Mental Toughness in Sport: Motivational Antecedents and Associations with Performance and Psychological Health

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To appear in: *Journal of Sport & Exercise Psychology*

Accepted for publication: 16th March 2014

Abstract

We argue that basic psychological needs theory (BPNT) offers impetus to the value of mental toughness as a mechanism for optimizing human functioning. We hypothesized that psychological needs satisfaction (thwarting) would be associated with higher (lower) levels of mental toughness, positive affect, and performance, and lower (higher) levels of negative affect. We also expected that mental toughness would be associated with higher levels of positive affect and performance, and lower levels of negative affect. Further, we predicted that coaching environments would be related to mental toughness indirectly through psychological needs, and that psychological needs would indirectly relate with performance and affect through mental toughness. Adolescent cross-country runners (136 male and 85 female, M_{age} = 14.36) completed questionnaires pertaining to BPNT variables, mental toughness, and affect. Race times were also collected. Our findings supported our hypotheses. We concluded that BPNT is generative in understanding some of the antecedents and consequences of mental toughness and is a novel framework useful for understanding mental toughness.

Keywords: Autonomy, Positive Youth Development, Coach Environments, Human Functioning,

Mental Toughness in Sport: Motivational Antecedents and Associations with Performance and Psychological Health

Mental toughness is a term that is often used to describe a collection of psychological characteristics thought to be central to high performance (Butt, Weinberg, & Culp, 2010; Jones, Hanton, & Connaughton, 2002). Over the last decade, researchers have expended considerable efforts in attempting to define and conceptualize mental toughness. As such, there have been recent advancements in understanding this concept. To progress this research field further, there is a need to investigate the positioning of mental toughness within a nomological network of relations that includes variables from established theories within the broad field of psychological enquiry. One such theory proposed in the literature as being connected to mental toughness (Gucciardi & Mallett, 2010) is self-determination theory (SDT; Deci & Ryan, 2002). Drawing on theory such as SDT would expand the boundaries of mental toughness research and provide new perspectives in understanding the development and consequences of this concept. The present investigation is a step toward this direction as it aims to examine how mental toughness is linked to motivational variables encompassed by self-determination theory, as well as psychological health, and objective sport performance.

Mental Toughness in Sport

Gucciardi, Hanton, Gordon, Mallett, and Temby (in press) recently defined mental toughness as a personal capacity to produce consistently high levels of subjective (e.g., personal goal achievement) or objective (e.g., race times) performance despite everyday challenges and stressors as well as significant adversities. This capacity has been discussed as a collection of personal characteristics including attributes such as self-confidence, optimistic thinking, and buoyancy, leading to a general consensus that mental toughness is a multidimensional concept (Butt et al., 2010; Jones et al., 2002). In testing this assumption regarding the dimensionality of mental toughness, Gucciardi et al. (in press) found that there

was considerable empirical overlap among such personal characteristics and that a multidimensional construct was limited in terms of discriminant validity. As a result, they proposed and found support for a direct, unidimensional model of mental toughness. They found excellent model fit and good-to-excellent factor loadings for the unidimensional model across three performance groups (i.e., sport, academia, business), as well as strong correlations with theoretically related properties (i.e., perceived stress, performance, goal attainment, thriving). Such evidence highlighted that the personal characteristics reported in previous studies aimed at conceptualizing mental toughness are not readily distinguishable by individuals in performance contexts and therefore called into question the multidimensionality of this concept. Gucciardi et al.'s (in press) work provides a foundation upon which to consider further lines of enquiry that would position mental toughness alongside variables from other theoretical frameworks and help identify associated predictors and outcomes of the concept.

Linking Mental Toughness with SDT

Although we focus on the links between mental toughness and SDT in this paper, we acknowledge that other theories of motivation (e.g., self-efficacy theory; Bandura, 1977; achievement goal theory; Elliot & McGregor, 2001) are potentially useful for understanding consistently high performance. For example, in line with self-efficacy theory, the degree to which individuals perceive their actions as efficacious will determine how much effort they expend and for how long they persist on tasks (Bandura, 1977). Similarly, findings from achievement goal theory (e.g., Puente-Diaz, 2012) suggest that effortful and persistent actions are determined by how individuals define (i.e., absolute, intra-individual, or normative) and valance (i.e., positive or negative) notions of competence. These motivational theories evidence strong links with behaviors implicit in Gucciardi et al.'s (in press) definition and, hence, are potentially useful in understanding mental toughness. Despite motivational

theories such as these holding currency for understanding mental toughness, we focus on SDT in the current study because of previous proposed links between this particular theory and mental toughness (e.g., Gucciardi & Mallett, 2010), as well as to open debate about the theoretical underpinnings of mental toughness and its development – an avenue researchers have largely neglected in previous research.

Self-determination theory is comprised of five mini-theories, one of which is particularly apt for the present study, namely basic psychological needs theory (BPNT, Deci & Ryan, 2002). In line with BPNT, the optimization of human functioning is contingent on the degree to which individuals perceive the satisfaction of three fundamental psychological needs: autonomy (the belief that one's actions are self-chosen), competence (the belief that one can bring about desired outcomes), and relatedness (the belief that one is meaningfully connected with a wider social network).

