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The Process by Which Relative Autonomous Motivation Affects Intentional Behavior: Comparing Effects Across Dieting and Exercise Behaviors

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Abstract A motivational model integrating self-determination theory and the theory of planned behavior was tested in two samples for exercise and dieting behavior respectively. Relative autonomous motivation from self-determination theory was hypothesized to predict intentions to exercise or diet via the mediation of attitudes and perceived behavioral control (PBC) from the theory of planned behavior. It was also expected that attitudes and PBC would predict actual levels of exercise and dieting behavior via the mediation of intentions. Relations in the proposed model were expected to be invariant across the behaviors. Two samples of participants ($N = 511$) completed measures of the autonomous motives, attitudes, subjective norms, PBC, and intentions with respect to exercise and dieting behavior. Four weeks later, participants self-reported their behavior. Structural equation models supported the replicability of the proposed model in both behaviors. Findings supported the majority of the hypothesized effects in the proposed model across the two health behaviors. However, four effects were significantly different across the two behaviors: the effect of autonomous motives on intentions, subjective norms and PBC on intentions, and intentions on behavior. Findings extend knowledge of the processes by which psychological antecedents from the theories affect health behaviors integral to the maintenance of energy balance.

Keywords Self-determination theory · Planned behavior · Theoretical integration · Energy balance

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Epidemiological research has indicated that regular, vigorous, sustained exercise and a nutritionally-balanced, low-fat diet are important contributory factors in the prevention of diseases such as cancer (Byers et al., 2002), cardiovascular disease (Hooper et al., 2001; Williams, 2001), and other health problems such as obesity (Ross, Freeman, & Janssen, 2000) and diabetes (Fritz, Wandell, Aberg, & Engfeldt, 2006). However, studies have shown (e.g., Martin, Morrow, Jackson, & Dunn, 2000) that people generally do not follow the recommended guidelines for exercise and healthy eating (Nutrition and Physical Activity Guidelines Advisory Committee, 2001). The past decade has therefore seen a proliferation in research that has examined the social psychological factors that influence people's exercise and dieting behavior with a view to targeting interventions and alter behavior in favour of greater levels of exercise (Hagger & Chatzisarantis, 2005b) and a healthier diet (Conner & Armitage, 2002).

Recent research has shown that exercise and dieting behaviors are related to the control of 'energy balance' and are therefore valuable in maintaining a healthy body weight and minimising disease risk. Researchers in epidemiology and health use the term 'energy balance' to describe the complex interaction of diet, physical activity, and body weight on the development of health problems such as obesity, cardiovascular disease, and cancer (Schuit, van Loon, Tijhuis, & Ocké, 2002; Simoes et al., 1995). These experts have

highlighted the importance of exercise and dietary behaviors to the maintenance a healthy body weight. Recent research has suggested that that these behaviors may have similar social cognitive antecedents (Kremers, de Bruijn, Schalmaa, & Brug, 2004). For example, Kremers et al. found the interpersonal social cognitive factors that influenced exercise and dieting behaviors tended to cluster together and indicated that the mechanisms behind these behaviors may be similar. The present study aimed to extend this research by examining a recently-developed motivational model of health behavior in these two behavioral contexts. The model integrates constructs from two prominent social psychological theories in a unified model of motivation to explain intentions and behavior; self-determination theory (Deci & Ryan, 2000) and theory of planned behavior (Ajzen, 1985, 1991). It aims to test the hypotheses that an integrated motivational model adopting these theories can help explain the proximal and distal determinants of each of these energy balance-related behaviors, that the antecedent motivational factors of these behaviors are the same, and that the pattern of influence of these antecedent constructs on intention and behavior are similar.

The theory of planned behavior and self-determination theory

The theory of planned behavior has been a useful social cognitive framework to understand the antecedents of intentional behavior in a number of health behavior contexts including exercise (Hagger, Chatzisarantis, & Biddle, 2002b; Hagger & Chatzisarantis, 2005b) and following a healthy diet (Armitage & Conner, 1999; Conner & Armitage, 2002; Conner, Norman, & Bell, 2002). The theory posits that stated intention to engage in a target social behavior like exercise or dieting is the most proximal predictor of behavioral engagement. Intention is considered a motivational construct that reflects the degree of deliberative planning and effort an individual is prepared to invest in pursuing a given target behavior. Intention in the theory is viewed as a function of three sets of belief-based judgements or expectations and the relative strength or value of these expectations regarding the target behavior (Ajzen, 2003). Personal beliefs reflect an individual's judgement as to the efficacy of the target behavior to produce certain outcomes and an evaluation of whether those outcomes are instrumental to the individual. These beliefs are summarised by standardized direct measures of a person's *attitude*, which represent an individual's overall evaluation of performing the behavior (Ajzen, 2003). Semantic differential rating scales with bipolar adjectives are typically employed for the direct measure of attitudes. Normative beliefs reflect the belief that significant others want the individual to engage in the target behavior and the individual's motivation to comply with those significant others. These beliefs are typically measured by an overall direct measure of a person's *subjective norm* towards the target behavior. Control-related beliefs reflect expectations regarding the degree of personal control an individual has over the target behavior, the perceived presence of barriers, and the perceived power attributable to each control-related belief. This is summarised in a global *perceived behavioral control* (PBC) measure of the construct. In terms of mechanisms, the attitude, subjective norm, and PBC constructs are viewed as *forming* intentions and affect behavior only via the mediation of intentions (Hagger & Chatzisarantis, 2005b). Considerable research has supported these hypothesized relationships and meta-analyses have supported the effects of the theory of planned behavior in a number of health-related contexts including exercise and diet (Armitage & Conner, 2001; Godin & Kok, 1996; Hagger et al., 2002b).

Self-determination theory takes a different approach to understanding social behavior. While the theory of planned behavior examines the immediate belief-based constructs thought to determine behavioral engagement, self-determination theory focuses on the quality of an individual's motivation in a given context and the environmental factors that affect motivation in that context (Deci & Ryan, 1985; Ryan & Connell, 1989). Central to the theory is the distinction between autonomous versus controlled types of motivation (Deci & Ryan, 2000). Individuals are autonomously motivated when they experience a sense of personal volition and choice when acting and feel controlled when they think they are pressured or coerced into behaving by external forces. The relative degree of autonomy perceived by an individual in a given behavioral context is often viewed along a continuum of motivation known as the perceived locus of causality (PLOC, Ryan & Connell, 1989). The continuum is outlined by organismic integration theory (Deci, Eghrari, Patrick, & Leone, 1994), a sub-theory of self-determination theory, that specifies a taxonomy of the forms of motivation experienced by individuals in life contexts. This taxonomy represents the qualitative differences in the types of motivation and outlines the behavioral experiences and outcomes associated with each form of motivation. The continuum is characterised by two relatively autonomous forms of motivation: *intrinsic motivation* and *identified regulation*, and two relatively controlling forms of motivation: *external regulation* and *introjected regulation* (Ryan & Connell, 1989).

