



## A test of self-determination theory in school physical education

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**Background.** Contemporary research conducted in the context of school physical education (PE) has increasingly embraced various tenets of self-determination theory (Deci & Ryan, 1985, 1991). Despite this increase in research attention, some postulates of the framework remain unexplored (e.g. impact of a need-supportive climate). As such, the present study sought to provide a more comprehensive test of self-determination theory. The present work also examined Deci and Ryan's claim that the motivational sequence embraced by their framework is invariant across gender.

**Aims.** (i) To examine a model of motivation based on the tenets of self-determination theory, and (ii) explore the invariance of the model across gender.

**Sample.** Participants were 950 British secondary school students (443 male, 490 female, 17 gender not specified)

**Method.** Participants completed a questionnaire that included measures of need support, need satisfaction, motivation, positive and negative affect, task challenge, and concentration.

**Results.** Structural equation modelling (SEM) analysis revealed that students who perceived a need-supporting environment experienced greater levels of need satisfaction. Need satisfaction predicted intrinsic motivation, which, in turn, linked to adaptive PE-related outcomes. In contrast, need satisfaction negatively predicted amotivation, which, in turn, was positively predictive of feelings of unhappiness. Multi-sample SEM invariance testing revealed the model to be largely invariant for male and female students.

**Conclusions.** The results of the study provide support for self-determination theory and corroborate the application of the framework to the context of school PE. Further, we largely found support for the invariance of the motivational processes embraced by self-determination theory across gender.

During the past decade, research aimed at understanding student experiences within the context of school-based physical education (PE) has increased. This upsurge in

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research attention has, to a large extent, been commensurate with position statements and research reports calling for increased physical activity levels (e.g. American College of Sports Medicine, 2000; British Heart Foundation, 2000; U.S. Department of Health and Human Services, 1996). Recognized and forwarded by many (e.g. Sallis & McKenzie, 1991; Sallis *et al.*, 1992) as a principal vehicle for health promotion, school-based PE offers a context in which the health, social, and psychological gains associated with physical activity can be promoted to large numbers of children and adolescents (cf. Biddle, Sallis, & Cavill, 1998; Sallis & Owen, 1999). However, in order for teachers, school administrators, and governmental bodies to successfully promote physical activity to the diverse range of students encountered in PE classes, a thorough understanding of student PE motivation is pivotal (Standage, Duda, & Ntoumanis, 2003). One broad theoretical framework that addresses the personal and situational factors that elicit differing types of motivation in various settings is self-determination theory (Deci & Ryan, 1985, 1991; Ryan & Deci, 2000a, 2002).

### **Self-determination theory**

Self-determination theory (Deci & Ryan, 1985, 1991; Ryan & Deci, 2000a, 2002) is an organismic-dialectic framework of motivation that considers humans to be actively seeking optimal challenges and new experiences to master and integrate (Deci & Ryan, 1991). Considering the individual to be an intentional organism, self-determination theory holds that individuals are motivated to achieve differing objectives (Deci, Ryan, & Williams, 1996). To this end, Deci and Ryan (1985) identified three types of motivation, namely *intrinsic motivation*, *extrinsic motivation*, and *amotivation* to account for the different reasons why individuals engage in activities. Specifically, self-determination theory (Deci & Ryan, 1985, 1991; Ryan & Deci, 2000a, 2002) holds that intrinsic motivation, various types of extrinsic motivation (namely external regulation, introjected regulation, and identified regulation), and amotivation lie on a continuum of self-determination. This continuum has received empirical support in a variety of contexts including education (Ryan & Connell, 1989), sport, exercise, and PE (Chatzisarantis, Hagger, Biddle, Smith, & Wang, 2003).

The most self-determined type of motivation is intrinsic motivation. Intrinsic motivation refers to the engagement in activities for their own sake, namely for the feelings of pleasure, interest, and satisfaction that derive directly from participation (Deci & Ryan, 1985). When intrinsically motivated, individuals are fully self-regulated, engage in activities out of interest, experience a sense of volition, and function without the aid of external rewards and/or constraints (Deci & Ryan, 1985). For example, an intrinsically motivated student would participate in PE because of feelings of satisfaction and pleasure that arise directly from the various activities embraced by the PE curriculum.

Although intrinsic motivation is marked by participation for the inherent interest and pleasure induced by an activity, extrinsic motivation refers to a variety of regulatory styles that are characteristically instrumental in nature. That is, extrinsic motivation is distinguished from intrinsic motivation by the fact that the individual's motive for performing an activity is directed by a separable outcome (e.g. threat, reward, punishment). Ranging in the relative autonomy manifested, extrinsic motivation

encompasses *integrated regulation* (degree of self-regulation = very high),<sup>1</sup> *identified regulation* (degree of self-regulation = moderately high), *introjected regulation* (degree of self-regulation = moderately low), and *external regulation* (degree of self-regulation = very low).

Identified regulation refers to a relatively autonomous regulatory style characterized by the acceptance of a regulation as one's own (Deci & Ryan, 1985). In identifying the activity as important to personal goals, the individual is expressing more choice regarding her/his participation than when introjected and external regulatory styles operate. However, the underlying motive to engage is still instrumental as it is the usefulness of the activity, rather than the activity's inherent interest that guides participation (Deci & Ryan, 2000). For example, a student who identifies PE as an important context for facilitating health gains and participates for such benefits (e.g. 'I can stay healthy by participating in PE') would be exhibiting identified regulation.

Introjected regulation represents a form of extrinsic motivation which is characterized by the individual internalizing external regulations (Ryan & Deci, 2002). With introjected regulation, the impetus for action is controlled by self-imposed sanctions (i.e. shame, self-guilt) as opposed to external constraints that underlie external regulation. An example of introjected regulation would be a student that participates in an after school physical activity programme, not because she/he wants to, but because the student feels that she/he should, because that is what 'good students' do (self-guilt). Deci and Ryan (2000) argue that this type of regulation is extremely interesting as the regulations are within the person, but at the same time still relatively external to the self.

External regulation is the least self-determined type of extrinsic motivation, referring to actions controlled by contingencies external to the individual (i.e. rewards, threat of punishment; Deci & Ryan, 1985). For example, a student who participates in PE to receive praise (reward) and/or to avoid confrontation from the teacher (appease) would be said to be externally regulated.

Representing a lack of intention and a relative absence of motivation, amotivation is the least autonomous regulation embraced by self-determination theory (Deci & Ryan, 1985, 1991). Amotivation stems from a lack of competence, the belief that an activity is unimportant, and/or when an individual does not perceive contingencies between her/his behaviour and the desired outcome (Ryan & Deci, 2000a, 2000b; Vallerand, 1997). For example, a PE student who states, 'I participate in PE, but I'm not sure why' would be considered amotivated.