We propose that mental toughness is connected to notions that underscore BPNT as it too concerns the optimization of human functioning in performance contexts. In addition, researchers have shown that BPNT variables are predictive of behaviors or characteristics consistent with the definitional and conceptual properties of mental toughness. For example, there is evidence to support associations between psychological needs satisfaction and persistence (e.g., Pelletier, Fortier, Vallerand, & Brière, 2001), effort (e.g., Boiché, Sarrazin, Grouzet, Pelletier, & Chanal, 2008), concentration (e.g., Standage, Duda, & Ntoumanis, 2003), adaptive coping (e.g., Smith, Ntoumanis, Duda, & Vansteenkiste, 2011), and challenging-seeking (e.g., Standage et al., 2003).

Other principles detailed in BPNT are also useful for interpreting mental toughness. In particular, within BPNT, psychological needs satisfaction is dependent on the degree to which autonomy, competence, and relatedness are supported by social environments. Social environments that nurture all three psychological needs are termed autonomy-supportive

(despite the title, autonomy-supportive environments support all three psychological needs), whereas those that thwart psychological needs are termed controlling (Bartholomew, Ntoumanis, & Thogersen-Ntoumani, 2009; Deci & Ryan, 2000). Su and Reeves (2011), in their meta-analysis of the extant literature, identified autonomy-supportive environments as being characterized by the offering of choice (within boundaries), the acknowledgement of feelings or perspectives, the use of non-controlling actions and feedback, the provision of meaningful rationales, and the nurturing of individuals' inner motivational resources (e.g., curiosity, enjoyment, belonging). In comparison, controlling environments are characterized by the manipulative use of rewards, negative conditional regard, intimidation, and excessive personal control (Bartholomew, Ntoumanis, & Thøgersen-Ntoumani, 2010).

In line with previous findings (Bartholomew, Ntoumanis, Ryan, Bosch, & Thogersen-Ntoumani, 2011) and recent speculations in the literature (Gucciardi & Mallett, 2010), we propose that the provision of autonomy-supportive environments may lead to the facilitation of mental toughness, whereas controlling environments may lead to the forestallment of mental toughness. Elucidating these suggestions further, previous findings show that factors believed to be responsible for the development of mental toughness share the characteristics of autonomy-supportive environments. In particular, researchers (e.g., Connaughton, Wadey, Hanton, & Jones, 2008; Gucciardi, Gordon, Dimmock, & Mallett, 2009) have suggested that mental toughness development is contingent on athletes being afforded opportunities to explore and engage in tasks volitionally (e.g., self-directed learning), perceiving themselves as competent and feeling challenged during learning (e.g., being able to demonstrate skill mastery, engage in competitive challenges), and feeling respected, cared for, and needed by those around them (e.g., positive social support, a sense of belonging). In line with BPNT, autonomy-supportive environments are key to the optimization of human functioning because

of how they nurture psychological needs satisfaction, suggesting an indirect association between social environments and functioning through psychological needs satisfaction.

As architects of athletes' experiences, coaches are pivotal in the provision of the social environments that may either foster (i.e., autonomy-supportive) or forestall (i.e., controlling) mental toughness. Although not explicitly focused on BPNT principles, Gucciardi et al. (2009) proposed that coaches who exhibit behaviors consistent with the notion of autonomy-supportive environments (e.g., encourage athlete input, challenge learning, promote mastery, create non-hostile social environments) were more likely to facilitate mental toughness. Gucciardi et al. (2009) also found that coaches who engage in behaviors consistent with notions of controlling environments (e.g., emphasize ego involvement) are likely to thwart mental toughness development. As articulated above, it is likely that coaching environments are associated with mental toughness indirectly depending on the degree to which such environments nurture individuals' psychological needs.

Linking BPNT to Adaptive Outcomes through Mental Toughness

Researchers have shown that athletic performance (e.g., Gillet, Vallerand, Amoura, & Baldes, 2010), as well as positive and negative affect (e.g., Aide, Duda, & Ntoumanis, 2008) are contingent on the satisfaction of psychological needs that result from the provision of autonomy-supportive environments. Findings from related fields of psychological enquiry provides evidence demonstrating that better athletic performances, higher levels of positive affect, and lower levels of negative affect are associated with the personal characteristics consistent with mental toughness conceptualizations (e.g., self-belief, Caprara, Steca, Gerbino, Paciello, & Vecchio, 2006; success mindset, Elliot & McGregor, 2001; emotional awareness and regulation, Salami, 2011). Further, preliminary research has supported theoretically expected relations between mental toughness and performance (Bell, Hardy, & Beattie, 2013; Gucciardi et al., in press), positive affect, and negative affect (Gucciardi et al.,

in press). Given the plausible links and preliminary evidence of relations between mental toughness and BPNT variables, performance, and both positive and negative affect, we contest a nomological network of relations that details the antecedents and outcomes of mental toughness. In particular, we propose that BPNT variables facilitate mental toughness that, in turn, results in adaptive athlete outcomes.

The aim of the current study was to explore 1) how motivational variables detailed in BPNT relate to adolescent athletes' mental toughness levels; and 2) the associations between both motivation variables and mental toughness and adaptive outcomes (i.e., performance and positive and negative affect). We were also interested in exploring the indirect relations between coaching environments and mental toughness through psychological needs, as well as the indirect relations between psychological needs and adaptive outcomes through mental toughness. Adolescence was considered because it is a stage of development most commonly associated with interpersonal differences in mental toughness and, therefore, arguably the most pertinent age group to investigate questions of substantive interest (Bell et al., 2013).