Intrinsic motivation represents the prototypical form of autonomous motivation and reflects engaging in a behavior for the intrinsic satisfaction of the behavior itself and for no external contingency. Identified regulation is also an autonomous form of motivation but is, strictly speaking, an extrinsic form of motivation because behavioral engagement is motivated by the pursuit of personally-valued outcomes rather than for the behavior itself. Pursuing behaviors for external contingencies such gaining extrinsic rewards or avoiding punishment characterises external regulation. Introjected

regulation refers to an extrinsic form of motivation in which behavioral control arises not from external contingencies administered by others, but contingencies administered by the self such as the pursuit of contingent self-worth or the avoidance of affective states such as guilt or shame. Intrinsic motivation and identified regulation lie adjacent to each other at the autonomous pole of the PLOC continuum while external regulation and introjected regulation are located alongside each other at the controlling end of the continuum (Ryan & Connell, 1989). Research adopting the PLOC to characterize contextual-level motivation has shown that autonomous motives positively affect behavioral engagement in exercise and dieting. Those with reporting high levels of autonomous motivation in exercise and dieting contexts are likely to value the outcomes of engaging in such behaviors like getting fit and maintaining a healthy body weight (Chatzisarantis, Biddle, & Meek, 1997; Chatzisarantis, Hagger, Biddle, Smith, & Wang, 2003; Pelletier, Dion, Slovinec-D'Angelo, & Reid, 2004; Vansteenkiste, Simons, Soenens, & Lens, 2004).

An integrated model

Recently, researchers have sought to integrate self-determination theory and the theory of planned behavior because these approaches are deemed to provide complimentary explanations of the processes that underlie motivated behavior. Several researchers have integrated these approaches in mediational models which illustrate the processes that lead to decisions to engage in health-related behaviors. For example, autonomous motives from the PLOC have been shown to directly predict behavioral intentions (Chatzisarantis, Hagger, Biddle, & Karageorghis, 2002; Hagger, Chatzisarantis, & Biddle, 2002a; Standage, Duda, & Ntoumanis, 2003; Wilson & Rodgers, 2004). However, some researchers have tested a more complete model in which the styles of autonomous motivation from organismic integration theory predict intentions via the mediation of attitudes and PBC. This motivational sequence has been supported in a number of studies (Chatzisarantis et al., 2002; Hagger et al., 2002a; Hagger, Chatzisarantis, Barkoukis, Wang, & Baranowski, 2005; Hagger, Chatzisarantis, Culverhouse, & Biddle, 2003; Hagger, Chatzisarantis, & Harris, 2006).

The proposition that self-determination theory can augment social cognitive theories such as the theory of planned behavior has been suggested previously, but has only recently received empirical support. Numerous authors have proposed that motivational, organismic theories such as self-determination theory could potentially offer explanations for the origins of constructs in social cognitive theories. As Andersen, Chen, and Carter (2000) state, "most information processing [social cognitive] models are silent on matters central to self-determination theory" (p. 272). Deci and Ryan (1985) have suggested that social cognitive theories identify the immediate antecedents of behavior, but neglect the origins of the antecedents: "Cognitive theories begin their analysis with what Kagan (1972) called a motive, which is a cognitive representation of some future desired state. What is missing, of course, is the consideration of the conditions of the organism that makes these future states desired" (p. 228). Constructs such as attitudes, PBC, and intentions from social cognitive theories like the theory of planned behavior are measured as explicitly-stated expectancies regarding future behavioral engagement. Therefore the integration of these theories may offer more information as to the mechanisms that underlie intentional social and health behavior.

The integration of the theory of planned behavior and self-determination theory is based on two key premises. The first premise is based on the hypothesis that the relationship between autonomous motives from self-determination theory and the constructs from the theory of planned behavior is a *formative* one. People who have high levels of autonomous motivation in a given domain are likely to experience their behavior in that domain as personally relevant and valued in that it is concordant with their psychological needs (Sheldon, 2002). As a consequence, autonomously-motivated people will have a greater tendency to critically examine the importance and value of the outcomes of engaging in any future target behavior. In the case of exercise and dieting, autonomous people will be likely to find information that points to the importance of these health behaviors and thus form a positive attitude towards future participation in that behavior. In contrast, people who report high levels of controlling forms of motivation will tend to focus on external contingencies of the future engagement in a target behavior, which are likely to have little to do with the valued consequences of the behavior.[1]

In addition, individuals with high levels of relative autonomous motivation are likely to feel more confident in reaching their goals and engaging in subsequent behavior to satisfy these goals because they satisfy their need for competence. Links between autonomous motivation and perceived competence have been found in previous research in the health domain (e.g., Williams, Gagne, Ryan, & Deci, 2002; Williams, McGregor, Zeldman, & Freedman, 2004). It is hypothesized that autonomous motives will influence expectations that engaging in the behavior in future will be under the individual's personal perceived behavioral control.

In contrast, autonomous motives are not expected to influence subjective norms. This is because subjective norms tend to be conceptualized as the perceived desires of significant others and research has indicated that these are associated

[1]We would like to thank an anonymous reviewer for providing additional justification for the theoretical links between autonomous motives and attitudes.

with perceived pressure and external contingencies for engaging in a target behavior rather than autonomous reasons (Chatzisarantis, Hagger, Smith, & Sage, 2006). This is why attitudes, perceived behavioral control, and intentions, but not subjective norms, are hypothesized to play an important role in the effect of autonomous motives on future participation in intentional behavior (Chatzisarantis et al., 2006; Hagger et al., 2006).

The second premise relates to the relative degree of generality reflected by the constructs from the two theories. As previously stated, the PLOC reflects an individual's motives in a particular context and is therefore expected to predict his/her behavioral engagement across a variety of specific behaviors in that context. Vallerand (2000) labels this form of motivation, *contextual-level motivation*, as it reflects motives that affects behavior in a given context. However, the constructs from the theory of planned behavior are *expectations* of engaging in the behavior in future and measures of these constructs therefore specify explicitly the target behavior and time frame of that bout of behavior. Vallerand suggested that contextual level motivation, such as the PLOC, affects motives at the situational level in a top-down fashion. Intentions in the theory of planned behavior are hypothesized to be located at this level because they reflect expectations for engaging in a specific target behavior at as specific future point in time. They are therefore conceptualized as perceptions to engage in a behavior at the situational level. In addition, Vallerand also hypothesized that contextual level motivation would also influence cognitions at the situational level. It is therefore expected that motivation at the contextual level would influence the beliefs that underlie engagement in specific bouts of a behavior in the future, which, according to the theory of planned behavior, are constructs like attitudes and PBC. In accordance with this theory, it would be expected that contextual level motives would predict the performance of behavior at the situational level and its antecedents.

The present study and study hypotheses

The present prospective study aims to test an integrated model using two complimentary theoretical approaches in two behavioral contexts related to maintaining energy balance: exercise and dieting. The study aims to extend current research by illustrating that the two theories provide complimentary explanations of the processes that underpin social behavior and aims to indicate that these processes are similar across two related health behaviors. In the study, self-report measures of the theory constructs will be administered to two samples to tap the theory constructs in the exercise and dieting behavioral contexts respectively. The proposed motivational sequence stipulates that contextual motivational constructs from self-determination theory will predict intentions to act via the mediation of attitudes and PBC. This is based on the premise that autonomous motives will influence an individual's situational level cognitions, namely attitude and control (Chatzisarantis et al., 2002; Hagger et al., 2002a), and intentions in a top-down fashion (Hagger et al., 2006; Vallerand, 2000), and that autonomous motives are perceptions regarding the behavioral context that affect situational-level expectations and judgements regarding future behavioral engagement (Hagger et al., 2006).

