Article accepted for publication in Psychology of Sport and Exercise on 10th March 2021

A Longitudinal Examination of Thriving in Sport Performers

Date of resubmission: 8th March 2021

Date of initial submission: 6th July 2020
Abstract

To sustain success in sport, athletes need to function effectively in their competitive encounters and maintain this level over repeated events. Yet, to date, little is known about how athletes can continue to fully function (i.e., thrive) in their sporting encounters. Equally, there is a lack of research in relation to the factors that predict thriving. Testing the premise that basic psychological needs (i.e., for autonomy, competence, and relatedness) predict optimal functioning, the aim of this study was to provide the first longitudinal examination of thriving in sport. Sport performers ($N = 268$) completed questionnaires assessing thriving and basic psychological need satisfaction on three occasions across 28 days. Longitudinal structural equation modeling showed thriving to be highly predicted by both the experience of recent thriving and the perceived satisfaction of basic psychological needs. These findings highlight an important mechanism through which coaches and practitioners can initiate and maintain thriving in the athletes that they work with across a series of sporting encounters.

*Keywords*: basic psychological need satisfaction; performance; thrive; well-being.
To sustain success in sport, athletes need to deliver high levels of performance in competitive situations and repeat these levels over time. For example, performers will need to produce multiple, high-level performances over consecutive weekends of a sport season or in sequential daily rounds of a competition. Additionally, athletes’ sporting success and their experience of optimal functioning is governed by their continued, adaptive engagement with these events via the experience of well-being (e.g., display of high levels of energy and vigor, experience of positive mood; see Verner-Filion & Vallerand, 2018). Simultaneously achieving both performance and well-being outcomes is reflective of the experience of thriving, whereby the concurrent perception of high-level performance and experience of high well-being in a specific encounter reflects the state-based form of the construct, and their repeated occurrence across a series of encounters is purported to lead to sustained development and success (Brown, Arnold, Fletcher, et al., 2017). Lending support to this position, Brown et al. (2018) found that thriving in elite sport performers was perceived by athletes, coaches, and sport psychology practitioners to comprise a sustained high-level of performance and dimensions of well-being (e.g., sense of belonging, having an active awareness, feeling optimistic). Understanding thriving therefore appears critical to addressing what is deemed one of the most pressing and important issues in contemporary sport; that is, to understand how athletes’ performances can be enhanced while simultaneously optimizing their well-being within highly demanding environments (Arnold & Fletcher, 2021; Fletcher, 2019).

A key feature of the construct of thriving is that it reflects the human experience of functioning fully and holistically (see, Brown, Arnold, Fletcher, et al., 2017; Brown, Sarkar, et al., 2020; Ryan & Deci, 2017; Su et al., 2014). From a self-determination theory (Ryan & Deci, 2017) perspective, this fullness or holism represents one’s collective access to the
faculties enabling awareness and true self-regulation, one’s ability to mobilize and harness psychological and physical energy for valued activities (i.e., vitality), as well as the experience of positive subjective states (e.g., happiness; Ryan & Deci, 2017). The need for this breadth of (positive) functioning indicators is also reflected in the work of Su et al. (2014) who contend that “to thrive in life is not only marked by feelings of happiness, or a sense of accomplishment, or having supportive and rewarding relationships, but is a collection of all these aspects” (p. 272). Thus, to be thriving, one would be expected to demonstrate high levels across multiple functioning indicators; critically, however, Brown, Sarkar, et al. (2020) note that the dimensions of functioning used to determine thriving will be contingent on the context (e.g., education, sport, work) and lens (e.g., context-specific vs. life-general) being studied.

Within sport-based research, indicators of functioning have typically included hedonic well-being (e.g., positive affect), eudaimonic well-being (e.g., psychological well-being, vitality), and performance (e.g., perceived accomplishment; see, e.g., Gucciardi et al., 2017; Verner-Filion & Vallerand, 2018), and scholars have begun to use these assessments to identify individuals who have thrived (see, Brown, Arnold, Standage, et al., 2017; McNeill et al., 2018). With a sample 535 sport performers, Brown, Arnold, Standage, et al. (2017) assessed functioning using self-reported responses on subjective performance (via performance satisfaction), eudaimonic well-being (via subjective vitality), and hedonic well-being (via positive affect) and conducted factor mixture analysis to determine the shape and level of functioning profiles. Their results demonstrated no shape effects, suggesting that all performers could be described as having a tendency to report high (i.e., thriving), moderate (i.e., above average or below average), or low scores (i.e., low functioning) across all dimensions. Using cluster analysis, McNeill et al. (2018) found similar patterns in their work with coaches, despite employing alternative positive and negative indicators of functioning
(i.e., personal accomplishment, emotional well-being, social well-being, psychological well-being, emotional exhaustion, and depersonalization). Collectively, the results of Brown, Arnold, Standage, et al. (2017) and McNeill et al. (2018) suggest that multiple indicators can be used to measure functioning in sport and that these indicators can be modelled with a single, global factor (i.e., functioning/thriving; see also, Brown, Arnold, et al., 2020; Rouquette et al., 2021).

