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20 Autonomy support, basic need satisfaction and the optimal functioning of adult male and

21 female sport participants: A test of basic needs theory

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Abstract

Grounded in Basic Needs Theory (BNT; Ryan & Deci, 2000a), the present study aimed to: a) test a theoretically-based model of coach autonomy support, motivational processes and well-/ill-being among a sample of adult sport participants, b) discern which basic psychological need(s) mediate the link between autonomy support and well-/ill-being, and c) explore gender invariance in the hypothesized model. Five hundred and thirty nine participants (Male = 271; Female = 268; $M_{age} = 22.75$) completed a multi-section questionnaire tapping the targeted variables. Structural Equation Modeling (SEM) analysis revealed that coach autonomy support predicted participants' basic need satisfaction for autonomy, competence and relatedness. In turn, basic need satisfaction predicted greater subjective vitality when engaged in sport. Participants with low levels of autonomy were more susceptible to feeling emotionally and physically exhausted from their sport investment. Autonomy and competence partially mediated the path from autonomy support to subjective vitality. Lastly, the results supported partial invariance of the model with respect to gender.

KEYWORDS: coach-created environment, sport motivation, self-determination theory, psychological development, well-being, mediation, gender invariance.

Autonomy support, basic need satisfaction and the optimal functioning of adult male and female sport participants: A test of basic needs theory

Perceptions of high energy and vitality are critical to physical and psychological functioning, and the experience of well-being, among sport participants. Diminished functioning and a sense of ill-being are evident when athletes perceive a loss of positive energy or feel emotionally and physically exhausted. The coach is a significant figure in the sporting environment who has the potential to influence the psychological and physical health and quality of engagement of an athlete or team of players. Grounded in basic needs theory (BNT; Ryan & Deci, 2000a), research has begun to examine the mechanisms linking dimensions of the coach-created environment to positive and negative indicators of players' welfare in the sports domain (Gagné, Ryan & Bargmann, 2003; Reinboth, Duda & Ntoumanis, 2004). The present study aimed to test the postulates of BNT among a sample of adult male and female sport participants.

BNT (Ryan & Deci, 2000a), a mini-theory of self determination theory (SDT; Deci & Ryan, 1985, 2000), proposes that humans function and develop effectively as a consequence of the social environment and its potential for basic need satisfaction. According to BNT, humans have three basic psychological needs; namely, the innate needs for autonomy, competence and relatedness (Deci & Ryan, 2000; Ryan & Deci, 2000a). The inherent need for *autonomy* (deCharms, 1968; Deci & Ryan, 1985) is fulfilled when people perceive that they are the origin of their choices and decisions, and that they are acting in accord with their integrated sense of self. *Competence* (White, 1959) concerns an individual's need to feel a sense of mastery through effective interaction within their environment. The third need, *relatedness*, corresponds to feeling securely attached to and being respected by significant others (Baumeister & Leary, 1995). Satisfaction of these psychological needs is assumed to directly enhance psychological and physical well-being (Deci & Ryan, 2000). When the three

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4 basic psychological needs are thwarted however, ill-being is posited to ensue (Ryan & Deci,
5
6 2000a).

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8 Contemporary conceptual approaches argue that well-being is not simply the absence
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10 of pain/displeasure or the mere presence of happiness/positive affect (Ryan & Deci, 2000b;
11
12 2001). Rather, from the *eudaimonic* perspective, well-being is defined in terms of self-
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14 realization and the degree to which a person is functioning optimally in a particular context
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16 (see Ryff, 1989; Waterman, 1993). SDT (and BNT more specifically) embraces the
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18 eudaimonic conceptualization of well-being (Ryan & Deci, 2001). In the present study,
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20 subjective vitality, a positive feeling of having available energy emanate from the self (Ryan
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22 & Frederick, 1997), was targeted as a key indicator of eudaimonic well-being. The emotional
23
24 and physical exhaustion facet of burnout (Raedeke & Smith, 2001), was assessed as an index
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26 of ill-being. In this way, we attempted to capture both the brighter and darker sides of
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28 athletes' sporting life (Ryan & Deci, 2000b).

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33 With respect to social environmental factors that are assumed to be important for need
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35 satisfaction and ensuing well-being (Ryan & Deci, 2000a), emphasis has been placed on the
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37 degree of *autonomy support* (Deci & Ryan, 1987) provided by significant others in the
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39 context in question. Autonomy support is evident when an authority figure respects and takes
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41 the subordinate's perspective, promotes choice and encourages decision-making. An
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43 autonomy supportive environment is assumed to foster participants' sense of personal
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45 autonomy and perceptions that they are the origin of their behavior. Previous studies in a
46
47 variety of contexts have supported this theoretical prediction (Ratelle, Larose, Guay &
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49 Senécal, 2005; Reinboth et al., 2004; Standage, Duda, & Ntoumanis, 2006). Autonomy
50
51 support is also posited to facilitate the needs for competence and relatedness (Ryan & Solky,
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53 1996; Mageau & Vallerand, 2003) and research in sport (Smith, Ntoumanis & Duda, 2007),
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4 the workplace (Baard, Deci & Ryan, 2004) and classroom settings (Ratelle et al., 2005) has
5
6 corroborated this assumption.
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9 In the sport setting specifically, the coach can be considered to be the most proximal
10 contact for all athletes on a team and consequently plays a key role in nurturing their needs
11 for autonomy, competence and relatedness (Mageau & Vallerand, 2003; Smith et al., 2007).
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13 Grounded in the BNT framework, sport research has begun to test the hypothesized links
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15 between perceptions of the coach-created environment, basic need satisfaction, and indices of
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17 athletes' welfare (Gagné et al., 2003; Reinboth et al., 2004). Gagné and associates (2003)
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19 conducted a diary-based study among a group of female adolescent gymnasts and found
20
21 fluctuations in daily need satisfaction to predict changes in daily well-being (operationalized
22
23 as levels of vitality, self-esteem, and positive and negative affect). In a cross-sectional study
24
25 of young adolescent male soccer and cricket players, Reinboth and colleagues (2004)
26
27 investigated how different aspects of the coach-created environment predicted athletes' need
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29 satisfaction and ensuing indices of well- and ill-being. They found that autonomy support, the
30
31 degree of mastery focus and social support positively corresponded to reported satisfaction of
32
33 the needs for autonomy, competence, and relatedness, respectively. In turn, the needs for
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35 autonomy and competence predicted higher levels of vitality and intrinsic interest. Low levels
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37 of perceived competence were associated with more frequent reports of physical ill-health
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39 symptoms (e.g., headaches).
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47 BNT assumes the psychological needs essential for optimal functioning are universal
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49 (Ryan & Deci, 2000a). However, Ryan and Deci (2000a) suggest that the degree of influence
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51 of social environmental factors supporting need satisfaction may not necessarily be consistent
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53 across the lifespan. Thus, with respect to the existent research conducted in the sport domain,
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55 testing the tenets of BNT among older participants would advance theoretical knowledge. For
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57 example, the immediate environment created by the coach may hold differential significance
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4 for senior athletes when compared to their younger counterparts because of the extensive
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6 sport experience and greater maturity of the older sport participants. Moreover, feelings of
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8 competence, autonomy, and relatedness may not correspond to indicators of health and
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10 engagement quality among older competitors to the same degree and/or in the same manner
11
12 as has been found for young sport participants. To our knowledge, only one BNT-based study
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14 has moved beyond the inclusion of youth sport participants. In research involving university
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16 student-athletes, Reinboth and Duda (2006) found that the task-involving features of the
17
18 coach climate predicted need satisfaction. Satisfaction of the needs for autonomy and
19
20 relatedness were linked to players' reported subjective vitality over the course of a season.
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22 Interestingly, the need for competence was unrelated to vitality and physical ill-health
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24 symptoms within this older age-group sample. However, this study did not consider the
25
26 degree of autonomy support provided by the coach. Extending the extant sport research
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28 testing BNT (Gagné et al., 2003; Reinboth & Duda, 2006; Reinboth et al., 2004), the present
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30 study examined the hypothesized sequence between the autonomy supportive aspect in the
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32 coach-created environment to need satisfaction to indices of well- and ill-being in the case of
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34 adult sport participants.
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40 Aligned with self determination theory (Mageau & Vallerand, 2003; Ryan & Deci,
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42 2000a) and previous work in the physical domain (Smith et al., 2007; Standage et al., 2006),
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44 we hypothesized that perceptions of autonomy support would positively predict satisfaction
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46 of the needs for autonomy, competence and relatedness (Hypothesis 1). Based on the tenets
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48 of BNT (Ryan & Deci, 2000a) and past sport research by Reinboth and colleagues (2004), we
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50 proposed that satisfaction of the three psychological needs would predict feelings of vitality
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52 (Hypothesis 2a), whereas low need satisfaction would link to greater emotional and physical
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54 exhaustion (Hypothesis 2b).
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4 The second aim of this study was to examine why the autonomy supportive features
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6 of the coach-created environment might predict positive and negative indicators of athletes'
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8 welfare. Deci and Ryan (2000) argue that the psychological needs represent the “why” of
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10 goal pursuit or, central to the focus of this study, the mechanisms by which the social
11
12 environment impacts on motivation, psychological health and well-being. Specific to the
13
14 sport domain, Mageau and Vallerand (2003) propose that the three psychological needs
15
16 *mediate* the link between coach autonomy support and healthy outcomes. In previous
17
18 research examining the social environment-optimal functioning relationship, the expected
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20 mediational role of the needs has been assumed but not tested (e.g., Baard et al., 2004;
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22 Reinboth et al., 2004) or examined via regression analyses (e.g., Reinboth & Duda, 2006) in
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24 accordance to the recommendations of Baron and Kenny (1986).
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29 Extending previous work, we examined the mediational effects of the three
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31 psychological needs from an autonomy supportive climate to positive and negative indices of
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33 athletes' welfare via structural equation modeling (SEM; Holmbeck, 1997). Two benefits of
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35 testing mediation via SEM rather than conventional regression analyses are that a) multiple
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37 outcome variables can be examined simultaneously, and b) this analytical approach controls
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39 for measurement error. Moreover, moving beyond previous SDT-based studies which have
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41 determined the potential mediating role of a composite index of basic need satisfaction (e.g.,
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43 Hagger, Chatzisarantis & Harris, 2006; Standage, Duda & Ntoumanis, 2005), we tested via
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45 SEM which specific basic need(s) would mediate the hypothesized relationship between
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47 autonomy support and indices of well- and ill-being. In accordance with theoretical
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49 predictions (Mageau & Vallerand, 2003) and previous findings in the educational and sport
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51 domains (Ratelle et al., 2005; Reinboth & Duda, 2006), we expected that all three basic needs
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53 would mediate the relationship from coach autonomy support to the targeted indicators of
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55 well- and ill-being (Hypothesis 3).
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4 The final major purpose of the study was to test our model for gender invariance.
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6 Ryan and Deci (2000a) argue that the motivational processes essential for human functioning
7
8 are equivalent across gender groups. To our knowledge, this proposition has not received
9
10 empirical attention in the physical domain. This is because previous BNT-based sport studies
11
12 have either employed single sex samples (Gagné et al., 2003; Reinboth et al., 2004), or have
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14 assumed the link between basic needs satisfaction to well-being to be equivalent for male and
15
16 female participants (Reinboth & Duda, 2006). To address these limitations, we conducted
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18 multi-sample SEM analyses to ascertain whether male and female athletes interpreted an
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20 autonomy supportive climate, psychological needs, and indices of well-/ill-being in a similar
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22 manner (i.e., we tested measurement invariance). We further examined whether the
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24 theoretical (Ryan & Deci, 2000a) links between the coach-created environment, need
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26 satisfaction, and markers of well- and ill-being were invariant across gender (i.e., we tested
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28 structural invariance). Based on Ryan and Deci's (2000a) theorizing, we predicted that the
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30 conceptual model would be comparable across gender (Hypothesis 4).
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35 Method