Data will be analysed using covariance structure analysis which is advantageous since it allows the a priori specification of a proposed model according to theory and tests it against observed variables. In the hypothesized model it is expected that peoples' autonomous motives from self-determination theory, as reflected by a graduated composite of the PLOC constructs, will significantly predict their attitudes and PBC toward exercise and dieting behavior, in accordance with previous findings in exercise (Chatzisarantis et al., 2002; Hagger et al., 2002a). Attitudes, PBC, and subjective norms are expected to predict intentions to exercise and diet in accordance with the theory of planned behavior, though it is expected that attitudes and PBC will have the most pervasive effect as indicated by previous meta-analytic findings (Hagger et al., 2002b). Importantly, it is expected that the effect of autonomous motives on intentions to exercise and diet will be completely mediated by the attitude and PBC constructs. Such a mediation effect is in accordance with previous findings in exercise (Chatzisarantis et al., 2002; Hagger et al., 2002a) and Ajzen's (1991) hypothesis that the theory of planned behavior constructs will mediate the effects of all other social cognitive constructs on intentions.

Finally, it is expected that intentions will be the sole predictor of exercise and dieting behavior, completely mediating the effects of attitudes, PBC, and subjective norms on behavior and that there will be no direct effect of autonomous motives on behavior. In order to test these hypotheses, an alternative model in which autonomous motives will affect intentions and autonomous motives, attitudes, subjective norms, and PBC will predict behavior directly be tested in each sample to indicate whether the effect of autonomous motives is completely or partially mediated by the attitude and PBC constructs. In the event that these additional paths exhibit non-significant parameter estimates and the hypothesized indirect effects are significant, we will have confirmation of the complete mediation of these effects. However, in the event that both direct and indirect effects are significant, then partial mediation of the hypothesized effects is supported.

Since exercise and dieting behaviors are both implicated in the maintenance of energy balance (Kremers et al., 2004), it is expected that the pattern of predict proposed by the motivational sequence in the present study will be invariant across the behavioral context at both the measurement (same number of factors and measurement parameters) and

structural (same pattern and size of relationships among factors) levels. Put simply, it is expected that there will be no differences in the pattern and size of the factor loadings for the items that make up the self-report measures of the theory constructs and no differences in the relationships among the constructs across the behavioral contexts.

Method

Participants and design

Two samples of undergraduate and postgraduate students agreed to participate in the study. Participants in the first sample ($N = 261$; 166 women, 95 men; M age $= 24.93$, $SD = 9.69$), hereafter referred to as the 'exercise sample,' were informed they were taking part in a survey on 'exercise habits' prior to completing the study measures. The target behavior was defined for the participants via a standardized set of instructions as "vigorous physical activities such as sports and active pass times that raise your heart rate/pulse and make you breathe deeply for 20 minutes at a time." Participants in the second sample ($N = 250$; 141 women, 109 men; M age $= 24.64$, $SD = 6.39$), referred to as the 'dieting sample,' were notified they were participating in a survey on 'watching your diet.' The target behavior was defined as "cutting down on sugary foods, cutting down on fatty foods, avoiding snacks between meals, decreasing food intake in general by eating lighter meals, not having seconds and not overeating, and eating diet foods. It does not necessarily imply being on a specific diet or dietary programme."

An identical prospective correlational design and two-wave data collection procedure was followed in each sample. Participants were asked to complete a questionnaire containing the study measures at an initial time-point. Four weeks after completing the questionnaire containing the initial measures, participants self-reported either their leisure-time exercise (exercise sample) or dieting behavior (dieting sample). Participants' anonymity was protected by using date of birth to match questionnaires rather than names. There were no differences in the ages of the participants and in the ratio of male to female participants across the samples.

Measures

The theory of planned behavior

We based our measures of the theory of planned behavior constructs on standardized instructions given by Ajzen (2003).[2] Behavioral intentions were measured by three items using six-point Likert-type scales (e.g., "I intend to watch my diet over the next fortnight"). Three items using six-point semantic differential scales measured attitudes in response to a common stem: "For me, watching my diet in the next four weeks is . . ." Items had endpoints reflecting the affective (*happy-sad*), instrumental (*satisfying-unsatisfying*), and moral (*good-bad*) components of attitude. Subjective norms were assessed by three items with endpoints *extremely false* (1) and *extremely true* (6) (e.g., "Most people who are important to me would want me to watch my diet over the next four weeks"). Perceived behavioral control (PBC) was assessed on three items using six-point Likert-type scales (e.g., "How much personal control do you think you have watching your diet over the next four weeks?") with scale endpoints *no control at all* (1) and *complete control* (7).

Perceived locus of causality

An adapted version of Ryan and Connell's (1989) perceived locus of causality (PLOC) inventory was used to measure participants' level of relative autonomous motivation in the exercise and diet contexts. Participants were initially presented with a common stem: "Why do you participate in active sports and/or vigorous physical activities in your spare time?" or "Why do you watch your diet?" and then asked to rate several reasons pertaining to four regulation styles: Intrinsic motivation (e.g., "because I enjoy doing exercise/watching my diet"), identified regulation (e.g., "because I value the benefits of doing exercise/watching my diet"), introjected regulation (e.g., "because I will feel guilty if I don't exercise/watch my diet"), and external regulation (e.g., "because others want me to exercise/watch my diet"). There were three items for each regulation style measured on four-point Likert-type scales ranging from "not true at all" (1) to "very true" (4). As the aim of the present study was to examine the role of autonomous motives in the context of decision-making in the theory of planned behavior, the four constructs from the PLOC inventory were collapsed to form items representing a single measure of relative autonomous motivation known as the *relative autonomy index* (RAI). This was conducted according to a standardized procedure suggested by Grolnick and Ryan (1987) that assigns weights to each of the PLOC constructs according to their relative level of autonomy.

Self-reported behavior

Self-reported exercise/dieting behavior was measured four weeks after participants completed the initial study measures. Participants rated their four-week behavioral frequency on two items for each behavior (e.g., "In the course of the past four weeks, how often have you participated in

[2] For brevity, only sample items from the dieting context are given. A questionnaire containing all measures from the present study is available on request from the first author.

vigorous physical activities in your leisure time?"; "In the course of the past four weeks, how often have you watched your diet?") using six-point Likert scales with scale endpoints *never* (1) and *everyday* (6). The concurrent and criterion validity of these self-report measures has been confirmed against more comprehensive measures such as heart rate monitoring (Cale, 1994) and food diaries (Hagger & Chatzisarantis, 2005a). Further, factor analytic studies have shown these items to indicate latent behavioral measures with high factor loadings and average variance extracted supporting their construct validity (Hagger & Chatzisarantis, 2005a).

