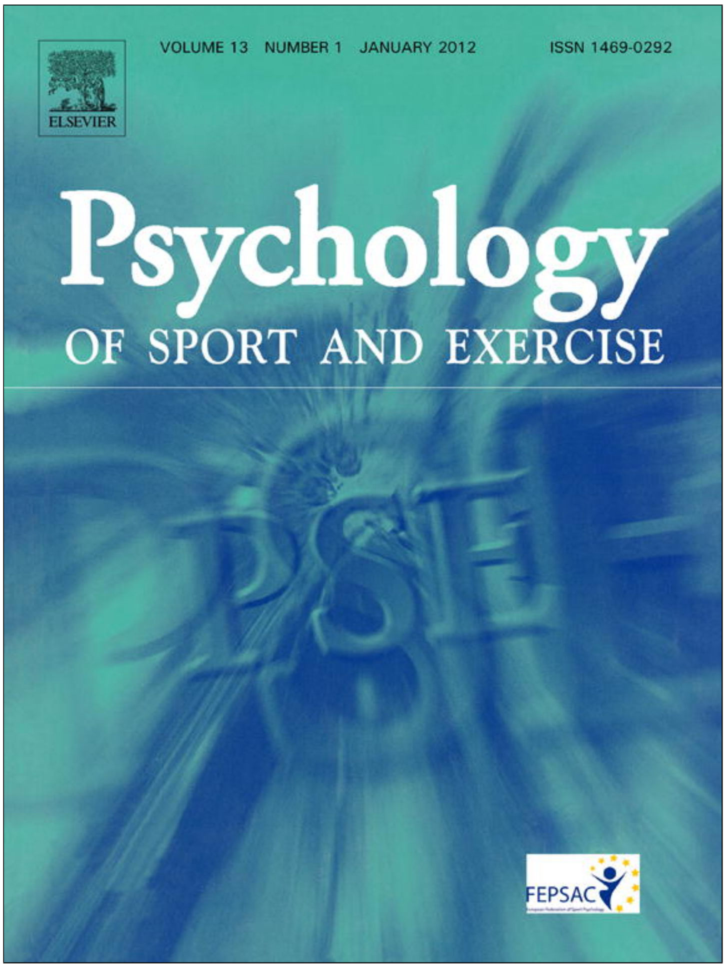

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On the nature and function of scoring protocols used in exercise motivation research: An empirical study of the behavioral regulation in exercise questionnaire

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ABSTRACT

Objectives: The purpose of this study was to examine the effects of different scoring protocols used with instruments designed to assess motivation in line with Organismic Integration Theory (OIT; Deci & Ryan, 2002).
Design: This study used non-probability based sampling within a cross-sectional (survey) design.
Methods: Participants across four samples (N's ranged from 236 to 1200) completed either (a) the Behavioral Regulation in Exercise Questionnaire (BREQ), (b) the BREQ-2, or (c) the BREQ-2R in conjunction with a self-report assessment of physical activity behavior.
Results: Participants endorsed more self-determined than controlled motives for physical activity. Identified regulation was the dominant correlate of more frequent physical activity behavior. The link between external regulation and physical activity was consistently weak. Multiple regression analyses revealed identified regulation was the strongest predictor of physical activity compared with other motives. Regression models using omnibus scoring protocols accounted for less variance in physical activity behavior in contrast to an item-aggregation scoring protocol.
Conclusions: Identified regulation may be a key source of physical activity motivation in adults. The scoring protocol used with OIT-based instruments represents an important consideration for advancing physical activity research.

Understanding why people choose to sustain participation in physical activity (or terminate their involvement) has become a focal point of research in exercise psychology (Wilson, 2012). This is not surprising given that population health studies consistently link lower levels of physical activity with biomedical (e.g., hypertension) and psychological (e.g., depression) health problems that reduce the quality and longevity of life (Bouchard, Blair, & Haskell, 2007). Despite these health threats, substantial portions of the population in many countries remain insufficiently active (Bouchard et al.) while an estimated 50 percent of adults starting an exercise program will discontinue participation within six months (Buckworth & Dishman, 2002). Considering these participation trends, it is important to know why some people engage in physical activity whilst others remain less active. This 'participation paradox' is a complex yet important motivational question that has the potential to be understood by applying relevant theory (Markland & Ingledew, 2007). Organismic Integration Theory (OIT; Deci & Ryan, 2002) is one theory that could be useful for understanding the motivational basis of physical activity.

OIT is focused on the nature of extrinsic and intrinsic motivation in conjunction with the socio-contextual processes that can facilitate (or derail) behavioral regulation (Ryan & Deci, 2007). A central assumption embedded within OIT is that motivation varies along a continuum of perceived self-determination ranging from non-self-determined (or controlled) to self-determined (or autonomous) forms of behavioral regulation (Ryan & Deci). The relative positioning along this motivational continuum reflects the extent to which different reasons motivating action have been internalized by the person and ultimately integrated with, or fragmented within, the person's sense of self (Ryan & Deci). The six constructs aligning the OIT continuum include: Amotivation, external regulation, introjected regulation, identified regulation, integrated regulation, and intrinsic regulation (Ryan & Deci).

Amotivation is concerned with "lacking the intention to act" (Deci & Ryan, 2002, p.17) or a state whereby insufficient motivation

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exists to move a person to action (Vallerand, 2007). External regulation involves engaging in a behavior to obtain incentives (e.g., rewards) or avoid unwanted sanctions (e.g., punishment; Deci & Ryan). Introjected regulation concerns sanctions that motivate behavior via self-imposed pressure to avoid negative emotions (e.g., shame) or maintain conditional self-worth (Deci & Ryan). Identified regulation is the "lower boundary of autonomous regulation" (Wilson, Rodgers, Fraser, & Murray, 2004, p.82) that motivates action due to the personal importance (or value) affixed to outcomes stemming from participation (Deci & Ryan). Integrated regulation concerns the incorporation of identified regulations with the self insofar as pursuing the target behavior is aligned with core values and personal beliefs (Deci & Ryan). Finally, intrinsic regulation refers to "doing an activity for its own sake" (Ryan & Deci, 2007, p.2) such that behavior is motivated by enjoyment, fun, interest, or inherent satisfaction of the activity itself (Deci & Ryan).