36 *Participants*

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40 Five hundred and thirty nine adults (males = 271, females = 268) from the United
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42 Kingdom volunteered for the study with a mean age of 22.75 years ($SD = 4.63$; range = 18-
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44 36). All participants were engaged in a team sport: field hockey (135), cricket (108), netball
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46 (86), ultimate Frisbee (55), basketball (42), American football (37), soccer (35), rugby (19),
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48 lacrosse (13), and volleyball (9). On average, participants were invested in personal training
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50 for seven hours per week ($M = 6.94$; $SD = 4.83$), and had worked with their coach for three
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52 years ($M = 3.10$; $SD = 4.15$). The majority of participants were involved in their sport at club
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54 level ($n = 370$) with fewer participants playing at higher standards of competition: county
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56 (39), regional (70), national (48), and international (12).
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Measures

Autonomy support. Coach autonomy support was assessed via a modified version of the Health Care Climate Questionnaire (HCCQ; Williams, Grow, Freedman, Ryan & Deci, 1996). Following the approach of Reinboth et al. (2004), seven items were drawn from the HCCQ and adapted to tap the degree to which coaches were perceived by athletes to be autonomy supportive (e.g., “*I feel that my coach provides me choices and options*”).

Evidence for the internal consistency and factorial validity of the modified HCCQ has been provided in previous sport based research (Reinboth et al., 2004; Smith et al., in press).

Participants responded to the autonomy support items on a 7-point Likert scale (*strongly disagree* = 1; *strongly agree* = 7).

Basic Psychological Needs. The need for autonomy was tapped using a three item measure created by Sheldon, Elliot, Kim and Kasser (2001). A sample item on this scale is “*my choices [e.g., in soccer] are based on my true interests and values*”. Consistent with past studies (e.g., Reinboth et al., 2004), the satisfaction of the need for competence was assessed by the five item perceived competence subscale of the Intrinsic Motivation Inventory (IMI; McAuley, Duncan & Tammen, 1989). An example item is “*I think I am pretty good [e.g., at soccer]*”. The Acceptance subscale of the Need for Relatedness Scale (NRS; Richer & Vallerand, 1998) was adapted to assess players’ perceptions of relatedness with respect to their teammates. Specifically, participants responded to five adjectives asking them to rate the degree to which they felt connected to and by other players on the team (i.e., “*I feel...supported, listened to, valued, understood, and safe*”). Participants responded to the stem “*On this team...*” for each basic needs scale and reported their scores on a 5-point Likert scale (for relatedness and autonomy) or a 7-point Likert scale (for competence), ranging from *strongly disagree* to *strongly agree*. The internal consistency, factorial and predictive validity

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4 of these measures have been supported in previous research conducted in the physical domain
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6 (e.g., Hagger et al., 2006; Reinboth & Duda, 2006; Standage et al., 2005).
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9 *Well/ill-being outcomes.* A five item version of the Subjective Vitality Scale (SVS;
10 Ryan & Frederick, 1997) was employed to measure athletes' personal feelings of possessing
11 positive energy. More specifically, this scale was used to assess the degree to which
12 participants felt alive and energetic when playing their chosen team sport (e.g., "*I feel alive*
13 *and vital*"). Participants responded on a 7-point scale (1 = *not at all true*; 7 = *very true*). Past
14 sport research has supported the internal reliability and predictive validity of this scale (e.g.,
15 Gagné et al., 2003; Reinboth et al, 2004).
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24 As an indicator of ill-being, the five item emotional and physical exhaustion subscale
25 from the Athlete Burnout Questionnaire (Raedeke & Smith, 2001) was employed to assess
26 participants' perceptions of energy loss. A sample item includes "*I am worn out by the*
27 *physical and mental demands [e.g., from playing soccer]*". Participants responded on a 5-
28 point Likert scale (1 = *almost never*; 5 = *almost always*). Previous sport research has shown
29 this subscale to exhibit satisfactory levels of internal reliability as well as providing evidence
30 for temporal stability and construct validity (e.g., Lemyre, Treasure & Roberts, 2006;
31 Raedeke & Smith, 2001).
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43 *Procedures*

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45 Ethical approval to conduct the study was provided by the investigators' School
46 committee for research with human participants. The principal investigator invited players
47 from nearby clubs to participate in the study. At the time of data collection, participants
48 provided written consent before responding anonymously to a multi-section questionnaire
49 that was administered, either before or after practice, by the principal investigator. Prior to
50 completing the questionnaire, participants were instructed to respond to the questions
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4 independently and as honestly as possible, and were told that there were no right or wrong
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6 answers. Participants completed the questionnaire in approximately 15 minutes.
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8 Results

9 *Descriptive Statistics and Pearson Correlations*

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11 The descriptive statistics, internal reliability scores and correlation matrix for the
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13 study variables are presented in Table 1. Participants exhibited high mean scores for all the
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15 scales (i.e., above the midpoint), except for emotional and physical exhaustion which was
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17 reported as moderate. The measures employed were also marked by relatively high levels of
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19 internal reliability ($\alpha = .72-.87$).
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23 *Overview of the SEM Analyses*

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25 SEM (EQS 6.1; Bentler, 2004) was performed to analyze the data. The robust
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27 maximum likelihood method was preferred because the Mardia's coefficient was large
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29 (normalized estimate = 43.06). In using the robust method, Satorra and Bentler's (1988)
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31 adjustment for the chi-square is provided because it generates more accurate standard errors
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33 under conditions when data are marked by non-normality. Thus, the Satorra-Bentler χ^2
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35 statistic was considered as a fit index in the present study to evaluate the adequacy of the
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37 factor and the structural models. A non-significant Satorra-Bentler χ^2 value indicates an exact
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39 fit to the data. However, Marsh, Balla and McDonald (1988) advise caution when interpreting
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41 the chi-square statistic as it is sensitive to sample size. Further, they argue that an exact fit
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43 indicated by a non-significant chi-square is not obtainable in real-world settings where
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45 multiple models could potentially fit the data. Thus, we also evaluated model adequacy using
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47 additional goodness-of-fit indices. These were the Robust Comparative Fit Index (R-CFI), the
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49 Robust Non-Normed Fit Index (R-NNFI), the Standardized Root Mean Square Residual
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51 (SRMR) and the Robust Root Mean Square Error of Approximation (R-RMSEA) along with
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53 its 90% Confidence Interval (90% CI). The robust incremental fit indices (e.g., R-CFI) and R-
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4 RMSEA were used in the present study because they are calculated based on the robust chi-
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6 square, and not the normal one. According to Hu and Bentler (1999), a good-fitting model is
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8 indicated when the CFI and NNFI values are close to or ideally above .95, and the SRMR and
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10 RMSEA values are ideally below .08 and .06, respectively. These cutoff values are also
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12 applicable to the interpretation of the robust fit indices.
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15 *The Measurement and Structural Models*