Data analysis

Data were analysed using the LISREL approach (Jöreskog & Sorbom, 1996). This approach advocates initially estimating a confirmatory factor analytic (CFA) or measurement model that tests the hypothesis that questionnaire items for each scale are adequately explained by an unobserved or latent variable with minimal residual error. Assuming the measurement model meets goodness-of-fit criteria for an acceptable model, the hypothesized relationships between the study variables are tested in a structural equation model. In this model, unidirectional paths representing the network of relations among the autonomous motives and theory of planned behavior constructs are set as free parameters. This procedure was conducted in both the dieting and exercise samples independently and the invariance of the measurement and structural parameters tested across the two samples.

Hu and Bentler (1999) recommend the use of relative fit indexes to evaluate model fit. This is because the goodness-of-fit chi-square that compares the hypothesized model with the independent or 'totally free' model is almost always significant, even for well-fitting models, making it an inadequate basis for model evaluation. Therefore, the comparative fit index (CFI), the non-normed fit index (NNFI), and the root mean square error of approximation (RMSEA) were used to evaluate model fit because simulation studies have shown that these fit indices provide relatively consistent and stable assessments of model fit (Fan, Thompson, & Wang, 1999). The accepted cut-off values for an acceptable model are .95 for the CFI and NNFI and .05 for the RMSEA (Hu & Bentler, 1999). Recently, however, Marsh, Hau, and Wen (2004) recommended that researchers treat such cut-off criteria as guidelines rather than criteria to be used in conjunction with a strict hypothesis-testing approach. In addition, we also evaluated the model on the basis of solution estimates, namely, factor loadings, factor correlations, reliability coefficients, and average variance extracted.

Results

Preliminary analyses

In order to maximise the parsimony of the models used to evaluate study hypotheses, we collapsed the four constructs from the PLOC into the single index of autonomous motivation, known as the relative autonomy index (RAI, Vallerand & Ratelle, 2002). The RAI was calculated by assigning weights to each of the items from the PLOC inventory according to their relative positions on the continuum. Therefore, items from the intrinsic motivation scale were assigned a weight of $+2$, identified regulation items a weight of $+1$, introjected regulation items a weight of -1, and external regulation items a weight of -2. The resulting weighted item scores from each scale were then summed to produce a composite parceled item score for the indication of a latent RAI factor (Little, Cunningham, Shahar, & Widaman, 2002). As there were three items for each scale, three 'parceled' RAI items were produced using this weighting system. Therefore each parceled item reflected a participant's degree of relative autonomy with high scores representing higher levels of autonomy. These parcels were used as indicators of a single latent RAI factor according to the procedure used in previous studies (e.g., Vallerand & Ratelle, 2002). Scores on the RAI factor represented the degree of relative autonomous motivation participants generally experienced in the exercise or dieting contexts.

We then conducted a confirmatory factor analysis (CFA) to test the construct and discriminant validity of the study variables in each sample. This *measurement* CFA model incorporated six factors, namely, the RAI, attitudes, subjective norms, perceived behavioral control (PBC), intention, and self-reported behavior factors. Each factor was a latent or unobserved variable and was indicated by three items with the exception of the self-reported behavior factor which was indicated by two items. In order to define the scale of the factors and to ensure that the model was properly identified, one indicator for each factor was arbitrarily set to the value of one. In addition, all the latent factors were freely correlated as is the norm in CFA models.

Goodness-of-fit statistics for the measurement CFA models in both samples indicated that the hypothesized model adequately described the data (Table 1). In addition, the standardized factor loadings for the constructs in both samples shown in Table 2 indicate that all of the factors were adequately represented with only one factor loading falling below .60. Means and standard deviations of the composite model constructs in both samples are provided in Table 3. Correlations among the latent constructs in the measurement CFA models are given in Table 4. The correlations were all significantly different from unity supporting their discriminant validity (Bagozzi & Kimmel, 1995). In addition, the

Table 1 Goodness-of-fit statistics for single- and multi-sample measurement confirmatory factor analysis and structural equation models

Model	[a]SB-χ^2	*df*	CFI	NNFI	RMSEA
Single-sample Analyses					
Exercise					
Measurement CFA model	184.763**	104	.972	.963	.055
Structural equation model	210.850**	110	.964	.956	.059
Structural equation model, revised to include $\gamma_{4,1}$[b]	187.658**	109	.972	.965	.053
Dieting					
Measurement CFA model	150.098**	104	.969	.959	.042
Structural equation model	157.816**	110	.968	.960	.042
Multi-sample analyses					
Baseline	343.933**	219	.971	.964	.047
λ's invariant	361.942**	230	.969	.964	.047
λ's and ξ's/ζ's invariant	401.522**	236	.961	.956	.053
λ's, ξ's/ζ's, and ζ_{cov}'s invariant	408.602**	239	.961	.955	.053
λ's, ξ's/ζ's, ζ_{cov}'s, and γ/β's invariant	437.054**	245	.955	.950	.055

Note. CFA = Confirmatory factor analysis; df = Model degrees of freedom; CFI = Comparative fit index; NNFI = Non-normed fit index; RMSEA = Root-mean squared error of approximation; λ = Factor loadings; ξ = Exogenous factor variances; ζ = Factor disturbance (error of endogenous latent variable); ζ_{cov} = Covariance between endogenous factor disturbances; γ = Structural paths from exogenous to endogenous factors; β = Structural paths between endogenous factors.

[a]Sattora-Bentler scaled chi-square.

[b]Model includes the relative autonomy index → intention path ($\gamma_{4,1}$) as an additional free parameter.

composite reliability estimates (ρ_c) for the latent factors, the latent variable equivalent to internal consistency statistics, in both samples were above the recommended .70 mark (Table 4).

Table 2 Standardized factor loadings for the measurement confirmatory factor analytic models in the exercise and dieting samples

Factor	Parameter	Parameter estimate	
		Exercise	Dieting
Relative autonomy index	λ_x1,1	.849	.714
	λ_x2,1	.897	.669
	λ_x3,1	.880	.650
Attitude	λ_x4,2	.830	.885
	λ_x5,2	.885	.849
	λ_x6,2	.925	.870
Subjective norm	λ_x7,3	.489	.780
	λ_x8,3	.849	.876
	λ_x9,3	.884	.776
Perceived behavioral control	λ_x10,4	.907	.783
	λ_x11,4	.762	.751
	λ_x12,4	.922	.828
Intention	λ_x13,5	.920	.772
	λ_x14,5	.848	.779
	λ_x15,5	.963	.859
Behavior	λ_x16,6	.959	.746
	λ_x17,6	.947	.766

Note. λ_x = Standardized factor loading.

