

# Development and validation of the performance environment of practice scale

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## ABSTRACT

The performance climate is affected by time, situation, and case, which requires frequent measurement within practice environments where athletes spend most of their time. This study aimed to develop and validate the Performance Environment of Practice Scale (PEPS). Three waves of data collection and analysis were conducted: content validity ( $n = 30$ ), exploratory factor analysis ( $n = 389$ ), and confirmatory factor analysis ( $n = 198$ ). The scale development process provided initial evidence for the face validity and internal reliability of the 7-factor 26-item PEPS for use with athletes in a competitive practice environment. The PEPS provides a performance environment measure that carries lower response burden than previous measurement attempts. The PEPS can be used by coaches at regular intervals to measure the psychological performance climate of their practice environment. Further evaluation of the test-retest reliability and predictive validity of the PEPS is required, along with accuracy assessments against coach performance perceptions and the gathering of normative data.

**Keywords:** Physical activity psychology, Scale development, Validation, Psychological climate, Psychology, Sport.

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## INTRODUCTION

Psychological climate is produced from individuals' perceptions of the environment in which they conduct tasks to meet outcomes (James & Sells, 2013). Perceptions are created by emotionally laden judgements (Lazarus, 1991) where an individual appraises a situation as either beneficial or harmful towards their goals (Pensgaard & Duda, 2002). The array of influencing factors that contribute towards psychological climate can be isolated and quantified (Durand-Bush & Salmela, 2002). The emotions experienced from situational appraisals have been found to provide a lasting impact on an individual and their behaviour (Roseman & Smith, 2001). First studied within industrial and organizational domains, psychological climate is recognized as a moderator variable between the structures and processes of an organization and employee outputs, making psychological climate a primary cause of job satisfaction and job performance (Furnham, 2012).

Psychological climate in the sporting domain has received considerable research attention (Arnold & Fletcher, 2012) because athletes operate within highly complex social and organizational environments that exert major influences on task performance (Hardy et al., 1996). As such, psychological climate in sport, which is based on the criteria of success and failure against contextually rich goals, can offer a measure of performance (Buch et al., 2017). Due to the performance focus, psychological climate research in sport (e.g., Douglas & Carless, 2006) has used the term performance environment, which will be used henceforth in this paper.

To better understand athletic performance environments, previous research has predominantly focused on competition. However, athletes spend most of their time within environments for practice, meaning the practice domain has an influence on competitive performance (Durand-Bush & Salmela, 2002; Ericsson, 2020; Macnamara et al., 2014). Deliberate practice activities have the goal of improving performance, are effortful and attention-demanding, are not necessarily enjoyable, and do not lead to immediate social or financial rewards (Ericsson et al., 1993). Deliberate practice has been suggested to have a linear relationship with the learning of sport-specific skills, physical fitness, and team strategies (Baker et al., 2003), which positions the psychological influencing factors of the practice environment as key components in athlete development and performance. Also, on-going long-term emotional exposure sustained through extensive practice activities has been found to influence performance (Baumeister, Vohs, DeWall, & Zhang, 2007), evidenced through coach-athlete conflict occurring far more often during practice than competition (Wachsmuth et al., 2018), which further strengthens the argument that practice can influence athletic performance.

Competition-dominant performance environment measures include those undertaken by Pain and Harwood (2007, 2008) who identified the psychological influencing factors within competitive soccer and developed the Performance Environment Survey (PES); a conceptually based instrument that captures information about physical, psychological, coaching, social, organizational, and environmental domains that influence team performance and preparation within a competitive environment. Pain et al. (2012) used the PES to measure the performance environment within a soccer team during a competitive season, which provided coaching staff with data to enhance performance outcomes. However, the 66-item PES (see Pain & Harwood, 2008) is focused only on perceptions within competitive environments (i.e., match day) and provides a response burden that can impact its functionality within a sport context (Rolstad et al., 2011). Despite the need to provide psychological measures that satisfy quality criteria, Horvath and R othlin (2018) suggest there is a greater need for measurement tools to be shorter in sport performance settings to increase usability and accuracy.

