

Testing a self-determination theory-based teaching style intervention in the exercise domain

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Abstract

Drawing from self-determination theory (SDT), this study examined the effect of an autonomy supportive, well structured and interpersonally involving teaching style on exercise class participants' psychological need satisfaction, motivational regulations, exercise behaviour, behavioural intention and affect. Female exercise class participants enrolled in a 10-week exercise program were exposed to an SDT-based (i.e. SDTc; n = 25) or typical (i.e. control group; n = 31) teaching style. The control condition reported a significant decrease in autonomy support, amotivation and behavioural intention over time. In addition, they reported a significant increase in competence and introjected regulation. Compared to the control condition, the SDTc reported a significantly greater linear increase in structure and interpersonal involvement, relatedness and competence need satisfaction and positive affect. Attendance rates were significantly higher in the SDTc. SDT-based social-contextual characteristics and psychological needs predicted autonomous regulations; all these variables collectively predicted adaptive outcomes. Copyright © 2007 John Wiley & Sons, Ltd.

Although regular physical activity is conducive to physical and psychological health (Biddle & Mutrie, 2001), less than 30% of adults meet current physical activity recommendations (e.g. Department of Health, 2004). To increase the number of people that engage in, and maintain, a physically active lifestyle, the social psychological factors conducive to exercise adoption and adherence need to be delineated. Self-Determination Theory (SDT; Deci & Ryan, 1985), a contemporary theoretical perspective of human motivation, appears to hold promise for elucidating the socio-contextual and psychological factors influencing participation in physical activity.

BASIC PSYCHOLOGICAL NEED SATISFACTION AND A MOTIVATIONAL CONTINUUM

SDT assumes that all humans possess three basic psychological needs that are fundamental to the nature and quality of engagement in any given domain (Deci & Ryan, 1985), a proposition supported by previous research (e.g. Sheldon, Elliot, Kin, & Kasser, 2001). A need for autonomy reflects a desire to engage in activities of one's choosing and to be the origin of one's own behaviour (deCharms, 1968; Deci & Ryan, 1985). A need for relatedness involves feeling connected to others,

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or feeling that one belongs in a given social milieu (Baumeister & Leary, 1995; Deci & Ryan, 1985). Finally, a need for competence implies that individuals have a desire to interact effectively with the environment, to experience a sense of effectance in producing desired outcomes and preventing undesired events (Deci & Ryan, 1985).

SDT also proposes three categories of motivation: amotivation, extrinsic motivation, (which is itself made up of four different types of regulation: external, introjected, identified and integrated) and intrinsic motivation. Each type of motivation varies with regard to the amount of autonomy associated with it, and thus, lies along a continuum ranging from low (amotivation) to high (intrinsic motivation) self-determination (Deci & Ryan, 1985).

Amotivation represents 'a state lacking of any intention to engage in a given behaviour' (Deci & Ryan, 1985; Markland & Tobin, 2004). With *external regulation*, an individual engages in an activity to obtain external rewards or to avoid punishments (Deci & Ryan, 1985). Individuals guided by *introjected regulation* engage in the activity because of internal pressure, feelings of guilt or to attain ego enhancement (Ryan & Deci, 2000). *Identified regulation* reflects participation in an activity because one holds certain outcomes of the behaviour to be personally significant (e.g. improved health). *Integrated regulation* occurs when identified regulations are fully assimilated into the self and are brought into congruence with one's other values and needs (Deci & Ryan, 2000). *Intrinsic motivation* involves partaking in an activity because it is inherently enjoyable (Deci & Ryan, 2000).

SDT posits that satisfaction of the basic psychological needs is central to determining the type of regulation guiding behaviour (Deci & Ryan, 2000). Satisfaction of the needs of autonomy and competence is proposed as central to promoting intrinsic motivation. If autonomous forms of extrinsic motivation (i.e. integrated and identified regulation) are to guide behaviour, the needs of autonomy and relatedness must be satisfied. However, when the needs are pitted against one another, or are thwarted, more controlling forms of motivational regulation (i.e. introjected and external regulations) or amotivation ensue (Deci & Ryan, 1985, 2000; Koestner & Losier, 2002). When the psychological needs are satisfied and more autonomous forms of regulation guide behaviour, adaptive behavioural, cognitive and affective responses are expected (Deci & Ryan, 1985; Vallerand, 1997). In contrast, need thwarting and less autonomous forms of regulation are proposed to result in non-optimal outcomes (Ryan & Deci, 2000).

FACILITATING PSYCHOLOGICAL NEED SATISFACTION, AUTONOMOUS MOTIVATION AND ADAPTIVE OUTCOMES

SDT may be considered a particularly attractive theory for health and exercise professionals attempting to facilitate health behaviour change, as it specifies three socio-contextual variables (i.e. autonomy support, structure and interpersonal involvement) which are held to correspond to variability in psychological need satisfaction, the motivational regulations undergirding behaviour and ensuing motivational outcomes.

Autonomy support refers to the provision of choice and meaningful rationale from those in a position of authority, acknowledgment of the perspective of others and minimization of pressure (Deci, Eghrari, Patrick, & Leone, 1994). For example, an exercise instructor who is behaving in an autonomy supportive manner will see the situation from the exercisers' perspective and encourage them to make their own decisions. He/she would not try to impose his/her own perspective on them, or attempt to make them change (Williams, Gagne, Ryan, & Deci, 2002). When at least two of the components of autonomy support are present, it is postulated that the regulation of behaviour will be perceived by the exerciser as his/her own, and the most autonomous forms of external regulation will guide his/her behaviour. If only one or none of these factors are present, partial internalization will occur and less autonomous forms of regulation will arise (Deci et al., 1994).