In line with previous research on BPNT, we predicted that athletes who reported higher levels of autonomy support from their coaches would perceive higher levels of psychological needs satisfaction and lower levels of psychological needs thwarting (*H1a*). In contrast, higher levels of perceived coach control was expected to be associated with lower levels of psychological needs satisfaction and higher levels of psychological needs thwarting (*H1b*). Further, athletes who perceived higher levels of psychological needs satisfaction would report higher levels of positive affect, lower levels of negative affect, and faster race times (*H2a*), whilst greater psychological needs thwarting would be associated with lower levels of positive affect, higher levels of negative affect, and slower race times (*H2b*).

Based on the arguments articulated above pertaining to how BPNT variables inform an understanding of mental toughness, we predicted that athletes who perceived higher levels

of psychological needs satisfaction would report higher levels of mental toughness (*H3a*) and athletes who perceived higher levels of psychological needs thwarting would report lower levels of mental toughness (*H3b*). We also predicted that, based on preliminary findings (Bell et al., 2013; Gucciardi et al., in press) athletes who reported higher levels of mental toughness would also report higher levels of positive affect, lower levels of negative affect, and quicker race times compared to adolescent athletes who reported lower levels of mental toughness (*H4*). These hypothesized direct relations can are illustrated in Figure 1. Finally we made several predictions pertaining to indirect relations. We predicted that autonomy-supportive coaching environments would be positively (*H5a*) and controlling environments would be negatively (*H5b*) related with mental toughness through psychological needs satisfaction. Conversely, we expected that autonomy-supportive coaching environments would be negatively (*H5c*) and controlling environments would be positively (*H5d*) related with mental toughness through psychological needs thwarting. We also expected that psychological needs satisfaction would be positively (*H6a*) and psychological needs thwarting would be negatively (*H6b*) associated with positive affect through mental toughness, whilst psychological needs satisfaction would be negatively (*H6c*) and psychological needs thwarting would be positively (*H6d*) associated with negative affect and race times through mental toughness.

Method

Participants

Participants were 136 male (M_{age} = 14.39, *SD* = 1.44) and 85 female (M_{age} = 14.29, *SD* = 1.53) cross-country runners recruited from high schools in Australia (*N* = 221). On average, participants had been competing in inter-school cross-country events for 4.47 years (*SD* = 2.57) and trained 2.10 hours per week (*SD* = 1.63).

Measures

Demographics. Participants' age, gender, years competing in cross-country, and number of training hours per week were garnered using single item measures.

Mental Toughness Index (MTI). The MTI (Gucciardi et al., in press) is an eight-item direct measure of mental toughness (e.g., "I am able to regulate my focus when performing tasks"). Each question represents one of the eight facets of mental toughness proposed in Gucciardi et al.'s (2011) synthesis of the literature. Participants respond to each item on a 7-point scale (1 = *false, 100% of the time* and 7 *true, 100% of the time*). The scale has received psychometric support with samples of university students, athletes, and employees, and theoretically consistent relations with performance, stress, and psychological health (Gucciardi et al., in press).

Sport Climate Questionnaire – Short Form (SCQ-SF). The SCQ-SF is a sport-adaption of the Learning Climate Questionnaire (Williams & Deci, 1996), which measures athletes' perceptions of coach autonomy support (e.g., "I feel that my coach provides me with choices and options"). Participants respond to the 6-item questionnaire using a scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). The SCQ-SF has been validated in sport samples (e.g., Hagger, Chatzisarantis, Culverhouse, & Biddle, 2003).

Basic Needs Satisfaction in Sport Scale (BNSSS). The BNSSS (Ng, Lonsdale, & Hodge, 2011) measures athletes' perceptions of competence (e.g., "I am skilled at my sport"), relatedness (e.g., "I show concern for others in my sport"), and autonomy. Ng et al.'s (2011) measure separates autonomy into three categories, namely volition (e.g., "I feel I participate in my sport willingly"), choice (e.g., "In my sport, I get opportunities to make choices"), and internal perceived locus of causality (e.g., "In my sport, I feel I am pursuing goals that are my own"). Participants respond on a scale ranging from 1 (*not at all true*) to 7 (*very true*). Psychometric analyses showed the 20-item measure to have satisfactory internal consistency

scores and model fit, and good nomological validity and test-retest reliability (Ng et al., 2011).

Psychological Needs Thwarting Scale (PNTS). The PNTS (Bartholomew, Ntoumanis, Ryan, & Thogersen-Ntoumani, 2011) is a 12-item measure of athletes' perceptions of psychological needs thwarting. This measure includes statements pertaining to the thwarting of autonomy (e.g., "I feel pushed to behave in certain ways"), competence (e.g., "There are situations where I am made to feel inadequate"), and relatedness (e.g., "I feel rejected by those around me"), and requires participants to respond on a seven-point scale (1 = *strongly disagree* and 7 = *strongly agree*). Analyses have revealed support for the three-factor model and internal consistency (Bartholomew et al., 2011).

Controlling Coach Behaviors Scale (CCBS). The CCBS (Bartholomew et al., 2010) includes 15 items pertaining to athletes' perceptions of their coaches' behaviors. The scale is comprised of four factors: controlling use of rewards (e.g., "my coach only rewards/praises me to make me train harder"), negative conditional regard (e.g., "my coach pays me less attention if I have displeased him/her"), intimidation (e.g., "my coach threatens to punish me to keep me in line during training"), and excessive personal control (e.g., "my coach tries to control what I do during my free time"). Reponses are rated on a 7-point scale from 1 (*strongly disagree*) to 7 (*strongly agree*). Statistical analyses have revealed sound content and factorial validity for the measure, as well as internal consistency and invariance across gender and sport type (Bartholomew et al., 2010).

