Pt 2), 261-273.

Swain, D. P., & Franklin, B. A. (2006). Comparison of cardioprotective benefits of vigorous versus moderate intensity aerobic exercise. *The American Journal of Cardiology, 97*(1), 141-147.

Vandelanotte, C., De Bourdeaudhuij, I., Philippaerts, R., Sjöström, M., & Sallis, M. (2005). Reliability and Validity of a Computerized and Dutch Version of the International Physical Activity Questionnaire (IPAQ). *Journal of Physical Activity and Health*, *2*, 63-75.

Vandelanotte, C., Matthys, C., & De Bourdeaudhuij, I. (2004). Reliability and validity of a computerised questionnaire to measure fat intake in Belgium. *Nutrition Research, 24*(8), 621-631.

Webb, T. L., & Sheeran, P. (2006). Does changing behavioral intentions engender behavior change? A meta-analysis of the experimental evidence. *Psychological Bulletin, 132*(2), 249-268.

Webb, T. L., & Sheeran, P. (2007). How do implementation intentions promote goal attainment? A test of component processes. *Journal of Experimental Social Psychology, 43*, 295-302.

Wiedemann, A. U., Schüz, B., Sniehotta, F. F., Scholz, U., & Schwarzer, R. (2009). Disentangling the relation between intentions, planning, and behaviour: A moderated mediation analysis. *Psychology and Health, 24*(1), 67-79.

Wooldridge, J. M. (2002). *Econometric analysis of cross section and panel data*. Cambridge, Mass. ; London: MIT Press.

Zheng, H., Orsini, N., Amin, J., Wolk, A., Nguyen, V. T., & Ehrlich, F. (2009). Quantifying the dose-response of walking in reducing coronary heart disease risk: meta-analysis. *European Journal of Epidemiology, 24*(4), 181-192.