The performance environment has also been studied more holistically within sporting organizations (Wagstaff, 2019). The High Performance Environment (HPE) model was theoretically constructed by Jones et al. (2009) to identify the optimal psychological climate of elite sporting groups. The model comprised of four factors to identify high performance, which included an organizational climate factor. Fletcher and Streeter (2016) applied the HPE model to an elite high performing swimming environment and reported the model to be capable of aiding practitioners in creating optimized performance environments for elite athletes. However, no further development of an HPE measurement tool has been conducted, which is most likely due to the complexity, volume and ever-evolving factors found within an entire organization. Therefore, measures of isolated performance environment domains, such as practice, would provide data that are more manageable and workable for real-world application (Arnold & Fletcher, 2012).

To better understand the psychological influences within the practice environment, motivational climate has been a focus of study for many decades (Lacerda et al., 2021). Motivational climate is the psychological environment that encompasses both competition and practice, which is created by coaches, peers and parents through situational factors that develop motivation based upon task/mastery and ego orientations (Harwood & Thrower, 2020; Smith et al., 2008). Based on Achievement Goal Theory (Nicholls, 1984), several measures of motivational climate have been developed to evaluate motivation towards the goals set within the environment (Lacerda et al., 2021). However, the performance environment of practice is impacted by affective facets that exist outside of the direct activities undertaken within competition and practice. For example, influencing factors include preparatory lifestyle behaviours, such as following recovery protocols between practice sessions (Smith et al., 2019), and appraisals being conducted on non-performance directed goals (i.e., threat from not conforming to the social identity of the group) (Smith et al., 2007). The psychological influencing factors between different domains (i.e., practice and competition) have also been found to differ (Fletcher et al., 2012). Therefore, motivational climate measures have limited capability to measure the performance environment of practice and further exploration of a valid domain-specific measure is required.

Smith et al. (2019) undertook the first known examination of the practice performance environment and reported differences against previously stated influencing factors from other sport domains (i.e., competition). For example, ability evaluations were made against teammates during practice that produced internalized ranking positions, which underpinned expectations about an athlete's own performance. Previous research by Mellalieu et al. (2009) identified internal and external performance expectations as providing competitive stress (negative) on athletes, but Smith et al. (2019) revealed a far more complex situation to exist in practice where contextual differences interacted with performance expectations to produce both positive and negative perceptions.

Further evaluation of the practice performance environment by Smith et al. (2020a; 2020b) explored the influencing factors cited by multiple stakeholders within the environment (e.g., players and coaches) and produced the Practice Environment Model (PEM). The PEM illustrates the cyclical (e.g., preparatory activity for the next session starts immediately after the last) and interrelatedness of the influencing factors in the practice environment (Smith et al., 2020b) and highlights the holistic nature of perception and influence. For example, influencing factors within the practice environment may be latent or without clear effect at the time of initial perception (e.g., negative emotions that provide resilience leading to positive performance) (Brown et al., 2015). Whereas measures of motivation climate, such as the perceived motivational climate in sport questionnaire-2 (PMCSQ-2) (Newton et al., 2000), provide a scale based on present situational perceptions focused solely upon task execution and does not consider the repetitive nature of practice due to its dual (competition and practice) focus.

A season long implementation of the PEM using an educational strategy with a national standard basketball team was conducted by Smith et al. (2021). The strategy was based on key influencing factors from the PEM that included high effort as a primary goal, pre-practice performance reflections, supportive communication, working towards shared team goals, enhanced practice preparation, and the understanding of what can be controlled within the environment. Findings provided evidence of enhanced performance following the educational strategy and highlighted the level of perceived control, expected performance, support behaviour, team-focused goals, internalized ability ranking against others within the group and practice preparation as key influencing factors of the psychological climate of practice. As the framework of factors provided by Smith and colleagues can be manipulated to enhance performance (Smith et al., 2021), the development of a valid and reliable measure of the performance environment of practice will aid those who create and maintain practice environments (i.e., coaches) to both evaluate and enhance athlete performance. To address the issue of not having a valid measure of the performance environment of practice, this study provided an initial validation of the Performance Environment of Practice Scale (PEPS).