Armed with the knowledge that thriving can occur within sport and that it can be determined using performers’ subjective experiences of performance and well-being in sporting encounters, researchers can now begin to examine the consequences of thriving, along with the predictors of it. With regards to the consequences, an intriguing finding from Brown et al.’s (2018) qualitative study was the description of both positive (i.e., personal development and performance benefits) and negative (i.e., decreased mood/motivation) outcomes following the occurrence of thriving in elite sport performers. This finding raises an important question about whether experiencing thriving serves to promote or hinder future thriving, and, ultimately, whether it can bring about sustained development and success as previously suggested (see, Brown, Arnold, Fletcher, et al., 2017). Furthermore, Brown et al. (2018) speculated that the timing of thriving may have transient or more enduring effects on the positive and negative outcomes contingent on whether it occurred within the regular season or in an encounter followed by a period of rest (e.g., off-season). More specifically, they contend that thriving within the regular season may provide opportunities for momentum, for a rebound in mood/motivation, and for initiating change, whereas thriving in end-of-season encounters may result in a failure to capitalize on the positive experience or in prolonged lethargy. With these hypotheses yet to be tested, conducting a quantitative assessment of the lasting effects of thriving represents a critical next step in our knowledge of the construct, as well as providing important insight for whether it is promoted and/or
managed.

Turning to the prediction of thriving, it is thought that humans possess universal and basic needs which, when satisfied, can result in optimal functioning and thriving (Ryan & Deci, 2017). These needs are considered basic given that growth, integrity, and well-being depend on their satisfaction, that they bring about observable and meaningful positive consequences for thriving, and that harm results from their deprivation or frustration (Deci & Ryan, 2000; Ryan & Deci, 2017). While various candidate psychological needs have been proposed (e.g., security, self-actualization-meaning; Sheldon et al., 2001), Ryan and Deci (2017) argue that it is only the needs for autonomy (i.e., need for volitional, congruent, and integrated functioning), competence (i.e., need to feel effectance and mastery), and relatedness (i.e., need to feel socially connected and cared for) that meet these criteria. Each of the needs are considered independently important, meaning that all three must be satisfied for a person to be fully functioning; however, the needs are also highly interdependent and intercorrelated, meaning that they are often reciprocally promoted and psychometrically integrated into an overall need satisfaction score (Ryan & Deci, 2017). In sum, not only is basic psychological need satisfaction predicted to relate to thriving, but the collective satisfaction of these needs is proposed as “a necessary condition” for its occurrence (Ryan & Deci, 2017, p. 242).

The role of basic psychological need satisfaction on the occurrence of thriving in sport has been empirically examined within two studies to date. In the first of these studies, Brown, Arnold, Standage, et al. (2017) examined the predictive effects of self-reported basic psychological need satisfaction on sport performers’ membership to functioning profiles. Their results showed need satisfaction to be a significant, positive predictor of performers’ membership to the “thriving” group when compared to the “above average” group, the “below average” group, and the “low functioning” group. In the second study, Brown,
Arnold, et al. (2020) collected daily diary entries on players’ perceptions of basic psychological need satisfaction in advance of an important hockey match. In contrast to previous research reporting daily fluctuations in autonomy, competence, and relatedness satisfaction (see, e.g., Quested et al., 2013), daily levels were shown to be stable, with pre-match levels positively predictive of in-match thriving. While both studies offer support for the hypothesized relationship between basic psychological need satisfaction and thriving, they are limited by their singular assessment of thriving as this precludes insight into whether needs continue to act as a significant correlate of thriving over time. Moreover, although scholars have demonstrated significant positive associations between early season need satisfaction and end-of-season functioning indicators (e.g., subjective vitality; see Balaguer et al., 2012, 2018), they are yet to examine the (direct or indirect) predictive effect on distal occurrences of functioning indices or thriving beyond the immediate event. It is pertinent to note that one mechanism for need satisfaction to impact future thriving may be via the prediction of future need satisfaction, with researchers having previously found positive, longitudinal relationships for basic psychological need satisfaction when examined across two timepoints either as a whole (e.g., Balaguer et al., 2018) or the basic needs separately (e.g., Reinboth & Duda, 2006). Establishing knowledge of the reliability and enduring nature of these predictive effects is likely to offer significant insight to researchers wishing to understand the theoretical mechanisms that underpin thriving, as well as to coaching, sport science, and medical staff seeking robust frameworks on which to develop interventions to promote their athletes’ well-being alongside performance.

Therefore, in view of the aforementioned importance of thriving in sport, coupled with the limited empirical research that exists on the enduring effect of thriving on subsequent thriving and the relationship between basic psychological needs and thriving, the aim for this study was to conduct the first longitudinal examination of thriving in sport.
addition, this study aimed to provide the first replication assessment for the predictive effects of basic psychological need satisfaction on thriving by looking at these effects on repeated occasions. The study aims are unpacked through the following research questions and are depicted via the regression paths displayed on Figure 1: (RQ1) Do previous levels of thriving predict subsequent thriving? (RQ2) Do consistent predictive effects exist for basic psychological need satisfaction on thriving over time? (RQ3) Do previous levels of basic psychological need satisfaction directly or indirectly predict subsequent thriving?

**Method**

**Temporality of Variables and Study Design**

Inherent in the aims and research questions of this study were several implicit assumptions regarding the temporality of the constructs (for a fuller discussion on temporality, see George & Jones, 2000), which guided the longitudinal study design. First, basic psychological need satisfaction and thriving were considered in state form whereby their experience was bracketed for a specific sporting encounter (cf. Brown, Arnold, Fletcher, et al., 2017). That is, it was assumed that each participant experienced a level of need satisfaction and thriving that discretely begun and ceased as the encounter started and finished, and that this experience could be captured by an overall ‘sporting encounter score’.

In so doing, we acknowledge that this ignored any momentary fluctuations that may have occurred within the encounter by aggregating them into a singular, post hoc response.