Structure describes the extent to which behaviour-outcome contingencies are made understandable, and whether those in a position of authority make their expectations clear and provide feedback (Deci et al., 1994; Deci & Ryan, 1991; Reeve, 2002; Ryan, 1993). Thus, to provide structure, an exercise instructor would set clear goals at the start of the class. To facilitate autonomous regulation, the components of structure should be delivered in an autonomy supportive manner (Deci & Ryan, 1991). For example, in the case of an exercise class, it would be best for the instructor to involve class participants in the goal setting process.

Finally, *interpersonal involvement* refers to the quality of the relationship between those in a position of authority and the individuals they interact with, and represents the formers' willingness to dedicate psychological resources, such as

time, energy and affection (Deci & Ryan, 1991; Reeve, 2002). In an exercise class, the instructor would demonstrate interpersonal involvement by recognizing participants' interest and disinterest, and if a problem arose, trying to counter the difficulty and re-engage the class. To derive advantageous outcomes, interpersonal involvement must also be delivered in an autonomy supportive manner; that is, the authority figure should provide unconditional positive regard which is non-contingent and non-judgmental (Deci & Ryan, 1991).

PREVIOUS RESEARCH EXAMINING THE SOCIO-CONTEXTUAL CHARACTERISTICS ADVANCED BY SDT

Perceived autonomy support has been shown to be positively related to psychological need satisfaction, autonomous regulation and/or adaptive behavioural, cognitive and affective outcomes in the educational (e.g. Reeve, 2002; Reeve, Jang, Carrell, Jeon, & Barch, 2004; Vansteenkiste, Simons, Lens, Sheldon, & Deci, 2004), health care (e.g. Kennedy, Goggin, & Nollen, 2004; Williams, Grow, Freedman, Ryan, & Deci, 1996; Williams, Rodin, Ryan, Grolnick, & Deci, 1998; Williams, McGregor, Zeldman, Freedman, & Deci, 2004) and exercise (e.g. Edmunds, Ntoumanis, & Duda, 2006; Wilson & Rodgers, 2004) domains. Research has also demonstrated that it is possible for teachers to learn how to become more autonomy supportive with students (Reeve, 1998; Reeve et al., 2004), and experimental studies have revealed that an autonomy supportive interpersonal counselling or teaching style can predict adaptive motivational and behavioural outcomes in health care (e.g. smoking cessation; Williams et al., 2002, 2006) and exercise (e.g. Vansteenkiste, Simons, Soenens, & Lens, 2004) settings.

To our knowledge, however, previous SDT-focused studies have only considered the potential advantage of an autonomy supportive interpersonal climate; the socio-contextual characteristics of structure and interpersonal involvement have yet to be considered. Further, studies have examined the effect of autonomy support on only one need [e.g. competence (Williams et al., 2002, 2006) or autonomy (e.g. Vansteenkiste, Simons, Soenens et al., 2004)], or have used, in the majority of instances, an autonomous motivation composite (Vansteenkiste, Simons, Lens et al., 2004; Williams et al., 2002, 2006). Research has yet to delineate the impact of a manipulated SDT-based social climate, which incorporates the dimensions of autonomy support, as well as structure and interpersonal involvement, on the satisfaction of all three psychological needs and each of the motivational regulations encompassed within SDT.

AIMS AND HYPOTHESES OF THIS STUDY

The first objective of the present study was to examine whether an exercise instructor's teaching style can be manipulated so that it is perceived by exercise class participants and independent observers as providing more autonomy support, structure and interpersonal involvement. Autonomy support has been defined as a mode of communication that is context free, and research in the educational domain has shown that teachers can be taught how to be autonomy supportive (e.g. Reeve, 1998; Reeve et al., 2004; Williams et al., 2002, 2006). Consequently, it was hypothesized that over time an autonomy supportive, as well as a well-structured and interpersonally involved, teaching style (i.e. SDT-focused condition; SDTc) would be rated by exercise class participants and independent observers as providing higher levels of autonomy support, structure and interpersonal involvement, compared to a control condition/standard practice exercise class environment.

The second objective was to examine the impact of an exercise class taught in accordance with the socio-contextual variables advanced by SDT on the psychological needs, autonomous motivation and related outcomes. Based on empirical and theoretical reviews (e.g. Edmunds et al., 2006; Mageau & Vallerand, 2003), it was also hypothesized that, compared to participants in the control group, those in the SDTc would report significant increases in psychological need satisfaction and self-determined motivation over time. As psychological need satisfaction and autonomous regulation are held to promote adaptive outcomes (Deci & Ryan, 1985), it was also expected that the SDTc would also facilitate significant increases in exercise related behavioural engagement and positive affect.

The third objective was to examine the motivational sequence embedded in SDT. Specifically, we hypothesized that autonomy support, structure and interpersonal involvement would predict psychological need satisfaction. In conjunction with the social-contextual variables, psychological need satisfaction was hypothesized to positively predict autonomous regulation, and negatively predict more controlling forms of regulation. Finally, social-contextual characteristics, psychological need satisfaction and autonomous regulations were hypothesized to predict adaptive behavioural, cognitive and affective outcomes. Controlling regulations were expected to result in less desirable consequences.