Psychological health. Positive affect was measured using the Mental Health Continuum Short Form (MHC-SF, Keyes, 2005). This 14-item questionnaire requires individuals to indicate the degree to which they have experienced certain thoughts and feelings over the past month on a 6-point scale (1 = *never* and 6 = *every day*). Questions are categorized into three factors, emotional (e.g., "happy"), psychological (e.g., "that your life

has a sense of direction or meaning to it"), and social (e.g., "that people are basically good"). High internal consistency scores and evidence of discriminatory validity support the use of the MHC-SF (Keyes, 2005).

The 21-item Depression Anxiety Stress Scale (DASS-21) was employed to measure negative affect (Lovibond & Lovibond, 1995). The DASS-21 measures depression (e.g., "I felt down-hearted and blue"), anxiety (e.g., "I felt I was close to panic"), and stress (e.g., "I found it difficult to relax"), and requires individuals to respond on a 4-point scale (0 = *did not apply to me*, 1 = *applied to me to some degree, or some of the time,* 2 = *applied to me a considerable degree, or a good part of time,* and 3 = *applied to me very much, or most of the time*). The DASS-21 has been shown to have strong factor loadings, discriminator validity, and internal consistency (Antony, Bieling, Cox, Enns, & Swinson, 1998).

Performance. Race times over varying distances (depending on age and gender) were collected during the end-of-season championship and served as a measure of performance. This event was selected because of the high attendance of athletes and because mental toughness is thought to be most pertinent during pressure-filled performances such as end-of-season championships (Bell et al., 2013). Race times were standardized to account for differences in race distance across age and gender (e.g., 15 year old boys ran 4 km, 15 year old girls ran 3 km). A higher race time equated to poorer performance.

Procedure

Following university ethics approval, school staff (i.e., principals and/or sport directors) were approached and informed about the aims and procedures of the research. Information sheets and written consent forms were then distributed to parents/guardians and adolescent athletes during training sessions. Once parent/guardian and participant written consent was received, participants were asked to complete a booklet that included the abovementioned questionnaires. Participants completed the questionnaires roughly one

month before the end-of-season inter-school championship. The demographic questions appeared first in all booklets and the remaining questionnaires were randomly counter-balanced. Race times were recorded during the championship event by race organizers.

Data Analysis

Path analysis with a Bayesian estimator was applied in Mplus 7.11 (Muthén & Muthén, 1998-2012) to examine the hypothesized model depicted in Figure 1 (for general examples and descriptions of Bayesian analysis see, van de Schoot et al., in press; Zyphur & Oswald, in press) including both direct and indirect pathways (see, Yuan & MacKinnon, 2009). Bayesian analysis is an approach that has garnered the interests of sport and exercise psychology researchers in recent years (Doran & Gaudreau, 2014; Jackson, Gucciardi, & Dimmock, 2014). This approach leverages off theory and previous research to form a *prior distribution* – a combination of the specific magnitude and variability of effect sizes. Prior distributions are then incorporated into the analysis to determine the probability of a hypothesized model, given the data (Muthén & Asparouhov, 2012). Prior distributions can range from non-informative, where no prior knowledge is asserted about the magnitude or variance of the parameter, to highly informative, where the distribution is constrained by very precise parameter estimates. These prior distributions are combined with new data to form the *posterior distribution* – an updated understanding of the prior distribution in light of the given data. In totality, all available evidence – prior and current – is considered in the process of Bayesian analysis. Additionally, Bayesian analysis does not depend on asymptotic (large-sample) theory and, as such, provides more accurate estimates of parameters and model fit than frequentist approaches when sample size is small. Another benefit of Bayesian analysis over traditional approaches is that it is more flexible when handling complex models, as the use of prior knowledge incorporates additional information into the analysis that help identify

parameter solutions that otherwise might not be achieved by using a frequentist approach (Asparouhov & Muthén, 2012, July 18).

We used both empirical evidence and theoretical knowledge to guide the specification of priors in our analysis. First, prior knowledge regarding the relations between coaching climate and psychological needs, and psychological needs and psychological health were guided by empirical evidence (Bartholomew et al., 2011). We utilized Bartholomew et al.'s findings because of the similarity between the aims, sample, and measures of their study and ours. For similar reasons, we utilized Gucciardi et al.'s (in press) findings to inform the selection of priors for the relations between mental toughness and both positive and negative affect. The empirically informed priors and their respective variances can be seen in Table 1.

Although the effects of both BPNT variables (Gillet et al., 2010) and mental toughness (Bell et al., 2013; Gucciardi et al., in press) on performance have been examined in previous research, it is difficult and often inappropriate to guide priors when exploring unrelated performances (e.g., mean performances in closed sports are not equivalent to mean performances in endurance sports). Hence, drawing on statistical recommendations (Muthén & Asparouhov, 2012; Zyphur & Oswald, in press) and theoretical expectations, the priors for the effects of psychological needs satisfaction/thwarting on mental toughness were set with a mean of -.40 and a variance of .03, meaning that 95% of the loadings should fall between -.06 and -.74. These means and variances were selected to reflect the expected direction of relations between mental toughness and race times (i.e., inverse relations), as informed by past research, whilst limiting constraints on the strength between these associations (for further details about the use and selection of theoretically informed priors see, Zyphur & Oswald, in press). As the use of different priors can influence the relations between variables (Zyphur & Oswald, in press), we conducted a sensitivity analysis by comparing the hypothesized model (i.e., informed by empirical and theoretical priors) with two other

models; one with the same mean parameters but with variances around the expected parameter estimates set to be highly precise, and another with low precision for the variance of the parameter distribution (see Table 1).