Second, when measured over a broader time frame (e.g., a month), we anticipated that the state-specific experiences of need satisfaction and thriving would be aggregated by participants to offer an overall perception of their experiences. We recognize that this aggregation may have been created evenly (i.e., each encounter perceived equally, and an average experience of those encounters reported) or unevenly (i.e., specific encounters within the timeframe given greater precedence than others). Third, we hypothesized that each
discrete experience of need satisfaction and thriving would have a predictive effect on future occurrences grounded in the belief that previous behavior is the best predictor of the present behavior on the same variable (Geiser, 2013); however, with little knowledge of the duration of these relationships, we designed our study to test the predictive effects between adjacent sporting encounters within the ‘regular season’. Furthermore, to examine the effect of the level of time aggregation on this relationship we included both monthly and situation-specific assessments.

Participants

Two hundred and sixty-eight sport performers (80 females) aged between 16 and 62 years ($M_{age} = 24.00$ years, $SD_{age} = 8.69$ years) participated in this study and represented a subset of those previously sampled in the cross-sectional work of Brown, Arnold, Standage, et al. (2017). The majority of participants (82.1%) were recruited from team sports (e.g., basketball, cricket, field hockey), but a variety of individual sports (e.g., archery, fencing, horse riding) were also represented. Participants’ average competitive sporting experience was 12.03 years ($SD = 7.44$). A range of competitive standards were identified with 2.2% of performers reporting currently competing at an intraclub level, 24.3% at a local level, 40.3% at a regional level, 27.2% at a national level, 4.9% at an international level, and 0.4% as a professional.

Procedures

All sport performers who previously took part in the work of Brown, Arnold, Standage, et al. (2017; T1) were contacted 10 days after study completion to enquire whether they would be willing to continue their involvement as a participant in a longitudinal study. Participants were informed about the nature of the extended project and of their ethical rights (e.g., confidentiality, anonymity, right to withdraw). Participation was voluntary, and consent was required from adult participants or from coaches or teachers in loco parentis for sport
performers under the age of 18 years. The study involved participants completing two further multi-section questionnaires (T2 and T3), which were available in both written and electronic formats. The additional questionnaires were designed to be distributed at 14-day intervals, as it was deemed likely that participants would have had subsequent sporting encounters within this timeframe. In the follow-up questionnaires, participants were asked to reflect on their experiences in a self-nominated sporting encounter within the two-week window; this was an important difference to the data collected at T1 wherein participants were asked to reflect on their general experiences in sporting encounters over the past month (see, Brown, Arnold, Standage, et al., 2017). Reminder emails were sent to participants seven and 14 days after the initial request, with the deadline for responses set as 21 days after the initial request; therefore, the maximum allowable time between questionnaires was 35 days. These additional days also afforded greater flexibility for participants who did not have a sporting encounter within the initial 14-day window. Participants were excluded from the study if they did not provide data for a minimum of two of the timepoints.

**Measures**

**Thriving.** To determine whether sport performers thrived in their encounters, assessments of their subjective performance and well-being were provided (cf. Brown, Arnold, Standage, et al., 2017). In accordance with existing work (e.g., Levy et al., 2011), subjective performance was determined via the participant reporting their satisfaction with their performance in their nominated sporting encounter (e.g., competition, match) on an 11-point scale (0 = *totally dissatisfied*, 10 = *totally satisfied*; cf. Pensgaard & Duda, 2003).

Positive affect was used as a marker of hedonic well-being (cf. Kahneman et al., 1999) and was assessed using the International Positive and Negative Affect Schedule Short Form (I-PANAS-SF; Thompson, 2007). Specifically, participants reported the regularity with which they experienced five emotional descriptors (e.g., inspired) during the encounter on a five-
Cronbach’s alpha values for the I-PANAS-SF ranged from 0.66 to 0.77. Subjective vitality was used as an indicator of eudaimonic well-being (cf. Ryan et al., 2008) and was assessed using a 4-item version of the Subjective Vitality Scale (SVS; Ryan & Frederick, 1997). Specifically, participants responded to items assessing their levels of aliveness and energy by judging the accuracy of the statements (e.g., I had energy and spirit) in relation to their experience in the encounter on a six-point scale (1 = not at all true, 6 = very true). Cronbach’s alpha values for the SVS ranged from 0.87 to 0.90 in the present study.

**Basic psychological need satisfaction.** Sport performers’ levels of basic psychological need satisfaction experienced in the nominated sporting encounter were assessed using The Basic Needs Satisfaction in Sport Scale (Ng et al., 2011). Specifically, performers responded to items measuring autonomy satisfaction (six items), competence satisfaction (five items), and relatedness satisfaction (five items) on a seven-point scale (1 = not at all true, 7 = very true). In the present study, Cronbach alpha scores ranged from 0.81 to 0.84 for the autonomy satisfaction scale, 0.88 to 0.92 for the competence satisfaction scale, and 0.80 to 0.87 for the relatedness scale.

**Data Analysis Plan**

Analyses were conducted using SPSS 25 (IBM, 2017) and Mplus 8.4 (Muthén & Muthén, 2019). All analyses in Mplus 8.4 were conducted using a maximum likelihood estimation with robust standard errors to account for any non-normality within the data and any missing values (Muthén & Muthén, 2015); Mplus syntax and outputs from all analyses can be viewed in the Electronic Supplementary Resources.

**Data screening and preliminary analysis.** The data set was initially screened for univariate outliers and missing values. Univariate outliers were determined using the minimum and maximum scores on the raw data items. Missing value analysis was used to
determine the proportion of missing data for each case in the data set at each timepoint and to establish if any missing data patterns existing. Cases considered to have large amounts of missing data (> 10%) were removed from the data set (cf. Hair et al., 2010). Cases with < 10% of missing data at each timepoint were retained with missing values either subsumed within the subsequently computation of subscales or, for the subjective performance single item, accounted for using the robust maximum likelihood estimation in MPlus. Item-level data were then averaged to create parcelled subscale scores for autonomy satisfaction, competence satisfaction, relatedness satisfaction, subjective vitality, and positive affect. The composite subscale scores were used to test for multivariate outliers using Mahalanobis distances with $p < .001$ (Tabachnick & Fidell, 2013).