METHOD

Participants

Participants were female university students and staff who had signed up for one of two exercise classes conducted in the university sports centre (no men signed up for either class). As participants paid for their class, they chose the class in which they participated. One class was randomly designated as the SDTc, whilst the other formed the control condition. Twenty-five females were in the SDTc. These women ranged from 18–53 years of age ($M = 21.26$, $SD = 3.80$). The control group included 31 females, who ranged in age from 18–38 years ($M = 21.36$, $SD = 6.71$). The two groups did not significantly differ in age ($t(54) = .07$, $p = .94$). The majority of participants in the SDTc classified themselves as White (96%; 4% as Chinese). In the control group, 74% of participants classified themselves as White, 19.3% as Asian/Asian British (i.e. Indian, Pakistani, Bangladeshi or any other Asian background) and 6.5% as Chinese. Chi-square analysis, based upon Fisher's exact probability test (utilized because 50% of cells had expected cell counts less than 5), revealed a significant difference ($p = .03$) between the groups in terms of their ethnic/racial composition (i.e. White versus Non-White). Ninety six per cent of participants in the SDTc, and 90% in the control group, were university students.

Procedures

This study was approved by the ethics subcommittee of a large UK University. Two intermediate level 'cardio combo' (i.e. a mix of boxing choreography and step aerobics) classes constituted the mode of exercise in the current study. Classes were held on a Monday (SDTc) and Wednesday (control) evening, once a week, for 10 weeks. Both classes were run by the same exercise instructor (i.e. a 28 years old White Canadian female, certified by the Canadian Association of Fitness Professionals, with 11 years of teaching experience), in the same venue, throughout the same academic term (i.e. October–December) and at a similar time of the day (i.e. both classes were held in the early evening). As in previous studies of SDT-based interventions in the health care domain (i.e. smoking cessation; Williams et al., 2002), we decided that we would have one exercise instructor delivering both conditions as this would control for individual differences in treatment styles.

Week 1 class constituted a 'taster' session, whereby individuals could try out the exercise class before signing up and paying for the duration of the term. The social-contextual characteristics were not manipulated in this week; the instructor exhibited her typical teaching style. At the end of this first session, the principle investigator informed participants that their class had been selected to take part in a study being conducted at the University. Upon stressing that participation was voluntary, participants were informed that the study aimed to examine personal and psychological characteristics of the exerciser and exercise class leader which can influence the exercise experience. Participants in the SDTc were not informed that the leadership style in their class was manipulated, and in neither class were they told that they would be compared to participants in another class/condition. To act as an incentive, class members were informed that if they agreed to participate and provided all required data, they would be entered into a £50 (approximately \$100 US) prize draw.

Those participants that decided to sign up to the class for the duration of the term, and who were willing to take part in the study, provided informed consent (observations of the classes suggested that this constituted approximately 70% of the members of each class). They also completed an initial questionnaire packet measuring basic demographic variables, perceived autonomy support, structure and interpersonal involvement provided by the exercise instructor, psychological need satisfaction, motivational regulations, behavioural intention and positive and negative affect (see Measures

subsection for details). In addition, two trained, independent observers, blind to the experimental conditions, rated the level of autonomy support, structure and interpersonal involvement provided by the exercise instructor in week 1. Moreover, the independent observers also rated the 'active engagement' demonstrated by participants in each condition (i.e. the behavioural intensity and emotional quality of participants' involvement in the class; Reeve et al., 2004).

From week 2 to the end of the study the exercise class leader manipulated her teaching behaviour to fit the regulatory style selected for each group. In creating the SDTc, the exercise instructor focused upon promoting autonomy support by taking the perspective of the exercise class participants into account, acknowledging their feelings and providing them with pertinent information and opportunities for choice (Deci et al., 1994). Participants in the SDTc were given choice regarding which exercises they wanted to do and these exercises were then replicated in the control condition. Thus, members of the two classes received comparable physical work-outs, reducing the likelihood that class differences in outcome variables could be attributed to differences in physical workload. The use of pressure, demands and extrinsic rewards were also minimized (Black & Deci, 2000; Reeve et al., 2004). Structure was established by providing clear expectations, optimal challenge and timely and informative feedback (Reeve, 2002; Reeve et al., 2004). The exercise instructor dedicated psychological resources to the participants, showing that she was interested in them, and that she was concerned about their well being (Reeve, 2002; Reeve et al., 2004). Practical examples detailing how the SDTc was created, which pull predominantly from the work of Reeve et al. (2004) are available from the first author upon request. The control group was intended to replicate the style of teaching regularly observed in the exercise setting. Although autonomy support, structure and interpersonal involvement were not intentionally promoted in this group, no attempts were made to purposefully undermine participants' experiences in this condition.

The same measures of autonomy support, structure and interpersonal involvement completed during week 1, were also rated by participants in weeks 5 and 9. In addition, during weeks 4 and 8, the same independent observers as those utilized in week 1 rated the autonomy support, structure and interpersonal involvement provided by the exercise class leader, and the amount of 'active engagement' (Reeve et al., 2004) displayed by the exercise class participants. These measures tested the extent to which the desired social-contextual characteristics were effectively manipulated in the SDTc versus control condition. In weeks 6 and 10, the same measures of psychological need satisfaction, motivational regulations, behavioural intention, and affect, as those provided during week 1, were completed by the participants.

When all measures were collected, participants were debriefed about the purposes of the study and their questions answered. We recognized that it was possible for participants in the two conditions to have known one another, and that they could have discussed their participation or guessed the nature of the study. Thus, the principle investigator also asked participants whether they had discussed their study involvement with participants of other exercise classes or guessed the actual purpose of the study. No participants reported doing so.