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17 To have confidence in the structural model, it is critical that the measurement of the
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19 latent factors is psychometrically sound (Byrne, 1994). To assess the relationship of the
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21 indicators to their respective latent factors, we first tested the factorial structure of each scale
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23 via Confirmatory Factor Analysis (CFA). The findings showed that all the scales exhibited
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25 good fit indices with acceptable factor loadings (median loading = .70). The results of the
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27 separate CFA's are available upon request from the principal author. A full measurement
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29 model was also tested for divergent validity of the latent factors. An adequate fit was
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31 obtained: Satorra-Bentler $\chi^2(374) = 853.59, p < .001$; R-CFI = .92; R-NNFI = .91; SRMR =
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33 .13; R-RMSEA = .05 (90% CI of the R-RMSEA = .044-.053). Similar to the separate factor
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35 analyses, all the indicators loaded significantly on their respective constructs.
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40 The hypothesized structural model provided a good fit to the data: Satorra-Bentler
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42 robust $\chi^2(365) = 648.76, p < .001$; R-CFI = .95; R-NNFI = .95; SRMR = .05; R-RMSEA =
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44 .04 (90% CI of the R-RMSEA = .033-.043). The standardized regression path coefficients are
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46 illustrated in Figure 1. The results revealed support for the hypothesized model with the
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48 exception of the regression paths from the needs for competence and relatedness to emotional
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50 and physical exhaustion. Ryan and Deci (2000a) propose that the basic needs are inter-
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52 related. Based on the principle that dependant variables can not be correlated in SEM
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54 analyses, we estimated and found the disturbance terms of the three needs to be inter-related
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(autonomy, competence: $r = .33$; autonomy, relatedness: $r = .32$; competence and relatedness: $r = .20$) to be significant ($p < .05$).

Mediational Effects

The mediational effects in the hypothesized model were tested following the SEM approach advanced by Holmbeck (1997). First we tested a model estimating the direct path from the predictor to the outcome variables. The model hypothesizing paths from coach autonomy support to vitality and exhaustion provided a good fit to the data: Satorra-Bentler $\chi^2 (102) = 269.56, p < 0.01$; R-CFI = .95; R-NNFI = .95; SRMR = .05; R-RMSEA = .05 (90% CI of the R-RMSEA = .041-.057). In estimating this model, the path from autonomy support to emotional and physical exhaustion was not significant. As such, the mediational condition that a significant relationship should exist between the predictor and outcome variable was only supported for the path from coach autonomy support to vitality ($\beta = .30; p < .001$).

The next step in testing mediation was to confirm the fit of the constrained model (Holmbeck, 1997). As reported earlier, this model (Figure 1) satisfied the mediational conditions of significant associations between the predictor and mediators and between the mediators and the outcome variable (Baron & Kenny, 1986). The final step was to examine an unconstrained model by adding a direct path from autonomy support to subjective vitality whilst controlling for the psychological needs. Similar to the constrained model, the fit of the unconstrained model was good: Satorra-Bentler $\chi^2 (366) = 707.31, p < .001$; R-CFI = .95; R-NNFI = .94; SRMR = .05; R-RMSEA = .04 (90% CI of the R-RMSEA = .034-.043). It should be noted that in the unconstrained model, the path from the need for relatedness to vitality was non-significant ($\beta = .11; p > .05$). This implies that only the needs for autonomy and competence could potentially serve mediating roles (Baron & Kenny, 1986).

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4 The final step to determining mediation was to perform a chi-square difference test
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6 between the less (i.e., unconstrained) and more restrictive (i.e., constrained) models
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8 (Holmbeck, 1997). A correction developed by Satorra and Bentler (2001) was used to
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10 compare the nested models. This was done because the Satorra-Bentler chi-square is not
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12 distributed as a chi square statistic (Satorra & Bentler, 2001). The Satorra-Bentler chi-square
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14 difference test indicated no difference between the two models ($\Delta SB\chi^2(1) = 2.87; p > 0.05$).
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16 That is, the hypothesized model was not improved by adding the path from autonomy support
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18 to subjective vitality. Providing evidence for partial rather than full mediation, the path
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20 coefficient from autonomy support to vitality, although remaining significant ($p < .01$),
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22 reduced to half when controlling for the needs for autonomy and competence (i.e., from $\beta =$
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24 $.30$ to $\beta = .14$). All mediated effects were statistically significant, but there were differences
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26 in the size of the specific indirect effects from autonomy support to subjective vitality
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28 through the needs for autonomy ($\beta = .08; p < .01$) and competence ($\beta = .05; p < .001$).
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33 *Multi-group SEM Analyses*

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36 Aligned with the analytical steps recommended by Bentler (1995), multi-group SEM
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38 analyses were conducted to explore the degree to which the hypothesized model was
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40 equivalent for male and female athletes. The initial step is to test a model across male and
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42 female groups simultaneously without imposing any equality constraints. The purpose of this
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44 step is to establish a baseline model for subsequent testing of increasingly restrictive nested
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46 models. As shown in Table 2, the baseline model produced a good fit to the data. As is often
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48 the case in the psychological literature (e.g., Standage et al., 2005), the baseline model in the
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50 present study was not fully identical across groups (see Figure 2). Specifically, three
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52 regression coefficients differed across the male and female samples. To compare the same
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54 regression coefficients across groups, the un-standardized coefficient (b) should be reported
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56 (see Hair, Anderson, Tatham, & Black, 1998). The path from autonomy support to the need
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4 for competence was significant for males ($b = .26; p < .001$) but not for females ($b = .10; p >$
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6 $.05$). In addition, the path from the need for autonomy to exhaustion was significant for
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8 females ($b = -.23; p < .01$) but not for males ($b = -.13; p > .05$). Lastly, the path from the need
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10 for relatedness to vitality was significant for females ($b = .18; p < .05$) but not for males ($b =$
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12 $.11; p > .05$). These paths were not constrained in subsequent steps of invariance testing. In
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14 effect, we proceeded to test and confirm the partial invariance (see Byrne, Shavelson &
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16 Muthén, 1989) of the baseline model.
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20 The nested models were evaluated based on two criteria. First, the goodness of fit of
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22 each model was examined so that it met the guidelines for model fit suggested by Hu and
23
24 Bentler (1999). Second, the Satorra-Bentler (2001) chi-square difference test was performed
25
26 to compare nested models. A non-significant difference in chi-square indicates invariance
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28 between two nested models. To supplement this approach, differences in the incremental and
29
30 absolute fit indices of the less and more constrained models were also considered (Bentler,
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32 1995). For example, the more constrained model is suggested to fit significantly worse than
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34 the less constrained one when the difference between the CFI values of both models exceeds
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36 $.01$ (Cheung & Rensvold, 2002).
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40 The results (see Table 2) show that the model imposing equality constraints of the
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42 factor loadings across gender provided an acceptable fit. However, this model (i.e., Model 2a)
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44 was significantly worse than the baseline model according to the Satorra-Bentler chi-square
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46 difference test (e.g., $\Delta SB\chi^2(24) = 46.33, p < .001$). The Lagrange multiplier test revealed that
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48 the equality constraints of five factor loadings were significantly different across gender
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50 groups. Further information on this is available upon request from the principal author. The
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52 constraints were released and the model was re-estimated. The revised constrained factor
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54 loadings model (Model 2b), without the five aforementioned constraints, was not
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56 significantly different compared to the baseline model.
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4 The next step (Model 3) showed that the single factor variance (i.e., autonomy
5 support) in the model was equal across gender groups. No significant differences emerged
6 between the two nested models. The final and most important step with respect to the third
7 aim of the present study was to add the equality constraints of the regression paths linking the
8 latent factors (autonomy support with autonomy/relatedness, and autonomy/competence with
9 vitality) across male and female groups (Model 4). Gender invariance was supported in this
10 final step.
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20 Discussion