Following data screening, preliminary analyses were conducted to ascertain whether age, gender, or competition level explained variance in the endogenous variables (i.e., basic psychological need satisfaction [BPNS] and thriving [THRIVE]) at each timepoint (i.e., T1, T2, or T3). For these analyses, average scores were computed for BPNS and THRIVE based on the subscale indicators (i.e., autonomy satisfaction, competence satisfaction, and relatedness satisfaction for BPNS; standardized values for subjective performance, subjective vitality, and positive affect for THRIVE). Correlations were used to determine the relationship with age, and ANOVAs were used to establish whether any significant differences existed on BPNS or THRIVE for gender and competition level. Given that some participants were nested within teams, preliminary analyses were also conducted to determine whether clustering effects existed. To gauge the potential impact from nesting, subscale-level intraclass correlation (ICC) values were computed. Disagreement exists on the level at which ICC values become noteworthy, with Muthén (1997) suggesting that when group sizes

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1 The distribution of participants across groups resulted in low covariance coverage and prevented the creation of group-based models using the GROUPING function in Mplus. As such, these analyses were conducted using ANOVAs in SPSS.
exceed 15 and findings yield ICC values of $\geq 0.10$, the multilevel structure of data should be used; but others (e.g., Julian, 2001) arguing that ICC values $< 0.10$ should not be ignored. Within these studies, variable effects have been found dependent on group size and group-to-member ratio, and it is therefore important that any ICC values are interpreted against the composition of the groups within the data set.

**Measurement model and longitudinal measurement invariance.** To calculate the descriptive statistics for, and correlations between, basic psychological need satisfaction and thriving, a measurement model was constructed using a configural longitudinal structure (see Electronic Supplementary Resources); that is, the model was constructed without any invariance constraints imposed over time (see, Marsh et al., 2016). Within the model, error covariances between matching indicators (e.g., subjective performance) across assessments were estimated freely because the same items were used and the sources of error were anticipated to be the same (Geiser, 2012). Several indices were used to assess the fit of the model to the data, including an absolute fit index (i.e., Standardized Root Mean square Residual, SRMR), incremental fit indices (i.e., Comparative Fit Index, CFI; Tucker-Lewis Index, TLI), and a parsimony correction index (i.e., Root Mean Square Error of Approximation, RMSEA). Much debate exists on the appropriate thresholds for evaluating goodness of fit on these indices (Gunnell et al., 2016), with longitudinal models commonly acknowledged to display poor fit against conventional criteria (Preacher, 2010; Preacher et al., 2008). As a result, acceptable values for models in the present study were considered to be close to or above .90 for CFI and TLI, and close to or below .08 for RMSEA (Little, 2013). With regards to SRMR, Little (2013) notes that guidelines for acceptable values are generally the same as for interpreting RMSEA (i.e., close to or below .08), but that “SRMR has not been well evaluated for longitudinal models in any systematic way” (p. 112). Thus, SRMR values were interpreted with caution in the present study.
The configural longitudinal structure was then used as a framework and baseline for testing longitudinal measurement invariance. Longitudinal measurement invariance is used to establish whether a construct is measured in the same metric across multiple occasions and is achieved when any changes in the observable variables are carried by changes in the factor scores (see, Grimm & Ram, 2009). In the present study, it was necessary to achieve scalar (or strong) invariance (i.e., invariance in factor loadings and item intercepts over time), as the purpose of the study was to compare latent means at different timepoints (see, Marsh et al., 2016). Invariance testing followed a nested approach whereby increasingly restrictive models were fitted to the data (Marsh et al., 2016). In the first step, the configural model was applied to the data with all parameters freely estimated. In the second model, a metric configuration was used with factor loadings held constant across assessments, and in the third model (i.e., the scalar configuration), factor loadings and intercepts were fixed to equality. CFI and RMSEA indices were used to determine measurement invariance. Invariance was indicated when changes of ≤ 0.010 were found for CFI (Cheung & Rensvold, 2002), and ≤ 0.015 for RMSEA (Chen, 2007) when comparing each pair of models (e.g., configural and metric).

**Longitudinal structural equation model.** To address our research questions (RQ1-3), a longitudinal structural equation model was constructed containing freely estimated autoregressive (i.e., prediction from previous measurement of the same variable), situation-specific (i.e., prediction from a variable measured at the same occasion), and cross-lagged (i.e., prediction from temporally preceding variables) paths (see Figure 1). To answer RQ1, first-order (e.g., THRIVE_T1 → THRIVE_T2) and second-order (i.e., between nonadjacent timepoints; e.g., THRIVE_T1 → THRIVE_T3) autoregressive paths were specified to examine whether previous levels of thriving predicted subsequent thriving. To answer RQ2, THRIVE variables were regressed on BPNS variables measured at the same timepoint (e.g., BPNS_T2 → THRIVE_T2) to measure situation-specific effects. To answer RQ3, first-order
(e.g., BPNS_T1 → THRIVE_T2) and second-order (e.g., BPNS_T1 → THRIVE_T3) cross-lagged paths were included to examine the direct effects of BPNS on future thriving. Indirect effects on THRIVE_T2 and THRIVE_T3 were also estimated to identify alternative pathways through which prior perceived levels of basic psychological need satisfaction or thriving influenced subsequent thriving. Lastly, to examine the consistency within these relationships and potential stationarity in the model (i.e., the extent to which parameter estimates are invariant over time), an alternative model was specified with the related autoregressive, situation-specific, and first-order cross-lagged paths constrained to be equal. Given the nested nature of the freely estimated (Model 1) and constrained (Model 2) models, model fit was compared via Δ CFI and Δ RMSEA with the more parsimonious model retained if the decrease in fit was < 0.01 for CFI and RMSEA increased by < 0.015 (Cheung & Rensvold, 2002; Chen, 2007). The direct and indirect effects in the best fitting model were interpreted using the unstandardized and standardized factor loadings, and statistical significance (p < .05 and confidence intervals that did not cross zero). The statistical significance of the indirect effects was also interpreted using bootstrap bias-corrected 95% confidence intervals from 10,000 bootstrap replacement samples (MacKinnon et al., 2004). To test the plausibility of the effect sizes for the direct paths derived from our design and analytical approach, we conducted post hoc power analysis using Monte Carlo studies against the threshold for desired power of 0.80 (Muthén & Asparouhov, 2002; Muthén & Muthén, 2015).