### **Construction and scale development**

The development of the PEPS was guided by MacKenzie et al. (2011) scale development framework. This paper details stages one to eight whereby the process of scale development (including defining the overarching construct, developing items, and specifying the measurement model) and scale validation (including content validity and factorial analysis) were undertaken.

Content validity is defined as ‘the extent to which a specific set of items reflects a content domain’ (DeVellis & Thorpe, 2022, p. 71) and was a central consideration throughout the development of the scale. Relevant literature was consulted to determine aspects that would construct the scale (Lamm et al., 2020). The performance environment of practice was theoretically underpinned by the practice environment research (Smith et al., 2019; 2020a; 2020b; 2021), which contained the key aspects and attributes of the construct (MacKenzie et al., 2011). Motivational climate and performance (competition-based) environment research that was referred to in the previous practice environment research, where psychological factors existed within the practice environment, were also reviewed (e.g., practice strategies grouped with competition (Harwood et al., 2015) and the requirement for practice activity between competitive play (Pain & Harwood, 2008)). However, no further aspects of the construct were identified outside of the contemporary practice environment research due to the specificity of the psychological influencing factors of practice. The first named author compiled a list of influencing factors that existed within the practice environment. All identified factors had a clear relationship with performance. To enhance robustness of scale construction and content validity by providing multiple sources, the second named author, who was an academic subject expert, acted as a critical friend to support the creation of initial items from the relevant influencing factors identified (Lamm et al., 2020).

In line with recommendations from MacKenzie et al. (2011), a detailed conception of the target construct was created that included specifying the phenomena to which the construct refers and the referents to which the construct applies. The performance environment of practice was defined as an athlete’s perceptions of the psychological factors influencing performance in the sport practice environment. The construct is a representation of the emotional appraisals that identify both positive (beneficial) and negative (harmful) influences on performance (Lazarus & Folkman, 1984; Roseman & Smith, 2001) and are generated from both internal (self) and external (social) sources. The construct can be affected by time, situation, and case (Neil et al., 2007).

Following the review of previous practice environment literature, the authors identified seven reflective sub-

dimensions that captured the essential aspects of the construct. A definition of each sub-dimension can be seen in Table 1, and sub-dimension descriptions can be found in Appendix 1. Items were developed using procedures set out by Boateng et al. (2018) and MacKenzie et al. (2011), which included items being inductively developed using existing literature and deductively developed by two researchers until the saturation of ideas. Specifically, items had to start with the stem “*Within my Practice Environment I...*”, could not be double-barrelled and the critical friend had to agree that the item reflected its sub-dimension definition. A large volume of items were developed due to the expected extraction of items throughout the scale development process (Raykov & Marcoulides, 2011). An initial 89 item pool was created and organized into the seven sub-dimensions of control (9 items), expected performance (11 items), supportive behaviour (12 items), team-focused goals (14 items), ability ranking (22 items), preparation (11 items), and challenge (10 items).

Table 1. Definition of sub-dimensions.

Sub-Dimension	Definition
Control	The elements of practice performance that athletes attempt to directly influence through their own actions
Expected Performance	The impact of practice goals that define actions towards the outcome of performance
Support Behaviour	The assistance received from others within the practice environment to meet performance outcomes
Team-focused Goals	The extent that performance goals are adopted by all individuals within the practice environment
Ability Ranking	The self-creation of a hierarchy based on performance skills between oneself and teammates
Preparation	The lifestyle behaviours undertaken before entering the practice environment
Challenge	The activities of practice that build resilience from failure through reflective performance behaviours

The decision-making rules for formally specifying the measurement model proposed by Jarvis et al. (2003) were used to specify the model as reflective. Therefore, the model was suitable for factor analysis, which satisfied stage four of MacKenzie and colleagues (2011) scale development framework.

## METHOD AND RESULTS

Following MacKenzie et al. (2011) stages one to eight, there were three waves of data collection reflecting assessment of content validity, and both exploratory and confirmatory factor analysis. Data were collected over a six-month period where each wave of data collection was analysed before the next wave was collected. This ensured that data collection/analysis informed the next wave of data collection/analysis. Institutional ethical approval was gained from the lead researcher's university ethics board. Data were analysed using the protocol outlined by MacKenzie et al. (2011).