Model convergence is an important consideration for valid estimation and inference with Bayesian modeling. Bayesian analysis employs a sophisticated estimation process known as Markov Chain Monte Carlo (MCMC) whereby the prior distribution is specified and through an iterative process an accurate representation of the posterior distribution is approximated from representative samples of parameter values from the entire posterior distribution (for detailed discussions about MCMC methods and application, see Chen, Shao, & Ibrahim, 2000; Gamerman & Lopes, 2006). At least two MCMC estimation "chains" are run in parallel, each using different starting values for model parameters to ensure the iterative process provides an opportunity to monitor convergence (Muthén & Asparouhov, 2012). Two diagnostic tools can be created from these chains: (i) the potential scale reduction (PSR) factor, which takes into account the overall parameter variability both within and between the chains; and (ii) trace plots, which graphically represent the fluctuation in parameter values as the MCMC estimator iterates toward the solution. A PSR value of ≤ 1.1 provides evidence in support of convergence to the true posterior distribution, as it suggests that parameter variability could not be appreciably reduced with further iterations (Asparouhov & Muthén, 2010, September 29). Visual inspection of trace plots should indicate that the multiple independent chains have all stabilized to essentially the same distribution (Asparouhov & Muthén, 2010, September 29).

Model fit is subsequently assessed using posterior predictive checking (for more detail, see Lynch & Western, 2004). This method compares the probability of the observed data against that of the generated posterior distribution of parameters, while taking into account variability in the parameters. Specifically, the posterior predictive *p* (PPP) value

indicates the degree of deviation between the observed and generated data and is accompanied by a 95% confidence interval. In line with recommendations (Muthén & Asparouhov, 2012), PPP values closer to .50 reflect good fitting models where the real data is just as probable as the generated data and, as such, should be preferred when comparing competing models.

Throughout our analyses we considered parameters to have gained substantive support when the 95% credibility interval (95% CI) did not encompass zero. It is necessary to note that credibility intervals are different from the more common confidence intervals from Frequentist approaches. Both credibility and confidence intervals service a similar aim: to provide the best estimate of the true nature of the parameter. However, credibility intervals incorporate prior knowledge into the estimate and represent an estimation of the probability that the true value of a parameter falls between two bounds (i.e., upper and lower intervals), whereas confidence intervals are based solely on the data and estimate a range in which the parameter would occur over time with repeated sampling (Curran, 2005). In interpreting credibility intervals, researchers can conclude, for example, that they are 95% certain that the true value of the parameter exists between the upper and lower bounds. In comparison, researchers interpreting confidence intervals could conclude that, on average, 95% of intervals generated via repeated sampling would contain the true value of the parameter (for further discussions, see, Curran, 2005)

Results

Table 2 includes descriptive statistics, reliability scores, and correlations of the study variables and relevant demographic markers. Model convergence was supported through a smooth decrease in PSR values at the first iteration and PSR stability once < 1.1 was reached, as well as visual inspection of trace plot (these results are extensive and are not included in this manuscript, but are available from the first author upon request). All three models (see

Table 1) demonstrated sound fit indices. In light of these results, and in keeping with prior findings, we focus our discussions on the hypothesized model (i.e., Model A).

Bayesian estimates and 95% CIs for the associations between the study variables for all three models are summarized in Table 1. Theoretically consistent relations were evidenced between social environments and psychological needs. In particular, autonomy-supportive environments were positively associated with psychological needs satisfaction and negatively associated with psychological needs thwarting. Further, controlling environments were positively associated with psychological needs thwarting and negatively related with psychological needs satisfaction. Psychological needs were also strongly associated with mental toughness, as well as positive and negative affect, and performance. Specifically, psychological needs satisfaction was positively associated with mental toughness and positive affect, and negatively associated with negative affect and race times. Further, psychological needs thwarting was positively associated with negative affect and race times, and negatively associated with mental toughness and positive affect. Finally, mental toughness was strongly associated with positive and negative affect, and race times as hypothesized. Specifically, mental toughness was positively related to positive affect and negatively associated with negative affect and race times.

Psychological needs satisfaction mediated the relation between autonomy-supportive environments and mental toughness, as well as the relations between controlling environments and mental toughness. Similarly, psychological needs thwarting mediated the relations between autonomy-supportive environments and mental toughness, as well as controlling environments and mental toughness. Further, mental toughness mediated the relations between psychological needs satisfaction and positive and negative affect, and performance, as well as psychological needs thwarting and positive and negative affect, and performance (Table 3).

Discussion

Guided by basic psychological needs theory (Deci & Ryan, 2002), mental toughness is a concept that can be positioned within a nomological network of relations that provides an insight into to its motivation antecedents and relations with performance and psychological outcomes. The aims of the current study were to explore 1) how motivational variables detailed in BPNT relate to adolescent athletes' mental toughness levels and 2) the associations between both motivation variables and mental toughness and adaptive outcomes (i.e., performance and positive and negative affect). We were also interested in exploring how coaching environments and mental toughness were indirectly related through psychological needs, as well as how psychological needs and adaptive outcomes were indirectly associated through mental toughness.