Early physical activity research using OIT as a guiding framework focused on developing instruments to assess motivation. Markland and colleagues spearheaded this line of research with the Behavioral Regulation in Exercise Questionnaire (BREQ; Mullan, Markland, & Ingeldew, 1997) and the BREQ-2 (Markland & Tobin, 2004). Mullan et al. developed the BREQ using confirmatory factor analysis to reduce an initial pool of 30 items modified from the Academic Motivation Scale (Vallerand et al., 1992) and the Self-Regulation Questionnaire (Ryan & Connell, 1989) to a total of 15-items assessing external, introjected, identified, and intrinsic regulations for exercise. A subsequent investigation by Markland and Tobin used a similar approach to develop the BREQ-2 that includes a subscale to measure amotivation toward exercise. Consistent with other OIT-based instruments (e.g., Sport Motivation Scale; Pelletier, Fortier, Vallerand, Tuson, & Briére, 1995), neither the BREQ nor the BREQ-2 assess integrated regulation. Subsequently, the BREQ-2R (Wilson, Rodgers, Loitz, & Scime, 2006) was developed to include a subscale measuring integrated regulation for exercise that can be used in conjunction with either the BREQ or BREQ-2.

The development of these instruments has stimulated several lines of research attesting to the construct validity of score interpretations. Construct validation is central to instrument development processes geared toward understanding physical activity motivation (Wilson, 2012; Wilson, Mack, & Grattan, 2008). Based on existing research, the construct validity of scores derived from the BREQ (and to a lesser degree the BREQ-2 and BREQ-2R) is impressive in terms of scope and quality (see Wilson, 2012, for a review). Nevertheless, Messick (1995) contends that construct validation is an ongoing process requiring the constellation of evidence from multiple sources to imbue test score interpretations with clarity and meaning. To date, research efforts have afforded limited attention to the 'optimal' method of representing scores derived from each instrument. Scoring is a fundamental component of test use and interpretation and construct validation (Messick, 1995) that is worthy of scrutiny with reference to the BREQ, BREQ-2, and BREQ-2R instruments to further inform and develop the OIT literature (Wilson, 2012).

Scoring protocols and OIT instrumentation

A number of different scoring protocols have been proposed (or implied) for use with OIT-based instruments. The first scoring protocol noted in the exercise psychology literature was presented by Mullan et al. (1997). In their initial development and validation work, Mullan et al. advocated summarizing participant responses by averaging the items comprising each individual BREQ subscale into four unique scores that represent distinct OIT-based motives. This is referred to as the 'item-aggregation approach' in this paper (see Method A in Table 1).

Another scoring protocol initially termed the 'Relative Autonomy Index' (RAI; Ryan & Connell, 1989; also known as the Self-Determination Index [SDI]; Vallerand, 2007) has also been commonplace in physical activity research using OIT. The RAI approach is predicated on the assumption of a "quasi-simplex pattern" (Deci & Ryan, 2002, p.18) of associations displayed between motives spanning OIT's continuum. In simple terms, Deci and Ryan (2002) assert that one form of evidence favoring the conceptualization of motivation as an underlying continuum of internalizations varying in perceived self-determination is apparent when adjacent regulations on the continuum (e.g., $r_{\text{external-introjected regulations}}$) display more positive associations with one another compared to distal regulations (e.g., $r_{\text{external-intrinsic regulations}}$). In the RAI approach, the scores from each BREQ subscale are weighted then aggregated to form a solitary numerical index representing the extent to which a person's exercise behavior "is more or less self-determined" (Mullan & Markland, 1997, p.356). The most prominent RAI formula evident in the exercise psychology literature using the BREQ is based on Ryan and Connell's (1989) work (see Method B in Table 1).

The inclusion of an amotivation subscale within the BREQ-2 (Markland & Tobin, 2004) and BREQ-2R (Wilson et al., 2006) that also assesses integrated regulation warrants alternative RAI formulas to accommodate these additional constructs. Markland (March 3rd, 2011) suggested one approach to calculating an RAI based on using scores from all five BREQ-2 subscales (see Method C in Table 1). Vallerand and colleagues proposed a third formula for

Table 1
Overview of scoring protocols for the BREQ, BREQ-2, and BREQ-2R.

Scoring protocol	Formula	Source reference
Method A		
Item-aggregation	$\Sigma[\text{item}_1, \text{item}_2, \text{item}_3, \text{item}_4]/n_{ij}$ items	Ryan and Connell (1989)
Method B		
RAI_{BREQ}	$\Sigma([\text{External} \times -2] + [\text{Introjected} \times -1] + [\text{Identified} \times 1] + [\text{Intrinsic} \times 2])$	Ryan and Connell (1989)
Method C		
$\text{RAI}_{\text{BREQ-2}}$	$\text{RAI}_{\text{BREQ-2}} = \Sigma([\text{Amotivation} \times -3] + [\text{External} \times -2] + [\text{Introjected} \times -1]$ $+ [\text{Identified} \times 2] + [\text{Intrinsic} \times 3])$.	Markland (2011)
Method D		
$\text{RAI}_{\text{BREQ-2R}}$	$\text{RAI}_{\text{BREQ-2R}} = \Sigma([\text{Amotivation} \times -3] + [\text{External} \times -2] + [\text{Introjected} \times -1]$ $+ [\text{Identified} \times 1] + [\text{Integrated} \times 2] + [\text{Intrinsic} \times 3])$.	Vallerand et al. (2008)
Method E		
Autonomous motives	$\text{BREQ}_{\text{autonomous motives}} = \Sigma([\text{Intrinsic}) + (\text{Identified})/2)$	Sebire et al. (2008)
Controlled motives	$\text{BREQ}_{\text{controlled motives}} = \Sigma([\text{External}) + (\text{Introjected})/2$	

Note: BREQ = Behavioral Regulation in Exercise Questionnaire (Mullan et al., 1997). BREQ-2 = Behavioral Regulation in Exercise Questionnaire-2 (Markland & Tobin, 2004). BREQ-2R = Behavioral Regulation in Exercise Questionnaire-2 Revised (Wilson et al., 2006). Where n_{ij} = number of test items on the *j*th construct.

computing an RAI score when instruments assess all six concepts (such as the BREQ-2R) outlined within OIT (Vallerand, Pelletier, & Koestner, 2008; see Method D in Table 1). Most of the physical activity research using OIT has relied on the BREQ and by extension the RAI approach (listed as Method B in Table 1) introduced by Ryan and Connell (1989). Both Markland (2011) and Vallerand et al. advocate further empirical scrutiny concerning the effects of using different approaches to computing an RAI score in research using instruments that assess the full complement of OIT-based constructs.[1]

A third scoring protocol is evident in applications of OIT to the study of physical activity. This protocol draws on the conceptual distinction made within OIT between autonomous and controlled motivation (Deci & Ryan, 2002). In brief, Deci and Ryan contend that autonomous motives regulate behavior through personal volition, a sense of choice, and an internal locus of causality. In contrast, people who participate because of a desire to appease others, to acquire rewards, or because they feel pressure to avoid negative emotions linked with non-involvement exemplify controlled motivation (Deci & Ryan). Conceptually, both external and introjected regulations symbolize controlled motives within OIT whereas identified, integrated, and intrinsic regulations characterize autonomous motives (Deci & Ryan). This is referred to as the 'bifurcation-approach' in this paper (see Method E in Table 1). Two recent studies have used the bifurcation approach with the BREQ to examine autonomous and controlled exercise motives (Sebire, Standage, & Vansteenkiste, 2008; Standage, Sebire, & Loney, 2008). Collectively, the evidence reported in both studies suggested the bifurcation approach warrants consideration as a plausible way to score OIT-based instruments within physical activity research.