Viewing the regulatory types in terms of a gradient of self-determination is helpful when one wants to hypothesize their associations with outcome variables (Deci & Ryan, 1991). Self-determination theory proffers that more autonomous motivational regulations lead to greater levels of effective functioning and personal adjustment than those considered more controlling (Deci & Ryan, 1991). A plethora of studies have supported this postulation by showing self-determined types of regulation (intrinsic motivation and identified regulation) to be associated with desirable consequences (e.g. persistence, effort, concentration, positive affect) in a variety of contexts including

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<sup>1</sup>Self-determination theory (Deci & Ryan, 1985, 1991) embraces integrated regulation as a type of extrinsic motivation. This type of motivation is more often encountered among adults rather than children, as younger populations may be too young to have experienced or achieved a sense of integration within their self (Deci & Ryan, 2000; Vallerand, 1997). For this reason, this construct is not assessed nor elaborated on further in the present study.

education and sport (Deci & Ryan, 1991; Reeve, 2002; Ryan & Deci, 2000b; Vallerand, 1997).

Another central tenet of self-determination theory (Deci & Ryan, 1985, 1991; Ryan & Deci, 2000a, 2002) is that intrinsic motivation and optimal psychological functioning are not a direct function of social factors (e.g. degree to which the environment supports student autonomy), but are dependent on the degree to which these social factors satisfy three innate psychological needs. Defined as the nutrients that are essential for healthy and effective functioning (cf. Ryan, 1995), the needs are autonomy (need to be agentic, give input, self-endorse activities and beliefs), competence (need to effectively interact with one's environment and yield wanted effects and outcomes), and relatedness (need to feel connected and accepted by significant others). When individuals satisfy these basic psychological needs, self-determined motivation, psychological growth, and well-being are expected to be facilitated. In contrast, when these needs are thwarted, intrinsic interest and well-being are diminished, and ill-being and maladaptive consequences are posited (Deci & Ryan, 2000).

Recent studies in work organizations have combined the needs for autonomy, competence, and relatedness into a composite variable that has been labelled *psychological need satisfaction*. This research has supported the link between need satisfaction and well-being (as indexed by vitality, self-esteem, and a reverse anxiety score) both in US (Baard, Deci, & Ryan, 2000; Deci *et al.*, 2001) and in Bulgarian (Deci *et al.*, 2001) samples. Although these studies examined the direct effects of need satisfaction on indices of well-being, in this investigation we examined the mediating role of self-determined motivation on motivational outcomes.

An understanding of the social conditions that support need satisfaction and subsequent motivation becomes a pressing issue for those interested in promoting positive outcomes in particular life domains. Despite theoretical postulations that the social supports for autonomy, competence, and relatedness provide the conditions to enhance need satisfaction (Deci *et al.*, 1996, 2001), research from a self-determination perspective has, for the most part, focused on the effects of autonomy supportive versus controlling environments (Black & Deci, 2000; Deci *et al.*, 2001; Vallerand, Fortier, & Guay, 1997). Although it is important that the need for autonomy is supported, as the satisfaction of this need is essential to fully internalize our reasons for doing an activity, this somewhat unidimensional approach may overlook environmental factors that could contribute to the satisfaction of the other two important psychological needs.

### **Self-determination theory and PE**

Despite being applied successfully to the educational domain for over a decade (see Deci, Vallerand, Pelletier, & Ryan, 1991; Reeve, 2002), the emergence of work grounded in self-determination theory was slow to transpire in the context of school PE. Recently, a few studies have been conducted to examine the tenability of the self-determination framework to the PE setting (e.g. Ntoumanis, 2001; Standage *et al.*, 2003).

Standage *et al.* (2003) examined the impact of perceptions of an origin climate (autonomy-supportive), using an instrument devised by deCharms (1976), on PE students' perceptions of autonomy, competence, and relatedness. Results revealed an origin climate to be moderately predictive of autonomy satisfaction and weakly predictive of competence and relatedness satisfaction. Ryan and Deci (2000b) propose, however, that 'in schools, the facilitation of more self-determined learning requires classroom conditions that allow satisfaction of these three basic human needs - that is

that support the innate needs to feel connected, effective, and agentic as one is exposed to new ideas and exercises new skills' (p. 65). In the present study, we extended the work of Standage *et al.* by exploring the relationship of a multifaceted environment encompassing perceptions of *autonomy-support*, *competence-support*, and *relatedness-support* to students' psychological need satisfaction. While we recognize that there are various significant others in PE classes that may impact need satisfaction (e.g. peers), in the present study a composite score for autonomy-support, competence-support, and relatedness-support provided by the PE teacher was calculated. We labelled this construct *need-support* and hypothesized that it would positively predict need satisfaction.

Because self-determination theory holds that the satisfaction of all three needs is needed for optimal psychological functioning (Deci & Ryan, 2000), overall need satisfaction was expected to be an important mediator between a need-supporting environment and the various motivational regulations assessed in the present study. Specifically, we expected positive associations between need satisfaction and intrinsic motivation and identified regulation. In contrast, we predicted need satisfaction to be negatively related to external regulation and amotivation. One prediction was explored that deviated slightly from the theoretical tenets of self-determination theory. Given that previous PE-based research has shown perceptions of autonomy and relatedness (Standage *et al.*, 2003), and perceptions of competence and relatedness (Ntoumanis, 2001) to be positively associated with introjected regulation, we hypothesized that introjected regulation would be positively predicted by need satisfaction.

Grounded in self-determination theory (Deci & Ryan, 1985, 1991; Ryan & Deci, 2000a, 2002), past work in PE has often been restricted to one motivational outcome (e.g. Standage *et al.*, 2003). Aligned with the postulation made by self-determination theory (Deci & Ryan, 1985, 1991; Ryan & Deci, 2000a, 2002) that positive affective, cognitive, and behavioural indices are a function of autonomous motivational regulations, as opposed to controlling ones, four outcome indices were explored. These were the students' level of concentration (cognitive outcome), experience of positive and negative affect (affective outcome), and preference to engage in challenging tasks (self-reported behavioural outcome). Aligned with self-determination theory and previous PE-based work (Ntoumanis, 2001; Standage *et al.*, 2003), we hypothesized that intrinsic motivation and identified regulation would positively predict concentration, positive affect, and preference for challenging tasks, and would negatively predict negative affect. In contrast, we predicted that external regulation and amotivation would positively predict negative affect, and negatively predict concentration, positive affect, and the preference for challenging tasks. Consistent with previous work (Ntoumanis, 2001; Standage *et al.*, 2003), we did not expect introjected regulation to predict any outcome variable.<sup>2</sup> It is important to note that in the current work, we examined the PE students' 'usual' motivation towards their PE class.