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22 Grounded in BNT (Ryan & Deci, 2000a) and extending previous sport research
23 (Gagné et al., 2003; Reinboth & Duda, 2006; Reinboth et al., 2004), one major aim of this
24 study was to test a motivational sequence regarding hypothesized relationships between adult
25 athletes' perceptions of coach autonomy support, basic need satisfaction, and positive and
26 negative indices of well-being. The hypothesized motivational sequence was mainly
27 supported.
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36 Aligned with SDT (Ryan & Deci, 2000a), we found athletes' perceptions of an
37 autonomy supportive coach to correspond to greater satisfaction of their needs for autonomy,
38 competence and relatedness. Consonant with past work (Ratelle et al., 2005; Standage et al.,
39 2006), autonomy support emerged as a positive (and moderate) predictor of the need for
40 autonomy. It makes theoretical sense that a coach perceived as encouraging athlete-decision
41 making and choice would foster athletes' feelings that they are acting with volition and that
42 they are the origin of their own behavior (e.g., Mageau & Vallerand, 2003).
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52 Similar to the findings of Ratelle and associates (2005), an environment characterized
53 by autonomy support emerged as a positive but weak predictor of participants' satisfaction of
54 the need for competence, explaining approximately 3% of the variance. This finding is
55 contrary to Standage et al. (2006) who found teacher-autonomy support to strongly predict
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4 PE students' level of competence, accounting for up to 22% of explained variance. With
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6 these discrepant findings in mind, it seems reasonable that the strength of the relationship
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8 between autonomy support and satisfaction of the need for competence could vary as a
9
10 function of setting and/or age. In terms of older athletes playing at a high competitive level,
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12 other sources of competence (e.g., coach informational feedback, Horn & Amorose, 1998) or
13
14 other dimensions of the coach-created environment not measured in this study (e.g.,
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16 perceptions of the motivational climate, Reinboth & Duda, 2006) may have a stronger
17
18 influence in supporting players' need for competence. It could also be the case that older and
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20 more experienced athletes tend to rely more on recent personal performance information
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22 (e.g., Bandura, 1997) than on the degree of autonomy support provided by their coach.
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27 The strongest observed relationship between perceived autonomy support and the
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29 players' three basic needs was for relatedness. This finding is parallel to the results from
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31 research conducted in the PE setting. For example, in a study by Standage et al. (2006) a
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33 teacher-created autonomy supportive environment strongly and positively predicted
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35 participants' need satisfaction for relatedness with respect to other PE students in the
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37 classroom. The present findings suggest that athletes feel a stronger connection to their
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39 teammates when the coach considers their perspective, solicits input, and provides choice.
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41 Such a personally empowering environment seems to be more amenable to athletes in
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43 developing close and mutually respectful relationships with their teammates. It would be
44
45 interesting in future work to examine the implications of autonomy supportive features of the
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47 social environment created by different significant others (e.g., peers, parents, and the mass
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49 media) for the need satisfaction reported by athletic participants at different developmental
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51 stages.
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57 Consistent with our hypotheses, the findings suggest that athletes' needs for
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59 autonomy, competence and relatedness provide the essential nutrients for eudaimonic well-
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4 being (Ryan & Deci, 2000a). Autonomy and competence were both moderate, strong
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6 predictors of participants' subjective vitality. Since subjective vitality is defined as a state of
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8 high positive energy emanating from the self (Ryan & Frederick, 1997), athletes are expected
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10 to experience it when they perceive themselves as the origin of their actions; that is, when
11
12 their need for autonomy is satisfied (deCharms, 1968). The results further suggest that adult
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14 athletes who perceive high levels of sport-related competence also report feelings of personal
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16 vitality in their sport participation. Past studies have shown competence to play a central role
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18 in facilitating participants' optimal functioning in youth sport (e.g., Reinboth et al., 2004). In
19
20 sum and specific to the domain of sport, our findings reinforce the proposition that feelings of
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22 effectance and a sense of personal autonomy are necessary to promote eudaimonic well-being
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24 and quality engagement in sport activities (Ryan & Deci, 2000a).
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30 Congruent with our hypotheses and similar to the findings of Gagné and colleagues
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32 (2003), satisfaction of athletes' need for relatedness was a positive, albeit weak predictor of
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34 subjective vitality. Contrary to the present result and Ryan and Deci's (2000a) claim that
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36 relatedness is essential for optimal functioning, Reinboth et al. (2004) did not find relatedness
37
38 to predict vitality among youth team sport players. Future research could employ SEM multi-
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40 sample invariance testing to determine whether the hypothesized links between satisfaction of
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42 each of the three needs and subjective vitality are equivalent across age groups and settings.
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46 Thwarting of the basic needs is assumed to contribute to poor mental health (Ryan &
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48 Deci, 2000a; 2000b). In the present study, athletes who expressed low perceptions of
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50 autonomy reported higher levels of emotional and physical exhaustion connected with their
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52 sport participation. This result suggests that when athletes perceive a lack of personal
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54 causation and diminished self determination the demands of participating in sport can drain
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56 feelings of emotional and physical energy (see also Lemyre et al., 2006). Under conditions
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58 when athletes perceive their energy resources to be exhausted, athletes are at a higher risk of
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4 under-performing, incurring injury, experiencing diminished benefits from training, and
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6 dropping out from sport (Gould, Tuffey, Udry & Loehr, 1996).
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9 Inconsistent with our hypotheses, satisfaction of the needs for competence and
10 relatedness were unrelated to athletes' sport-related emotional and physical exhaustion,
11 despite a significant bivariate correlation for competence. Therefore, the present results and
12 past sport research (e.g., Reinboth et al., 2004) provide only partial support for Ryan and
13 Deci's (2000b) proposition that all three needs are relevant to the occurrence of ill-being in a
14 sport setting. Furthermore, aligned with other research in sport (Gagné et al., 2003; Reinboth
15 & Duda, 2006), our findings corroborate Sheldon and Bettencourt's (2002) arguments, who
16 claim that psychological need satisfaction is more pertinent in understanding the promotion
17 of well-being, as opposed to explaining the absence of ill-being. Collectively, our findings
18 emanating from SEM, and the low bivariate correlation between vitality and exhaustion,
19 provide evidence that well-being does not necessarily lie on the same continuum as ill-being;
20 they are separate phenomena (Ryan & Deci, 2001). However, more research grounded in
21 BNT is warranted to establish if these claims hold true in sport and other domains. Further,
22 future studies might examine how the three psychological needs relate to other facets of
23 burnout (e.g., sense of personal accomplishment and sport devaluation; Raedeke & Smith,
24 2001), as well as alternative indices of ill-being (e.g., anxiety).
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44 *Mediational Role of the Psychological Needs*

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47 Drawing from BNT (Ryan & Deci, 2000a), a second aim of the present work was to
48 test the mechanisms through which social environmental factors can predict both well- and
49 ill-being of individuals within the context at hand. We found that the needs for autonomy and
50 competence partially mediated the pathway from coach autonomy support to athletes' levels
51 of subjective vitality. The results of the specific indirect effects imply that the need for
52 autonomy (in contrast to competence) was marginally more important in explaining the
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4 autonomy support-vitality relationship. From a practical standpoint however, it appears that
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6 coaches can play a role in improving and/or maintaining the positive energy of their athletes
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8 in training and competition by supporting athletes' needs for both autonomy and competence.
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11 Contrary to theoretical predictions (Deci & Ryan, 2000) and findings reported by
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13 Reinboth and Duda (2006), athletes' need for relatedness did not mediate the relationship
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15 between the coaching environment and athletes' feelings of being alive and vital. In
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17 explicating this result, it is important to note that in Reinboth and Duda's (2006) study, the
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19 relationship between a task-involving climate and vitality over the course of a competitive
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21 season was partially mediated by relatedness operationalized in terms of athletes' interactions
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23 with the coach, rather than a sense of connection with one's teammates. Based on Reinboth
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25 and Duda's (2006) findings and the present results, it seems sagacious to measure relatedness
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27 with respect to both the coach *and* teammates when examining its potential mediational role
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29 in the autonomy support-subjective vitality relationship. In explaining the present null finding
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31 from a statistical point of view, it is important to recognize that autonomy and competence
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33 potentially accounted for a higher proportion of the shared variance in the prediction of
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35 athletes' reporting positive energy. Thus, there may have been insufficient unique variance
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37 that could be accounted for by relatedness (especially when considering the observed
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39 significant, positive correlation between relatedness and subjective vitality). With that said,
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41 the ecological validity of the results would have been compromised had we examined the
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43 potential mediational role of each psychological need in separate analyses.
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50 The direct path from autonomy support to emotional and physical exhaustion was
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52 non-significant and, therefore, we could not test the hypothesized mediation of the
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54 psychological needs in this case (Holmbeck, 1997). This result is contrary to other research
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56 indicating that the occurrence of sport-related burnout is a function of the social environment
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58 created by significant others in this context (e.g., Krane, Greenleaf & Snow, 1997). Reinboth
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4 and Duda (2004) found that adolescent athletes who perceived the coach to emphasize more
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6 ego-involving aspects of the motivational climate were more likely to report experiencing
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8 emotional and physical exhaustion. It might be the case that coach-provided autonomy
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10 support is predictive of other facets of burnout (Raedeke & Smith, 2001) not assessed in the
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12 present work or that other dimensions of the social environment (e.g., the degree of coach
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14 controllingness and/or the ego-involving features) are more relevant to athletes' feelings of
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16 depleted emotional and physical energy.
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19 20 *Multi-group Analyses*

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22 BNT assumes that the significance of basic psychological need satisfaction to human
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24 functioning is universal across all groups (Ryan & Deci, 2000a). In previous work, this
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26 postulate has been supported in analyses of invariance across culture (e.g., Deci, et al., 2001).
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28 In the current research, we theorized that the hypothesized relationships between autonomy
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30 support, basic need satisfaction and well-being would remain invariant for adult male and
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32 female athletes. Given that three regression paths (i.e., autonomy support to competence,
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34 autonomy to exhaustion, and relatedness to subjective vitality) were significant for one
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36 gender group but not the other in the baseline model, we could not proceed to test their
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38 equality constraints. Although these paths were not constrained to be equal in subsequent
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40 steps of invariance testing, they were relatively similar in size in the two gender groups and
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42 in the same direction. Taken in their totality, the results of the full SEM multi-sample
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44 analyses partially supported Ryan and Deci's (2000a) invariance hypothesis.
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50 The partial support for gender invariance in the present study is consistent with
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52 previous work testing the tenets of self-determination frameworks in physical education (e.g.,
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54 Ntoumanis, 2005; Standage et al., 2005). All in all, the findings stemming from the present
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56 SEM multi-sample analysis have implications for male and female athletes in the sport
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58 domain. Drawing from the present findings, it appears that it is not necessary for coaches to
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4 consider an athlete's gender when working to develop an autonomy supportive environment
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6 to facilitate basic need satisfaction and ensuing vitality.
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8 *Limitations and Conclusions* 9