In the first instance, all direct relations between the coaching climate and psychological needs (*H1a-b*), and between psychological needs and outcome variables (*H2a-b*) were supported. These findings compliment previous research that has identified associations between social environments and psychological needs, and between psychological needs and outcome variables (Deci & Ryan, 2000; Ntoumanis, 2012). Beyond these results, the major substantive findings of our study pertain to the direct and indirect associations involving mental toughness, which highlight a nomological network within which this concept can be understood. To our knowledge, this study is the first to show that psychological needs satisfaction is positively, whilst psychological needs thwarting is inversely associated with mental toughness (*H3a-b*). Arguably, to produce consistently higher levels of performance despite obstacles faced – that is, to demonstrate greater levels of mental toughness – individuals need to not only expend a great deal of cognitive and behavioral effort, but also maintain this effort over time. In line with BPNT, the quality and quantity of cognitive and behavior effort available to individuals is contingent on the degree

to which psychological needs are satisfied (Deci & Ryan, 2000). That is, psychological needs satisfaction promotes perceptions of personal control, self-efficacy, and self-value that result in the maintenance of high levels of effort. In comparison, psychological needs thwarting inhibits individuals' sense of personal control, efficaciousness, and importance, resulting in a reduction or forfeiting of effort – behaviors that reflect lower levels of mental toughness.

We also found that mental toughness levels were positively associated with positive affect and inversely associated with negative affect and race times (*H4*). These relations are consistent with preliminary evidence in sport (Bell et al., 2013; Gucciardi et al., in press). Further, these data provide additional support for Gucciardi et al.'s (in press) definition of mental toughness (i.e., that higher levels of mental toughness are representative of better performances) and helps shore up the conceptual foundations of this concept by highlighting meaningful associations. However, there are numerous avenues that researchers need to consider before firmer conclusions can be drawn about the adaptive potential of mental toughness. A recommendation previously presented in the literature (Andersen, 2011) concerns the perceptions and actions of injured athletes who are more mentally tough. It is possible that such individuals would jeopodize their recovery by ignoring feelings of pain and not adhere to rehabilitation recommedations in order to pursue competition goals, meaning that mental toughness is maladaptive in particular contexts. Researchers could investigate such contexts to further explore whether or not mental toughness is solely adaptive or also relates to maladaptive outcomes.

We also found support for the expected indirect association between coaching environments and mental toughness through psychological needs (*H5a-d*). These findings are consistent with a body of previous research which has shown environmental supports and outcome variables to be indirectly related through psychological needs (e.g., Bartholomew, Ntoumanis, Ryan, Bosch, et al., 2011). However, our findings are unique as they are, to our

knowledge, the first to identify associations between BPNT variables and mental toughness. Our findings extend on previous research by Gucciardi et al. (2009) who reported that different coaching styles can foster or forestall mental toughness development. We agree with Gucciardi et al.'s (2009) conclusions, but also extend them by contesting that the degree to which coaching environments nurture psychological needs is one mechanism through which coaches may contribute to mental toughness development.

A final substantive finding of our study was the indirect relations between psychological needs and adaptive outcomes through mental toughness (*H6a-d*). Above we proposed that psychological needs satisfaction promoted continuous, high effort because of an increased sense of personal control, efficaciousness, and self-value, and that this was reflective of mental toughness. We extended this line of thinking by suggesting that higher levels of continuous effort are more likely to result in individuals feeling as though they are mastering new skill, goal achievement, and a sense of productivity and, as such is likely to enhance perceptions of positive affect. The opposite could be said of individuals who expend little effort on tasks because their psychological needs are thwarted. That is, less effort is likely to result in stagnation, underachievement, and reduced productivity and, as such, is likely to produce greater levels of negative affect.

Some shortcomings of the current study offer possible avenues for future research. The first notable limitation was the use of a cross-sectional methodology. The use of longitudinal methods in subsequent studies would allow researchers to monitor changes in social environments, psychological needs, mental toughness, and markers of human functioning (e.g., positive affect, performance). Another possible methodological avenue to overcome the cross-sectional limitation of the current study would be to conduct an experimental trial where coaches are exposed to a training program aimed at fostering more autonomy-supportive and less controlling interpersonal styles. Athletes' perceptions of

coaching behaviors, psychological needs satisfaction, and mental toughness could then be monitored at the end of the intervention and at follow-ups to determine the causal effects of BPNT variables on mental toughness. A second limitation of the current study was the sole emphasis on coaching environments. Coaching environments were selected in the current study because of their prevalence in previous mental toughness literature (e.g., Connaughton et al., 2008; Gucciardi et al., 2009), but also because coaches often form strong relationships with adolescents as they emancipate from their primary caregivers (Jowett & Timson-Katchis, 2005). Nevertheless, parents and peers are two other groups identified as playing a meaningful role in the provision of autonomy-supportive or controlling environments (Su & Reeve, 2011), as well as mental toughness development (e.g., Connaughton et al., 2008). Researchers could explore how other social agents contribute to psychological needs, mental toughness, and associated outcomes. A third limitation of this study concerns the manner in which prior distributions in the Bayesian analysis were informed. Specifically, a single source informed the selection of some priors, whereas others were theoretically informed. We acknowledge that ideally these priors would have been informed by point and variance estimates of effect sizes obtained from meta-analyses and that it is impossible to account for variability across contexts with such sparse prior knowledge. In line with changing trends in statistical enquiry and the growing interests in Bayesian approaches in particular, we suggest that researchers continue to add to the pool of available data on topics such as mental toughness in order to allow substantiated conclusions to be formed. Finally, as alluded to in the introduction of this paper, SDT is but one lens through which to consider mental toughness and its development. Other theories such as self-efficacy theory (Bandura, 1977) and achievement goal theory (Elliot & McGregor, 2001) may be useful for understanding mental toughness and its development and should be considered in subsequent research.