Results

Data Screening and Preliminary Analysis

Following data screening, 41 cases were removed from the data set for having more than 35 days between responses, three cases were removed for missing > 10% of data at a
timepoint\(^2\), and 11 multivariate outliers were excluded. Therefore, the sample size for the remaining analyses was 213. The average time between the first, second, and third data collection points were 21.32 days \((SD = 7.18)\) and 22.03 days \((SD = 8.11)\), respectively. Preliminary analyses showed that age was not significantly associated with BPNS or THRIVE at any time point \((ps > .41)\), and that no significant differences were found based on gender \((ps > .11)\) or competition level \((ps > .08)\). With regards to potential clustering effects, the present study had a high group-to-member ratio (37:1) with 88 groups and an average group size of 2.4 members. As such, although many ICC values were above the threshold of 0.10 proposed by Muthén (1997), the composition of groups in the data set meant a multi-level framework was not deemed appropriate for subsequent analyses.

**Measurement Model and Longitudinal Measurement Invariance**

Descriptive statistics including the means and standard deviations for, and correlations between, basic psychological need satisfaction and thriving were calculated from the measurement model and are shown in Table 1. The measurement model demonstrated good fit to the data \(\chi^2(102) = 149.722, p = .002; \ CFI = .965; \ TLI = .948; \ SRMR = .068; \) RMSEA [90% CI] = .047 [.030, .062], and the correlations between the latent constructs showed that all variables were related at each timepoint and over time (see Electronic Supplementary Resources). This configural longitudinal factor model was then used as a framework and baseline to test measurement invariance. As shown in Table 2, metric invariance was achieved when the factor loadings were fixed over time \((\Delta \text{CFI} = .001, \ \Delta \text{RMSEA} = .003)\); however, scalar invariance was not initially found \((\Delta \text{CFI} = .023, \ \Delta \text{RMSEA} = .012)\). Interpretation of the modification indices suggested that releasing the constraint on the intercept of T1 positive affect would achieve partial scalar invariance, which

\(^2\) Missing value analysis suggested that the three cases followed a common pattern of failing to complete part or all of the items on the final questionnaire page, which resulted in the large quantity of missing data. Comparison of the descriptive data for the three cases to the remaining data set revealed no differences, suggesting that these cases may have represented a random subset of the population.
was considered to be the only solution available (Bengt Muthén, personal communication, March 08, 2018). When this intercept was freely estimated, partial scalar invariance was achieved ($\Delta$CFI = .008, $\Delta$RMSEA = .004).

**Longitudinal Structural Equation Model**

The two longitudinal structural equation models were constructed using the partial scalar invariance framework to compare the fit of the freely estimated (Model 1) and constrained (Model 2) models to the data. Model 1 showed acceptable fit for the data ($\chi^2(120) = 180.248, p < .001; \text{CFI} = .956; \text{TLI} = .944; \text{SRMR} = .083; \text{RMSEA [90% CI]} = .049 [.033,.063]$). When compared to the fit of Model 2 ($\chi^2(125) = 181.716, p < .001; \text{CFI} = .959; \text{TLI} = .949; \text{SRMR} = .085; \text{RMSEA [90% CI]} = .046 [.030,.060]$), the changes in CFI and RMSEA did not indicate notable reductions in model fit when imposing the additional constraints.

This comparison therefore favored the more parsimonious Model 2 and indicated that stationarity existed in the model. The standardized factor loadings and statistical significance for the direct autoregressive, situation-specific, and cross-lagged paths for Model 2 are displayed in Figure 2; estimated power for each path can be viewed in Table 3. The paths show that first-order autoregressive paths exist for BPNS and for THRIVE, and that second-order autoregressive effects also exist for THRIVE (RQ1). Situation-specific effects were found with BPNS shown to be a consistent, significant predictor of THRIVE over time (RQ2). First-order and second-order cross-lagged paths between BPNS and THRIVE were not found to be positive and statistically significant (RQ3). However, previous experience of BPNS was found to have positive and statistically significant indirect effects on subsequent THRIVE (RQ3). Specifically, the (standardized) indirect effect of BPNS_T1 on THRIVE_T2 was 0.678 ($p < .001$) resulting from paths via BPNS_T2 ($0.486, p < .001$) and THRIVE_T1 (0.192, $p = .01$). BPNS_T1 was also found to have a positive and significant indirect effect on THRIVE_T3 ($0.498, p < .001$) resulting from paths via THRIVE_T1 (0.219, $p = .004$), the
BPNS first-order autoregressive path (0.292, \( p = .001 \)), BPNS_T2 and THRIVE_T2 (0.115, \( p = .02 \)), and THRIVE_T1 and THRIVE_T2 (0.045, \( p = .017 \)). BPNS_T2 had a positive and significant indirect effect on THRIVE_T3 (0.610, \( p < .001 \)) resulting from the paths via BPNS_T3 (0.437, \( p = 0.001 \)) and THRIVE_T2 (0.173, \( p = .016 \)). In contrast, while a positive and significant direct path existed between THRIVE_T1 on THRIVE_T3, the total indirect path for THRIVE_T1 via THRIVE_T2 was non-significant (0.066, \( p = .215 \)). These effects were verified using the bias-corrected bootstrap 95% confidence intervals; these results, along with the full results from Model 2, are available in the Electronic Supplementary Resources.