### WAVE ONE

#### *Participants*

The first wave of data collection was used to assess the developed items for content validity ( $n = 30$ ). The sample (19 males, 11 females, mean age 21.27 years  $\pm$  1.31) were considered expert judges of content validity as they were the main population of interest for the scale whereby the sample met the following

inclusion criteria: (a) involved in a team sport practice environment for at least two years; (b) in a practice environment focused on performance development; (c) competing in governed leagues or tournaments; (d) undertaking deliberate practice activities regularly for a sustained period, such as an entire competitive season; (e) 16 years or over and possess sufficient intellectual ability to rate items against definitions of construct domains.

### **Protocol**

For the first wave of data collection, potential participants were emailed an information sheet and consent form and given the opportunity to ask questions. To recruit participants, the research team promoted the study to sports teams and clubs that held an association, through staff, students, and professional activities, to the United Kingdom university through which the study was being undertaken. If participants met the recruitment criteria and were interested in partaking, they replied to the researcher with a signed consent form. Recommendations from MacKenzie et al. (2011) guided the assessment of content validity. Each participant was given a paper item rating sheet that contained a matrix with eight columns (see Appendix 2 for the task instructions and first two pages of the form). The first column and subsequent rows randomly listed the 89 items initially developed for the PEPS. A definition of each of the seven sub-dimensions headed columns two to eight (see Table 1). Three randomized versions of the item rating sheet were created to control for response-order effect (Mackinnon & Wang, 2020). Each participant was asked to familiarize themselves with the sub-dimension definitions. Participants were then asked to read each item and rate the appropriateness against all the sub-dimensions on a 5-point Likert scale ranging from 1 (*not at all*) to 5 (*completely*). Due to the item rating sheet being 10 pages long with 89 items to individually rate, participants were encouraged to take regular breaks and reassured they could have up to two weeks to complete the task.

### **Data analysis**

SPSS statistics (version 28; IBM, Armonk, NY) was used to analyse wave one data. First, data were assessed for normality via a Shapiro-Wilk test. Once normality assumptions were satisfied, a repeated measures analysis of variance (ANOVA) per item to determine whether items significantly captured their sub-dimension definition was computed. Pairwise comparisons, which indicate an item's mean rating against all sub-dimensions, were consulted to see if a significant difference was found. Items that were not significantly rated with their sub-dimension definition were removed. Significance was defined by an alpha level of .05.

### **Results**

The normality assumptions were met, as assessed by Shapiro-Wilk ( $p > .05$ ) and there were no missing data. Fifty-eight items were significantly rated by the sample to represent their intended sub-dimension's definition ( $p$ 's  $< .05$ ) and were subsequently retained for wave two analysis (i.e., exploratory factor analysis [EFA]). Items that were not rated as significantly representing their intended sub-dimension were removed ( $n = 31$ ).

## **WAVE TWO**

### **Participants**

The second wave of data were collected from 389 participants (227 males, 161 females, 1 preferred not to state gender, mean age 19.98 years  $\pm$  5.32), and all participants met the same criteria stated in wave one above.

### **Protocol**

Data for wave two were collected using Jisc online survey and distributed to sports clubs, teams, and educational organizations that were associated to the university. Participant information, recruitment criteria and demographic data collection were on the first page of the survey with a required checkbox to confirm consent. Items were randomized using an online random generator before uploading them onto the survey platform. Participants were asked to rate each item based on their current perceptions of their practice environment on a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). All responses were anonymous.