Few investigations using the BREQ (BREQ-2 or BREQ-2R) have reported multiple scoring protocols applied to the same data relative to criterion of interest within the nomological network of OIT (Cronbach & Meehl, 1955). One exception to this trend is an early study by Mullan and Markland (1997) who report evidence for both the item-aggregation and RAI approaches with reference to the stage of readiness (or change) associated with exercise behavior. Predictive discriminant function analysis supported the *a priori* hypothesis that people in the action/maintenance stages reported higher RAI scores or stronger endorsement of both identified and intrinsic regulations than those in the pre-action stages (Mullan & Markland). While the results of this study align with OIT (Deci & Ryan, 2002), they remain an isolated example of research applying more than one of the available OIT scoring protocol to investigate questions of applied interest with the same data. Such limited attention to the nature and function of different scoring protocols embedded within the OIT framework is surprising, yet warrants additional attention for at least two reasons.

The first reason concerns the evidence-base informing test users of construct validity inherent in scores derived from different instruments designed to assess motivation in line with OIT (Deci & Ryan, 2002). The BREQ has been the most popular instrument used compared with either the BREQ-2 or BREQ-2R (Wilson, 2012), rendering a full evaluation all possible scoring protocols available within the OIT framework untenable. Evaluation of these scoring protocols may yield additional insights pertinent to construct validation – especially since Messick (1995) notes that all scientific evidence fundamentally informs the interpretability and use of test scores. Vallerand et al. (2008) noted that empirical studies investigating the optimal method of combining scores from various instruments (such as the BREQ, BREQ-2, or BREQ-2R) is a viable yet understudied avenue for inquiry in the OIT literature.

A second line of reasoning concerning attention to the different scoring protocols used with OIT-based instruments stems originally from research conducted beyond the realm of physical activity. Studies of political voting have noted that identified, rather than intrinsic regulation, is associated with more frequent behavior (c.f., Burton, Lydon, D'Alessandro, & Koestner, 2006; Koestner, Losier, Vallerand, & Carducci, 1996). Subsequent investigations in exercise settings note that identified regulation may hold greater predictive value than intrinsic regulation in relation to frequency of exercise behavior (Wilson et al., 2004), intentions to exercise (Wilson & Rodgers, 2004), or stage of change for exercise (Daley & Duda, 2006). Yet such observations have not been uniformly noted within the physical activity literature (Silva et al., 2010). Ryan (1995) was the first to contend that in domains where the target behavior may lack inherent stimuli to foster personal interest or enjoyment, identified regulation would likely be a more useful motivational resource underpinning behavior than intrinsic motivation. It seems likely that any important conceptual distinctions between the factors motivating behavior perceived as uninteresting (or monotonous) will be masked when using either the RAI or bifurcation approaches to instrument scoring. At present, it remains unclear to what extent using any omnibus scoring protocols with the BREQ-2 or BREQ-2R will mask distinctions between OIT-based motives and physical activity behavior.

Study aims and hypotheses

The aim of this study was to examine the tenability of different scoring protocols applied to the BREQ, BREQ-2, or BREQ-2R. Specifically, we explored the utility of using different scoring protocols across four samples of adults who provided data using these instruments. Our hypotheses were based on previous studies of physical activity motivation (i.e., Daley & Duda, 2006; Edmunds, Ntoumanis, & Duda, 2008; Mullan & Markland, 1997; Rhodes, Plotnikoff, & Spence, 2004) combined with Deci and Ryan's (2002) theorizing. First, it was hypothesized that motives spanning the OIT continuum would display a quasi-simplex pattern of relationships whereby constructs adjacent to one another (e.g., $r_{external\text{-}introjected}$) would correlate more positively than distal constructs (e.g., $r_{external\text{-}intrinsic}$). Second, it was hypothesized that autonomous (not controlled) motives would be associated with more frequent physical activity behavior. Finally, it was hypothesized that the item-aggregation approach would be the most informative scoring protocol. This last hypothesis was exploratory in nature yet predicated on two lines of reasoning. First, previous studies applying OIT to investigate behavioral issues have demonstrated unique links between distinct types of motivation spanning the regulatory continuum with various aspects of physical activity (e.g., Daley & Duda, 2006; Wilson et al., 2004). Second, a study of scoring issues framed within Social Cognitive Theory (Bandura, 1997) questioned the utility of arbitrarily summing distinct indictors into global constructs for use in predictive models where physical activity is the behavioral criterion of interest (Rhodes et al.). Combining these lines of reasoning, it was assumed that unique relationships between distinct points spanning OIT's motivational continuum and physical activity behavior would be obfuscated when using either the bifurcation or RAI approaches to instrument scoring compared with the item-aggregation approach.

[1] One additional method to calculating the RAI score has been forwarded Niemiec and colleagues primarily for use with latent variable modeling of data collected with OIT-based instruments (Niemiec, Lynch, Vansteenkiste, Bernstein, Deci & Ryan, 2005). In this approach, items rather than subscale scores are transformed by applying the weighting procedures advanced by Ryan and Connell (1989). Transformed items are then aggregated to create manifest indicators that conceptually represent variations in relative autonomy and can be used to define a latent RAI variable.

Methods

Participants

The following section provides an overview of the samples providing data for this study.

Sample 1: A total of 95 males (M_{age} = 21.61 years, SD = 1.69 years; 90.50% White/Caucasian) and 170 females (M_{age} = 21.26 years, SD = 2.34 years; 97.60% White/Caucasian) enrolled in medium sized post-secondary institution in Canada provided data on a single occasion using paper-and-pencil questionnaires. Body Mass Index (BMI) values ranged from 17.37 to 36.02 kg/m^2 across male (M_{BMI} = 24.90 kg/m^2, SD = 2.71 kg/m^2) and female (M_{BMI} = 22.67 kg/m^2, SD = 2.82 kg/m^2) subsamples. Self-reported physical activity varied considerably across both male (M_{METS} = 51.80, SD_{METS} = 17.80; Range = 17.00–108.00) and female (M_{METS} = 52.79, SD_{METS} = 18.86 Range = 14.00–93.00) subsamples based on responses to the Leisure Time Exercise Questionnaire (LTEQ; Godin & Shephard, 1986; see instruments section for details regarding the LTEQ).