One purpose of the present study was to test a model of motivation grounded in self-determination theory within the context of school PE. The second purpose of our investigation was to explore the measurement invariance of the proposed

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<sup>2</sup> Based on the tenets of self-determination theory (Deci & Ryan, 1985, 1991), which would not classify these variables as orthogonal constructs, and to account for the simplex pattern of their relationships, the residuals of the motivational types were allowed to be correlated. This is aligned with previous work (Ntoumanis, 2001; Standage *et al.*, 2003).

model with respect to gender. Measurement invariance refers to the extent to which a measure, model, or construct maintains its meaning across groups or over time (Byrne, 1989). A central issue pertaining to theoretical measurement models assuming universality is that of gender invariance. That is, when samples are studied in a combined fashion, as often they are within the extant psychological literature, our theoretical understanding and proposed recommendations are often contingent upon the presence of no gender differences. As Hoyle and Smith (1994) note, when there is a significant departure from invariance the comparison of models can become a classic example of comparing apples and oranges. To this end, the establishment of measurement equivalence (i.e. invariance) across gender groups is a requirement if we are to make meaningful comparisons for male and female students, collectively. To date, and despite numerous assertions pertaining to potential gender effects, only a few studies have examined gender invariance within their samples (e.g. Ferrer-Caja & Weiss, 2000; Ntoumanis, 2001). We would argue that this represents a significant void in the existing literature.

From a theoretical perspective, a fundamental precept of Deci and Ryan's theorizing is that the psychological processes and constructs embraced by self-determination theory are universal to all cultures, across gender, and throughout developmental periods (Deci & Ryan, 2000, 2002; Ryan & Deci, 2000a, 2002).<sup>3</sup> Consistent with preliminary findings (Ntoumanis, 2001), we expected the model to be largely invariant across gender.

## Method

### *Participants and procedures*

A total of 950 students (443 male, 490 female, 17 gender not specified;  $M$  age = 12.14 years;  $SD$  = .91; range = 11 - 14 years) attending four secondary schools situated in the midland and southern districts of England served as study participants. All schools were located in predominantly middle-class areas, and data were collected from several classes taught by 21 PE teachers. Preceding the collection of data, consent to conduct the study was issued from the School Human Subjects Committee of a large British university, and written consent was obtained from the head teachers of the four state schools who were asked to act in *loco parentis* in accordance with the British Psychological Society (2000) guidelines.

Prior to participating in their scheduled PE lesson, participants were requested to respond anonymously to a multi-section inventory assessing the study variables. The principal investigator distributed the inventory, and was on hand to help any participant who had questions pertaining to the wording and/or meaning of the questionnaire items. At this time, it was emphasized to the students that there were no right or wrong responses to any item, and that responses should reflect their own perceptions of the PE class/experience. Participants were also offered the option to withdraw from the study at any time without any negative repercussions. No child refused to participate, and none withdrew from the study. The inventory took approximately 20 minutes to complete.

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<sup>3</sup> Cultural and developmental invariance were not examined in this study as participants were from the same culture and the participants' age range was too small.

### Measures

#### Need support

To assess the degree to which the participants perceived the PE teacher to support their autonomy, competence, and relatedness, we used three scales. To assess autonomy support, a PE-modified version of the Learning Climate Questionnaire (LCQ; Williams & Deci, 1996) was employed. Previous work with college-aged students in organic chemistry (Black & Deci, 2000) and medical sciences (Williams & Deci, 1996) has supported the internal reliability of the LCQ and the presence of a single autonomy support factor (15 items). To assess competence support and relatedness support, nine items were devised for use in the present study (four items for competence and five for relatedness). Responses to all items were preceded by the stem, 'In this PE class', and were made on a 7-point Likert scale anchored by 1 (*strongly disagree*) to 7 (*strongly agree*). Example items are: 'we feel that the PE teacher provides us with choices and options' (autonomy support), 'the PE teacher makes us feel like we are able to do the activities in class' (competence support), and 'we feel that the PE teacher encourages us to work together in class activities' (relatedness support). Scores from these three subscales were used as indicators for the latent factor *need support*.

#### Need satisfaction

To assess the degree to which the participants experienced the satisfaction of the three psychological needs, three previously validated questionnaires were used. Scores from these three subscales were used as indicators for the latent factor *need satisfaction*.

The participants' sense of autonomy was measured using five items collated by Standage *et al.* (2003) from previous work (Blais, Vallerand, & Lachance, 1990; Ntoumanis, 2001). An additional reverse-scored item was also incorporated in the present study, 'I have to force myself to do the activities'. Participants responded to the items (e.g. 'I have some choice in what I want to do' and, 'I have a say regarding what skills I want to practice'), preceded by the stem 'In this PE class'. Responses were made on a 7-point Likert scale anchored by 1 (*strongly disagree*) to 7 (*strongly agree*). Support for the internal reliability of the five-item version of this scale has been shown in previous PE work with British children (Standage *et al.*, 2003).

Perceived competence towards PE was assessed using the five items from the perceived competence subscale of the 18-item IMI (McAuley, Duncan, & Tammen, 1989). An example item from the competence subscale is, 'I am pretty skilled at PE.' Reworded to target the PE context, responses were indicated on a 7-point Likert scale anchored by 1 (*strongly disagree*) to 7 (*strongly agree*). The competence subscale of the IMI has demonstrated acceptable reliability with similar aged participants in previous PE based-research involving British children (Ntoumanis, 2001; Standage *et al.*, 2003).

Relatedness was assessed using the acceptance subscale of the Need for Relatedness Scale (Richer & Vallerand, 1998). Originally developed to assess the need for relatedness in the workplace, the stem was modified in the present study to ask the question, 'With the other students in my PE class I feel. . .'. The stem is followed by five items such as close, valued, and supported to which the participants responded on a 7-point Likert scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). Previous work with similar-aged British children in PE has supported the internal reliability of this scale (Standage *et al.*, 2003).

#### *Motivation*

The different types of motivational regulation were assessed using the Perceived Locus of Causality (PLOC) scale devised by Goudas, Biddle, and Fox (1994) which was based on the work of Ryan and Connell (1989). The amotivation subscale of the Goudas *et al.* (1994) instrument was adapted from the Academic Motivation Scale (Vallerand *et al.*, 1992). Participants were asked to respond to the items using the stem, 'I take part in this PE class. . .'. Example items (four for each subscale) are 'because PE is fun' (intrinsic motivation), 'because it is important for me to do well in PE' (identified regulation), 'because I'll feel bad about myself if I didn't' (introjected regulation), 'because I'll get into trouble if I don't' (external regulation), and 'but I really don't know why' (amotivation). Responses were made on a 7-point Likert scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). Support for the psychometric properties of this scale has emerged in previous work with British school children (Goudas *et al.*, 1994; Ntoumanis, 2001).

#### *Concentration*

Six items were devised for the present study to assess students' concentration levels in PE. Example items are, 'I really concentrate in PE' and, 'I really focus when participating in PE'. Responses were indicated on a 5-point frequency scale ranging from 1 (*never*) to 5 (*always*).