Figure 1: Integrated health behaviour model

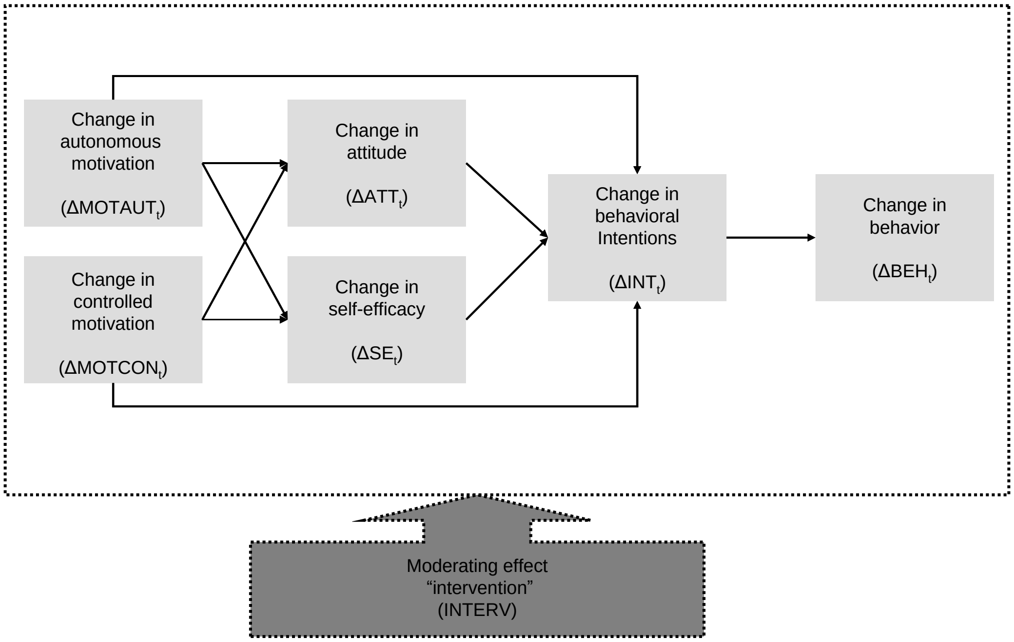

Figure 2: Participants flow diagram

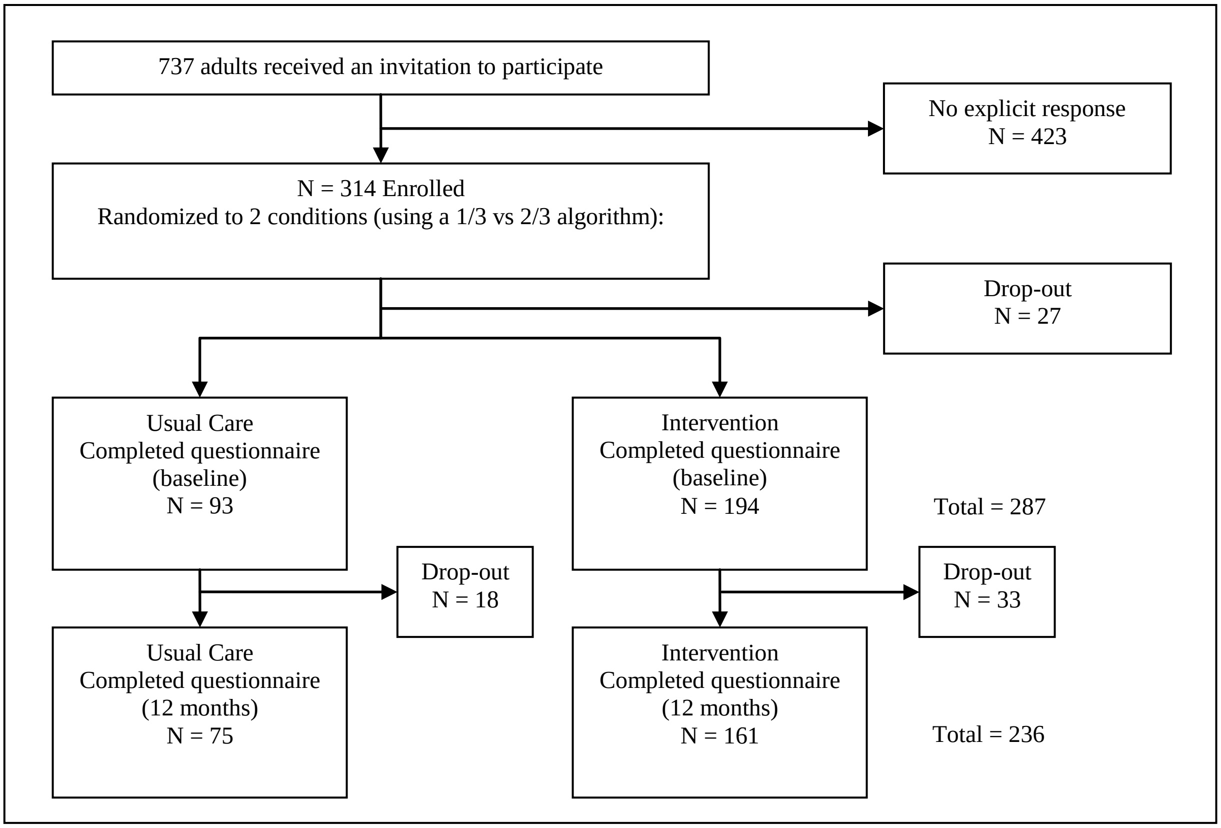

Table 1a: Descriptive statistics and correlations “Food”

	M† t=0	SD† t=0	SK† t=0	KU† t=0	M† t=1	SD† t=1	SK† t=1	KU† t=1	1	2	3	4	5	6	7	8	9	10
1. motaut1	5.25	1.36	-0.61*	-0.24	4.95	1.49	-0.41*	-0.53	**1.00**	0.69*	0.06	0.11	0.35*	0.32*	0.18*	0.31*	0.35*	-0.19*
2. motaut2	5.21	1.40	-0.53*	-0.17	4.80	1.48	-0.38*	-0.42	0.70*	**1.00**	0.16*	0.18*	0.41*	0.41*	0.34*	0.45*	0.37*	-0.16*
3. motcon1	2.86	1.63	0.44*	-0.89*	2.56	1.58	0.86*	-0.17	0.06	0.06	**1.00**	0.58*	0.07	0.01	0.08	0.06	0.12	0.11
4. motcon2	2.44	1.45	0.74*	-0.33	2.32	1.52	1.01*	0.47	0.12	0.10	0.56*	**1.00**	0.02	0.02	0.09	0.13	0.14	0.10
5. att1	3.95	1.56	0.04	-0.50	3.78	1.79	0.05	-0.81*	0.29*	0.39*	-0.01	-0.04	**1.00**	0.78*	0.33*	0.46*	0.31*	-0.36*
6. att2	4.14	1.32	0.07	0.20	4.00	1.49	0.05	-0.03	0.32*	0.40*	-0.03	0.00	0.75*	**1.00**	0.30*	0.45*	0.24*	-0.22*
7. se1	4.67	1.78	-0.42*	-0.94*	4.61	1.82	-0.42*	-0.83*	0.28*	0.44*	0.06	0.11	0.29*	0.27*	**1.00**	0.68*	0.64*	-0.09
8. se2	4.80	1.43	-0.43*	-0.52	4.67	1.39	-0.31*	-0.27	0.27*	0.42*	-0.08	-0.02	0.34*	0.40*	0.59*	**1.00**	0.48*	-0.15*
9. int	5.30	1.47	-0.82*	0.31	4.99	1.8	-0.50*	-0.61*	0.39*	0.52*	-0.02	0.04	0.32*	0.32*	0.56*	0.44*	**1.00**	-0.07
10. beh	107	39	0.95*	1.19*	102	42	2.04*	9.41*	-0.12	-0.15	0.21*	0.17*	-0.20*	-0.15*	-0.07	-0.09	-0.12	**1.00**