Discussion

The aim of this study was to conduct the first longitudinal examination of thriving in sport and, in so doing, provide novel insight into the enduring effect of thriving and the role played by basic psychological need satisfaction. The results from the longitudinal structural equation model showed thriving to be highly predicted by both the experience of recent thriving and the satisfaction of the basic psychological needs for autonomy, competence, and relatedness. More specifically, and in response to RQ1, experiencing thriving was found to positively predict future thriving in sporting encounters up to 28 days after its occurrence.

With regards to RQ2, stationarity was found within the model, suggesting that basic psychological need satisfaction had a consistent, facilitative effect on thriving when measured on repeated occasions. Furthermore, and in addressing RQ3, significant indirect effects were found for predicting thriving from the experience of basic psychological need satisfaction in a previous encounter; yet no direct effects were observed. Additionally, and in-keeping with the tenet that the basic psychological needs are universal and invariant across groups (Ryan & Deci, 2017), no effects were found based on age, gender, or competitive level suggesting that the findings are consistent across these groups. The findings from the main analyses are
discussed in turn, in the following paragraphs.

With growing interest in the experience of thriving in sport, scholars have begun to speculate on the lasting effect of thriving for future functioning with both positive and negative outcomes proposed (see, Brown et al., 2018). The results of the present study provide original and robust evidence for a positive predictive effect, with statistically significant direct paths found between thriving levels measured on adjacent (e.g., timepoint one and timepoint two) and nonadjacent (i.e., timepoint one and timepoint three) timepoints.

The fortnightly spacing between measurements allowed for experiences in sequential encounters to be collected, supporting the notion that the experience of thriving in one encounter (e.g., match, competition) may act as an enabler or springboard for thriving in the next (Brown et al., 2018). Beyond these neighboring encounters, it is also particularly interesting to note that levels of thriving reported over the preceding month (as measured at timepoint one) had a predictive effect on levels of thriving up to 28 days after that measurement (i.e., at timepoint three). Curiously, this effect occurred directly, rather than via an intermediary experience of thriving, suggesting that this effect occurred independent of the second encounter and any transient changes that it may have had. A possible explanation for this finding may reside in the level of generality used at timepoint one (i.e., aggregated experiences over the past month), as this may have captured a broader, enduring experience of thriving (see, e.g., Brown, Arnold, Fletcher, et al., 2017) which provided a more substantive effect than an experience in a specific, one-off encounter. Indeed, tentative support for this interpretation is offered by the greater magnitude of predictive effects found from thriving at timepoint one compared to thriving at timepoint two. This interpretation does, however, rely on the assumption that participants experienced stable levels of functioning across sporting encounters over the month when, in reality, they may have perceived an overall, general experience of thriving, but subsumed within that perception.
were a mixture of thriving and non-thriving experiences. To test this assumption in future work, researchers are encouraged to utilize multilevel or latent growth curve modeling frameworks to examine the within-person changes in thriving over time (see, Stenling, Ivarsson & Lindwall, 2017). Returning to the present findings, these results afford athletes, coaches, and practitioners the knowledge that if they can successfully create social contexts that promote thriving on one occasion (see, Brown et al., 2021), then it can have lasting effects on future thriving.

The second research question sought to better understand the relationship between basic psychological need satisfaction and thriving and, specifically, whether the predictive relationship previously identified within the literature (see, Brown, Arnold, Standage, et al., 2017; Brown, Arnold, et al., 2020; see also, Ryan & Deci, 2017) was replicated over time. Commensurate with existing work, a positive, predictive effect was repeatedly found between the extent to which performers experienced satisfaction of autonomy, competence, and relatedness and their reported levels of thriving. Furthermore, stationarity was supported within the model suggesting that this predictive effect was consistent over time. Although stationarity effects have not previously been examined in relation to thriving, research has considered the temporal and longitudinal associations of basic psychological need satisfaction with subjective vitality, positive affect, and performance separately. For example, and via a four-week diary study, Gagné et al. (2003) demonstrated that increases in basic psychological need satisfaction experienced during a training season predicted pre- to post-practice levels of subjective vitality and positive affect. Similarly, Cheval et al. (2017) showed that within-person variations in autonomy and competence satisfaction were associated with within-person changes in subjective vitality, and Verner-Filion and Vallerand (2018) found that satisfaction of each of the three needs was positively associated with within-person changes in positive affect over time. To date, no studies have considered the association of basic
psychological need satisfaction with subjective performance over time; however, where studies do exist for alternative performance measures (e.g., Sheldon et al., 2013; Verner-Filion & Vallerand, 2018), no direct associations have been found between players’ fluctuating levels of psychological need satisfaction and objective performance (e.g., basketball shot percentage, coach assessed performance). Notwithstanding the lack of direct effects, it is interesting to note that Verner-Filion, and Vallerand (2018) did find indirect effects for within-person changes in competence satisfaction on within-personal changes in performance via concurrent changes in the quality of preparation. Taken collectively, these replicated findings position basic psychological need satisfaction as a reliable and highly important precursor to indices of thriving; thereby offering coaches and practitioners a systematic framework through which they can positively impact the occurrence of thriving in the athletes they work with. To this end, being able to map the qualities and nature of the inputs and environments that are supportive of autonomy, competence, and relatedness holds particular importance to sport practitioners (cf. Standage & Ryan, 2020).