#### *Positive and negative affect*

Positive and negative affect were assessed using nine items devised by Ebbeck and Weiss (1998), and indicated the extent to which the participants experienced each adjective (e.g. happy, unhappy) on a 5-point frequency scale ranging from 1 (*not at all*) to 5 (*most of the time*). Participants responded to the stem, 'In this PE class I feel. . .'. Previous work has supported the use of these items with similar-aged North American children in the context of youth sport (Ebbeck & Weiss, 1998).

#### *Preference for challenging tasks*

Participants responded to an item devised by Ames and Archer (1988) which tapped their preference to attempt challenging tasks. Responses were made on a 5-point scale anchored by 1 (*not likely at all*) to 5 (*very likely*). Specifically, participants were asked to indicate the likelihood that they would engage in 'a task in which you can learn a lot of new things but will also have some difficulty and make many mistakes'. This item, often used with a parallel reverse item, has been successfully incorporated in classroom-based education (Ames & Archer, 1988), and more recently in school PE (Treasure & Roberts, 2001).

#### **Data analysis**

Initially, descriptive statistics for all variables were computed and Cronbach's (1951) alphas were calculated to assess the internal reliability of the multi-item subscales. At this time, psychometric tests (i.e. confirmatory factor analysis) were also conducted on the study inventories. For the sake of brevity, full psychometric details of these analyses are available from the corresponding author. Two important findings emerged from confirmatory factor analyses (CFA) conducted on the PLOC and the negative affect scales. First, with respect to the PLOC, the intrinsic motivation and identified subscales



were very highly correlated (.99) suggesting singularity. Because these scales are designed to assess distinctively different motivational regulations (cf. Deci & Ryan, 1991), and to avoid confounding findings in the SEM analyses, we eliminated the identified regulation scale from the SEM analyses and retained intrinsic motivation, the prototype of self-determined motivation. Second, the negative affect items were not supported by CFA. As such, we used a single item indicator that asked the participant to indicate the extent to which they felt unhappy in PE.

The slightly modified original model (Fig. 1) was analysed through SEM using EQS 5.7b (Bentler, 1998).<sup>4</sup> Following slight modifications, the final model was also tested for equality of constraints across gender using multi-sample invariance analysis. The present multi-sample analysis was conducted in line with the procedure advanced by Bentler (1995). The initial step in this analysis involves the establishing of a baseline model for male and female students via single sample analysis. This non-invariant step provides a critical base for subsequent model comparisons (Marsh, 1993). At this stage, if the models are not identical then partial invariance (i.e. some parameters in model are invariant but not all) is supported (cf. Byrne, 1994). Having established a baseline model for male and female participants separately, a sequence of increasingly constrained nested models is explored. Invariance testing begins with the least restrictive model, in which only the form of the model (namely the baseline model) is tested for invariance across samples without placing any constraints (Marsh, 1993). Next, the factor loadings are constrained to be invariant across the groups. The subsequent step involves constraining the factor variances and covariance matrix to equivalence across groups. Subsequently, the path coefficients (structural regression paths) are set to equivalence. The penultimate step entails constraining the variances and covariances of the residuals of the latent factors to be invariant across groups. Finally, the variances/covariances of the residuals of the observed variables are set to equivalence across groups. In the present study, no covariances among the residuals of the observed variables were specified.

The validity of the equality constraints can be tested simultaneously at a multivariate level using the Lagrange Multiplier (LM) test. The LM test indicates the drop in the  $\chi^2$  statistic if a constraint is released. In line with Scott-Lennox and Lennox (1995), equality constraints were removed only if they dramatically improved the model fit (value of 5.0 or higher per *df*). To determine the relative importance of any constraints that emerged and to facilitate comparisons between groups, both the standardized ( $\beta$ ) and un-standardized (*b*) coefficients were reported. While the standardized coefficients are important for determining the relative importance of different paths within a group, they remain sample specific. On the other hand, because un-standardized coefficients are expressed in terms of their constructs' variance, they can be used to compare the same paths across groups (Hair, Anderson, Tatham, & Black, 1998).

## Results

### *Descriptive statistics and scale reliabilities*

Descriptive statistics and alpha coefficients (Cronbach, 1951) for all measures are presented in Table 1. As shown, most alpha coefficients ranged from .80 to .96, and can

<sup>4</sup> For visual simplicity, the four observed indicators for each motivational regulation, six indicators for concentration, and five indicators for positive affect are not shown in Figs 1, 2.