### **Data analysis**

An EFA was carried out to examine the psychometric properties of the scale. Data were analysed using SPSS statistics (version 28; IBM, Armonk, NY), the R package psych (version 2.5.6) of R software (version 4.4.3), and R Studio (version 2024.04.2). Data were assessed for univariate outliers (z-scores > 3.29) and multivariate outliers, via calculation of Mahalanobis distances and comparison to a  $\chi^2$  distribution ( $df = 23$ ,  $p < .001$ ). Nineteen cases were identified with potential outliers. These cases were checked for data entry errors and any 'suspicious' patterns of responding (e.g. selecting all 1s). No such issues were identified. Based on this, all responses were retained as valid. To understand the influence of these potential outliers, an EFA was computed with and without outliers. The results yielded a similar factor structure in both cases, with one additional factor when outliers were excluded. This additional factor comprised of three items relating to "preparation." However, when the analysis was run with outliers included there was still the "preparation" factor evident, and the authors were satisfied that the solution adequately represented the underlying theory of practice performance environment. Consequently, as both versions of the analysis resulted in similar solutions, and because the intention was for respondents to use the full range of values on the 7-point Likert scales, a decision was made to retain the analysis with all cases included, including extreme responses, and this analysis is reported in full next.

Given the ordinal nature of the data, polychoric correlations were computed to assess underlying sub-dimensions. Although observed ordered categorical responses are often treated as continuous variables with multivariate normality, enabling the use of maximum likelihood (ML) method (Muthén & Kaplan, 1985), the complexity of the ordinal items and the models under examination led to using oblique EFA on the polychoric correlations among the latent variables. Hence, the EFA was run using an oblique technique with promax rotation, allowing for intercorrelated factors as opposed to the orthogonal rotation (Fabrigar et al., 1999). In factor analysis, principal axis factoring was employed based on the assumptions that the underlying factors remain interrelated.

Furthermore, with no missing data, multiple criteria were used to identify the most appropriate factor solution for the PEPS (Table 2; Pett et al., 2003; Harrington, 2009; Comrey & Lee, 2013; Tabachnick & Fidell, 2014). First, eigenvalues were looked at, along with the scree plot, to identify where the eigenvalues start to level off. Eigenvalues greater than 1.0 were used as the benchmark for factor retention (Kaiser, 1974). Data were checked for suitability of factor analysis by inspection of Kaiser Meyer Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity (Carpenter, 2018). A parallel analysis was also conducted to retain the number of factors, and ordinal alpha values (Zumbo et al., 2007) were checked for all factors to assess internal consistency. Finally, the cutoff for factor loadings was set to .40 or above on a single factor (Nunnally & Bernstein, 1994).

Table 2. Item extraction method.

Stage	Criteria for item removal
1	Correlation coefficient is >0.8
2	Mis-loading
3	Cross-loading occurs over >2 factors
4	Cross-loadings over 2 factors: remove items with higher cross-loadings first
5	Items with singular loadings $\leq .4$

### Results

Using the wave two data set, an EFA was conducted to investigate the factor structure. The Kaiser-Meyer-Olkin measure of sampling adequacy was .80, exceeding the cut-off value of .70, and the Bartlett's test of sphericity was statistically significant ( $\chi^2 [253] = 4375.73, p < .001$ , indicating that the data were suitable for factor analysis (Kaiser, 1974). Based on low scores ( $\lambda < 0.2$ ), the items from the subdimensions *Expected Performance* and *Control* were removed, along with 25 items that were misloaded (an item loading onto a factor that it was not theorized to) or cross-loaded (an item loading onto more than one factor). Furthermore, the Ability Ranking subscale was split into three factors due to showing a clear relationship between items and particular aspects of the subscale Ability Ranking, which were renamed Teammate Performance, Effort Changes, and Hierarchy Focus, with sub-dimension definitions displayed in Table 3.

Table 3. Split ability ranking sub-dimension definitions.

Sub-Dimension	Definition
Teammate performance	The perceived ability position within the team based on the success and failure of a teammate rather than own performance
Effort changes	Altered competitive focus against teammates of different ability level
Hierarchy focus	Self-perceived ability dependent on comparisons made against teammate performance

While the parallel analysis suggests that not all factors should be retained, factors six and seven are conceptually important and align with the theory of practice performance environments. Factors five, six and seven only included two items, but were retained due to their reliability scores, high factor loadings, and conceptual importance. A new item was developed for each factor, reflecting the sub-dimension definitions and the two remaining items (*effort changes*: "change my effort level when competing against different teammates"; team-focused goals: "fully commit myself to team goals"; preparation: "prepare myself to perform well").