Single-sample structural equation models

Given the robust fit of the measurement CFA models, the hypothesized structural relations among the RAI construct and the theory of planned behavior variables were tested in an SEM. The hypothesized model is given in Fig. 1 using LISREL notation. In accordance with the findings of previous studies (Chatzisarantis et al., 1997; Hagger et al., 2002a), the RAI was expected to significantly predict intentions indirectly via the mediation of the attitude and PBC constructs but not subjective norms. In addition, in accordance with the theory of planned behavior (Ajzen, 1991), attitudes, subjective norm, and PBC were expected to have significant

Table 3 Means and standard deviations for self-determination theory and theory of planned behavior subscales for the exercise and dieting samples

Subscale	Sample			
	Exercise		Dieting	
	M	*SD*	*M*	*SD*
Relative autonomy index[a]	4.066	3.322	.689	2.656
Attitude	4.609	.948	3.908	1.114
Subjective norm	4.284	.809	3.595	1.124
Perceived behavioral control	4.467	1.092	3.969	1.035
Intention	3.877	1.384	3.495	1.232
Behavior	3.086	1.485	3.156	1.396

[a]Relative autonomy index scores include negative numbers due to the weighting procedure assigned to each type of regulation in the perceived locus of causality.

Table 4 Factor correlations (ϕ) and composite reliability estimates (ρ_c) for the factors from the measurement confirmatory factor analysis model for the exercise and dieting samples

Factor	ρ_c [a]	1	2	3	4	5	6	ρ_c [b]
1. Relative autonomy index	.908	–	.406**	.108	.409**	.363**	.076	.720
2. Attitude	.912	.338**	–	.414**	.260**	.694**	.323**	.902
3. Subjective norm	.746	.055	.332**	–	.288**	.503**	.240**	.851
4. Perceived behavioral control	.900	.387**	.421**	.344**	–	.424**	.101	.832
5. Intention	.939	.544**	.568**	.290**	.729**	–	.600**	.843
6. Behavior	.952	.439**	.462**	.205**	.559**	.787**	–	.784

Note. Coefficients above principal diagonal are for the dieting sample, and below for the exercise sample.

[a]Composite reliability coefficients (ρ_c) for the exercise sample.

[b]Composite reliability coefficients for the dieting sample.

*$p < .05$. **$p < .01$.

indirect effects on behavior, mediated by intentions. It was also anticipated that there would be no direct effect of the RAI on behavior. In order to test the alternative hypotheses that the RAI would influence intentions and behavior directly and that attitude, subjective norms, and PBC would influence behavior directly, we specified an alternative model in which each of these paths were free parameters.

Goodness-of-fit statistics for the hypothesized SEMs in both samples are given in Table 1. The models in both samples met the multiple criteria for adequate model fit. We then tested an alternative model in each sample to confirm the hypothesized direct and indirect effects. In the alternative model, the RAI → intention, RAI → behavior, attitude → behavior, subjective norms → behavior, and PBC → behavior relationships were free parameters in the model. The alternative model for the dieting sample did not differ significantly from the more restricted model ($\Delta\chi^2 = 6.659$, $df = 5$, $p > .05$) indicating that none of the additional parameters were significant. The alternative model for the exercise sample resulted in a significant increment in goodness of fit ($\Delta\chi^2 = 25.456$, $df = 5$, $p < .01$). However, LISREL modification indexes (MIs) indicated that only the RAI → intention parameter was significant and releasing this path to be a free parameter resulted in a model that did not differ significantly from the original hypothesized model ($\Delta\chi^2 = 2.264$, $df = 4$, $p > .05$). Although the RAI → intention path was hypothesized to be non-significant, it was allowed to remain free in the final model for the exercise sample because it is theoretically plausible. It is not unreasonable to put forward an alternative hypothesis for this effect because the effects of the RAI on intentions mediated by attitudes and PBC may not be the exclusive process by which autonomous motives lead to intention formation. Goodness-of-fit statistics for this final model are given in Table 1.

Standardized path coefficients for the final SEMs in both samples are given in Fig. 2. As hypothesized, the RAI significantly predicted attitudes (exercise $\beta = .324$, $p < .01$; dieting $\beta = .373$, $p < .01$) and PBC (exercise $\beta = .374$, $p < .01$; dieting $\beta = .391$, $p < .01$). The direct effect of the RAI on intentions was significant in the exercise sample ($\beta = .258$; $p < .01$) but not in the dieting sample. In order to confirm the hypothesized mediation effects, we adopted the procedures advocated by Baron and Kenny (1986). There are four criteria that require satisfaction in order for mediation to be supported: (1) the dependent variable (in this case, intentions) should be correlated with the independent or predictor variable (RAI), (2) the mediator (attitude/PBC) should be correlated with the independent variable, (3) the mediator should have a significant unique effect on the dependent variable when it is included alongside the independent variable in a multivariate test of these relationships, and (4) the effect of independent variable on the dependent should be significantly attenuated or nullified when the mediator is included as an independent predictor of the dependent variable (Baron & Kenny, 1986).

The RAI construct was significantly correlated with attitude, PBC, and intentions (see Table 4) in both samples, satisfying the first two mediation criteria. The significant structural effects of the attitude and PBC constructs on intentions in the SEMs from both samples satisfied the third criterion for mediation. The fourth criterion was confirmed by the alternative models which included the RAI → intention path. For the dieting sample, this effect was non-significant and a Sobel (1982) test revealed a significant indirect effect of RAI on intention (indirect $\beta = .286$, $p < .01$). However, in the exercise sample, this effect was significant, but the Sobel test also indicated a significant indirect effect of RAI on intentions (indirect $\beta = .278$, $p < .01$), supporting a partial mediation effect.

Attitudes (exercise $\beta = .263$, $p < .01$; dieting $\beta = .544$, $p < .01$) and PBC (exercise $\beta = .515$, $p < .01$; dieting $\beta = .212$, $p < .01$) significantly predicted intentions in both samples in accordance with theory of planned behavior. There was also a significant effect of subjective norms on intentions but only in the dieting sample ($\beta = .212$, $p < .01$).