Taken together, our findings represent several meaningful contributions for understanding mental toughness. They provide new insight into how motivational variables proposed by BPNT are linked to mental toughness and highlight a conceptual model that helps researchers to understand some of the antecedents and consequence of mental toughness. Conceptually, we believe findings such as those reported in this study advances mental toughness research by directing it into a new wave of enquiry. Further exploration along these lines is required to offer a more comprehensive understanding of the positioning of mental toughness amongst other psychological concepts and its value in supporting optimal human functioning.

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Table 1

Comparison of Unstandardised Weights of Parameter Estimates of Bayesian Estimates using Different Priors, including Prior Means and Variances of Hypothesized Model

	Hypothesized Model	Model A	Model B	Model C
Model Fit				
PPP (95% CI)		.43 [-25.00, 29.47]	.43 [-25.06, 29.37]	.43 [-25.19, 29.84]
Parameters	Prior Mean (Variance)	μ [95% PPI]	μ [95% PPI]	μ [95% PPI]
AS → NS	.46 (.03)	.45 [.18, .74]*	.46 [.40, .52]*	.43 [-.07, .95]
AS → NT	-.22 (.01)	-.24 [-.42, -.05]*	-.22 [-.28, -.16]*	-.32 [-.81, .17]
CO → NS	-.07 (.001)	-.07 [-.13, -.01]*	-.07 [-.13, -.01]*	-.08 [-.78, .69]
CO → NT	.50 (.03)	.50 [.18, .81]*	.50 [.44, .56]*	.50 [-.24, 1.25]
NS → MT	.40 (.03)	.43 [.14, .72]*	.40 [.34, .46]*	.47 [-.02, .96]
NS → PA	.66 (.03)	.48 [.18, .79]*	.65 [.59, .71]*	.30 [-.34, .95]
NS → NA	-.16 (.005)	-.15 [-.28, -.02]*	-.15 [-.21, -.09]*	-.12 [-.78, .44]
NS → RT	-.40 (.03)	-.39 [-.72, -.05]*	-.40 [-.46, -.34]*	-.35 [-1.20, .46]
NT → MT	-.40 (.03)	-.37 [-.70, -.05]*	-.40 [-.46, -.34]*	-.31 [-.99, .39]
NT → PA	-.10 (.001)	-.10 [-.17, -.04]*	-.10 [-.17, -.04]*	-.18 [-.88, .52]
NT → NA	.24 (.01)	.22 [.04, .41]*	.24 [.18, .30]*	.14 [-.43, .85]
NT → RT	.40 (.03)	.38 [.05, .72]*	.40 [.34, .46]*	-.29 [-.51, 1.13]
MT → PA	.57 (.03)	.39 [.09, .69]*	.56 [.50, .62]*	.21 [-.45, .90]
MT → NA	-.18 (.005)	-.18 [-.31, -.05]*	-.18 [-.24, -.12]*	-.20 [-.81, .40]
MT → RT	-.40 (.03)	-.39 [-.72, -.05]*	-.40 [-.46, -.34]*	-.35 [-1.22, .48]

Note. Model A = originally hypothesized model; Model B = variance around the expected parameter estimates of original model was set to be highly precise (i.e., .001 or a 95% limit of ± .06 around the mean); Model C = variance around the expected parameter estimates of original model was specific with low precision (i.e., .20 or a 95% limit of ± .87 around the mean). AS = autonomy support; CO = controlling; NS = needs satisfaction; NT = needs thwarting; MT = mental toughness; PA = positive affect; NA = negative affect; RT = race times.
*CI did not encompass zero

Table 2

Descriptive Statistics, Reliability Scores, and Correlations for all Study Variables

	Variables	*M (SD)*	Skew.	Kurt.	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
1	Age	14.36 (*1.47*)			-									
2	Years	4.47 (*2.57*)			0.22**	-								
3	Hrs/wk	2.10 (*1.63*)			0.02	0.08	-							
4	AS	5.27 (*1.16*)	-.74	.61	0.27**	0.12	0.16*	(.88)						
5	CO	2.22 (*0.92*)	.77	.31	-0.15*	0.01	0.05	-0.32**	(.88)					
6	NS	5.53 (*0.80*)	-.60	.39	0.07	0.03	0.20**	0.53**	-0.26**	(.89)				
7	NT	2.57 (*1.05*)	.53	-.21	-0.23**	-0.07	-0.05	-0.52**	0.58**	-0.40**	(.88)			
8	MT	5.48 (*0.78*)	-.63	1.00	0.06	-0.01	0.18**	0.31**	-0.24**	0.59**	-0.38**	(.79)		
9	PA	4.97 (*0.74*)	-1.34	2.59	0.05	0.05	0.05	0.33**	-0.13	0.46**	-0.34**	0.40**	(.90)	
10	NA	0.53 (*0.41*)	1.18	1.36	-0.30**	-0.07	-0.06	-0.23**	0.25**	-0.29**	0.43**	-0.37**	-0.38**	(.84)
11	Race time	0.00 (*0.98*)†	.71	.26	-0.02	-0.21**	-0.22**	-0.16*	-0.04	-0.22**	0.43**	-0.21**	0.02	0.08