As an adjunct to the second research question, in research question three we also addressed whether experiencing basic psychological need satisfaction in a prior sporting encounter had a predictive effect of future levels of thriving. In agreement with previous literature (see, e.g., Balaguer et al., 2012, 2018), significant positive associations were found between levels of basic psychological need satisfaction reported at one timepoint and levels of thriving experienced in subsequent encounters (see Table 1). However, when examining the direct predictive effects via the cross-lagged paths between adjacent and nonadjacent timepoints, no significant effects were found and the direction of the relationship between prior need satisfaction and subsequent thriving shifted from a positive correlation to a negative regression path. These results may be indicative of a suppressor situation (cf. Cohen & Cohen, 1975) and infer a scenario where the suppressor variable (in this instance,
BPNS_T1 or BPNS_T2) correlates with the dependent variable (i.e., THRIVE_T2 or THRIVE_T3) and shares some relevant information in common with it, but that this level of shared relevant information is exceeded by the level of (dependent variable) irrelevant information shared between the suppressor variable and the other explanatory variables (see, for a description of negative suppression, Maassen & Bakker, 2001). The interpretation of this finding is that prior need satisfaction does not directly predict future thriving when modeled alongside prior levels of thriving (i.e., existence of autoregressive effects) and situation-specific variables (i.e., need satisfaction measured at the same timepoint as thriving); however, it does not mean that need satisfaction has a negative effect on future thriving or that it should be discarded if examined in isolation to the other variables. Indeed, significant indirect effects were found for levels of basic psychological need satisfaction over the past month (as measured at timepoint one) and in a specific, previous encounter (as measured at timepoint two) on future thriving, suggesting that general or one-off experiences can have an indirect effect on future match experiences. Thus, while the present findings do not demonstrate a direct effect, they do provide novel evidence that establishing a sports environment wherein athletes perceive their psychological needs to be satisfied will not only have a positive effect on their future motivational experiences, but it will also likely have subsequent enhancing effects on thriving up to 28 days later.

Notwithstanding these original findings, it is prudent to identify the study limitations and areas for future research. First, it should be noted that some participants’ level of sporting representation altered during the study as individuals moved between teams (e.g., junior to senior; club to regional), but that it was not possible to conduct analysis on such changes as a result of their idiosyncratic nature. As participants were required to provide subjective judgments of performance and well-being, it was anticipated that they would alter their expectations at each given competitive level and thus offer equitable assessments of
thriving. That said, it may be of interest for future researchers to investigate whether thriving at one competitive level can facilitate subsequent thriving at a higher or lower level. Second, given the multi-sport sample recruited in the present study, and the variability inherent in assessing the outcome of a match/competition across different sports (e.g., win-draw-loss in netball vs. ranking in swimming) and in interpreting the significance of the outcome (e.g., the size of worthwhile effects; Standage, 2012), we did not deem it appropriate to include information pertaining to match outcome in our analyses. However, we acknowledge that this may present as a limitation of our study as match/competition outcome as well as perceived success (McAuley & Tammen, 1989) may have provided a source of variance in need satisfaction and thriving, particularly with the participants completing their measures after their self-nominated sporting encounter. Third, by centering the analyses on the factors considered most proximal to the occurrence of thriving (i.e., previous levels of thriving, basic psychological need satisfaction), this study has not examined the social and environmental factors that may enable this process (e.g., psychologically safe environment, social support, coach need supportive behaviors). Although a large body of research exists on how autonomy, competence, and relatedness can be promoted in sport settings (see, for a review, Standage & Ryan, 2020), further examining the context in which performers are operating in future work would provide a more complete account of the thriving process.

Fourth, the test of longitudinal measurement invariance returned only partial-scalar invariance with the intercept of T1 positive affect needing to be freely estimated. It is possible that this resulted from measurement error occurring because of the different instructional sets used between the first and subsequent timepoints with participants asked to reflect on a more global level of generality at timepoint one compared to timepoints two and three. Fifth, this study used a variable-based approach to analyze the predictive effects within the sample. This approach is limited in so much as it means we were not able to partial out...
within-person processes from between-person differences, potentially resulting in erroneous conclusions about the lagged parameters if either basic psychological need satisfaction or thriving exhibited trait-like, time-invariant characteristics (see, Hamaker et al., 2015).

Although we attempted to test for these effects using a random-intercepts cross-lagged panel model (Hamaker et al., 2015; Hamaker, 2018a, b), this model failed to converge; therefore, the results from this analysis are not reported. Lastly, post hoc power calculations suggest that the analyses may have lacked statistical power for the autoregressive and cross-lagged paths based on the sample size, study design, and analytical approach, which may have resulted in null hypotheses being incorrectly accepted for some parameters. To inform sample size calculations and improve power in future studies, researchers are encouraged to draw on the parameter estimates and missing data patterns found herein, along with those from the emerging literature on thriving in sport (e.g., Brown, Arnold, Standage, et al., 2017; Brown, Arnold, et al., 2020).

To conclude, this study represents the first longitudinal examination of thriving in sport. In so doing, it provides original insight into the positive, predictive effects of previous levels of thriving on subsequent thriving experiences, and of the consistent role played by basic psychological need satisfaction on the occurrence of thriving over time. These findings highlight basic psychological needs as an important means through which coaches and practitioners can initiate thriving in the athletes they work with and, uniquely, how this experience can be sustained across a series of sporting encounters (e.g., run of fixtures, rounds within a competition).