10 Overall, our findings supported the hypothesized sequence of relationships proposed
11 in BNT (Ryan & Deci, 2000a). As these results stem from cross-sectional data, future studies
12
13 should test the links between environmental factors, psychological needs and indices of
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15 athletes' well- and ill-being via longitudinal and experimental designs. As the present work
16
17 relied on self-report instruments to measure the targeted variables, this line of inquiry would
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19 be advanced if researchers in subsequent studies employed objective measures of the social
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21 environment (e.g., coach behavioral observations) and athletes' welfare (e.g., injury
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23 occurrences, cortisol responses) in addition to subjective measures. Another direction for
24
25 future sport-related research would be to test the hypothesized motivational sequence
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27 between autonomy support to need satisfaction and ensuing well- and ill-being in a multi-
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29 level structure (e.g., considering variation as a function of the participant, team, and sport).
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35 In summary, the study findings support the tenets of BNT (Ryan & Deci, 2000a), and
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37 reinforce the importance of a coach created autonomy supportive environment to the
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39 fostering of basic need satisfaction and occurrence of optimal functioning among male and
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41 female adult athletes.
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Table 1

Descriptive statistics, Cronbach's Alpha Coefficients and Correlations for the Observed Subscale Scores

Variable	<i>M</i>	<i>SD</i>	Range	α	1	2	3	4	5	6
(1) Autonomy support	4.98	.93	1-7	.85	–					
(2) Autonomy	3.48	.69	1-5	.79	.26**	–				
(3) Competence	5.01	.88	1-7	.72	.17**	.33**	–			
(4) Relatedness	3.99	.65	1-5	.86	.40**	.35**	.30**	–		
(5) Subjective Vitality	5.32	.95	1-7	.81	.25**	.33**	.33**	.30**	–	
(6) Exhaustion	2.31	.85	1-5	.88	–.01	–.13**	–.13**	–.08	–.15**	–

Note. Exhaustion = Emotional and physical exhaustion.

** $p < .01$

Table 2

Goodness of Fit Indices for the Multi-Group SEM Analysis Across Gender.

Model	SB χ^2	<i>df</i>	Δ SB χ^2	Δ <i>df</i>	RCFI	RNNFI	SRMR	RRMSEA (90% CI)
Model 1	1157.06	790	–	–	.94	.94	.063	.042 (.036-.047)
Model 2a	1203.34	814	46.33***	24	.94	.93	.069	.042 (.037-.047)
Model 2b	1176.94	809	19.00	19	.94	.94	.065	.041 (.036-.046)
Model 3	1178.18	810	1.35	1	.94	.94	.066	.041 (.036-.046)
Model 4	1180.52	813	2.54	3	.94	.94	.067	.041 (.036-.046)

Note. Model 1 = Baseline model; Model 2a = Factor loading coefficients constrained; Model 2b = Factor loading coefficients constrained (released equality constraints of five non-invariant factor loadings); Model 3 = Factor loading coefficients and factor variance constrained; Model 4 = Factor loading coefficients, factor variance and regression paths constrained. SB χ^2 = Satorra-Bentler chi-square; RCFI = Robust Comparative Fit Index; RNNFI = Robust Non-Normed Fit Index; SRMR = Standardized Root Mean Residual; RRMSEA = Robust Root Mean Square Error of Approximation; 90% CI = 90% Confidence Interval of the RRMSEA.

*** $p < .001$

List of Figures

Figure 1. The structural model of motivational processes and well-being.

Note. All coefficients presented are standardized and significant ($z > 1.96$). The factor loadings are not presented for simplicity reasons but were nearly identical to those in the measurement model.

Figure 2. The baseline model of motivational processes and well-being for male and female athletes.

Note. Standardized path coefficients are presented for male (in bold) before the slash and for female athletes after the slash. Non-significant paths are denoted by n.s.

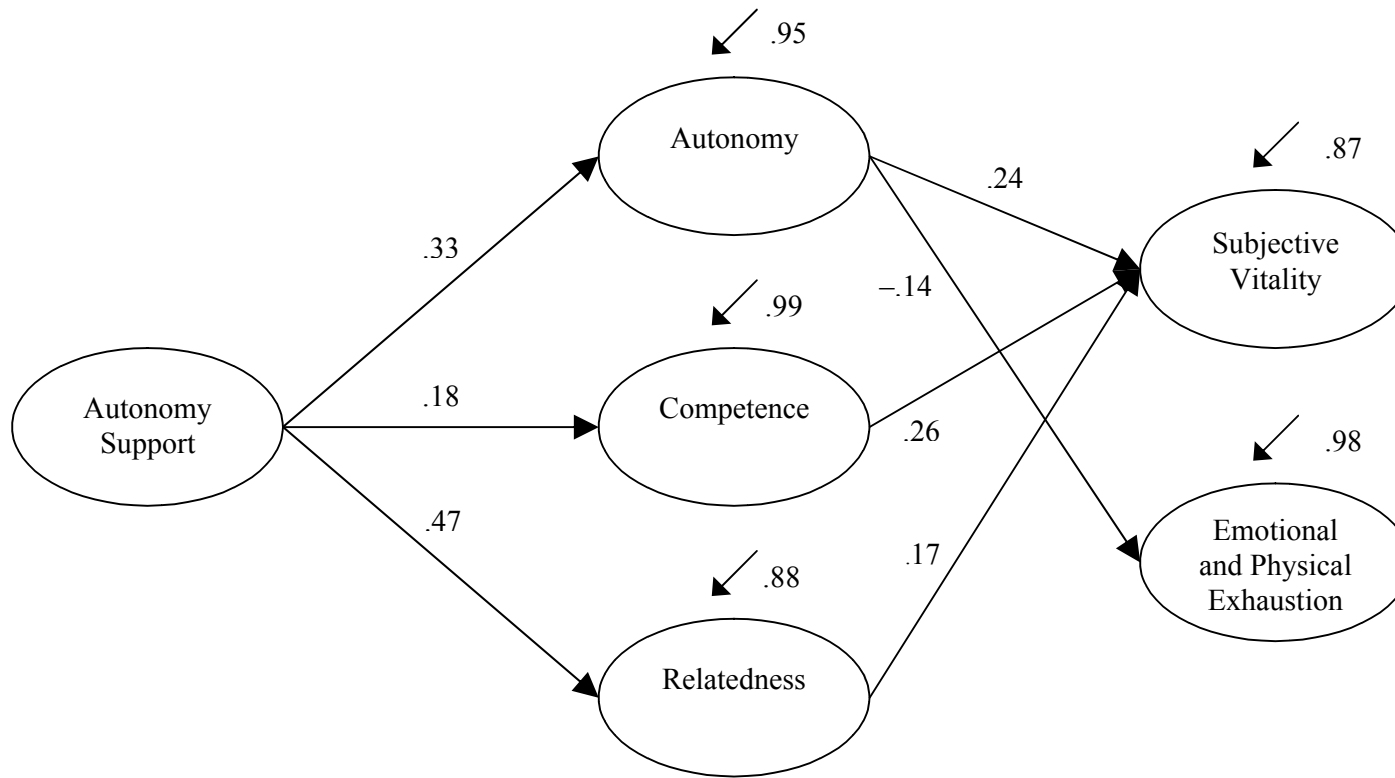


Figure 1.