Sample 2: A total of 188 men (M_{age} = 35.98 years, SD = 7.29 years; M_{BMI} = 27.53 kg/m^2, SD_{BMI} = 4.94 kg/m^2; 84.60% White/Caucasian) and 1012 women (M_{age} = 34.67 years, SD = 7.65 years; M_{BMI} = 25.29 kg/m^2, SD_{BMI} = 5.55 kg/m^2; 88.80% White/Caucasian) employed at a large non-profit, multinational company provided data on a single occasion using a web-based interface. Self-reported physical activity behavior varied considerably within both male (M_{METS} = 38.63, SD_{METS} = 25.28; Range = 1.50–174.00) and female (M_{METS} = 34.47, SD_{METS} = 24.12; Range 3.00–252.00) subsamples based on their LTEQ responses.

Sample 3: A total of 161 males (M_{age} = 18.91 years, SD_{age} = 1.25 years; M_{BMI} = 23.58 kg/m^2, SD_{BMI} = 3.71 kg/m^2; 67.10% White/Caucasian) and 220 females (M_{age} = 18.52 years, SD_{age} = 1.04 years; M_{BMI} = 21.84 kg/m^2, SD_{BMI} = 3.60 kg/m^2; 72.30% White/Caucasian) provided data using paper-and-pencil surveys on a single occasion in classes at general and vocational colleges located in central Canada. Self-report physical activity data showed considerable variation for men (M_{METS} = 56.99, SD_{METS} = 34.99; Range 0.00–227.00) and women (M_{METS} = 42.40, SD_{METS} = 25.34; Range 0.00–127.00).

Sample 4: A total of 87 men (M_{age} = 20.22 years, SD = 2.17 years; M_{BMI} = 20.22 kg/m^2, SD_{BMI} = 2.17 kg/m^2; 90.80% White/Caucasian) and 149 women (M_{age} = 19.77 years, SD = 1.71 years; M_{BMI} = 23.37 kg/m^2, SD_{BMI} = 3.28 kg/m^2; 98.70% White/Caucasian) students enrolled at two small-sized post-secondary institutions in central Canada. All data were provided on a single occasion using a secure web-based interface. Self-reported physical activity data varied considerably for both male (M_{METS} = 82.46, SD_{METS} = 51.98; Range 17.00–435.00) and female (M_{METS} = 71.16, SD_{METS} = 67.73; Range 3.00–750.00) subsamples.

Instruments

Physical activity motivation

Participants completed either the BREQ (Samples 1 and 2), the BREQ-2 (Sample 3), or the BREQ-2R (Sample 4). The BREQ is a 15-item instrument designed to capture reasons for physical exercise that vary along a graded continuum of self-determination (Mullan et al., 1997). The BREQ includes the following subscales: (a) External regulation (Sample item: "I exercise because other people say I should"; N_{items} = 4); (b) Introjected regulation (Sample item: "I feel guilty when I don't exercise"; N_{items} = 3); (c) Identified regulation (Sample item: "I value the benefits of exercise"; N_{items} = 4); (d) Intrinsic regulation (Sample item: "I exercise because it's fun"; N_{items} = 4). The BREQ-2 (Markland & Tobin, 2004) includes an additional subscale measuring amotivation (Sample item: "I don't see the point in exercising"; N_{items} = 4) plus the 15 BREQ items. The BREQ-2R includes an additional subscale assessing integrated regulation (Sample item: "I consider exercise a fundamental part of who I am"; N_{items} = 4) plus the 19 BREQ-2 items. Each instrument used the following stem: "Why do you exercise?". Responses were made on a 5-point Likert scale with verbal anchors affixed to '0' (Not true for me), '2' (Sometimes true for me) and '4' (Very true for me).

Physical activity

Participants completed 3 items assessing the frequency of mild, moderate, and strenuous exercise completed for at least 15 min per session across a typical week using the LTEQ (Godin & Shephard, 1986). Responses to each LTEQ item were transformed then summed into an overall physical activity score using this formula: $\Sigma[(\text{Mild} \times 3) + (\text{Moderate} \times 5) + (\text{Strenuous} \times 9)]$. The weights correspond to metabolic equivalent values that represent units of oxygen consumption at rest for physical activity of different intensities (Bouchard et al., 2007). Jacobs and colleagues reported a test-retest stability coefficient (r_{12} = 0.62) for overall physical activity across 1 month in adults (Jacobs, Ainsworth, Hartman, & Leon, 1993). Support for the convergent validity of LTEQ scores was noted based on associations with other indicators of exercise behavior and fitness test scores (Jacobs et al., 1993).

Data analysis procedures

Data analyses followed a sequential pattern. First, the data were inspected for missing values, outliers, and inspected for conformity with statistical assumptions. Second, missing values were imputed using an expectation maximization algorithm procedure (see Wilson & Garcia Bengoechea, 2010, for details). Third, internal consistency score reliability estimates were calculated using coefficient-α (Cronbach, 1951). Fourth, descriptive statistics and bivariate (Pearson r) correlations were calculated to assess interrelationships between motivation and physical activity. Finally, multiple linear regression analyses with simultaneous variable entry was used to determine the effects of each scoring protocol in terms of predicting variance in physical activity behavior.

A number of coefficients were used to facilitate interpretation in the multiple regression analyses. In accordance with convention (Pedhazur, 1997), standardized beta-coefficients (β) were reported to evaluate the strength of the relationship between each motive and physical activity behavior. It has long been observed that β-coefficients can be adversely affected by the magnitude of the covariance between individual predictors contained within a regression model (Pedhazur). It has also been noted that the strength of the relationship between different motives for exercise, particularly the most autonomous motives within OIT (Deci & Ryan, 2002), is consistently high across diverse samples of physically active adults (Wilson et al., 2008). As such, structure coefficients (r_s; Courville & Thompson, 2001) were calculated to aid the interpretation of the predictive relationships examined in this study. The r_s-coefficients provide an estimate of strength and direction of the relationship between an individual predictor variable and a criterion that is less susceptible to contamination from suppressor effects or collinearity (Courville & Thompson, 2001). In the present study, each r_s-coefficient was computed using the formula advanced by Courville and Thompson (2001): $r_s = r_{xY1}/R$ where R is the multiple correlation coefficient and r_{xY1} is the Pearson correlation between each predictor and criterion variable score.