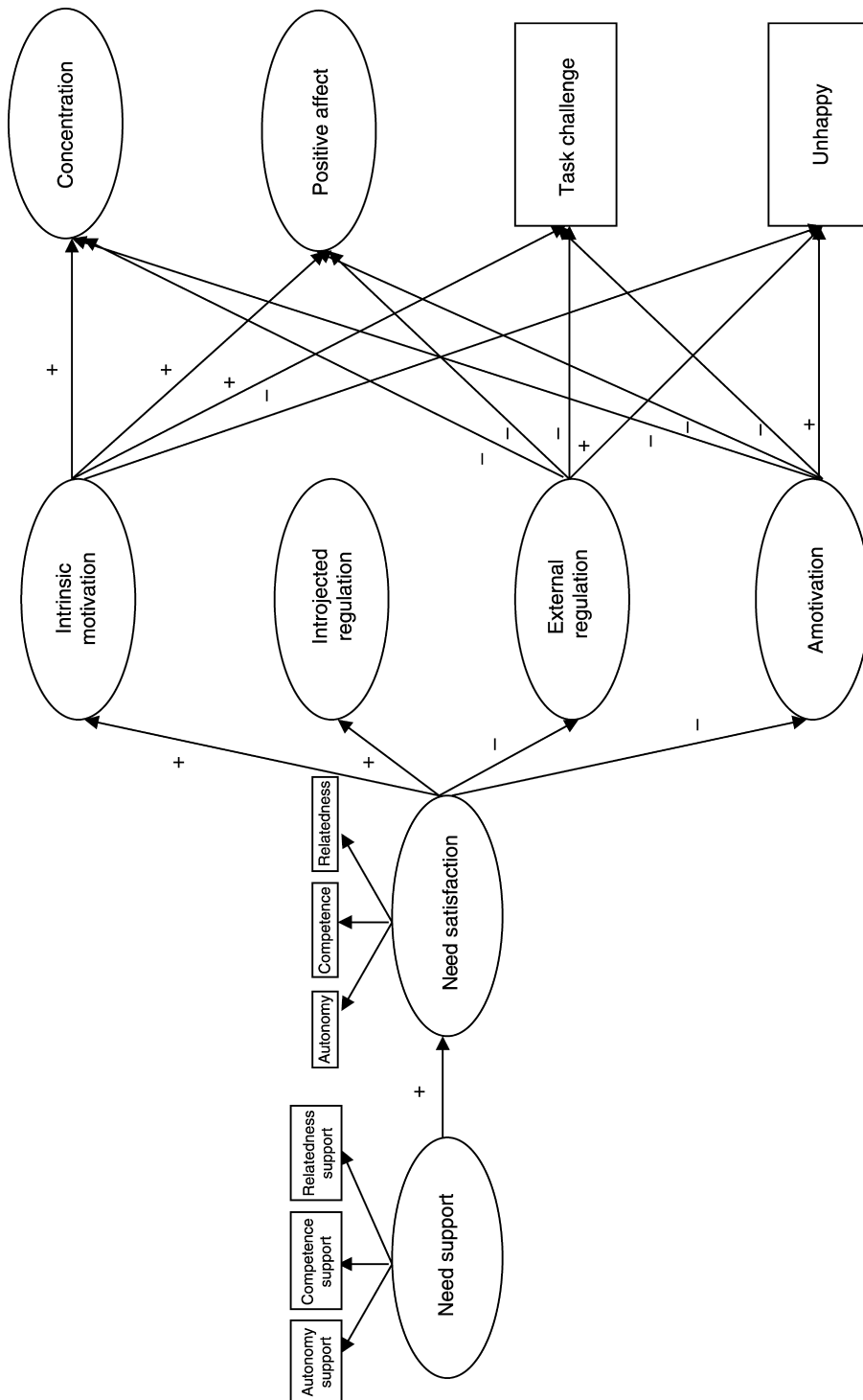


Figure 1. Hypothesized model of motivational processes in PE.

**Table 1.** Descriptive statistics and internal consistency for each measure

	Mean	SD	Skewness	Kurtosis	$\alpha$
Need support	4.67	1.24	-0.40	-0.47	.96
Autonomy-support	4.26	1.17	-0.18	-0.48	.92
Competence-support	5.07	1.35	-0.67	-0.13	.84
Relatedness-support	4.68	1.42	-0.36	-0.56	.88
Total need satisfaction	4.54	1.02	-0.55	-0.47	.88
Perceptions of autonomy	3.89	1.28	-0.04	-0.52	.80
Perceptions of competence	5.01	1.36	-0.77	0.19	.87
Perceptions of relatedness	4.71	1.26	-0.51	0.19	.87
Intrinsic motivation	4.73	1.60	-0.35	-0.67	.88
Identified regulation	4.97	1.46	-0.56	-0.23	.86
Introjected regulation	3.91	1.34	0.07	-0.28	.69
External regulation	3.83	1.64	0.12	-0.78	.81
Amotivation	2.86	1.56	0.68	-0.31	.84
Concentration	3.67	0.80	-0.58	0.17	.84
Positive affect	3.49	0.91	-0.42	-0.43	.82
Unhappy	2.08	1.03	1.01	0.66	-
Preference for challenging tasks	3.32	1.02	-0.31	-0.23	-

Note: Alpha coefficients are not reported for unhappy and task challenge as these constructs were assessed by single items.

be considered internally reliable based on the  $\alpha = .70$  criterion set for the psychological domain (Nunnally & Bernstein, 1994). The alpha for introjected regulation was .69 and can be considered to have a marginally acceptable internal reliability.

### Structural equation modelling (SEM)

Since the Mardia's coefficient was large in the present sample (normalized coefficient estimate = 45.43), the data were analysed using robust maximum likelihood analysis. According to Byrne (1994), this procedure offers more accurate standard errors when the data are not normally distributed. With this analysis, Satorra and Bentler's (1988) scaled chi-squared is calculated, as well as the Robust CFI.<sup>5</sup>

In order to evaluate the adequacy of the fit of the proposed model (Fig. 1) to the data, a combination of fit indices were examined (see Hu & Bentler, 1999). Based on their simulated data, Hu and Bentler (1999) proposed a good fitting model to the data to be indicated by values close to or greater than .95 for the CFI and NNFI, and values of (or less) than .08 and .06 for the SRMR and RMSEA (and its .90% confidence interval [CI]), respectively. It should be noted that certain psychometric experts (e.g. Marsh, 2002) consider these conventional fit criteria too restrictive when applied to complex models with multiple indicators, contending that such guidelines may be unrealistic in situations in which 'real' data are tested rather than simulated.

The fit indices for the proposed model (Fig. 1) revealed an adequate fit to the data, Satorra-Bentler  $\chi^2$  (539) = 1560.47,  $p < .001$ ; RCFI = .93; NNFI = .92; SRMR = .055;

<sup>5</sup> It should be noted that EQS 5.7b has not incorporated the robust maximum likelihood analysis to multi-group analysis.

RMSEA = .052 (90% CI = .049 - .054). The standardized parameter estimates are shown in Fig. 2.