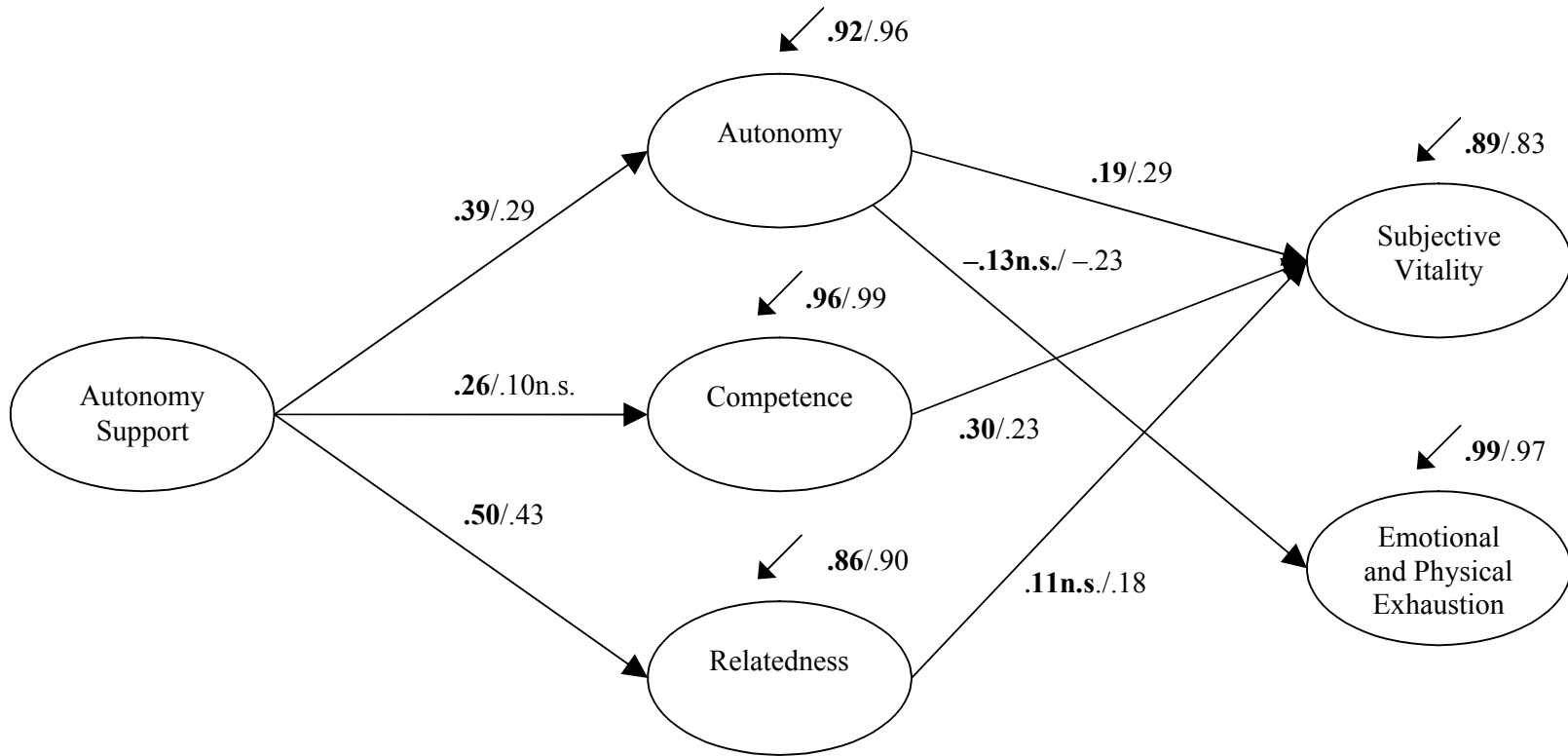


Figure 2.

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Re: #MOEM156

28 February 2008

Johnmarshall Reeve, PhD
Associate Editor, *Motivation and Emotion*

Dear Professor Reeve,

On behalf of my co-authors, Professor Joan Duda and Dr. Nikos Ntoumanis, I would like to thank you for the insightful and constructive comments regarding our manuscript entitled, "Autonomy support, basic need satisfaction, and the optimal functioning of adult sport participants: A test of basic needs theory". Please find enclosed within this letter our point-by-point response to your comments along with the revised submission of our manuscript.

Associate Editors Comments

Firstly, we would like to thank you for your insightful comments and useful suggestions regarding further improvement of our manuscript. Below we present your points in italics, followed by our response.

General comments

Concern #1: Is this paper important and does it make a significant contribution to the literature? Your Introduction is now clear that the paper seeks to make three contributions to the literature: (1) use a sample of adult team sport participants to test BNT; (2) use SEM analytic techniques to gain insight on which need or needs mediate a SDT perspective on eudaimonic well-being; (3) test gender invariance. I would add that the Discussion section nicely returns to these three contributions and helps frame the overall purpose and intent of the paper.

Indeed, these are the purposes of the present study. To date, we want to emphasize that there is limited research testing the tenets of BNT (Ryan & Deci, 2000, 2002) in sport settings. Further, we believe there is a compelling case for why it is important to answer these three questions in the general SDT-based literature and what unique contributions our paper adds to the limited body of research in the sport domain

specifically. Lastly, we would like to thank you for the positive comment you raised regarding the discussion section of the manuscript.

1. *Before I begin a discussion about the paper's unique contribution, let me also add a suggestion that you consider moving the currently clustered predictions/hypotheses up from the end of the Introduction (pp. 7-8) to the specific point in the Introduction in which they are most applicable (simply as a way to emphasize that the paper has three separate, testable objectives).*

We have addressed this request and as a consequence, the introduction has been shortened. We have now labelled the hypotheses in parentheses in the different paragraphs of the introduction (e.g., Hypothesis 1). This approach is in line with other research (e.g., Vansteenkiste et al., 2007).

2. *As to the first concern, your paper is very, very similar to Gagne et al. (2003) and to Reinboth et al. (2004). It is different because the rich sample features participants who are in team sports (and adults). This is the sort of contribution that would be most appropriate for a journal in exercise and sport psychology, rather than motivation/psychology per se. So, at present, I don't see the sort of contribution that can catapult the paper above the publication threshold.*

Research investigating the hypothesized direct link from basic need satisfaction to well-being in the sport domain is still very much in its infancy. The preliminary work testing the postulates of BNT has been primarily limited to youth sport (e.g., Gagné, Ryan & Bargmann, 2003; Reinboth, Duda & Ntoumanis, 2004). The present study moves beyond these past studies in important ways. Specifically, our current study addresses three tenets of BNT that have not been empirically tested in the sport domain to date.

Our first objective was to confirm a model hypothesizing the following sequence of relationships: autonomy support > basic need satisfaction > well-/ill-being. We wanted to know whether this model held up among adult sport participants, as it has in youth sport contexts (e.g., Reinboth et al., 2004). This is particularly important considering Ryan and Deci's (2002) assertion that psychological need satisfaction is essential for well-being across different age groups. For example, the finding that the need for relatedness did not predict vitality in a youth sport context (Reinboth et al., 2004), unlike in the present study, is testament to the importance of testing this particular assumption of BNT among different groups. Ryan and Deci (2002) also claim that the means by which the psychological needs are predicted may vary across groups and settings. Given that satisfaction of the needs is essential for optimal functioning, it would be interesting to practitioners (e.g., coaches) to understand how findings compare across sport studies employing different age groups (youth versus adult sport). For example, in the study by Reinboth et al. (2004) youth sport participants' perceived different dimensions of the coach-created environment to be important with respect to satisfying each individual need. In the context of the present study, adult athletes' perceived autonomy support provided by coaches was found to be pertinent to all three of their basic needs. These different findings could be attributable to the age group of the athletes.

Our second objective was to test theoretically predicted mediational effects, which in past work were only assumed by the indirect effects of autonomy support on well-

being via satisfaction of the needs. The present study not only adds to the sport-related SDT research (Gagne et al., 2003; Reinboth et al., 2004) by directly testing mediation but it does so by adopting a more rigorous strategy using an SEM approach (see Holmbeck, 1997) that is rare in the SDT-based literature. Using this strategy we were able to control for measurement error, test multiple mediators as well as multiple outcomes in one model, unlike studies using conventional regression techniques to test mediation (e.g., Reinboth & Duda, 2006; Vansteenkiste et al., 2004). Testing mediation in the context of the present study confirms the mechanism (i.e., basic needs) by which the social environment can influence well-/ill-being in a sport setting and is aligned with the recommendations of Mageau and Vallerand (2003). Gagne et al (2003) and Reinboth et al (2004) did not test the mediating role of the basic needs. Testing mediation not only advances theoretical understanding but also has practical implications. For example, it is interesting for researchers and practitioners alike to realize *why* the climates created by the coach influence optimal functioning among participants in a sport setting. In the present study, our results imply that satisfaction of the needs for autonomy and competence predicted athletes' levels of positive energy as a consequence of the coach being perceived to be autonomy supportive. This information could be useful for coaches who wish to aim to promote a healthy environment for their athletes, and for future research designing interventions. Further we also aimed to discern the relative importance of the mediating variables by examining specific indirect effects.

Our third objective was to test gender invariance in the sport domain. One limitation of the studies conducted by Reinboth et al (2004) and Gagne et al. (2003) were that they only employed single sex-samples. To our knowledge, we are the first researchers in the sport domain to test the tenets of BNT across gender groups. Given that the tenets of BNT are assumed to apply across contexts, and that, to our knowledge, the gender invariance question has received limited attention in other settings (e.g., Ryan et al., 1999), we view this feature of our work to be an important extension of the current SDT literature. Our findings also have practical implications in terms of whether an autonomy supportive coaching environment predicts the same processes and outcomes in male and female athletes.

In the revised introduction, we have aimed to more clearly illustrate how the present study advances the existent empirical literature tied to BNT in a sport setting and overall. We can add the practical implications of addressing the three questions if deemed necessary but we feel this would add to the length of the manuscript, plus these benefits have been highlighted in the discussion.