Results

Preliminary analyses: missing data and assumptions of normality

No out-of-range responses were observed in the data. Missing data was evident across all samples except sample 1. Little's (1988) test indicated that the missing data noted in sample 2 (Little's $\chi^2 = 390.69$, $df = 359$, $p = .12$) could be considered missing completely at random, while the missing data in sample 4 (Little's $\chi^2 = 204.56$, $df = 145$, $p < .01$) could at best be considered missing at random. All missing data were replaced with estimated values using an expectation maximization algorithm. A portion of the data provided in sample 2 ($n = 30–39$), sample 3 ($n = 6$) and sample 4 ($n = 3$) was discarded given the presence of large standardized residuals (>|3.00| *SD*'s) linked with LTEQ scores. Additional cases were removed on a model-by-model basis in the multiple regression analyses based on large standardized residuals (>|3.00|) for the model under scrutiny.

Estimates of internal consistency score reliability

Greater variability was evident in coefficient-α's (see Tables 2 and 3) reported for the item-aggregation approach ($M_\alpha = 0.81$, $SD_\alpha = 0.12$) compared to the bifurcation approach ($M_\alpha = 0.84$, $SD_\alpha = 0.07$). This is partly due to the value for coefficient-α recorded in sample 4 for responses to the BREQ-2's amotivation subscale. Estimates of score reliability for autonomous motivation ($M_\alpha = 0.89$, $SD_\alpha = 0.03$) were higher than controlling motivation ($M_\alpha = 0.78$, $SD_\alpha = 0.04$; see Table 3).

Descriptive statistics and bivariate correlations

Inspection of the descriptive statistics (see Tables 2and 3) revealed at least two noteworthy observations. First, autonomous motives were consistently more strongly endorsed as reasons for physical activity participation in contrast to controlling motives. Second, amotivation was always the construct least endorsed by any sample followed closely by external regulation in this investigation.

Table 2
Descriptive statistics and estimates of internal consistency reliability for all constructs derived from the item-aggregation scoring approach.

Samples	Variables	*M*	*SD*	*Skew.*	*Kurt.*	α
1	1. External regulation	0.63	0.74	1.37	1.82	0.84
	2. Introjected regulation	2.15	1.01	−0.10	−0.48	0.79
	3. Identified regulation	3.30	0.62	−0.70	−0.27	0.71
	4. Intrinsic regulation	3.12	0.85	−0.95	0.33	0.91
	5. Physical activity	52.24	18.70	0.20	−0.47	–
2	1. External regulation	0.65	0.82	1.55	2.30	0.83
	2. Introjected regulation	1.60	1.13	0.37	−0.81	0.80
	3. Identified regulation	2.71	0.98	−0.51	−0.55	0.84
	4. Intrinsic regulation	2.30	1.20	−0.24	−1.05	0.94
	5. Physical activity	35.12	24.34	1.81	7.86	–
3	1. Amotivation	0.21	0.38	1.82	2.39	0.81
	2. External regulation	1.43	0.55	1.53	2.36	0.82
	3. Introjected regulation	2.22	0.85	0.38	−0.75	0.80
	4. Identified regulation	3.02	0.68	−0.59	−0.21	0.76
	5. Intrinsic regulation	3.04	0.81	−0.54	−0.62	0.91
	6. Physical activity	46.90	26.32	0.77	0.13	–
4	1. Amotivation	0.03	0.10	3.53	11.96	0.39
	2. External regulation	0.90	0.79	0.89	0.24	0.85
	3. Introjected regulation	2.03	1.03	−0.12	−0.62	0.84
	4. Identified regulation	3.38	0.57	−1.37	2.97	0.72
	5. Integrated regulation	3.14	0.77	−0.95	0.65	0.86
	6. Intrinsic regulation	3.23	0.72	−1.45	3.29	0.90
	7. Physical activity	68.59	29.73	1.19	3.29	–

Note. M = Univariate Mean. *SD* = Standard Deviation. *Skew.* = Univariate Skewness. *Kurt.* = Univariate Kurtosis. α = Coefficient of Internal Consistency Reliability (Cronbach, 1951).

Table 3
Descriptive statistics and estimates of internal consistency reliability for bifurcation and RAI approaches to instrument scoring.

Samples	Variables	*M*	*SD*	*Skew.*	*Kurt.*	α
1	1. Autonomous motives	3.21	0.65	−0.73	−0.04	0.86
	2. Controlled motives	1.28	0.68	0.58	0.75	0.77
	3. RAI – Version A	6.12	3.02	−0.44	−0.17	–
2	1. Autonomous motives	2.50	1.02	−0.34	−0.82	0.93
	2. Controlled motives	1.06	0.76	0.85	0.68	0.78
	3. RAI – Version A	4.39	3.84	−0.41	−0.10	–
3	1. Autonomous motives	3.03	0.68	−0.54	−0.46	0.89
	2. Controlled motives	1.82	0.55	0.62	0.13	0.74
	3. RAI – Version A	4.02	2.53	−0.74	0.78	–
	4. RAI – Version B	9.45	4.32	−0.80	0.49	–
4	1. Autonomous motives	3.26	0.58	−0.95	1.43	0.90
	2. Controlled motives	1.35	0.77	0.22	−0.33	0.84
	3. RAI – Version A	3.15	2.88	−0.38	0.23	–
	4. RAI – Version B	12.65	3.89	−0.58	0.57	–
	5. RAI – Version C	15.53	4.36	−0.57	0.23	–

Note. M = Univariate Mean. *SD* = Standard Deviation. *Skew.* = Univariate Skewness. *Kurt.* = Univariate Kurtosis. α = Coefficient of Internal Consistency Reliability (Cronbach, 1951). RAI – Version A = Relative Autonomy Index calculated using the weighted subscale procedure advocated by Mullan et al. (1997) in the following formula: Σ[(external * −2) + (introjected * −1) + (identified * 1) + (intrinsic * 2)]. RAI – Version B = Relative Autonomy Index calculated using the weighted subscale procedure proposed by Markland (2011) to include amotivation using the following formula: Σ[(amotivation * −3) + (external * −2) + (introjected * −1) + (identified * 2) + (intrinsic * 3)]. RAI – Version C = Relative Autonomy Index calculated using the protocol extrapolated from the work of Vallerand et al. (2008) according to the following formula: Σ[(amotivation * −3) + (external * −2) + (introjected * −1) + (identified * 1) + (integrated * 2) + (intrinsic * 3)].