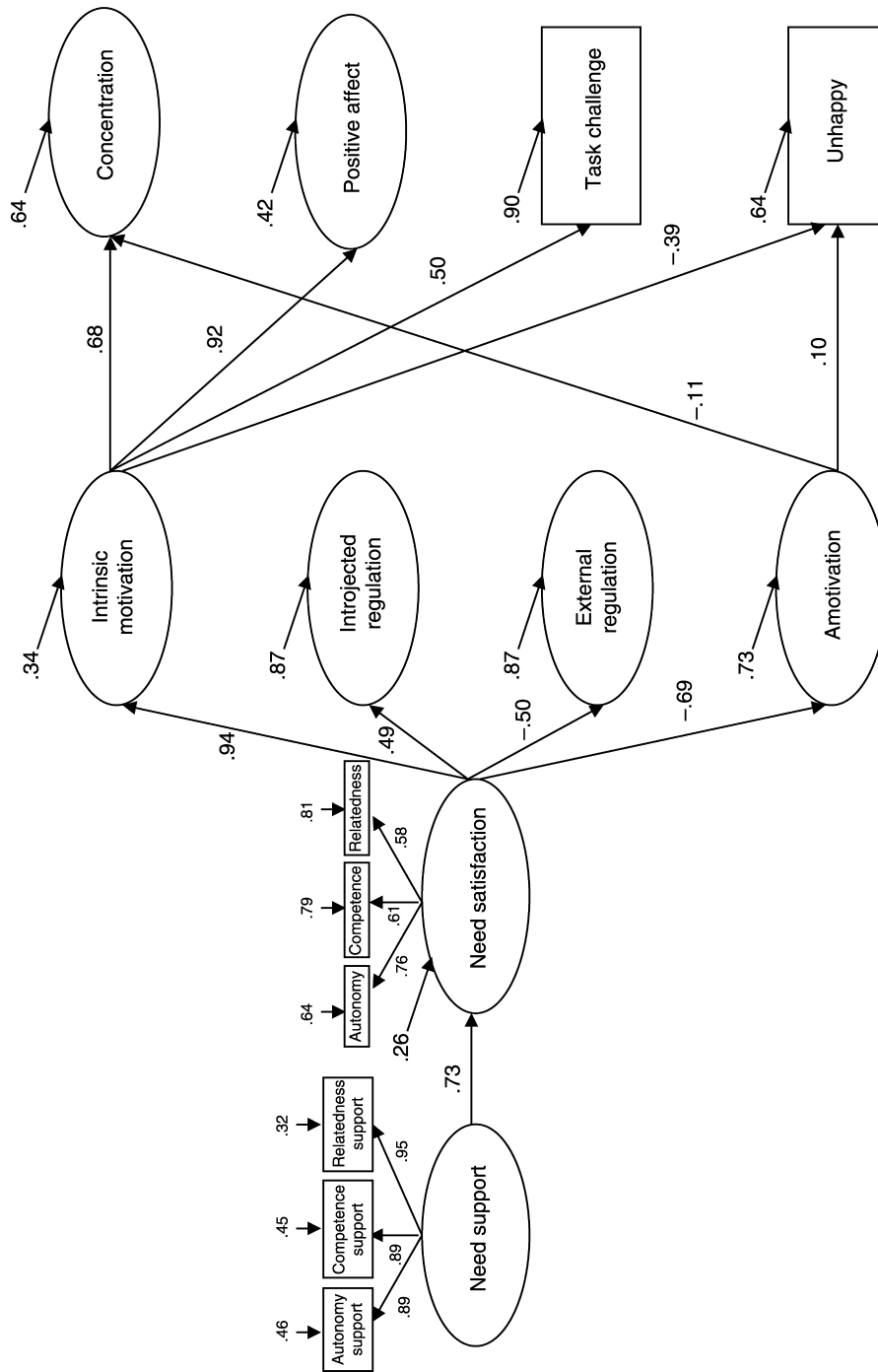
The standardized indirect effects revealed that need support had positive effects on intrinsic motivation ( $\beta = .68$ ) and introjected regulation ( $\beta = .36$ ), and negative indirect effects on external regulation ( $\beta = -.35$ ) and amotivation ( $\beta = -.50$ ) through need satisfaction. Need satisfaction was indirectly predicted by perceptions of autonomy-support ( $\beta = .64$ ), competence-support ( $\beta = .65$ ), and relatedness-support ( $\beta = .69$ ). Need support had positive indirect effects through need satisfaction and the motivational regulations on concentration ( $\beta = .52$ ), positive affect ( $\beta = .62$ ), and preference for challenging tasks ( $\beta = .28$ ), while a negative indirect effect was observed between need support and feelings of unhappiness ( $\beta = -.34$ ). Positive indirect effects emerged through the motivational regulations for need satisfaction on concentration ( $\beta = .72$ ), positive affect ( $\beta = .85$ ), and preference for challenging tasks ( $\beta = .39$ ), whereas a negative indirect effect was observed between need satisfaction and feelings of unhappiness ( $\beta = -.46$ ).

### **Multi-sample invariance analysis**

In conducting multi-sample invariance analysis, the equivalence of the variance-covariance matrices from the various samples (in this case, male and female) is tested to ascertain to what extent they are identical. Accordingly, the model (Fig. 2) was tested independently for male and female students. The Wald test revealed that for the male sample, the path between amotivation and concentration could be released as the path was non-significant ( $z < 1.96$ ). For the female sample, the Wald test suggested that two introjected regulation items ('because I want the teacher to think I'm a good student' and 'because I would feel bad about myself if I didn't'), and the correlation between the residuals of intrinsic motivation and amotivation be released from the model. Based on these modifications, the fit indices for the male and female models were Satorra-Bentler  $\chi^2(547) = 973.70$ ,  $p < .001$ ; RCFI = .93; NNFI = .92; SRMR = .070; RMSEA = .050 (90% CI = .046 - .054), and Satorra-Bentler  $\chi^2(514) = 1066.23$ ,  $p < .001$ ; RCFI = .93; NNFI = .91; SRMR = .056; RMSEA = .056 (90% CI = .052 - .059), respectively. As such, these indices of fit were close to, or better than the values advanced by Hu and Bentler (1999).

Because certain parameters in the male and female models differed, these parameters were not constrained in the subsequent multi-sample invariance analysis. Instead, they were allowed to be estimated freely across the two gender groups (see Byrne, 1994). As such, we tested the two baseline models for partial invariance. Although it is common to consider a non-significant chi-squared value to indicate invariance between two nested models, it is now commonly accepted that this index is sample size dependent (Marsh, Balla, & McDonald, 1988). Therefore, we also assessed differences in the absolute and incremental fit indices in order to provide an indication of invariance (Bentler, 1995).

As shown in Table 2, a non-significant chi-squared difference test value emerged for the form model and the constrained factor loadings model. Additionally, for the constrained factor loadings model, the absolute and incremental fit indices revealed the tenability of the model. The next step was to constrain the factor variances/covariances. Once again, the indices of fit showed factor variances/covariances to be invariant across male and female students. The subsequent step (path coefficients) yielded a significant chi-squared difference value and a slight increase in the SRMR for the model



**Figure 2.** Revised model of motivational processes in PE.  
 Note: All paths are significant (ie., their z scores are greater than 1.96).

**Table 2.** Results of the SEM multi-sample invariance analysis across gender

Model tested	$\chi^2$	df	$\Delta\chi^2$	$\Delta df$	CFI	NNFI	SRMR	RMSEA (90% CI)
Step 1	2473.70	1061	–	–	.92	.91	.055	.038 (.036–.039)
Step 2	2506.90	1085	33.20	24	.92	.91	.057	.037 (.035–.038)
Step 3	2509.14	1086	2.24	1	.92	.91	.059	.037 (.035–.039)
Step 4	2543.62	1094	34.48*	8	.92	.91	.068	.037 (.035–.039)
Step 5	2577.81	1105	34.19*	11	.92	.91	.068	.038 (.036–.039)
Step 6	2645.96	1138	68.15*	33	.91	.91	.068	.037 (.035–.039)

Notes. Step 1 = Baseline; Step 2 = factor loadings constrained; Step 3 = factor variances and covariance matrix constrained; Step 4 = path coefficients (structural regression paths) constrained; Step 5 = variances of the residuals of the latent factors constrained as well as the covariances of the residuals of the motivational regulation factors; Step 6 = variances of the residuals of the observed variables constrained (no residual covariances were specified in the present study).

\* $p < .001$ .

(.09 change), but for the most part, the fit indices remained the same. One constraint did, however, need to be released at this stage. Specifically, the path from need satisfaction to introjected regulation was higher for female students ( $\beta = .50$ ;  $b = .95$ ) than for male students ( $\beta = .16$ ;  $b = .25$ ). The last two steps involved constraining the variances and covariances of the residuals of factors and observed variables. To this end, it is often considered to be excessively stringent to test the equality constraints of error variances and covariances (Byrne, 2001). Nevertheless, with regard to this penultimate step, the indices of fit revealed the factor residuals variances and covariances between the residuals of the motivational types to be largely invariant across gender. Three constraints were released at this stage as they were highly significant ( $p < .001$ ). The final step entailed constraining the variances (in the present study no error covariances were specified) of the residuals of the observed variables. This step is the most restrictive in invariance analysis. LM tests revealed that four errors were not equal for male and female participants ( $p < .001$ ). However, despite a .01 drop in the CFI value, the model remained largely the same.