3. *But, let me brainstorm here and offer a suggestion. Your paper tests for gender invariance (which is highly appealing because it addresses the universality issue within SDT), so how about doing what the Gagne et al. and Reinboth et al. papers cannot do and that is testing for the generalizability (if that's the right word) of the BNT model across the several team sports? I realize you can't do a "sport invariance SEM" test (because you have 10 different sports, some with low Ns), but you do have the data to enter the team sport variable within an HLM analysis to test whether the specific sport(s) lead to different relationships among the variables. I don't know what your first impression to this suggestion is, but I offer it for two important reasons. First, if the BNT model holds across sports, your paper would be able to say something the other sports papers have not been able to say (e.g., their results are potentially limited to gymnasts). This would allow your paper to offer a*

greater contribution to the literature. Second, the gender invariance test in many ways can't really be interpreted outside the effort to consider or control for the specific team sport. Consider, for instance, that several of your team sports are clearly gender biases (e.g., football, rugby). If gender and sport covary, you do not yet have the means to speak to the question of whether your gender effects are attributable to gender or to type of sport. But the more basic concern I have here is the question of whether or not it is appropriate to collapse your data across type of team sport. If an analysis such as HLM shows that it is appropriate to collapse your data across these 10 sports, then it supports some important universality for BNT and it supports your interpretation of the gender invariance analyses. In doing so, it helps make your paper more important to the literature, at least I think so.

The prospect of testing sport-invariance in the present study raises our concerns with regard to a number of potential conceptual and statistical problems. If we were to proceed in testing sport-invariance of the model then we would need to do so using multi-level modelling. Adopting this statistical approach in the context of the present study would have consequences in terms of having to break-up the model into a large number of regression equations that will test specific aspects, but ignore the co-existence and potential interdependent influence of other parts, of the model. SEM avoids this issue by testing a model in its entirety. Further, the number of sports ($n=10$) is very small for multi-level analysis. Most MLM experts (Rasbach et al., 2005; Singer & Willett, 2002) recommend at least 30-50 units at Level 2 (e.g., sport-type). The low numbers of sports to run this technique would undoubtedly underestimate the variation at the higher level. Further, if we were to employ MLM, we would need to examine whether there is a significant variation at the team level in the relationships between the predictor(s) and the outcome variable. If the variance terms were significant, we would need to insert predictors that could account for this variation across sport, separately for each multilevel regression. Thus, adding MLM analysis would increase the size of the manuscript quite considerably. We feel that addressing this added question in addition to our three original purposes is beyond the scope of the present paper. It is a study in itself. We would suggest, for your consideration, that it would be more appropriate to examine the issue of multi-level effects of sport-type (e.g., level 1: individual, level 2: team, level 3: sport) in a different study where a much larger sample can be recruited with this question in mind. We have highlighted this point in the discussion.

In summary, our decision to test gender invariance of the hypothesized model is based on previous work in the physical domain (i.e., PE) that has indicated that psychological processes vary to some extent across males and females (e.g., Standage et al., 2005). It is also a unique question in the realm of sport to test if this universality claim is supported, as it has been supported to some extent in other domains (e.g., PE, Ntoumanis, 2001; education: Ryan et al., 1999). The practical significance of this question is also highly appealing in the current context. At this point in time, it is perhaps more meaningful and digestible for researchers and coaches to interpret the messages from the gender invariance findings alone as opposed to the findings across multiple sports *and* gender. We feel that testing gender invariance in itself is a significant contribution to the limited BNT-based work in the sport domain and in terms of the overall BNT literature.

4. *The second contribution of the paper is the SEM-based mediation analyses, which I will address in the next major point. That leaves the gender invariance contribution. At present, it is not yet clear if your data support or contradict gender invariance, as you conclude the data show "partial invariance" though you seem to reach the conclusion that BNT is largely invariant across gender (e.g., page 21). The model without imposed equality (model 1) fit the data better than did the model with imposed equality (model 2). Therefore, the data show gender variance, right? You conclude the data show partial invariance. That might be the right term, or it might be waffling, I'm not sure yet. I need you to be much clearer on this point, as it is a core question within the paper.*

First we would like to draw attention to the four essential steps required in conducting SEM multi-group invariance analyses (see Bentler, 1995; Byrne, 1994; Marsh, 1993). Multi-group SEM analysis is a technique employed to detect the degree to which a model is equivalent across two or more groups. It does this by testing and comparing a sequence of increasingly restrictive nested models. The first step comprises testing a baseline (or unconstrained) model. The unconstrained model (in our case model 1) establishes the extent to which the model is equivalent across the male and female groups. This model is estimated simultaneously across male and female samples without imposing any equality constraints. The purpose of this step is that it acts as a critical baseline for subsequent model comparisons (Marsh, 1993). The next step is to test a model (Model 2) with the equality of the factor loadings constrained across gender groups. The penultimate step involves testing a model (Model 3) constraining any factor covariances and variances to be equal across male and female samples. Finally, the equality constraints of the regression paths are imposed across gender groups (Model 4). The purpose of following these steps is to ascertain the degree to which the baseline model would hold up in a sequence of increasingly restrictive models imposing sets of equality constraints with regard to the measurement (e.g., factor loadings, factor variances/covariances) and structural parameters (i.e., regression paths) in the model. Other SDT studies have adopted a similar approach to invariance testing of a model with multiple samples (e.g., Deci et al., 2001).

The comparison of the nested models is evaluated using two forms of criteria. First, it is recommended that researchers examine that the goodness of fit of each model is acceptable according to contemporary guidelines (Hu & Bentler, 1999). Second, researchers are advised to evaluate the comparison of nested models based on the chi-square difference test (e.g., Satorra & Bentler, 2001). A non-significant value indicates invariance between the nested models. This implies that the more restrictive model does not change when more equality constraints are added. Because the chi-square difference test, like the chi-square statistic itself, is sensitive to sample size, we further supplemented this approach by also considering differences in the incremental fit indices of the less and more constrained models (see Bentler, 1995; Cheung & Rensvold, 2002). For example, the more constrained model is suggested to fit significantly worse than the less constrained model when the difference in the CFI between the two models is larger than .01 (Cheung & Rensvold, 2002). A significant difference between models necessitates detecting the significantly different equality constraint(s) (the latter are by definition non-invariant constraints). The Lagrange Multiplier (LM) test is used to detect these non-invariant constraints which are then

subsequently released from the model and not constrained in further tests (i.e., steps) of invariance.

The results of the present study revealed that the baseline model (Model 1) was not identical across multiple groups. As this is often the case in the psychological literature (Ryan et al., 1999; Standage et al., 2005), it is generally accepted that partial invariance (i.e., some but not all parameters in the model are invariant) be tested and confirmed (see Byrne et al., 1987; Byrne, 2001). Specifically, three parameters (i.e., regression paths) differed across samples in our baseline model. As recommended by Byrne (1994), these particular pathways were not constrained in subsequent steps of invariance testing. Thus we proceeded to test partial invariance of the baseline model with respect to gender. It is important to note here, as we have done in the discussion, that these differences in the paths across gender (in the baseline model) were relatively trivial in magnitude and do not provide substantial evidence that undermine the universality claim (see our response to comment 5).

When testing invariance, we constrain the tested parameters to be equal; if they are indeed equal the chi-square test of the constraint will not be statistically significant. The comparison of the baseline model (model 1) with the constrained factor loadings model (model 2) was significant and revealed that five items constrained to be equal were not actually equal; thus, since the equality constraints differed significantly across gender groups these were also released and not tested in the further tests of invariance. The next step was to examine equality constraints of the single factor variance (i.e., autonomy support) of the model (Model 3). This nested model was not significantly different to the previous one. The final and most stringent step used in the present study was Model 4 which tested the equality constraints of the regression coefficients across males and females. Most importantly, testing this final step was crucial to confirming whether the model supported Ryan and Deci's (2001) gender invariance postulate. No significant differences emerged when nesting Model 4. In summary, our findings confirmed the partial invariance of the baseline model with respect to gender. We apologize for the length of this explanation, but we wanted to make sure there was no doubt about the essential steps required in testing the invariance of a model across multiple groups and why we deemed it essential to present the findings of all four steps.

5. *Also, please identify in the text the three paths that were shown to be different for the two genders (e.g., top of page 14), and report the test statistics and p values associated with all three path coefficients, if possible.*

In line with your suggestion, we have reported both the unstandardized (b ; in text) and standardized (β ; shown in Figure 2) coefficients regarding the paths that were found to differ across gender groups in the baseline model. The standardized coefficients are important for determining the relative importance of different paths within a group but they do however remain sample specific. Instead the un-standardized coefficients are preferred when comparing the same parameters across groups. This is because the un-standardized coefficients are expressed in terms of their constructs' variance. As a result, the same paths can be compared across groups (Hair, Anderson, Tatham, & Black, 1998). Other studies testing for invariance also report the unstandardized coefficients (Deci et al., 2001) as well as the standardized (Standage et al., 2005).

6. *I mention this because I get the sense that the paper currently makes an intuitive judgment—that is, the path is significant for one gender but nonsignificant for the other, though both are in the expected and predicted direction. What is most important, however, is whether one beta weight is significantly larger than the other, right? The conclusion you reach is up to you—variant, invariant, partially invariant—but please be really clear about the data used to draw your conclusion.*

The baseline model was partially invariant across gender (i.e., most parameters were identical across groups but not all; see Byrne, 1994). We tested the stability of baseline model in a series on increasingly stringent nested models (see our response to comment 4). In terms of the regression paths that differed in the baseline model (significant for one gender group but not the other), the most important factor is the satisfaction of the psychological needs for well-being (Ryan & Deci, 2002) not the comparison of relative importance across gender. Despite slight and occasional differential findings between gender groups, each path for males and females was in the predicted and expected direction; that is, they tell the same story. For example, the path coefficients from the need for relatedness to vitality was significant for females ($b = .18$; $\beta = .22$; $p < .05$) but not for males ($b = .11$; $\beta = .11$; $p > .05$). Other than this relationship being significant in one group the story does not vary. In other words, these differences do not undermine the universality claim with respect to gender (Ryan & Deci, 2002). Had the beta coefficient, for example, been positive in one group and negative or zero in the other, then this would have been a very different story. This point has been made in the discussion of the revised manuscript.