Measures

Socio-contextual Characteristics

Exercise class participants' perceptions of autonomy support, structure and interpersonal involvement were assessed using the Perceived Environmental Supportiveness Scale (Tobin, 2003). Tobin demonstrated that these subscales were internally reliable (Cronbach α values were .79, .79 and .78, respectively). In addition, independent observers completed an adapted version of an observation rating scale developed by Reeve et al. (2004) to measure autonomy support, structure and interpersonal involvement provided by the exercise instructor, and the active engagement displayed by exercise class participants. Reeve and colleagues have shown these sub-scales to possess adequate reliability (i.e. α 's > .81).

Psychological Need Satisfaction

Autonomy, relatedness and competence were measured via the Psychological Need Satisfaction Scale (Tobin, 2003). Tobin reported Cronbach α values of .59, .72 and .69, respectively, for these subscales.

Motivational Regulations for Exercise

Participants' motivation to engage in the exercise class was measured using the Behavioural Regulation in Exercise Questionnaire-2 (BREQ-2; Markland & Tobin, 2004). Cronbach α s for all BREQ-2 subscales have been shown to exceed .75 (Wilson & Rodgers, 2004). The present study also utilized the integrated regulation of Li's (1999) Exercise Motivation Scale. This scale has also been shown to display adequate internal reliability in past work (i.e. α 's > .75; Li, 1999).

Exercise Behaviour

Adherence to the exercise class was measured via a weekly register of attendance, completed by the exercise instructor for each condition.

Behavioural Intention

Behavioural intention to continue participating in the exercise class was assessed using a methodology reported by Wilson and Rodgers (2004). During weeks 1 and 6 this measure assessed participants' intention to continue exercising in their current exercise class. At week 10 (the end of the course), items were worded to assess whether participants intended to join exercise classes run by their present exercise class leader during the following term. Wilson and Rodgers reported an internal consistency of $\alpha = .89$ for this scale.

Positive and Negative Affect

The Positive Affect and Negative Affect Scale (PANAS; Watson, Tellegen, & Clark, 1988) was used to measure the positive and negative affect that participants felt while exercising in their class. Watson et al. (1988) showed the scale to possess acceptable internal consistencies (i.e. α 's ranged from .86 to .90), good test-retest reliability and factorial and convergent validity.

RESULTS

Reliability Analyses and Descriptive Statistics

Internal consistency estimates and descriptive statistics were computed for all variables at each measurement point for both groups (see Tables 1 and 2). For each questionnaire completed by the exercise class participants, internal consistency coefficients were calculated. In most cases, observed Cronbach α s were greater than .70. Bivariate correlations were also computed to assess the reliability of the independent observer ratings, for each assessed variable (i.e. autonomy support, structure, interpersonal involvement and active engagement), across the three measurement occasions, in both conditions. Bivariate correlations ranged from .60 to .99, with the exception of one (i.e. $r = .33$ (for structure in the SDTc); Mean $r = .78$). However, these correlations should be interpreted with caution as they are based on two degrees of freedom only.

At week 1, autonomy support was the socio-contextual characteristic perceived most highly by participants in both conditions, followed by structure and then interpersonal involvement. In contrast, the independent observers rated structure most highly during week 1. Autonomy was the psychological need, and intrinsic motivation the motivational regulation, rated most highly by participants in both conditions in week 1. In general, mean scores, from the independent observations (for the socio-contextual variables) and participant self-reports, for the socio-contextual variables,

Table 1. Reliability analyses (Cronbach's coefficient α) and descriptive statistics for the social-contextual characteristics at weeks 1, 5 and 9, by condition

Variable	Range	Week 1			Week 5			Week 9		
		α	C M (SD)	SDTc M (SD)	α	C M (SD)	SDTc M (SD)	α	C M (SD)	SDTc M (SD)
Exercisers' self-reports										
Autonomy support	1-7	.78	5.90 (1.17)	5.60 (1.21)	.94	4.48 (1.22)	6.59 (0.50)	.91	5.08 (1.33)	6.33 (0.40)
Structure	1-7	.85	5.16 (1.04)	4.98 (1.45)	.84	5.21 (1.78)	5.68 (0.75)	.89	5.13 (1.35)	5.59 (0.72)
Interpersonal involvement	1-7	.95	4.97 (1.22)	4.79 (1.44)	.92	5.04 (1.40)	5.66 (0.85)	.96	5.17 (1.61)	5.63 (0.86)
Independent observers										
Autonomy support	1-7	—	4.50 (1.41)	5.13 (0.88)	—	2.75 (0.71)	5.63 (0.18)	—	2.25 (0.35)	5.88 (0.18)
Structure	1-7	—	5.40 (0.00)	5.30 (0.71)	—	3.70 (0.99)	5.50 (0.14)	—	4.20 (0.57)	6.10 (0.14)
Interpersonal involvement	1-7	—	4.88 (0.88)	4.75 (0.35)	—	3.13 (0.18)	5.63 (0.18)	—	3.25 (0.00)	5.63 (0.88)
Active engagement	1-7	—	4.00 (0.00)	4.70 (0.42)	—	4.50 (0.14)	4.90 (0.71)	—	4.70 (0.99)	5.70 (0.42)

Note: C, control group; SDTc, self-determination theory-based condition. Cronbach's α values could not be computed for the variables rated by the independent observers as there were only two ratings per variable at each time point.

psychological needs and autonomous forms of regulation, as well as the outcomes of interest (e.g. positive and negative affect), remained constant or decreased over time for the control group, whereas they increased in the SDTc.