Notes: * indicates $p < 0.05$; † M = mean; SD = standard deviation; SK = skewness; KU = kurtosis

Table 1b: Descriptive statistics and correlations “Exercise”

	M†	SD†	SK†	KU†	M†	SD†	SK†	KU†	1	2	3	4	5	6	7	8	9	10
	t=0	t=0	t=0	t=0	t=1	t=1	t=1	t=1										
1. motaut1	3.82	1.01	-0.96*	0.39	2.98	0.77	-0.26	-0.62*	**1.00**	0.80*	0.08	-0.04	0.31*	0.55*	0.41*	0.51*	0.49*	0.33*
2. motaut2	3.84	0.94	-0.96*	0.64*	2.98	0.76	-0.26	-0.49	0.81*	**1.00**	0.08	0.05	0.36*	0.64*	0.37*	0.48*	0.56*	0.30*
3. motcon1	1.78	0.93	1.24*	1.20*	1.58	0.70	1.18*	1.41*	0.06	0.05	**1.00**	0.58*	-0.08	-0.05	0.08	0.09	0.13*	0.03
4. motcon2	1.69	0.88	1.23*	1.12*	1.46	0.62	1.35*	2.21*	-0.08	-0.07	0.56*	**1.00**	-0.17*	-0.16*	0.01	0.02	-0.01	-0.05
5. att1	6.36	0.87	-1.32*	1.13*	6.24	1.04	-1.95*	5.42*	0.40*	0.37*	0.01	-0.09	**1.00**	0.69*	0.22*	0.25*	0.24*	0.16*
6. att2	5.94	1.17	-1.05*	0.60	5.82	1.36	-1.26*	1.48*	0.66*	0.65*	0.06	-0.05	0.59*	**1.00**	0.40*	0.48*	0.40*	0.25*
7. se1	4.52	1.72	-0.27	-1.07*	4.56	1.81	-0.36*	-0.97*	0.40*	0.40*	-0.04	-0.08	0.23*	0.40*	**1.00**	0.77*	0.57*	0.23*
8. se2	4.69	1.78	-0.32*	-1.06*	4.47	1.84	-0.27	-1.08*	0.36*	0.37*	0.00	-0.07	0.35*	0.43*	0.76*	**1.00**	0.57*	0.25*
9. int	5.29	1.42	-0.49*	-0.61	5.11	1.69	-0.53*	-0.85*	0.46*	0.44*	-0.03	-0.12	0.34*	0.43*	0.62*	0.67*	**1.00**	0.30*
10. beh	242	175	0.92*	0.72*	302	235	2.92*	17.06*	0.33*	0.36*	0.10	0.01	0.23*	0.32*	0.28*	0.32*	0.28*	**1.00**

Notes: * indicates $p < 0.05$; † M = mean; SD = standard deviation; SK = skewness; KU = kurtosis.

Table 2: Psychometric properties

Behavior	Construct	Construct level statistics t=0*	Construct level statistics t=1*	Items	Description	CI t=0*	CI t=1*
Food	Autonomous motivation	λ_1=1.70; λ_2=0.30	λ_1=1.69; λ_2=0.31	1		[0.83;0.83]	[0.85;0.93]
		ρ=0.92	ρ=0.91	2		[0.93;0.96]	[0.91;0.95]
		AVE=0.85	AVE=0.84				
Food	Attitude	λ_1=1.75; λ_2=0.25	λ_1=1.78; λ_2=0.22	1		[0.90;0.95]	[0.93;0.96]
		ρ=0.93	ρ=0.94	2		[0.91;0.96]	[0.91;0.96]
		AVE=0.88	AVE=0.89				
Food	Self-efficacy	λ_1=1.59; λ_2=0.41	λ_1=1.68; λ_2=0.32	1		[0.87;0.93]	[0.90;0.94]
		ρ=0.88	ρ=0.91	2		[0.80;0.92]	[0.87;0.94]
		AVE=0.79	AVE=0.84				
Exercise	Autonomous motivation	λ_1=1.81; λ_2=0.20	λ_1=1.80; λ_2=0.20	1		[0.93;0.97]	[0.92;0.96]
		ρ=0.95	ρ=0.95	2		[0.92;0.97]	[0.92;0.97]
		AVE=0.90	AVE=0.90				
Exercise	Attitude	λ_1=1.59; λ_2=0.42	λ_1=1.77; λ_2=0.23	1		[0.73;0.90]	[0.78;0.92]
		ρ=0.88	ρ=0.91	2		[0.91;0.95]	[0.94;0.97]
		AVE=0.79	AVE=0.83				
Exercise	Self-efficacy	λ_1=1.76; λ_2=0.24	λ_1=1.69; λ_2=0.32	1		[0.91;0.96]	[0.91;0.96]
		ρ=0.94	ρ=0.94	2		[0.92;0.96]	[0.92;0.96]
		AVE=0.88	AVE=0.89				