Pearson correlations testing bivariate associations between the motives and physical activity behavior using all scoring protocols are presented in Tables A and B (see Supplementary document). A few summary observations are noteworthy. First, support for the hypothesized quasi-simplex pattern of associations between OIT motives was evident aside from sample 4 where the correlation between introjected-integrated regulations marginally exceeded that noted between introjected-identified regulations. Second, identified regulation was the motive most strongly associated with physical activity behavior followed closely by intrinsic and integrated regulations. Third, autonomous motivation was more strongly correlated with more frequent physical activity behavior than controlling motivation. Fourth, the pattern of correlations between autonomous and controlled motives varied in terms of strength and direction per sample but was largely weak in nature ($M_{r12} = 0.10$, $SD_{r12} = 0.12$; Range = −0.03–0.25). Finally, higher RAI scores were consistently associated with more frequent physical activity behavior yet the magnitude varied across samples and RAI scoring protocols ($M_{r12} = 0.22$, $SD_{r12} = 0.14$; Range = 0.07–0.44).

Multiple regression analyses predicting leisure time physical activity from exercise motivation

The following section plus Table 4 summarizes the results of the multiple regression analyses.[2]

Sample 1: Regression models for different scoring configurations were all statistically significant ($p < .05$) based on the observed

[2] Four indices were considered to estimate potential collinearity (Pedhazur, 1997). Variance Inflation Factor (VIF), Tolerance Values (TV), Condition Index (CI), and Variance Proportion Values (VPV) were examined in each sample comprising this investigation with the following observations noted: (a) Sample 1: VIF = 1.00 to 1.78; TOL = 0.56 to 0.99; (c) CI = 0.00 to 12.34; (d) VPV = 0.00 to 0.95 (no two VPV ≥ 0.50 when the CI > 10); (b) Sample 2: VIF = 1.00 to 2.56; TOL = 0.39 to 0.99; (c) CI = 1.00 to 11.34; (d) VPV = 0.00 to 0.95 (two VPV's ≥ 0.50 when the CI > 10); (c) Sample 3: VIF = 0.12 to 2.76; TOL = 0.36 to 0.94; (c) No two VPV's exceeded 0.50 when the CI was greater than or equal to 10; and (d) Sample 4: VIF = 1.01 to 1.97; TOL = 0.51 to 0.99; (c) CI = 1.00 to 25.44; (d) VPV = 0.00 to 0.98 (no two VPV ≥ 0.50 when the CI > 10).

Table 4
Summary results from the regression models predicting LTPA from different scoring models.

Variables	Sample 1		Sample 2		Sample 3		Sample 4	
	β	r_s	β	r_s	β	r_s	β	r_s
Scoring model 1								
Amotivation	–	–	–	–	0.11	−0.30	0.25	0.43
External regulation	0.08	−0.03	−0.03	−0.22	−0.08	−0.23	−0.12	−0.10
Introjected regulation	−0.05	0.19	0.01	0.36	0.10	0.58	0.06	0.38
Identified regulation	0.33	0.97	0.39	0.98	0.24	0.91	0.27	0.79
Integrated regulation	–	–	–	–	–	–	0.10	0.67
Intrinsic regulation	0.09	0.69	0.19	0.89	0.21	0.86	0.01	0.41
Scoring model 2								
Autonomous motives	0.33	0.97	0.55	1.00	0.40	1.00	0.29	1.00
Controlled motives	0.05	0.12	−0.01	0.09	0.05	0.36	0.06	0.27
Scoring model 3								
RAI – Version A	0.19	1.00	0.44	1.00	0.29	1.00	0.08	1.00
RAI – Version B	–	–	–	–	0.34	1.00	0.07	1.00
RAI – Version C	–	–	–	–	–	–	0.11	1.00

Note. RAI – Version A = Relative Autonomy Index calculated using the weighted subscale procedure advocated by Mullan et al. (1997) in the following formula: Σ[(external * −2) + (introjected * −1) + (identified * 1) + (intrinsic * 2)]. RAI – Version B = Relative Autonomy Index calculated using the weighted subscale procedure proposed by Markland (2011) to include amotivation using the following formula: Σ[(amotivation * −3) + (external * −2) + (introjected * −1) + (identified * 2) + (intrinsic * 3)]. RAI – Version C = Relative Autonomy Index calculated using the weighted subscale procedure advocated by Vallerand et al. (2008) using the following formula: Σ[(amotivation * −3) + (external * −2) + (introjected * −1) + (identified * 1) + (integrated * 2) + (intrinsic * 3)]. Scoring Model 1 = Point estimate subscale scores for BREQ/BREQ-2/BREQ-2R responses across samples in the study. Scoring Model 2 = Global autonomous/controlled motives derived from unweighted BREQ item scores (excluding amotivation) across samples in the study. Scoring Model 3 = Overall RAI score derived from weighted BREQ/BREQ-2/BREQ-2R subscale scores across samples in this study. All standardized beta-coefficients were statistically significant at $p < .05$ if they exceeded (a) |0.10| in sample 1, (b) |0.15| in sample 2, (c) |0.15| in sample 3, and (d) |0.13| in sample 4.

values for the item-aggregation approach ($F_{4,261} = 9.91$; $p < .01$; $R = 0.36$; $R^2_{adj.} = 0.12$), the bifurcation approach ($F_{2,263} = 16.68$; $p < .01$; $R = 0.34$; $R^2_{adj.} = 0.11$), and the RAI approach ($F_{1,264} = 9.94$; $p < .01$; $R = 0.19$; $R^2_{adj.} = 0.03$).

Sample 2: Regression models for different scoring configurations tested were all statistically significant ($p < .05$) based on the observed values for the item-aggregation approach ($F_{4,1155} = 126.20$; $p < .01$; $R = 0.55$; $R^2_{adj.} = 0.30$), the bifurcation approach ($F_{2,1155} = 245.79$; $p < .01$; $R = 0.55$; $R^2_{adj.} = 0.30$), and the RAI approach ($F_{1,1157} = 284.29$; $p < .01$; $R = 0.44$; $R^2_{adj.} = 0.20$).

Sample 3: Regression models for different scoring configurations were all statistically significant ($p < .05$) based on the observed values for the item-aggregation approach ($F_{5,359} = 16.70$; $p < .01$; $R = 0.43$; $R^2_{adj.} = 0.18$), the bifurcation approach ($F_{2,362} = 38.15$; $p < .01$; $R = 0.42$; $R^2_{adj.} = 0.17$), and the RAI scoring approaches (RAI-Version A: $F_{1,363} = 35.23$; $p < .01$; $R = 0.29$; $R^2_{adj.} = 0.09$; RAI-Version B: $F_{1,363} = 47.02$; $p < .01$; $R = 0.34$; $R^2_{adj.} = 0.11$).