Multilevel Regression Analyses

Multilevel modelling (MLM), using MLwin (version 2.0; Rasbash, Steele, Browne, & Prosser, 2005), was used to test the main hypotheses. As with standard regression analyses, the aim of MLM is to express the dependent variable as a function of predictor variables. However, the multilevel regression equations specified in this study incorporated two levels of analyses: A within-person equation (or Level 1 model), which is concerned with within-individual change (i.e. how each

Table 2. Reliability analyses (Cronbach's coefficient α) and descriptive statistics for psychological need satisfaction, motivational regulations and behavioural, cognitive and affective outcomes at weeks 1, 6 and 10, by condition

Variable	Range	Week 1			Week 6			Week 10		
		α	C M (SD)	SDTc M (SD)	α	C M (SD)	SDTc M (SD)	α	C M (SD)	SDTc M (SD)
Psychological needs										
Autonomy	1-7	.72	5.56 (1.28)	4.85 (1.44)	.71	5.61 (1.16)	5.42 (1.07)	.61	5.59 (1.35)	5.39 (1.06)
Relatedness	1-7	.91	5.11 (1.27)	4.60 (1.51)	.73	5.44 (1.07)	5.38 (0.79)	.93	5.40 (1.28)	5.72 (0.84)
Competence	1-7	.85	4.54 (1.30)	3.80 (1.44)	.78	5.22 (1.23)	5.18 (0.90)	.75	5.33 (1.08)	5.61 (0.69)
Motivational regulations										
Amotivation	0-4	.73	0.45 (0.70)	0.37 (0.57)	.57	0.13 (0.29)	0.27 (0.45)	.87	0.03 (0.08)	0.13 (0.17)
External regulation	0-4	.77	0.50 (0.66)	0.68 (0.85)	.81	0.35 (0.39)	0.70 (0.90)	.84	0.58 (0.98)	0.71 (0.83)
Introjected regulation	0-4	.67	1.34 (0.91)	1.76 (0.78)	.69	1.61 (0.75)	2.04 (1.03)	.80	2.10 (1.03)	1.89 (1.00)
Identified regulation	0-4	.68	3.15 (0.55)	2.75 (0.68)	.80	3.48 (0.45)	3.10 (0.69)	.82	3.30 (0.72)	3.13 (0.81)
Integrated regulation	0-4	.66	2.49 (0.86)	2.21 (0.66)	.81	2.48 (0.63)	2.37 (1.15)	.92	2.87 (0.92)	2.38 (1.25)
Intrinsic motivation	0-4	.83	3.25 (0.67)	2.78 (0.59)	.74	3.48 (0.54)	3.05 (0.37)	.92	3.38 (0.81)	3.04 (0.50)
Cognitive and affective outcomes										
Behavioural intention	1-7	.92	6.44 (0.74)	6.48 (0.79)	.67	6.33 (0.75)	6.47 (0.55)	.87	4.67 (1.52)	5.67 (1.33)
Positive affect	1-5	.81	3.79 (0.59)	3.48 (0.50)	.90	3.88 (0.76)	3.59 (0.55)	.82	3.67 (0.57)	3.72 (0.51)
Negative affect	1-5	.75	1.37 (0.40)	1.38 (0.38)	.83	1.21 (0.22)	1.17 (0.25)	.86	1.52 (0.69)	1.18 (0.20)

Note: C, control group; SDTc, self-determination theory-based condition.

individual changes over time), and a between-person equation (or Level 2 model), which is concerned with inter-individual differences in change (i.e. what predicts differences between people in their rate of change). MLM is particularly useful for the analysis of longitudinal data in which there are several measurements nested within individuals. In this study, the data set was comprised of three weekly observations (weeks 1, 5 and 9 for the ratings of autonomy support, structure and interpersonal involvement, and weeks 1, 6 and 10 for all other study variables), nested within study participants. MLM is also suitable when there are missing data (i.e. participants not completing all assessments), as was the case in the present study (see Singer & Willett, 2003 for more information).

Is it Possible to Manipulate the Socio-Contextual Variables Proposed by SDT?

First, we tested conditional growth models examining the effects of the teaching style condition (a dichotomous variable was created, where control = 0 and SDTc = 1) on the intercept and rate of change (i.e. slope) of each social-contextual variable proposed by SDT. In these models, the intercept reflects the mean level of the dependent variable (e.g. autonomy support) at baseline (the time measure was centered at baseline) for the control group, whereas the main effect for condition represents the difference in the baseline scores between the two conditions. The slope represents the change in the dependent variables scores in the control group, whereas the interaction between the slope and condition shows the difference in the rate of change of scores between the control and the SDTc over the course of the 10-week program.

The SDTc and control group did not differ in the mean baseline levels of the socio-contextual variables. In the control group, autonomy support ($B = -0.65, p < .001$) demonstrated a significant linear decrease over time. The SDTc differed significantly to the control group in autonomy support ($B = 1.25, p < .001$), structure ($B = 0.56, p < .05$) and interpersonal involvement ($B = 0.49, p < .05$); each demonstrated a significant linear increase over time.