Notes: * The meaning of the different symbols and abbreviations is as follows λ_i = the i-th eigenvalue of the item correlation matrix; ρ = composite reliability; AVE = average variance extracted; CI= 95% bias-corrected percentile confidence interval.

Table 3a: Model performance

	Model performance statistics	**FOOD “frequency”**	**EXERCISE “frequency”**
Attitude	Bootstrap R^2	0.04	0.12
	Bias-corrected CI bootstrap R^2	[-0.01;0.05]	[0.06;0.17]
Self-efficacy	Bootstrap R^2	0.11	0.05
	Bias-corrected CI bootstrap R^2	[0.05;0.17]	[-0.01;0.08]
Behavioral intentions	Bootstrap R^2	0.29	0.33
	Bias-corrected CI bootstrap R^2	[0.17;0.37]	[0.26;0.38]
Behavior	Bootstrap R^2	0.03	0.06
	Bias-corrected CI bootstrap R^2	[0.01;0.06]	[0.03;0.09]
Overall model	Absolute GOF	0.36	0.33
	Relative GOF	0.94	0.93

Table 3b: Structural model parameter estimates

		FOOD			EXERCISE		
Dependent variable	Independent variables	Mean estimate	Bootstrap t-value	Confidence interval	Mean estimate	Bootstrap t-value	Confidence interval
Attitude	Autonomous motivation	-0.02	-0.14	[-0.37;0.30]	0.44	2.59	[0.11;0.77]
	Controlled motivation	-0.06	-0.49	[-0.31;0.19]	0.07	0.74	[-0.13;0.23]
	Intervention	-0.08	-0.98	[-0.20;0.10]	-0.09	-0.80	[-0.29;0.13]
	Autonomous motivation*Intervention	0.15	0.87	[-0.18;0.51]	-0.17	-0.94	[-0.52;0.19]
	Controlled motivation*Intervention	0.04	0.24	[-0.20;0.11]	-0.20	-2.02	[-0.39;-0.01]
Self-efficacy	Autonomous motivation	0.38	2.45	[0.02;0.65]	0.15	1.16	[-0.12;0.39]
	Controlled motivation	0.04	0.27	[-0.24;0.32]	0.08	0.70	[-0.15;0.28]
	Intervention	0.09	1.44	[-0.04;0.21]	0.10	0.93	[-0.10;0.31]
	Autonomous motivation*Intervention	-0.05	-0.29	[-0.35;0.29]	0.08	0.55	[-0.17;0.37]
	Controlled motivation*Intervention	0.01	-0.05	[-0.23;0.28]	-0.11	-0.93	[-0.32;0.13]
Behavioral intentions	Autonomous motivation	0.38	2.53	[0.09;0.68]	0.20	1.59	[-0.05;0.45]
	Controlled motivation	-0.01	-0.06	[-0.16;0.23]	-0.06	-0.55	[-0.29;0.15]
	Attitude	-0.20	-1.40	[-0.42;0.12]	0.21	1.54	[-0.04;0.48]
	Self-efficacy	0.36	2.31	[0.06;0.65]	0.07	0.54	[-0.16;0.34]
	Intervention	0.02	0.30	[-0.12;0.13]	0.03	0.43	[-0.12;0.19]
	Autonomous motivation*Intervention	-0.22	-1.36	[-0.52;0.10]	0.01	0.04	[-0.24;0.26]
	Controlled motivation*Intervention	0.04	0.35	[-0.16;0.21]	0.05	0.46	[-0.15;0.28]
	Attitude*Intervention	0.15	1.04	[-0.15;0.40]	-0.09	-0.79	[-0.34;0.13]
	Self-efficacy*Intervention	0.05	0.33	[-0.22;0.34]	0.37	2.98	[0.12;0.61]
Behavior	Behavioral intentions	0.08	0.72	[-0.14;0.29]	0.23	1.97	[0.01;0.47]
	Intervention	-0.18	-2.20	[-0.35;-0.04]	0.06	0.71	[-0.09;0.22]
	Behavioral intentions*Intervention	-0.08	-0.69	[-0.31;0.16]	0.00	0.00	[-0.26;0.23]