7. *On a related point, I have a suggestion. It is my understanding that what matters most is whether the path coefficients within the structural model are invariant and what matters least is whether the path coefficients related to the measurement model are invariant.*

Indeed, we were primarily concerned with testing the nested model that fixed the structural parameters (i.e., regression coefficients) to be equal across gender. This step in particular was essential to discerning whether the gender invariance postulate by Ryan and Deci (2002) was confirmed in the present study. Prior to confirming this step, it is imperative the measurement invariance with respect to gender is confirmed.

8. *With that said, I recommend you consider deleting the last 7 ½ lines on page 14 ("After inspecting the Lagrange.") and first 5 lines on page 15, deleting the last 6 lines on page 20 ("Further, five factor loadings."), and Table 2 from your paper. I recommend you work the statistical information from Models 1 and 2a in Table 2 into the text (top of page 14) and then delete the rest of that table. Why?—partly to trim the length of the manuscript and partly because the analyses reported on the bottom half of Table 2 are not as important as the analyses in the rest of the paper, though it seems to the reader like these analyses are important because they warranted a table.]*

We agree that the 7 ½ lines at the bottom of page 14 can be deleted and we have done so to shorten the manuscript. This section corresponds to the results of the model (i.e., model 2) constraining factor loadings to be equal across gender groups. Because five factor loadings were found to be significantly different across the gender groups,

we feel it is important to at least briefly highlight these findings. Thus, we have added a short note indicating that a full set of results with regard to this particular constrained model are available upon request from the first author. We hope you find this to be an acceptable solution.

We would argue, however, that the summary of the findings at the top of page 15 (“The subsequent nested models...”) is vital to the manuscript. This part of the section summarizes the results of the third and fourth steps essential for testing the partial invariance of the baseline model across gender groups (i.e., Models 3 and 4; bottom half of Table 2). By deleting this section of the findings, particularly for Model 4 (equality of the structural paths), we would not provide any evidence that we tested and confirmed the gender invariance claim of Ryan and Deci (2002). Based on this reasoning, we feel that it is important to retain this summary of the results that are fully available in Table 2 of the manuscript. Cognizant of your concerns regarding length, we have tried to make this summary to be as succinct as possible.

We also respectfully request that Table 2 be kept in the manuscript for several reasons. Firstly, the results of Models 1-4 correspond to the progressive steps essential to testing partial invariance of the model (explained in our response to comment 4). Second, the goodness of fit indices can be viewed for the baseline and subsequent constrained models. Third, significance tests comparing nested models are also reported ($\Delta\chi^2$) and can be observed (ΔCFI). Fourth, transferring this information to the text would take up considerable space in the manuscript (e.g., reporting the individual fit indices of each model in addition to the results of the chi-square difference tests). The table thus provides a useful and more efficient (space-wise) reference for readers more interested in the finer details of the results. Other SDT-based studies exploring the topic of invariance have presented their findings with regard to SEM multi-sample analyses in a table (e.g., Deci et al., 2001; Hagger et al., 2006; Standage et al., 2005). We hope you will find our rationale reasonable and agree to our request of leaving this table in the manuscript.

In the spirit of amenable negotiation, the section on Page 20 does not bear huge significance in terms of our research question and was therefore deleted.

Concern #2: The statistical analyses.

9. *On the one hand, the analyses are sophisticated and well done. On the other hand, I am not sure that the conclusions you reach are warranted given the results. After a great deal of effort on my part, I just was not able to come to a conclusion about this. Chiefly, there are two things I don't understand, and both emanate from this sentence on page 11: "The robust maximum likelihood method was preferred because the Mardia's coefficient was large (normalized estimate = 43.06). First, a Mardia's coefficient speaks to the normalized estimate of multivariate kurtosis (I believe), so is 43 high?"*

Yes, it is, if the normalized estimate is above 1.96. The value we found is typical of values other people have found analysing self-reports of motivational data (e.g., Deci et al., 2001; Reinboth et al., 2004).

10. *If so (if the data are not multivariate normal), you would need to report the Satorra-Bentler X2, right? Is "scaled X2" the same thing? Does "Satorra-Bentler X2" = "scaled X2" = "robust"?*

That is correct on both accounts. Firstly, Satorra-Bentler's scaled chi-square (estimated with the robust maximum likelihood method) is an adjusted chi-square statistic that attempts to correct for the bias introduced when data are marked by a non-normal distribution. The robust maximum likelihood method thus penalises the chi-square statistic and adjusts the standard errors when under conditions of nonnormality (Bentler, 1995; Satorra & Bentler, 1988). The adjusted or Satorra-Bentler chi-square (also known as the "scaled" or "robust" chi-square) was considered as a fit index in the present study. We have tried to make this clearer, and have consistently used the term Satorra-Bentler chi-square, in this revision of the manuscript (see also Hagger et al., 2006).

11. *Then, more importantly, you go on to report R-CFI, R-NNFI, R-RMSEA, etc. (instead of CFI, NNFI, and RMSEA) goodness-of-fit indicators. I found a couple of papers that used the Satorra-Bentler X2 that you are likely familiar with (the 3rd author's & Vansteenkiste et al.'s August 2005 papers in the Journal of Educational Psychology) and they both used standard goodness-of-fit indices, not robust ones. I'm not sure if R-RMSEA can be interpreted in the same way as can RMSEA. Do Hu and Bentler's recommended goodness-of-fit indicator cut-off scores (middle of page 11) apply equally well to R-CFI, R-NNFI, R-RMSEA, etc.? I don't know, you don't provide a supportive reference, and I fear that the typical reader of Motivation and Emotion won't readily know the answers to these questions either. What I am saying is that the reader needs your help in understanding, interpreting, and drawing meaning from your statistical analyses.*

EQS provides the robust estimates of the fit indices which are appropriate when the robust ML method is used (because they are calculated based on the Satorra-Bentler scaled chi-square). Hu and Bentler's (1999) criteria assume that the data are normal. In a personal communication with the EQS support team (17th January, 2008), we were informed that the robust fit indices should be interpreted in the same way as the cut-off values of the normal fit indices that are interpreted in the Hu and Bentler (1999) paper. It is not correct to report the scaled chi-square and then the normal fit indices because these indices are based on the normal and not the "scaled" chi-square (in fact, it is possible that Maarten interpreted the robust fit indices). In the study by Standage et al. (2005), the robust fit indices were interpreted (p. 421). In the revised manuscript, we explain our reasons for interpreting the robust indices using Hu and Bentler's (1999) guidelines.

Specific Comments

12. *You will need to shorten the Abstract. It is pretty good, but it is currently too many words.*

Thank you. The abstract has been cut. We feel that any further reductions to the abstract would result in a loss of clarity and content.

13. *I would like to see you be more specific on the reliability and validity information for your scales. For instance, page 9 offers, "The psychometric properties of these measures have been supported in previous research conducted in the physical domain (references).", while page 10 offers, "This subscale has exhibited satisfactory reliability and validity in previous sport reseach (references)." Please explain/elaborate a bit more (in a questionnaire-based study, the psychometric properties of the questionnaires used is very important). I am not asking for numbers but, rather, answers to questions such as, How was validity established-predictive validity?*

We have added the specific types of validity and reliability that previous sport research including basic need and well/ill-being measures has supported. These modifications have been incorporated in the revised manuscript.

14. *I think the Discussion section can still be trimmed by another page (e.g., 2nd full paragraph on page 16, paragraph covering both pp. 16 and 17), though you might consider adding points such as the low correlation between vitality and exhaustion, the speculation that coach controllingness might speak better to exhaustion, and taking a clearer stand on the gender invariance and differential need mediation issues.*

As suggested, the respective paragraphs on pages 16-17 have now been shortened. We have listed coach controllingness as a dimension of the social environment that potentially would directly predict athletes' emotional and physical exhaustion. We have also commented on the specific mediational effects, in particular contrasting the findings with respect to the need for autonomy and competence. Finally, we conclude and provide a rationale for why we concluded partial invariance of our baseline model with respect to gender.

15. *Lastly, add the column "Range" or "Possible Range" to Table 1, as some variables (autonomy, relatedness) were assessed on 1-5 (not 1-7) scales.*

We have done so accordingly.

We are very appreciative of the care and effort you have given to our first revision, and the feedback also provided by you and the reviewers of the original submission. This entire process has resulted in a much stronger paper and it has allowed us to more clearly articulate the contribution the present work makes to existent BNT sport-related research and the overall SDT literature. We truly hope this revision and additional explanation provided in our detailed response here means that our paper is now considered acceptable for publication in *Motivation and Emotion*.

Yours sincerely,

James Adie