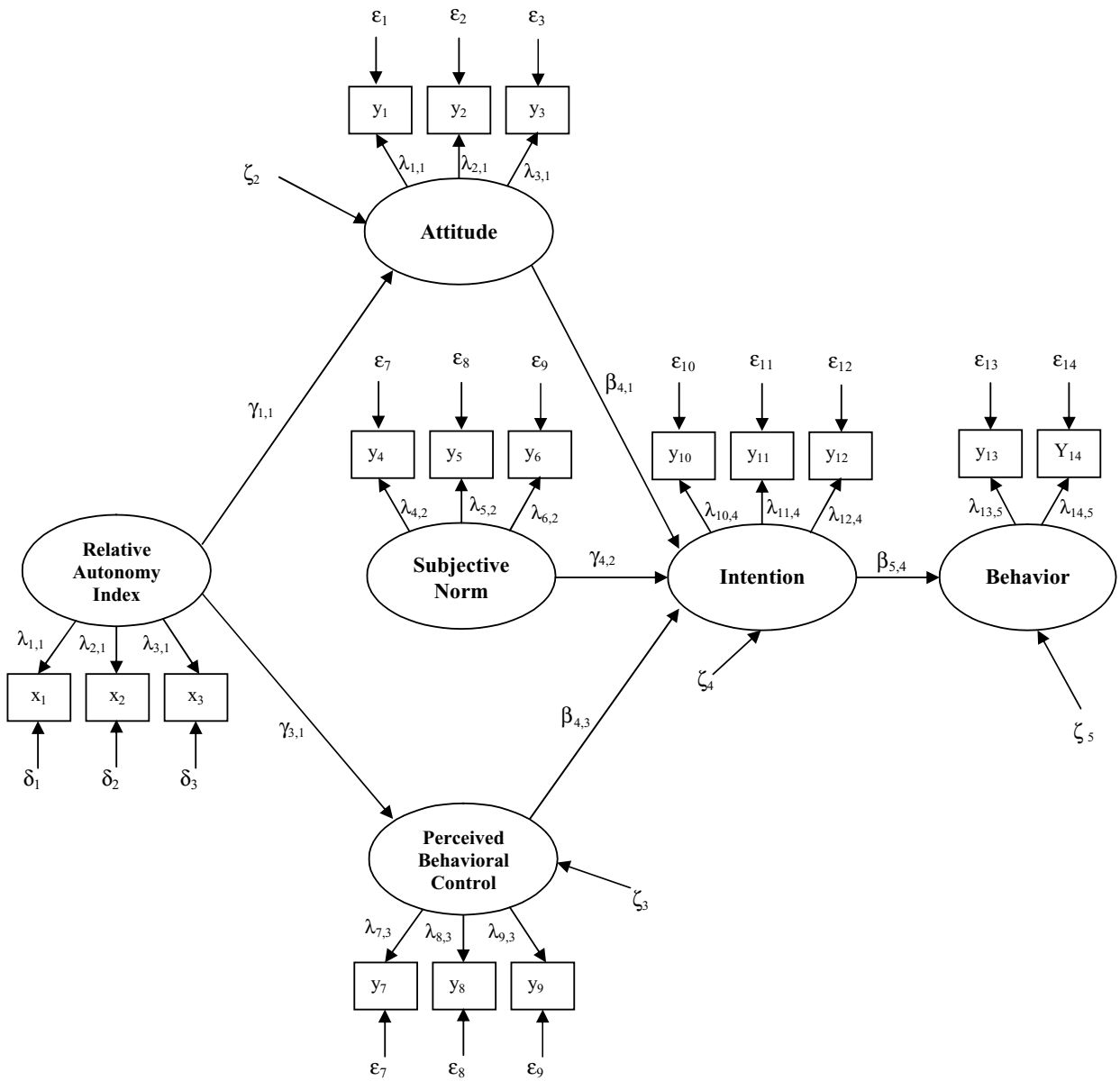

Fig. 1 Hypothesized structural equation model of the theory of planned behavior augmented to include autonomous motives. *Note*. x = Exogenous factor indicator; y = Endogenous factor indicator; λ = Standardized factor loading; γ = Structural paths among exogenous (independent) latent factors; β = Structural paths among endogenous (dependent) latent factors; δ = Error variance of exogenous latent factor indicator; ε = Error variance of endogenous latent factor indicator; ζ = Error variance (disturbance) of latent factor. *Note*. Covariances among for the attitude disturbance term, perceived behavioral control disturbance term, and subjective norm (ζ_{cov}) not shown

Overall, the model accounted for 66.3% and 55.6% of the variance in intentions in the exercise and dieting samples respectively. Finally, there were significant direct effects of intentions on behavior in both samples (exercise $\beta = .785$, $p < .01$; dieting $\beta = .565$, $p < .01$). There were no other significant predictors of behavior and the model explained 61.6 and 31.9% of the variance in behavior in the exercise and dieting samples respectively.

For completion we tested whether the intention construct mediated the effect of attitude, subjective norms, and PBC on behavior. Again adopting the procedures offered by Baron and Kenny (1986), we found that attitudes and subjective norms were significantly correlated with behavior in both samples (Table 4). PBC was significantly correlated with behavior in the exercise sample only. Intention was significantly correlated with attitudes, subjective norms, and PBC in both samples. These correlations satisfied Baron and Kenny's two initial criteria for mediation, although the non-significant correlation between PBC and behavior in the dieting sample indicated that the hypothesis of an indirect effect of this

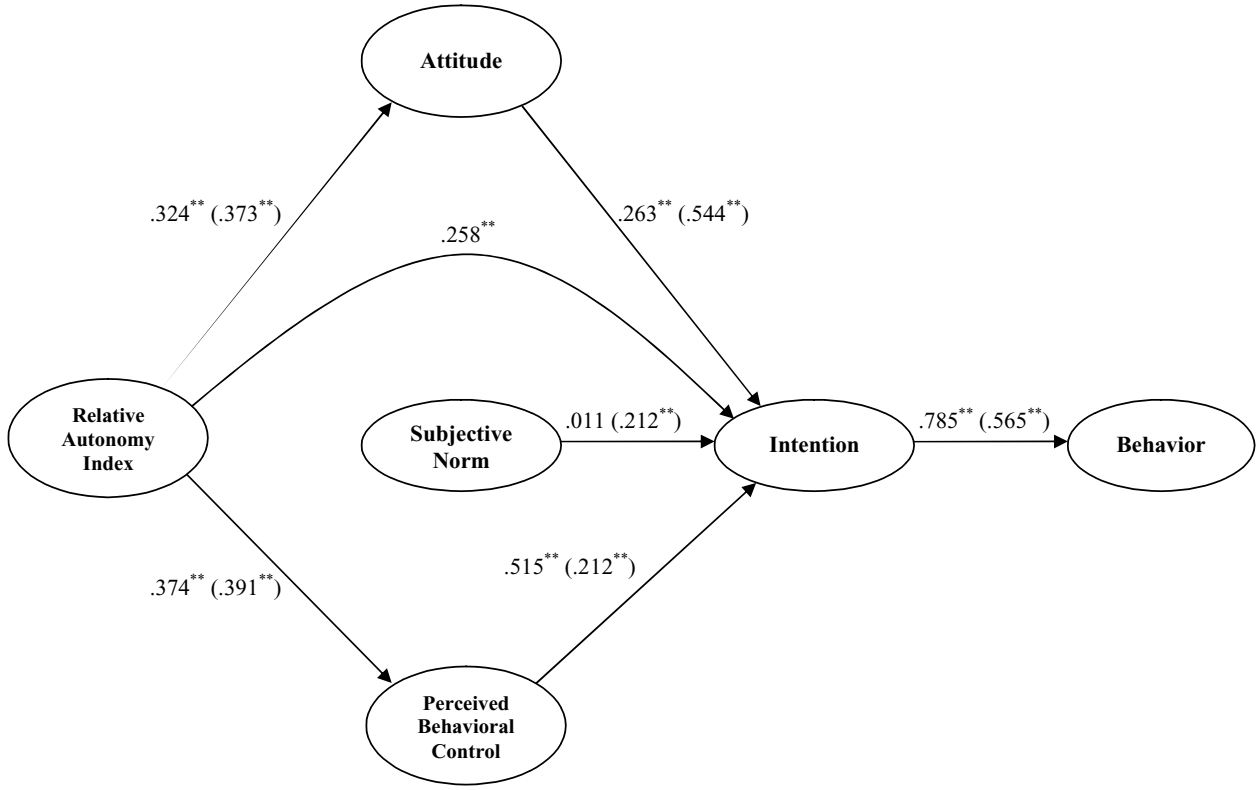

Fig. 2 Final structural equation model of the theory of planned behavior augmented to include autonomous motives illustrating standardized path coefficients. *Note*. Standardized path coefficients for the exercise sample are shown outside parentheses and coefficients for dieting sample shown within parentheses; The relative autonomy index → intention path was included in the model for exercise only; Covariances among for the attitude disturbance term, perceived behavioral control disturbance term, and subjective norm (ζ_{cov}) notshown.