Electronic Supplementary Resources

Electronic supplementary resources can be accessed here:

https://osf.io/h6uvj/?view_only=0b88f478ef544b3ba55fb5a781867875
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Table 1

Descriptive Statistics and Correlations Between Basic Psychological Need Satisfaction and Thriving

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
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<tbody>
<tr>
<td>1. BPNS_T1</td>
<td>—</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. BPNS_T2</td>
<td>.68***</td>
<td>—</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. BPNS_T3</td>
<td>.37**</td>
<td>.50***</td>
<td>—</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. THRIVE_T1</td>
<td>.66***</td>
<td>.47***</td>
<td>.31***</td>
<td>—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. THRIVE_T2</td>
<td>.52***</td>
<td>.75***</td>
<td>.56***</td>
<td>.49***</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>6. THRIVE_T3</td>
<td>.39***</td>
<td>.41***</td>
<td>.79***</td>
<td>.50***</td>
<td>.60***</td>
<td>—</td>
</tr>
<tr>
<td>Mean</td>
<td>5.86</td>
<td>5.85</td>
<td>5.78</td>
<td>6.61</td>
<td>6.88</td>
<td>6.41</td>
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<tr>
<td>S.D.</td>
<td>0.57</td>
<td>0.57</td>
<td>0.70</td>
<td>1.08</td>
<td>1.15</td>
<td>1.30</td>
</tr>
</tbody>
</table>

Note. Values computed from measurement model. Mean, standard deviation, and correlation values are model estimates. BPNS = basic psychological need satisfaction; THRIVE = thriving.

**p < .01. ***p < .001.
Table 2

**Results of the Longitudinal Measurement Invariance Tests**

<table>
<thead>
<tr>
<th>Model</th>
<th>N</th>
<th>$\chi^2$ ($df$)</th>
<th>TLI</th>
<th>CFI</th>
<th>ΔCFI</th>
<th>RMSEA</th>
<th>Δ RMSEA</th>
<th>RMSEA 90%CI</th>
</tr>
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<tbody>
<tr>
<td>Configural</td>
<td>213</td>
<td>149.722**</td>
<td>0.948</td>
<td>0.965</td>
<td>—</td>
<td>0.047</td>
<td>—</td>
<td>[0.030, 0.062]</td>
</tr>
<tr>
<td>Metric</td>
<td>213</td>
<td>156.100***</td>
<td>0.953</td>
<td>0.966</td>
<td>0.001</td>
<td>0.044</td>
<td>0.003</td>
<td>[0.027, 0.060]</td>
</tr>
<tr>
<td>Scalar</td>
<td>213</td>
<td>196.372****</td>
<td>0.926</td>
<td>0.943</td>
<td>0.023</td>
<td>0.056</td>
<td>0.012</td>
<td>[0.042, 0.069]</td>
</tr>
<tr>
<td>Partial-scalar</td>
<td>213</td>
<td>174.957****</td>
<td>0.945</td>
<td>0.958</td>
<td>0.008</td>
<td>0.048</td>
<td>0.004</td>
<td>[0.033, 0.063]</td>
</tr>
</tbody>
</table>

*Note.* Configural (all parameters freely estimated); Metric (factor loadings constrained to equality); Scalar (factor loadings and intercepts constrained to equality); Partial-scalar (factor loadings and intercepts constrained to equality, but with one intercept freely estimated); $\chi^2$ ($df$) = $\chi$-square and degrees of freedom; TLI = Tucker-Lewis Index; CFI = Comparative Fit Index; RMSEA = Root Mean Square Error of Approximation; CI = confidence interval.

**p < .01 ***p < 0.001
Table 3

*Post Hoc Power Results*

<table>
<thead>
<tr>
<th>Path</th>
<th>Power (% Sig Coeff)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TH1 → TH2</td>
<td>0.576</td>
</tr>
<tr>
<td>TH2 → TH3</td>
<td>0.224</td>
</tr>
<tr>
<td>TH1 → TH3</td>
<td>0.518</td>
</tr>
<tr>
<td>NS1 → TH1</td>
<td>1.000</td>
</tr>
<tr>
<td>NS2 → TH2</td>
<td>1.000</td>
</tr>
<tr>
<td>NS3 → TH3</td>
<td>1.000</td>
</tr>
<tr>
<td>NS1 → TH2</td>
<td>0.226</td>
</tr>
<tr>
<td>NS2 → TH3</td>
<td>0.134</td>
</tr>
<tr>
<td>NS1 → TH3</td>
<td>0.066</td>
</tr>
<tr>
<td>NS1 → NS2</td>
<td>1.000</td>
</tr>
<tr>
<td>NS2 → NS3</td>
<td>0.998</td>
</tr>
<tr>
<td>NS1 → NS3</td>
<td>0.066</td>
</tr>
</tbody>
</table>

*Note.* Sample size = 213, with the proportion of missing data set at 47% for timepoint 3 to reflect approximate attrition in responses. Power calculated using parameter values from Model 2 taken to represent population values.
Figure Captions

Figure 1. Longitudinal structural equation model displaying the autoregressive paths between repeated measures of the same variable, situation-specific paths between basic psychological need satisfaction (BPNS) and thriving (THRIVE) on the three occasions (T1, T2, and T3), and the cross-lagged paths between temporally preceding variables. In addition to these direct paths, an illustrative indirect path is depicted by the letters \(a\) and \(b\).

Figure 2. Model 2 (Stationarity). BPNS = basic psychological need satisfaction, THRIVE = thriving. All direct path coefficients are standardized. **\(p < .01\), ***\(p < .001\).