Assessing the Impact of a SDT-Based Instruction Style on Psychological Need Satisfaction, Motivational Regulations and Related Exercise Outcomes

In line with the models presented above, we then tested conditional growth models examining the effect of condition on the intercept and rate of change (i.e. slope) of each psychological need, motivational regulation and exercise related outcome. The interpretation of the intercepts and slopes is the same as in the models presented above.

Psychological Needs

Baseline means for autonomy, relatedness and competence need satisfaction for participants in the SDTc were not significantly different to those in the control group. Competence need satisfaction was the only psychological need to demonstrate a significant change over time in the control group ($B = 0.32, p < .05$). Compared to the participants in the control group, participants in the SDTc displayed a significantly greater linear increase in relatedness ($B = 0.50, p < .05$) and competence ($B = 0.66, p < .01$) need satisfaction.

Motivational Regulations

Baseline scores for participants in the SDTc differed significantly to those in the control group for intrinsic motivation ($B = -0.47, p < .01$), and identified ($B = -0.39, p < .05$) and introjected ($B = 0.46, p < .05$) regulations. Participants in the SDTc started the intervention with lower levels of autonomous motivation (i.e. intrinsic motivation and identified regulation) and higher levels of introjected regulation. For those in the control group, introjected regulation demonstrated a significant linear increase over time ($B = 0.29, p < .01$), whereas amotivation showed a significant linear decrease ($B = -0.22, p < .001$). The SDTc did not differ to the control group in terms of the rate of change observed for any of the motivational regulations.

Behavioural, Cognitive and Affective Outcomes

Participants in the SDTc started the exercise program with significantly lower levels of positive affect derived from exercise ($B = -0.34, p < .05$). In the control group, behavioural intention ($B = -0.77, p < .001$) decreased over time.¹ The SDTc demonstrated a significantly higher and positive slope for positive affect ($B = 0.25, p < .01$).

Differences in Attendance

An independent samples *t*-test revealed a significant difference between groups in attendance ($t(54) = -2.04, p < .05$), with participants in the SDTc ($M = 6.52, SD = 2.66$) attending significantly more often than those in the control condition ($M = 5.19, SD = 2.21$). This difference reflected a medium effect size ($d = 0.54$).

Examining the Motivational Sequence of SDT

A final group of models examined the main effects of key demographic and psychological predictors on the intercept (i.e. baseline levels) of each need, regulation and outcome. These models also examined whether the effects of these predictor variables varied over time (i.e. we tested the interaction of each predictor with the slope). Further, in all models we included 'condition' and its interaction with the slope term.

Predicting the Socio-Contextual Variables

Ethnicity and age did not play a role in predicting autonomy support, structure and interpersonal involvement. In fact, ethnicity and age did not emerge as significant predictors in any of the subsequent models, and thus, they shall not be discussed further.

Predicting the Psychological Needs

The social-contextual dimensions were added simultaneously as predictors of each psychological need. None of the social-contextual characteristics emerged as significant predictors of any of the psychological needs at baseline. Moreover, the effects of these variables on the three needs did not vary significantly over time.

Predicting the Motivational Regulations

The social-contextual characteristics and psychological needs were then added as predictors of each of the motivational regulations. However, the results of the multilevel regression analyses, when compared with data derived from simple correlation analyses, suggested that the models for external, introjected and integrated regulation were marked by net suppression. (Cohen & Cohen, 1983). Net suppression occurs when a correlation between two independent variables suppresses the real effect of each variable on the criterion variable under examination, and consequently, regression coefficients are reduced or emerge in the opposite direction to that indicated by correlation coefficients. Net suppression effects are common in the testing of complex models (Cohen & Cohen, 1983). To test for suppression effects, each variable (i.e. each socio-contextual variable and psychological need) was modelled separately as a predictor of each regulation

¹The measure of behavioural intention used at the third, and final, measurement point (i.e. week 10) was worded differently to that utilized at weeks 1 and 6. During weeks 1 and 6 the items referred to participants' intention to continue participating in the exercise class until the end of the course. However, at the last measurement point the items tapped whether participants intended to join exercise classes run by their instructor in the subsequent term. We recognize that this distinction may have impacted on our findings. Thus, we carried out separate paired samples *t*-tests focusing on the first two time points only. These tests revealed that from weeks 1 to 6 the control group decreased significantly in their behavioural intention to continue partaking in the exercise group. There was no such decrease in the SDTc group.

(i.e. external, introjected and integrated regulation). The problematic B 's emerged in the opposite direction to that observed in the original model, and thus, net suppression was confirmed. Consequently, for external, introjected and integrated each predictor variable was entered into the models separately. For all other motivational regulations, the predictor variables were entered and assessed simultaneously.

Structure ($B = 0.63, p < .05$) and competence ($B = 0.16, p < .01$) emerged as positive predictors of integrated regulation at baseline. Autonomy ($B = -0.39, p < .001$) emerged as a negative predictor of identified regulation at baseline. The effects of autonomy and autonomy support on identified regulation (autonomy $B = 1.06, p < .001$; autonomy support $B = 0.48, p < .01$) and intrinsic motivation (autonomy $B = 0.64, p < .01$; autonomy support $B = 0.62, p < .01$) varied significantly over time. The effect of autonomy on integrated regulation ($B = 1.35, p < .001$) also varied significantly over time. Plotting these interactions revealed that although autonomy need satisfaction was a negative predictor of identified regulation at baseline, it became a significant positive predictor at weeks 6 and 10. For integrated regulation and intrinsic motivation, autonomy was not a significant predictor at baseline, but it became a significant positive predictor at weeks 6 and 10. The effects of autonomy support on intrinsic motivation and identified regulation were positive on all three measurement occasions. Moreover, these effects increased over time.