construct on behavior via the mediation of intentions could be rejected. The alternative models did not reveal any significant direct effects of these constructs on behavior in both samples. Sobel tests flagged significant indirect effects of attitude on behavior in both samples (exercise $\beta = .207$, $p < .01$; dieting $\beta = .309$, $p < .01$), a significant indirect effect of PBC on behavior in the exercise sample ($\beta = .405$, $p < .01$, $p < .01$), and a significant indirect effect of subjective norms on behavior in the dieting sample ($\beta = .120$, $p < .01$).[3]

[3] We also tested an alternative hypothesis that the relationship between intention and behaviour would be moderated by autonomous motives. This is based on the theoretical assumption that individuals may form intentions to engage in dieting and exercise behaviour if, and only if, they reported high levels of autonomous motives in that context. In order to test this hypothesis, we formed groups with high and low levels of autonomous motives using a median split on the RAI variable and re-estimated the final structural equation models for each moderator group within the dieting and exercise samples. For both dieting and exercise, the standardized path coefficient between intentions and behavior was not significantly different as indicated by the lack of overlap in the 95% confidence intervals for the path coefficients across the high- and low-autonomous motives moderator groups. Therefore the hypothesis that the intention → behavior relationship was moderated by autonomous motivation had to be rejected.

Multi-sample structural equation model

A multi-sample SEM was used to test the invariance of the measurement and structural parameters of hypothesized model across exercise and dieting samples. The purpose of this analysis was to establish whether the number of specified factors and the items employed to define the latent factors in the SEMs (factor pattern and measurement parameters) were identical across the behaviors. More importantly, the analysis tested whether the pattern of prediction of the antecedent psychological variables in the proposed model (structural parameters) was equivalent across two behaviors. We conducted the analysis using the invariance routine advocated by Byrne, Shavelson, and Muthén (1989). First a baseline model was estimated that tested whether the contribution of each item to their respective factor was identical (factor loadings and cross-loadings) in both samples. Pending the satisfactory fit of this baseline model, a series of progressively more restrictive models was estimated. In these models a set of equality constraint equations was stipulated a priori that assumed that the following *measurement* parameters were invariant or equivalent across the samples from the two behavioral contexts: factor loadings, factor variances and disturbances, and the disturbance covariances. Finally,

a restricted model that constrained the *structural* parameters to be invariant across the two behavioral contexts was estimated. A difference in the CFI and NNFI of −.01 or less indicated that the model in the invariance routine achieved satisfactory goodness-of-fit relative to the baseline model (Cheung & Rensfold, 2002).

Goodness-of-fit statistics for the multi-sample SEMs are shown in Table 1. The baseline model fit the data adequately according to the criteria adopted which suggested that the factor pattern was tenable across the two behavioral contexts. The goodness-of-fit indices were within the −.01 critical value for the subsequent nested models in the invariance routine that constrained the factor loadings, factor variances and disturbances, and the disturbance covariances to be equivalent. This suggests that the number of factors, the relationships between the factors and their indicators, the variances of the factors and their error of prediction (disturbances), and the covariances between the disturbances all exhibited differences across these samples that were largely unsubstantial (Cheung & Rensfold, 2002). This supported the criteria suggested by Byrne et al. (1989) for measurement invariance. However, introducing constraints to the structural paths resulted in a drop in the fit indices that fell below the critical value suggesting that there was some misspecification in the model due to the introduction of the equality constraints. An examination of the model MIs indicated that two structural parameters were non-invariant: the intention → behavior ($\Delta\chi^2 = 7.711, df = 1, p < .01$) and the PBC → intention ($\Delta\chi^2 = 4.438, df = 1, p < .01$) paths.

Discussion

The present study tested an integrated theoretical model that explained the processes by which antecedent constructs from self-determination theory and the theory of planned behavior affected exercise and dieting behavior. Specifically, it was hypothesized that individuals' autonomous motives from self-determination theory would affect their intentions in both behavioral contexts via the mediation of their attitude and PBC constructs. It was also expected that intentions would mediate the effect of the attitude, subjective norm, and PBC on behavior in both contexts. In addition, it was expected that the models would be equivalent across both behavioral contexts at the measurement (same number of factors and measurement parameters) and structural level (same pattern and size of the relationships among factors) because the two behaviors are implicated in maintaining 'energy balance' (Kremers et al., 2004).

Findings of a structural equation model supported the hypothesis that autonomous motives, as represented by a weighted composite of the perceived locus of causality constructs, had pervasive effects on attitudes and perceived behavioral control (PBC) in both behavioral contexts, but not on subjective norms. Further, attitudes and PBC mediated the effects of autonomous motives on intentions, but contrary to hypotheses, autonomous motives also had a direct effect on intentions for the exercise sample. In addition, attitudes and PBC were strong predictors of behavioral intentions in both samples. The effect of subjective norms on dieting intentions was significant, although substantially lower than the contribution made by attitudes and PBC. However, the effect of subjective norms on intentions in the exercise sample was non significant, an unexpected finding. Intentions mediated the effects of attitudes and PBC on dieting and exercise behavior as hypothesized. Invariance analysis indicated that the models were equivalent at the measurement level and many of the structural paths were invariant across the behavioral contexts, supporting hypotheses. However, the invariance of the structural parameters was only partial (Byrne et al., 1989) because the effects of PBC on intentions and intentions on behavior were significantly higher in the exercise sample. Finally, the model accounted for more than half of the variance in intentions and behavior in both samples, illustrating the effectiveness of the model.

The present model supports the findings of previous studies that have attempted to integrate these theories in an exercise context and extends them to dieting, a related health behavior linked to 'energy balance' (Chatzisarantis et al., 2002; Hagger et al., 2002a, 2003, 2006). Importantly, it seems that the model can be replicated in both contexts as indicated by the well-fitting structural equation models for the exercise and the dieting behavior samples. In terms of mechanisms, the present study suggests that the role of autonomous motives from self-determination theory in predicting intentions in both behavioral domains is a pervasive one. The effect of autonomous motives on intentions is mediated by the belief-based constructs of attitudes and PBC from the theory of planned behavior. It seems, therefore, that people have the tendency to form personal and control-related perceptions regarding future participation in these two energy balance behaviors based on their perceptions that such behaviors are performed for autonomous reasons. In addition, it seems that attitudes and PBC are necessary for the translation of autonomous motives into intentions and that these sets of beliefs are important aspects of a motivational sequence involving motives, beliefs, and intentions. Further, the model highlights the central role of intentions, indicating that intentions also have an important role to play in the motivational structure in which autonomous reasons result in actual behavior. Intentions are an important step in translating autonomous motives into behavior in both behavioral domains, suggesting that the process is a deliberative one.