## Discussion

There were two main purposes to the present study. First, we tested a model of motivation grounded in self-determination theory that theorized that perceptions of a multifaceted need-supportive context would facilitate self-determined motivation and adaptive motivation-related consequences by fulfilling need satisfaction. Second, because self-determination theory proposes that the processes embraced by its framework are universal for all groups, we examined the invariance of the motivation model across male and female.

In line with self-determination theory (Deci & Ryan, 1985, 1991; Ryan & Deci, 2000a, 2002), the present results revealed that the degree to which the students perceived that the teacher-created context supported their autonomy, competence, and relatedness, predicted their overall *need satisfaction*. Indeed, the observed indicators for perceptions of autonomy-support, competence-support, and relatedness-support had similar loadings on the latent construct of overall *need support*. Moreover, because the indirect effects revealed a *need supportive* environment to positively impact intrinsic

motivation and positive motivational consequences, the present findings highlight the importance of teacher-created social contexts that promote, rather than forestall, need satisfaction, autonomous motivation, and adaptive responses.

Although the present findings demonstrate the teacher-created environment to be germane to understanding the impact of social contexts on need satisfaction, it is important that future PE-based work examine multiple social agents (i.e. peers, parents, school ethos). Consistent with calls made by researchers in the context of education (e.g. Vallerand *et al.*, 1997), work from this perspective might consider assessing these social agents simultaneously so as to provide a more comprehensive insight into how they impact student needs in the context of PE. Work may also want to complement assessments of the subjective environment with an objective measure. Such an approach may provide more insight into the factors that contribute to perceptions of the social context (Sarrazin, Vallerand, Guillet, Pelletier, & Cury, 2002).

Aligned with self-determination theory and recent PE-based work (Standage *et al.*, 2003), the perception that autonomy, competence, and relatedness were satisfied by the teacher-created context facilitated self-determined motivation. As shown in Fig. 2, the three psychological needs loaded on the latent factor overall *need satisfaction* that in turn strongly predicted intrinsic motivation towards PE. The latter finding supports the overarching hypothesis stemming from self-determination theory that psychological need satisfaction will facilitate intrinsic motivation (Deci *et al.*, 1996; Deci & Ryan, 2000).

Equally consistent with Deci and Ryan's theorizing was that *need satisfaction* negatively predicted external regulation and amotivation. To this end, external regulation and amotivation are controlling forms of motivational regulation that are posited to derive from a deprivation of the three innate needs (cf. Deci & Ryan, 2000).

Departing from theoretical postulations, but in line with previous work (Ntoumanis, 2001; Standage *et al.*, 2003), introjected regulation was positively predicted by the satisfaction of the innate psychological needs. In view of the constant and compelling messages advanced by the media and governmental health agencies/bodies detailing the benefits associated with participation in physical activities, Standage *et al.* (2003) argued that the antecedents of introjected regulation may differ in physical activity contexts as opposed to other life contexts. Going beyond cross-sectional work, future research may seek to examine the antecedents of introjected regulation (and other regulations) using longitudinal research designs. Through such work researchers may be able to ascertain whether the fulfilment of the basic needs over time results in the introjected students' reliance on performing activities through internal pressures (i.e. obligation, avoidance of self-guilt and shame, attainment of ego enhancements, etc.) to weaken. Equally, it would be interesting to examine the effects that result from continuous introjected motivation. That is, if internalization does not occur over time, do the negative repercussions believed to be coupled with this controlling form of behavioural regulation eventually manifest?

Self-determination theory postulates that intrinsic motivation leads to investment, creativity, and high quality learning in activities (Ryan & Deci, 2000a, 2000b). Adding support to this theoretical premise and previous work in the PE setting (Ferrer-Caja & Weiss, 2000; Ntoumanis, 2001; Standage *et al.*, 2003), the results of the present study revealed intrinsic motivation to positively predict concentration, preference to attempt challenging tasks, and positive affect, and negatively predict feelings of unhappiness. Collectively, the findings of the present work and the findings from the extant literature to date suggest that physical educators should attempt to foster this highly adaptive form

of motivation in all students. Indeed, given the strong path from intrinsic motivation to positive affect ( $\beta = .92$ ), the promotion of this self-determined regulation (via creating need-supporting environments) may serve to foster physical activity beyond the school years. From a practical perspective, the present work suggests that teacher education strategies designed to promote the facilitation of the basic needs of autonomy, competence, and relatedness are critical if we wish to promote intrinsic motivation and indices of positive engagement to students within PE. In order to foster perceptions of autonomy, PE teachers may seek to increase the students' opportunities for choice (e.g. provide a selection of activities), provide increased opportunities for student input, and/or establish peer-learning groups (e.g. students demonstrate skills to one another, referee games, and establish tactics). Students' perceptions of competence may be facilitated by promoting environments in which self-referenced standards and indicators of improvement are adopted as opposed to competitive situations in which evaluated outcomes are contingent upon the performance of others (Ames, 1992). Finally, to facilitate perceptions of relatedness, PE teachers may use small group activities and develop reward structures that support cooperation (e.g. the formulation of group level goals).

It should be noted that, while a measure of self-reported preference for challenging tasks can provide useful information regarding students' motivation, such a measure is far from ideal (e.g. it can be impacted by social desirability). With this in mind, researchers assessing the effectiveness of the self-determination framework in PE settings might begin to employ more objective markers of physical activity (Standage *et al.*, 2003). For example, future work might consider recording actual levels of physical activity via heart-rate monitors, doubly labelled water, pedometers, and/or accelerometers.

Amotivation emerged as a negative predictor of concentration and as a positive predictor of reported feelings of unhappiness. The paths between amotivation and positive affect and preference for challenging tasks were negative, but these failed to reach statistical significance. Since amotivation represents a lack of motivation, it is not surprising that this motivational regulation corresponded to maladaptive outcomes in the present study. Although reported amotivation was not particularly high in the present sample ( $M = 2.86$  on a 7-point scale), an avenue for future research is to delineate strategies in which levels of amotivation can be further reduced. To this end, Ntoumanis, Pensgaard, Martin, and Pipe (2004) used an idiographic approach to solicit recommendations of how best to reduce this motivational regulation among children who were classified as being amotivated towards PE. Results revealed that the enhancement of positive affect, environmental provisions for the satisfaction of autonomy, competence, and relatedness, and providing improvements to the structural and organizational aspects of PE (e.g. duration of class, provision for poor weather, etc.), to be recommendations for combating amotivation. Targeting these identified structures independently, and in a combined fashion, future field-based investigations may provide a greater insight into interventions that educators may use to reduce levels of reported amotivation.