Note. Skew = Skewtosis; Kurt = Kurtosis Years = years competing in cross-country; Hrs/wk = hours per week spent training in cross-country; AS = autonomy-supportive environments; CO = controlling coaching environments; NS = psychological needs satisfaction; NT = psychological needs thwarting; MT = mental toughness; PA = positive affect; NA = negative affect; Race time = performance times standardized across age, gender, and distance run; internal reliability estimates (Cronbach's alpha) provided on the diagonal in parentheses.

* $p < .05$. ** $p < .01$. † Z-scores, race time standardized across age, gender, and distance run.

Table 3

Unstandardized Weights of Parameter Estimates for Indirect Effects of Variables in Model A

Mediation variable	Estimate (*SE*)	95% PPI
Indirect path		
Needs satisfaction		
Autonomy-supportive → Mental toughness	0.18 (*.03*)	[0.04, 0.41]*
Controlling → Mental toughness	-0.03 (*.02*)	[-0.07, -0.01]*
Needs thwarting		
Autonomy-supportive → Mental toughness	0.08 (*.02*)	[0.01, 0.22]*
Controlling → Mental toughness	-0.17 (*.02*)	[-0.42, -0.02]*
Mental toughness		
Need satisfaction → Race time	-0.16 (*.04*)	[-0.39, -0.01]*
Need thwarting → Race time	0.13 (*.02*)	[0.01, 0.37]*
Need satisfaction → Negative affect	-0.07 (*.02*)	[-0.17, -0.01]*
Need thwarting → Negative affect	0.06 (*.01*)	[0.01, 0.16]*
Needs satisfaction → Positive affect	0.16 (*.03*)	[0.02, 0.38]*
Needs thwarting → Positive affect	-0.13 (*.01*)	[-0.34, -0.01]*

Note. SE = standard error, PPI = posterior probability interval.
*CI did not encompass zero.

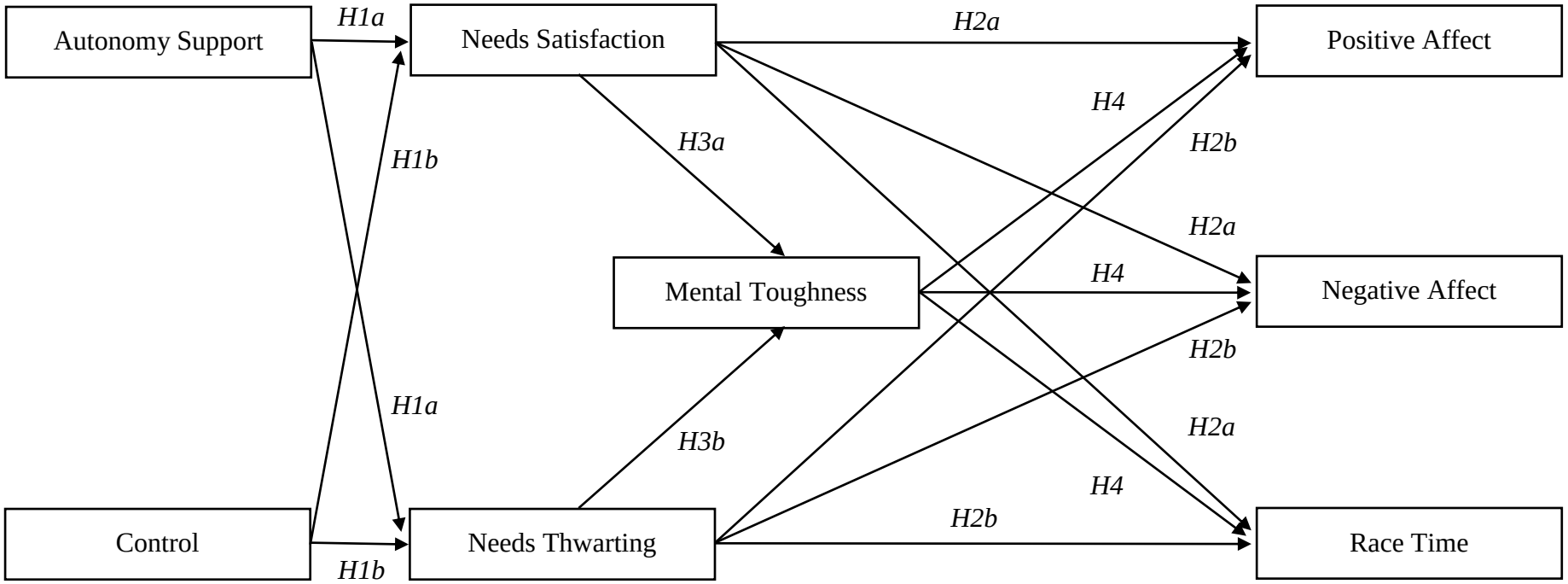

Figure 1. Hypothesized direct relations between coaching environments, psychological needs, mental toughness, performance, positive affect, and negative affect.