In the EFA, a 7-factor solution emerged with 22 items, explaining 59.7% of the total variance among the variables. Based on the screen plot, eigenvalues, parallel analysis, and model fit indices, we retained the final PEPS model with 7 factors and 22 items, which was used in the subsequent analysis. The results of the pattern matrix from promax rotation are presented in Table 4. All 22 items were loaded onto seven distinct factors, each representing a specific domain, without double loading: support behaviour (5 items), hierarchy focus (4 items), teammate performance (3 items), challenge (4 items), team-focused goals (2 items), effort changes (2 items), preparation (2 items). Ordinal alpha coefficients for the factors ranged from .73 to .92 (see Table 4), indicating that the overall items under each factor were all internally consistent and reliable.

Table 4. Rotated scale structure from EFA.

Code	Items (Within my Practice Environment I...)	Subdimensions						
		Support behaviour	Hierarchy focus	Teammate performance	Challenge	Team-focused goals	Effort changes	Preparation
SB2	Feel supported by coaches	<b>0.97</b>	-0.01	-0.05	-0.01	-0.06	-0.01	0.03
SB12	Have a good relationship with my coach/es	<b>0.82</b>	-0.12	-0.06	0.15	0.06	-0.03	-0.06
SB4	Feel my coach/es talk to me positively	<b>0.75</b>	-0.09	0.09	-0.07	0.01	0.05	0.13
SB8	Feel supported	<b>0.78</b>	0.02	0.02	0.15	-0.01	0.01	-0.03
SB10	Can rely on my coach to make me feel good even if I don't perform well	<b>0.76</b>	0.04	-0.02	-0.12	0.02	-0.03	0.05
AR4	Rank my ability against my teammates	-0.14	<b>0.92</b>	-0.02	0.02	0.01	0.04	-0.01
AR20	Compare my performance to others	0.03	<b>0.91</b>	-0.07	-0.18	0.12	-0.04	0.07
AR22	Judge my performance against teammate performance	-0.07	<b>0.83</b>	0.06	0.09	0.10	-0.09	0.03
AR15	Worry about what my teammates think of my ability	0.04	<b>0.43</b>	0.01	0.03	-0.19	0.05	0.05
AR7	Don't want teammates of similar ability to me to do well	-0.04	0.03	<b>0.92</b>	-0.05	0.10	-0.07	0.04
AR8	Want teammates to fail who are a similar level to me	-0.03	-0.09	<b>0.91</b>	0.09	-0.03	0.03	0.03
AR1	Don't want teammates to do better than me	0.02	0.25	<b>0.62</b>	-0.03	0.17	0.02	0.03
AR11	Get angry if a superior skilled teammate beats me in a drill	0.16	0.22	<b>0.43</b>	-0.03	-0.02	0.03	-0.18
CH7	See problems as challenges	-0.04	0.06	-0.12	<b>0.77</b>	0.06	-0.04	-0.16
CH2	Have overcome difficult situations	-0.12	-0.09	0.14	<b>0.58</b>	-0.05	0.01	0.15
CH5	Seek out challenge to improve	0.01	-0.13	0.06	<b>0.69</b>	-0.02	-0.02	0.02
CH6	Turn failure into future success	-0.12	0.21	-0.10	<b>0.62</b>	0.07	0.07	0.04
TG3	Put the team first and myself second	-0.03	0.04	0.03	0.07	<b>0.64</b>	0.01	-0.02
TG11	Hold the team's goals as more important than my individual goals	0.05	-0.03	0.02	-0.04	<b>0.85</b>	0.05	0.06
AR13	Drop my effort in drills against lesser skilled teammates	-0.01	-0.05	-0.06	0.06	-0.03	<b>0.91</b>	0.01
AR5	Change the way I compete against teammates depending on their ability level	-0.01	0.02	0.02	-0.07	0.08	<b>0.72</b>	-0.01
PR5	Perform injury prevention activities	0.05	0.10	-0.01	0.06	-0.01	-0.03	<b>0.65</b>
PR6	Perform recovery activities	0.08	0.01	0.02	-0.02	0.04	0.02	<b>0.82</b>
<b>Eigenvalues</b>		5.76	3.23	1.88	1.68	1.36	1.21	1.02
<b>Variance Explained (%)</b>		25.37	18.89	14.57	13.10	9.73	9.21	9.10
<b>Ordinal <math>\alpha</math></b>		0.91	0.83	0.77	0.77	0.77	0.72	0.74