Predicting Cognitive and Affective Outcomes

The SDT-based social-contextual characteristics, psychological needs and motivational regulations were then examined as predictors of exercise class specific behavioural intentions, and exercise related positive and negative affect. Net suppression effects were identified and confirmed for all outcome variables. Thus, each predictor variable was entered into each model separately.

Autonomy support ($B = 0.30, p < .05$), structure ($B = 0.49, p < .05$) and interpersonal involvement ($B = 0.36, p < .05$) positively predicted behavioural intention at baseline, whereas amotivation ($B = -1.06, p < .01$) was a negative predictor. Integrated regulation ($B = 0.30, p < .05$) emerged as a positive predictor of positive affect. Competence ($B = -0.09, p < .05$) negatively predicted, and external regulation ($B = 0.43, p < .01$) and amotivation ($B = 0.26, p < .05$) positively predicted negative affect at baseline. The effects of structure ($B = -0.41, p < .05$), interpersonal involvement ($B = 0.51, p < .05$) and amotivation ($B = 0.98, p < .05$) on behavioural intention also varied significantly over the three measurement occasions. Plotting these interactions revealed that structure and interpersonal involvement were significant positive predictors of behavioural intention at baseline, and amotivation was a negative predictor. However, these effects became non-significant on subsequent measurement occasions.

DISCUSSION

The present research entailed a manipulation of the autonomy supportive, structural and interpersonal facets of an exercise instructor's teaching style in a real-life exercise setting. We then examined whether the manipulated environment, in contrast to a standard exercise class environment, impacted changes in psychological need satisfaction, autonomous motivational regulations for exercise and behavioural, cognitive and affective exercise outcomes over the course of a 10-week exercise class program. Finally, this study also explored, over time, the inter-relationships between the socio-contextual variables, psychological needs, motivational regulations and exercise related behaviours, cognitions and affect.

Creating an Exercise Environment Based on SDT's Propositions

At week 1, the levels of autonomy support, structure and interpersonal involvement reported by participants in the control group and SDTc were not statistically different. This was expected considering that week 1 constituted a baseline for the study. Thus, the exercise class instructor taught both classes in accordance with her typical teaching style. This finding is desirable considering that random allocation of participants was not possible.

The results also demonstrate that it is possible to train an exercise instructor to create a class environment marked by autonomy support, structure and interpersonal involvement. Support for the effectiveness of the manipulation stemmed from participant self-reports as well as by ratings provided by two independent observers. These findings concur with prior research indicating that teachers, and health professionals, can be effectively trained to adopt a self-determination centered teaching style (e.g. Reeve, 1998; Reeve et al., 2004; Williams et al., 2002, 2006). In contrast, perceptions of structure and interpersonal involvement did not change over time in the control group, whereas perceptions of autonomy support decreased. The former results make sense as there was no manipulation of the teaching style in the control condition. Although decreasing significantly over time, it is important to note that the mean perceptions of autonomy support remained above average for the duration of the 10-week course among the control group participants. Thus, the control condition could not be considered as providing an unrealistically low, or potentially detrimental, level of autonomy support.

Facilitating Adaptive Motivational Processes and Outcomes

Besides exploring baseline differences and changes in the three socio-contextual characteristics, we were also interested to examine, in each condition, baseline levels and changes over time in reported psychological need satisfaction, motivational regulations and behavioural, cognitive and affective outcomes.

Participants in the control condition reported no changes in autonomy and relatedness need satisfaction, but demonstrated a significant linear increase in competence need satisfaction over the 10-week course. The former findings support our hypotheses but the latter finding was in contrast to predictions. However, it is plausible that, as long as the exercise tasks are not too complex or demanding, being involved in an exercise program could increase class participants' feelings of competence over time, especially for those with a short exercise history. Compared to the control group, and in line with SDT, SDTc participants demonstrated a significant linear increase in relatedness and competence need satisfaction over time.

For participants in both conditions, introjected regulation increased, whilst amotivation decreased, over time. The latter finding makes sense as, in a context in which attendance is *not* mandatory, it would be unlikely that anyone who was still engaged in the exercise class through 10 weeks would be higher in amotivation than when they started the class. Amotivation is manifested when the participant lacks the intention for behavioural engagement. In both conditions, as we moved through the 10-week class, those still involved in the class were by definition behaviourally engaged and most likely having their participation fuelled by more autonomous or controlling reasons. Amotivation is also held to stem from feelings that one is not competent to successfully engage in a particular activity (Ryan & Deci, 2002). However, among the present sample of participants, in both classes, perceptions of competence were relatively high.

The observed increase in introjected regulation for SDTc and control group participants is more difficult to explain. It might have been the case that, even when presented with a more self-determination focused class, the ego involvement of the students (perhaps revolving around social pressures regarding one's physique) became more pronounced over the 10 weeks. Previous research has indicated that females tend to be more concerned with appearance-related issues in general (e.g. Pliner, Chaiken, & Flett, 1990) and such body image concerns can be heightened in exercise settings (which typically involve a greater exposure of the body due to the clothing required, presence of mirrors, etc.; Martin Ginis, Jung, & Gauvin, 2003). Thus, the female participants in the current study may have used social standards of physique, increasingly so as the exercise program unfolded, to judge their self worth. Ego involvement and contingent other-referenced judgements of self worth are held to be contributors to greater introjection (Deci & Ryan, 2000; Ryan & Brown, 2003).