Sample 4: Summary observations noted in Table 4 indicate the item-aggregation approach ($F_{6,213} = 7.39$; $p < .01$; $R = 0.42$; $R^2_{adj.} < 0.15$), bifurcation approach ($F_{2,218} = 11.05$; $p < .01$; $R = 0.30$; $R^2_{adj.} = 0.08$), and RAI-Version C in Table 4 ($F_{1,220} = 2.79$; $p = .10$; $R = 0.11$; $R^2_{adj.} = 0.01$) appeared tenable in this sample. Two alternative configurations of the RAI approach resulted in a non-significant regression models in this sample (RAI-Version A: $F_{1,220} = 1.34$; $p = .25$; $R = 0.08$; $R^2_{adj.} < 0.01$; RAI-Version B: $F_{1,220} = 1.01$; $p = .32$; $R = 0.07$; $R^2_{adj.} < 0.01$).

Discussion

The purpose of this study was to examine the impact of different scoring protocols used with OIT-based instruments (Deci & Ryan, 2002) when assessing motivation for physical activity. To address this purpose, a multi-sample investigation was conducted to examine the tenability of different approaches proposed broadly within OIT to score the BREQ, BREQ-2, and BREQ-2R. Summary observations indicated that people endorsed more autonomous than controlled motives for physical activity, identified regulation was the strongest correlate and predictor of physical activity, and the scoring protocol used with OIT instruments holds the potential to unveil (or mask) the forces motivating physical activity behavior. Overall, the results of this study do nothing to undermine a central assumption set forth by Deci and Ryan (2002): The 'quality' (or type) of human motivation that regulates behavior matters at least as much as the 'quantity' (or level) of that motivation. It seems on the basis of these observations that the continued application of OIT to the study of motivation within and across diverse spheres and types of physical activity seems well justified.

Does the evidence provided across samples offer support for the 'quasi-simplex' pattern?

Mixed support for the first hypothesis concerning the pattern of expected associations between motives spanning the OIT continuum was evident in this study. It was assumed on the basis of Deci and Ryan's (2002) theorizing combined with previous studies (Mullan et al., 1997; Sabiston et al., 2010; Wilson et al., 2004) that adjacent pairs of motives assessed with the BREQ, BREQ-2, and BREQ-2R would display more positive links than distal pairs of regulations. Stated differently, Markland and Tobin (2004) note that evidence for a quasi-simplex pattern is apparent when stronger positive correlations emerge between adjacent motives and stronger negative links appear between distal motives. The central importance of this finding is predicated on the assumption that observations displaying a quasi-simplex pattern of relationships corroborate Deci and Ryan's theorizing concerning the nature of human motivation. Namely, that human motivation is best understood as a continuum of internalizations that vary in perceived self-determination.

Closer scrutiny of the data in this study provides mixed support for this hypothesis. Whereas the bulk of the evidence is supportive of the proposed quasi-simplex pattern, it is worth noting the associations between amotivation and other constructs (see samples 3 and 4 in Table A) deviate from *a priori* expectations. Several explanations could account for this anomaly. First, it is plausible that such observations reflect idiosyncratic variability or nuances of item interpretation unique to these samples. While this account is plausible, it is worth noting that Markland and Tobin (2004) also report parallel findings concerning the link between amotivation with identified regulation in patrons of an exercise referral scheme from the United Kingdom. The sample used by Markland and Tobin was, on average, considerably older than participants in this study ($M_{age} = 56.33$ years) and displayed more risk factors for all-cause mortality (i.e., higher BMI's). Such observations call into question the likelihood that sample idiosyncrasies fully explain this anomaly.

Second, it is possible that the measurement of amotivation by the BREQ-2 and BREQ-2R is overly focused on the lack of value stemming from exercise that excludes capacity beliefs, outcome expectations, and effort that may provide a more complete account of the content domain defining amotivation within OIT (Vlachopoulos, Letsiou, Palaiologou, Leptokaridou, & Gigoudi, 2010). Such a focus would undoubtedly explain the stronger links with identified regulation. Markland and Tobin (2004) were the first to acknowledge this possibility yet it remains uncertain if the BREQ-2 items capturing amotivation under-represent this construct. Messick (1995) contends that construct under-representation is a pivotal threat to the validity of test scores. At this juncture, it seems that two recommendations could be extrapolated from this study's findings. First, it would be useful to examine the full range of item content relevance and representation issues associated with the amotivation items used in the BREQ-2 and BREQ-2R. Second, it seems reasonable to suggest future studies consider the research question scrutinized plus the potential characteristics of the target sample when selecting OIT instruments to determine if amotivation is worthy of assessment.

Does the type of motivation underlying the regulation of physical activity behavior 'matter'?

Greater support for the tenability of the second hypothesis is evident in this study. In brief, the results noted in this study make it apparent that self-determined motives, irrespective of their intrinsic or extrinsic orientation, demonstrate more positive links with weekly physical activity behavior. Deci and Ryan (2002) extol the benefits of regulation that is more self-determined (and thereby autonomous) as opposed to controlled in nature. Relevant theorizing and evidence across domains of life including health behaviors (Deci & Ryan) supports the contention that action regulated in a self-determined manner is more enduring over time and associated with greater well-being. Support for this assertion has been forthcoming in previous studies linking more self-determined regulations with greater physical activity behavior (Mullan & Markland, 1997; Silva et al., 2010) and better well-being (Brunet & Sabiston, 2009; Wilson et al., 2006). It is apparent that the findings of this study do nothing to undermine Deci and Ryan's contentions in this regard.

Perhaps of greater interest in this study is the generalizability of Deci and Ryan's (2002) claims pertaining to the motivation-behavior link across various approaches to instrument scoring popular within OIT. Previous commentary indicates that various methods derived from Deci and Ryan's theorizing can be used to score instruments capturing the underlying reasons that motivate behavior in line with the major premises of the underlying theory (Vallerand et al., 2008). In the physical activity literature, this study is perhaps the first attempt to offer a transparent description and empirical assessment of scoring protocols used within OIT research examining physical activity (see Table 1). Of further importance is the evidence presented in this study that each scoring protocol underscores the basic premise that regulation of physical activity behavior for more self-determined reasons is positively linked with adaptive health behavior. Providing evidence to confirm (or deny) theorized links between various concepts integral to a nomological network (Cronbach & Meehl, 1955) represents a fundamental aspect of the construct validation process (Messick, 1995). In sum, the evidence reported herein albeit limited in scope provides empirical support for the utility and theoretical fidelity of each scoring approach proposed within OIT (Vallerand et al., 2008).