Contrary to our hypothesis that external regulation would also display maladaptive associations with the dependent variables, no significant paths were observed. The fact that no positive links emerged between external regulation and concentration, positive affect, and preference to attempt challenging tasks, does suggest that this type of motivation does not yield adaptive responses in PE. Also, consistent with previous work (Ntoumanis, 2001; Standage *et al.*, 2003), we did not find introjected regulation to predict any outcome variable. Such findings may be due to the cross-sectional design of



the current work. Perhaps any maladaptive consequences of external regulation and introjected regulation might be revealed in a longitudinal investigation. A prospective study conducted by Pelletier, Fortier, Vallerand, and Brière (2001) revealed external regulation to be unrelated to competitive swimmers' persistence in the first season, but negatively predictive of persistence in the second year. Moreover, the positive association between introjected regulation and persistence decreased across the years. Future PE-based investigations, adopting the same approach, would provide a valuable insight into the temporal patterns and adaptive/maladaptive functions of differing types of student motivation.

The results of the invariance analysis revealed that the model fit was largely invariant across gender. Interestingly, the path between need satisfaction and introjected regulation was significant for the female sample, but non-significant for the male sample. This finding suggests that female students, even when feeling autonomous, competent, and related, are still motivated to some degree by 'internal prods'. Deci and Ryan (2000) point out that introjected regulation can manifest itself as ego involvement, self-consciousness, and/or false self-ascriptions. It could be that girls have a tendency to possess greater contingent self-worth and be influenced by external factors during this period of adolescence than boys. Should this be the case, it is feasible that self-related feelings of guilt, shame, and anxiety would be present despite the fulfilment of the innate needs. Because physical activity has been shown to decline at a greater rate for girls in the teenage years than for boys (Center for Disease Control, 1998; Stone, McKenzie, Welk, & Booth, 1998), future work might focus on the motivational processes of this at risk group in an attempt to promote enjoyable engagement in PE, and to foster future physical activity adherence.

Only one other path differed between the male and female samples. Specifically, the path between amotivation and concentration was dropped in the male baseline model. It should be noted, however, that this path just failed to reach significance in the male sample ( $\beta = -.07$ ) and is most probably attributable to sampling variation. Finally, as would be expected, a number of error terms differed across the male and female samples. As alluded to earlier, the equality constraints for error variances and covariances is a highly stringent hypothesis and is unlikely to be met in most cases (Byrne, 2001).

Overall, the present findings reinforce the relevance of the self-determination model and underpinning constructs to predicting variability in indices of investment for both male and female students in the context of school PE. Similar to work in organizational settings (Deci *et al.*, 2001), it would be insightful in future work to examine the cross-cultural generalizability of the tenets and constructs embraced by self-determination theory with respect to understanding motivation in the PE context. Such work would reveal whether the present findings with a sample of British children bear relevance to students from other cultural settings. In a similar vein, future work would do well to examine the measurement equivalence of the tenets embraced by self-determination theory across various developmental stages.

Finally, in addition to examining the invariance of the self-determination framework across gender, culture, and developmental stages, future work could also consider potential class- and school-level variability within the variables embraced by the Deci and Ryan's (1985, 1991) theoretical framework. Although the number of class units in the present work was too low (<30 units) to conduct such analyses (Heck & Thomas, 2000), the application of multi-level modelling techniques (cf. Goldstein, 1995) would be useful in future research. Such analyses permit the hierarchical and concurrent examination of individual, group, and cross-level effects within a hierarchical structure.

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## **Appendix**

### ***Autonomy support***

In this PE class . . .

we feel that the PE teacher provides us with choices and options.  
we feel understood by our PE teacher.  
we are able to be open with our PE teacher during class.  
the PE teacher shows confidence in our abilities to do well in PE.  
we feel that our PE teacher accepts us.  
the PE teacher makes sure we really understand the goals of the lesson and what we need to do.  
the PE teacher encourages us to ask questions.  
we feel a lot of trust in our PE teacher.  
the PE teacher answers our questions fully and carefully.  
the PE teacher handles our emotions very well.  
we feel that our PE teacher cares about us as people.  
we don't feel very good about the way the PE teacher talks to us.  
the PE teacher tries to understand how we see things before suggesting new ways to do things.  
we feel able to share our feelings with the PE teacher.  
the PE teacher listens to how we would like to do things.

### ***Competence support***

In this PE class. . .

the PE teacher helps us to improve.  
the teacher makes us feel like we are good at PE.  
we feel that the PE teacher likes us to do well.  
the PE teacher makes us feel like we are able to do the activities in class.

### ***Relatedness support***

In this PE class. . .

the PE teacher supports us.  
the PE teacher encourages us to work together in practice.  
the PE teacher has respect for us.  
the PE teacher is interested in us.  
We feel that the PE teacher is friendly towards us.

### ***Autonomy***

In this PE class. . .

I can decide which activities I want to practice.  
I have a say regarding what skills I want to practice.

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I feel that I do PE because I want to.  
I have to force myself to do the activities.  
I feel a certain freedom of action.  
I have some choice in what I want to do.

### **Competence**

I think I am pretty good at PE.  
I am satisfied with my performance at PE.  
When I have participated in PE for a while, I feel pretty competent.  
I am pretty skilled at PE.  
I cannot do PE very well.

### **Relatedness**

With the other students in this PE class I feel. . .

Supported  
Understood  
Listened to  
Valued  
Safe

### **Motivation**

I take part in this PE class. . .

#### Intrinsic motivation

because PE is fun.  
because I enjoy learning new skills.  
because PE is exciting.  
because of the enjoyment that I feel while learning new skills/techniques.

#### Identified regulation

because I want to learn sport skills.  
because it is important for me to do well in PE.  
because I want to improve in sport.  
because I can learn skills which I could use in other areas of my life.

#### Introjected regulation

because I want the teacher to think I'm a good student.  
because I would feel bad about myself if I didn't.  
because I want the other students to think I'm skilful.  
because it bothers me when I don't.

**External regulation**

because I'll get into trouble if I don't.  
because that's what I am supposed to do.  
so that the teacher won't yell at me.  
because that's the rule.

**Amotivation**

but I don't really know why.  
but I don't see why we should have PE.  
but I really feel I'm wasting my time in PE.  
but I can't see what I'm getting out of PE.

**Positive and negative affect**

In this PE class I feel. . .

Happy  
Angry  
Unhappy  
Satisfied  
Excited  
Nervous  
Relaxed  
Proud  
Guilty

**Concentration**

For the items below indicate how often you are like this in your PE class. . .

I really concentrate in PE.  
I struggle to concentrate in PE.  
I pay attention in PE.  
I really focus when participating in PE.  
I get easily distracted during PE.  
I think carefully about the skills, tasks, and activities when participating in PE.

**Task challenge**

How likely are you to engage in . . .

a task in which you can learn a lot of new things but will make also have some  
difficulty and make many mistakes.