It is also important to note that the class sizes in both conditions were moderate. In groups of approximately 30 (or less) led by one instructor over 10 weeks, missing a class would be more noticeable than in exercise programme involving a larger number of participants and multiple instructors. Thus, the observed increase in introjection may have been due to participants feeling more guilty about missing their weekly session as the term progressed.

This study also explored the behavioural, cognitive and affective responses to the leadership styles manifested in the SDTc and control conditions. First, a significant difference in attendance was observed; with those in the SDTc condition attending more regularly than those in the control group. Based on Hunter and Schmidt's (1990) suggestion that effective psychological interventions usually have an effect size of 0.20–0.40, the effect size observed in the current study (i.e. $d=0.54$) highlights the potential for SDT-focused interventions to impact behavioural engagement in the exercise

domain. Second, compared to the control group, participants in the SDTc exhibited a significant increase in positive affect derived whilst exercising over the course of the 10-week exercise program. Taken together, these findings demonstrate that interventions grounded in SDT can enhance exercise adherence and facilitate positive affective exercise experiences.

Contrary to SDT, behavioural intention decreased over time in the SDTc (akin to the control group). It is possible that the different wording of the items used at weeks 1 and 6, which were specific to participation in the 10-week exercise program *per se*, compared to the wording of the items used in week 10, which measured intention to take part in future classes run by the instructor, impacted the results obtained. Supplementary analyses focusing on changes from week 1 to week 6 revealed that those in the control group demonstrated a significant reduction in behavioural intention whilst those in the SDTc did not. In understanding the reduction in intention after week 6 observed in both conditions, we should note that the majority of participants recruited in the current study were students. The decrease in behavioural intention may have reflected a realization of how hard it is to adhere to an exercise program whilst embracing the work (in UK universities, the majority of assessment takes places at the end of term) and social commitments of university life.

Relationships between Psychological Need Satisfaction, Motivational Regulations and Adaptive Behavioural, Cognitive and Affective Exercise-Related Outcomes

This study also examined the relationships between psychological need satisfaction, motivational regulations and exercise-related outcomes. These relationships were established at baseline, however, if the interaction between a predictor and the slope was not significant, they also represented the relationship between a predictor and an outcome during the 10-week exercise programme. Structure emerged as a significant predictor of competence need satisfaction, a finding which is consistent with Reeve (2002). Also supporting SDT (Deci & Ryan, 1985; Ryan & Deci, 2002), competence need satisfaction emerged as a negative predictor of negative affect, whereas the least autonomous form of motivation (i.e. external regulation) and amotivation emerged as positive predictors of the same variable. Amotivation was negatively associated with behavioural intention, whereas integrated regulation emerged as a positive predictor of positive affect. In addition, autonomy support, structure and interpersonal involvement were positively linked to behavioural intention.

The beta weights for autonomy support and autonomy need satisfaction became more positive over time in the prediction of the three most self-determined forms of motivational regulation. These findings add credence to Deci and Ryan's (2000) arguments that social-contextual characteristics and psychological needs play an important role in facilitating the internalization process (i.e. by becoming more important in the prediction of autonomous regulation over time).

Limitations

The present study was marked by a number of limitations. First, the inclusion of participants from a university setting limits the generalizability of the findings. Future studies involving less educated and/or male exercisers, and/or taking place outside of the University setting are warranted. It should also be noted that study participants were not randomized into conditions (and we did not control for variables such as previous exercise involvement). Perhaps as a consequence, participants in the SDTc were observed to start the study with lower levels of autonomous and higher levels of controlling motivation. Subsequent work would benefit from a cluster randomized design which considers levels of potentially important discriminating variables, such as pre-existing psychological need satisfaction, autonomous motivation for physical activity engagement and past history regarding exercise involvement, on entry to the programme.

In addition, we were unable to examine the motivational processes underpinning longer-term exercise engagement. This shortcoming could be rectified in the future by examining whether variations in 'teaching style' (i.e. SDT versus control class condition) correspond to differential long-term participation in exercise classes. Finally, it is important to emphasize that this study involved only one exercise instructor teaching across two exercise classes. By using the same exercise instructor to deliver both treatment types/conditions, we were able to control for the personal characteristics of the exercise leader (as advocated by Williams et al., 2002). Manipulation checks confirmed that the environments of the two exercise classes were perceived to be different by class participants and independent observers. Research is now

needed to explore the impact of different instructors, as well as the effect of different class contexts. For example, future work could involve a number of different instructors randomly assigned to an SDT-based training programme or control group (standard practice), and examine the effects of these teaching styles in different exercise settings (University, community, health care). Future work with multiple instructors may also assess the impact of different personality traits and individual differences in teaching styles on the success of interventions.

CONCLUSIONS

This study represents the first comprehensive experimental test of an SDT-based intervention in a real life setting. The findings suggest that the degree of autonomy-support, structure and interpersonal involvement provided by exercise leaders can positively influence exercise class participants' behavioural, cognitive and affective responses to exercise. Consequently, the present research supports the external validity of SDT's theoretical framework in relation to exercise (Mook, 1983). The observed interdependencies between the socio-contextual characteristics, psychological needs, motivational regulations and related outcomes were also consonant with the theoretical propositions of SDT (Deci & Ryan, 1985; Koestner & Losier, 2002; Reeve, 2002). Although this research needs to be replicated and expanded, our results should be considered as a first, encouraging step for the application of effective exercise promotion strategies grounded in SDT.

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