Does the nature of the scoring protocol impact our understanding of the motivational basis for physical activity behavior?

The final issue addressed in this study concerned the impact of scoring protocols that permeate the OIT literature. Consideration of previous research (e.g., Daley & Duda, 2006; Rhodes et al., 2004; Wilson et al., 2004) led to the hypothesis that using the bifurcation and/or RAI approaches would be less informative in predicting behavior compared to the item-aggregation approach. Evidence across the four samples in this study provided general support for our *a priori* assumptions concerning the use of different scoring protocols with OIT instruments. It is apparent within this investigation that identified regulation, a self-determined yet extrinsic source of motivation, seems to play a critical role in understanding why people engage in physical activity. Such observations are hardly novel yet reinforce Ryan's (1995) contention that identified regulation can be a powerful source of motivation if the target behavior is perceived as uninteresting or monotonous. Yet it is worthy of note that participants in this study also endorse the intrinsically motivating nature of behaviors that comprise their typical physical activity regimen (see Table 2). A recent study (Silva et al., 2010) offered support for the role of intrinsic motivation in predicting structured (not habitual) physical activity behaviors in overweight women enrolled in a weight-loss program. The LTEQ fails to distinguish lifestyle from structured physical activities when using the unitary score that combines behaviors differentiated on the basis of perceived intensity into a global index. Given the limitations imposed by using the LTEQ, it seems plausible to suggest that identified regulation is merely the stronger predictor of these two autonomous motives in the samples investigated when assessing global physical activity behavior. Overall, it seems fair to suggest that joint consideration of these observations combined with the findings of Silva et al. (2010) could be interpreted as evidence favoring the item-aggregation approach that reveals links between each motive spanning the OIT continuum and physical activity behavior in a transparent and precise manner.

The main focus of this study hinged on the interplay between theory (namely OIT) and measurement which Messick (1995) argues is fundamental to advancing evidence-based practice in applied sciences. Two broad implications seem evident from the present study for the underlying theory informing this investigation. First, it is apparent that each scoring protocol adopted by research using OIT holds at least some credence when used with instruments designed to assess physical activity motivation. The wealth of the evidence for all scoring protocols tested in this study corroborates a central premise of OIT – namely that regulating human action for self-determined reasons is more adaptive with reference to participatory behavior (Deci & Ryan, 2002). Yet weaker effects seem evident with the RAI approach compared to the item-aggregation approaches to instrument scoring. Such observations were also noted by Rhodes et al. (2004) and likely arise from amalgamating conceptually distinct constructs. Using the work of Rhodes et al. in conjunction with the present study, the implication for OIT research is simply that attention and forethought is warranted in terms of using scoring protocols with instruments designed to assess physical activity motives that align with relevant theory.

A second set of implications can be extrapolated from the present study to the realm of interventions designed to change physical activity behavior. Evidence-based decision-making has become the norm amongst health professionals attempting to change physical activity behavior, a point that has not escaped proponents of OIT (e.g., Deci & Ryan, 2002). It seems plausible that a net effect of using various scoring models with OIT instruments will be to elucidate (or mask) the 'key' motives linked with physical activity. Health professionals will undoubtedly then target intervention efforts toward changing these motives with the belief that such efforts hold the greatest potential to yield adaptive behavioral change. Assuming this logic is tenable, albeit may be premature, it is reasonable to conclude that scoring protocols used with OIT hold the potential to impact cumulative knowledge development concerning the motivational basis for physical activity. Overall, it seems worthwhile to recommend that any (and preferably all) future studies using OIT to study physical activity issues justify the scoring protocol used with instruments measuring behavioral regulations in line with Deci and Ryan's (2002) theorizing.

Limitations and future directions

There are several limitations that warrant recognition in this study. First, this study used cross-sectional designs with non-probability sampling that preclude causal inferences and limit external validity. Future studies using longitudinal designs and sampling from known populations where motivating physical activity behavior remains a key issue (e.g., cancer survivors) seem integral to advancing this line of inquiry. Second, all the physical activity data relied on self-report methods using the LTEQ. Future investigations may elect to use alternative methods to capture physical activity behaviors (e.g., accelerometers) to offset issues of recall bias, socially desirable responding, and common methods variance that can plague the interpretability of self-report data. Third, a single context (i.e., physical activity) and set of instruments (i.e., BREQ, BREQ-2, BREQ-2R) was examined in the present study with reference to OIT-based scoring protocols. Future studies may wish to determine if using various scoring protocols in other contexts (e.g., diet) and at different hierarchical levels (e.g., situational) or using other instruments designed to assess motivation in line with OIT replicate these observations. Fourth, our study examined a select number of scoring protocols applied to OIT-based instruments measuring physical activity motivation. Additional research testing other scoring protocols seems justifiable in order to advance OIT. One useful route may include separating amotivation from other concepts aligning the OIT continuum in the scoring protocol to determine the utility of this concept alongside the bifurcation and RAI models.[3] Finally, our study was restricted to assessing the motivation-behavior link. Further studies using cognitive and/or affective criterion theoretically linked with motivation (Deci & Ryan, 2002) would expand our understanding of the inherent utility of different scoring protocols used with OIT.

Summary

Overall, the purpose of this study was to examine the viability of different scoring protocols evident in the OIT literature (Deci & Ryan, 2002) in relation to physical activity behavior. The central issue under investigation in the study concerned what (if any) impact the use of different approaches to instrument scoring imposes on our understanding of the motivation-physical activity link. The key finding of this investigation is that scoring protocols represent an important consideration for research attempting to unravel the dynamics linking human motivation with physical activity behavior using OIT as a framework. Use of the item-aggregation approach seems justifiable on the grounds that identified regulation was consistently a key source of physical activity motivation linked with more frequent behavior. Suffice it to say that the observations noted for the two alternative scoring approaches displayed links with physical activity behavior that appear consistent with the underling theory informing their development and use. Future studies that use either the bifurcation or RAI approaches with OIT instruments do not seem unreasonable given the current findings yet could benefit from overt justification for amalgamating distinct types of motivation into more globalized constructs. In sum, the results of this initial study make it clear that additional investigations of the scoring protocols drawn from OIT (Deci & Ryan) represent an important and potentially useful avenue for future research.

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Appendix A. Supplementary material

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.psychsport.2012.03.009.

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