While the major contribution of the present study is that an integrated model comprising two theories can offer a more complete explanation of social behavior in both the

exercise and dieting behavioral contexts, the study has also indicated that there is considerable equivalence in the pattern and size of the effects across the behavioral contexts. The means that not only do the same independent variables (e.g., autonomous motives, attitudes, PBC) predict the same dependent variables (e.g., intentions, behavior) in the model across behavioral contexts, but the size of the effects do not vary. This is in keeping with previous research that has shown that the antecedents of behaviors relating to energy balance tend to cluster together (Kremers et al., 2004). In particular, it shows that the indirect effects of autonomous motives on intentions mediated by attitudes and PBC are consistent, as are the effects of attitudes on intentions.

There were, however, some effects that varied across the behavioral contexts. Most pervasive was the direct effect of autonomous motives on intentions which was significant in the exercise sample, but not the dieting sample. This indicated that the mediation of the autonomous motives → intention relationship by attitudes and PBC was only partial in the exercise sample. There have been inconsistent findings with respect to this direct effect in previous studies. Some studies have found a significant direct effect of autonomous motives on intentions (Chatzisarantis et al., 2002; Hagger et al., 2005, 2006) while others have found no direct path (Hagger et al., 2002a, 2003). This finding indicates that attitudes and PBC do not account for all of the effects of autonomous motives on intentions. The mediated route via attitudes and PBC reflects a motivational sequence in which autonomous motives affect the formation of attitudes and perceptions of control congruent with these motives prior to intention formation. The unmediated path may reflect the formation of intentions that is independent of these particular beliefs. This route likely represents the spontaneous formation of plans to act in accordance with autonomous motives without unnecessary deliberation over outcomes or perceptions of control. An example may be when the behavior is not novel and has clear, unambiguous outcomes that do not need to be considered for an intention to be formed. It is also possible that other belief-based variables related to autonomous reasons for engaging in dieting and exercise may mediate the direct effect of autonomous motivation on intentions for this behavior. For example, social support (Rhodes, Jones, & Courneya, 2002), a set of beliefs which reflect more autonomy-supportive perceptions of social influence rather than the controlling aspects that tend to be tapped by subjective norms, could be hypothesized to mediate the effect of autonomous reasons on intentions.

A further significantly different effect across the two behavioral contexts is the effect of subjective norms on intentions which was significant for dieting behavior but for exercise behavior, although the difference was not large enough to be flagged as varying across the behavioral contexts. A possible reason for this significant, albeit small, effect of subjective norms in dieting behavior may be because individuals tend to perceive more social pressure to engage in dieting behavior, possibly because it tends to be done for controlling reasons among some people. Indeed, there is evidence to suggest that both behaviors and people can be particularly subject to the pressure perceived to emanate from significant others regarding behavioral engagement in the health domain (Finlay, Trafimow, & Moroi, 1999; Hagger, Anderson, Kyriakaki, & Darkings, in press; Hagger & Chatzisarantis, 2006). Dieting may be one of these types of behaviors. However, it is important to note that the relative autonomous motivation construct did not affect subjective norms, and would be expected to if this construct reflected more-controlling aspects of social influence.

There were two further paths that were non-invariant across the exercise and dieting samples which, although both significant, were stronger in the exercise sample than the dieting sample. The stronger effect of PBC on intention may suggest that control-related perceptions are particularly relevant to intention formation than attitudes or subjective norm for exercise as illustrated in many studies using the theory of planned behavior in an exercise context (Hagger et al., 2002b). The variation in the intention-behavior relationship may indicate that intentional processes are more apt in explaining changes in exercise behavior compared with dieting behavior. Dieting behavior may be more susceptible to influences from other constructs not encompassed by intention such as personality (Conner & Abraham, 2001; Hagger et al., in press). Dieting behavior may be more subject to desire or impulsive influences rather than considered, intentional processes (Bagozzi & Kimmel, 1995).

A final important finding of the present study that should not be disregarded is the invariance of the measurement aspects of the model. This is important because it suggests that the measures used to tap the various study constructs from both theoretical perspectives are valid in both contexts. This construct validity relates to the efficacy of each latent factor to account for variance in its set of indicators or constituent items and the number of factors, or 'factor pattern,' across behavioral contexts. Importantly, this corroborates supports previous findings with the theory of planned behavior (Bagozzi, Lee, & Van Loo, 2001) and measures of autonomous motives (Hagger et al., 2006). Such evidence therefore paves the way for such measures to be used in other behavioral contexts related to the maintenance of a healthy body weight. It also suggests that researchers adopting these measures can be confident of producing valid models of the same latent constructs in other populations.

Limitations and future directions

There are a number of limitations of the present study that restrict the generalizability of the findings. First, the study was

conducted on a sample of undergraduate and postgraduate students. While exercise and dieting behaviors are important to the health of young people in University settings, findings from such a relatively homogenous population may not generalize well to the wider population. Further replication of this integrated theory in the general population and in other target populations are warranted, particularly in clinical populations where exercise and dieting behaviors may be of vital importance such as in patients undergoing rehabilitation from coronary heart disease or in morbidly obese people.

Second, although the present study adopted a prospective design, these data are correlational in nature and future studies may attempt to replicate these findings experimentally. For example, a possible study may experimentally enhance autonomous forms of motivation as well as the theory of planned behavior constructs and examine the effect of such manipulations on exercise and dieting intentions and behavior. Indeed, preliminary findings from a recent study that has adopted an intervention targeting these variables has shown that manipulating constructs from both theories results in unique additive effects on behavioral intentions in an exercise context (Chatzisarantis & Hagger, 2005).

Finally, the present results also rely on self-report measures of exercise and dieting behavior. Every effort was made to provide clear definitions of the specific target behaviors for the respondents and to adopt a measure that provided accurate estimates of the health behaviors with minimal response bias within the confines of a large-scale survey. This was achieved through measures that had strong correlations with more comprehensive measures and been shown to produce latent measures of behavior in previous studies (Hagger & Chatzisarantis, 2005a). However, these measures do have inherent limitations, may be subject to response bias, and, as such, may have introduced some additional method variance into the behavior estimates.

Conclusion

The present study provided some support for our hypothesized multi-theory model that autonomous motivation results in intentional action and behavior by affecting the immediate determinants of intentions, namely, attitudes and behavior. This contributes to theory on motivation by illustrating the processes that lead to intentional action based on autonomous forms of motivation. It also contributes to the health psychology literature by indicating that the antecedents and the processes that lead to two behaviors relevant to maintaining a healthy body weight are similar. Finally, the present study also indicates that practitioners have numerous targets for intervention and may choose to intervene to change perceptions at each point in the causal chain presented here. For example, interventions could not only provide salient and accessible information on the importance of exercise and diet to health, a strategy known to influence attitudes, but also provide it in an autonomy-supportive manner, which would serve to foster autonomous motives towards these behaviors (Chatzisarantis et al., 2006).

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