## WAVE THREE

### **Participants**

The wave three data were collected for a confirmatory factor analysis (CFA;  $n = 198$ ; 119 males, 79 females, mean age 22.20 years  $\pm$  8.24). All participants met the same criteria stated in the wave one above.

### **Protocol**

As with the wave two data collection, a Jisc online survey was distributed to sports clubs, teams, and educational organizations that were associated to the university with the same participant information and consent collected. Items were randomized and uploaded to the survey platform. Participants were asked to rate each item based on their current perceptions of their practice environment on a 7-point Likert scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). All responses were anonymous.

### **Data analysis**

A CFA was conducted to examine the fit of the model identified in the EFA. Data were analysed using SPSS statistics (version 28; IBM, Armonk, NY), the lavaan package (version 0.6—19; Rosseel, 2012) of R software (version 4.4.3), and R Studio (version 2024.04.2). Previous research has indicated that psychological data are rarely normally distributed, resulting in overestimation of factor loadings (Chou & Bentler, 1995). Hence, weighted least squares with mean and variance adjusted (WLSMV) estimators, instead of the ML method, were used because it is appropriate for Likert-type scaled data and is robust to nonnormality, which is common in ordered categorical data (Myer et al., 2023). However, the ML estimation was also adopted for comparison with the WLSMV method. To evaluate the model fit, the Hu and Bentler's (1999) indices were employed: the comparative fit index (CFI), the Tucker-Lewis index (TLI), the root mean square error of approximation (RMSEA), the root mean square residual (SRMR), and the weighted root mean square residual (WRMR). The following cut-offs indicate an acceptable fit (CFI > .90; TLI > .90; RMSEA < .06; SRMR < .09; WRMR < 1.0), and significance was defined by an alpha level of .05 in this study.

### **Results**

A CFA was first conducted to examine the 7-factor structure found in the previous EFA by employing the WLSMV estimation. Results of the CFA analysis revealed acceptable fit to the data ( $\chi^2 [254] = 483.30$ ,  $\chi^2/df = 1.90$ ,  $p < .001$ , CFI = .98, TLI = .97, RMSEA = .06, WRMR = 1.04). The correlations among the factors ranged from small (effort changes and preparation,  $r = .17$ ) to moderate-to-large (challenge and preparation,  $r = .68$ ). A second CFA was conducted using ML estimation for comparison. While the ML estimation model showed reasonably good to acceptable fit ( $\chi^2 [254] = 483.30$ ,  $\chi^2/df = 1.90$ ,  $p < .001$ , CFI = .98, TLI = .97, RMSEA = .07, SRMR = .07), the results were consistent with the WLSMV method. Two competing CFA analyses were evaluated, with factors expected to be related since the factor correlations were low to moderate (ranging from .17 to .68). The model fit indices were nearly identical ( $|\Delta CFI| = .00$ ), not exceeding the threshold of .01 for meaningful difference (Cheung & Rensvold, 2002). Given the ordinal nature of the data, we chose to retain the WLSMV estimator.

As for construct reliability, both the ordinal alpha ( $\alpha_o = .71-.87$ ) and the composite reliability (CR = .77-.88) were considered satisfactory (Nunnally & Bernstein, 1994). The communalities of the items ranged from .24 to .84. Although the items AR11 (get angry if a superior skilled teammate beats me in a drill) and CH2 (have overcome difficult situations) had low communalities ( $h^2 < .3$ ), all items showed factors loadings above .40, ranging from .49 to .91 (Hair et al., 2010). Therefore, these items were kept given their significant factor loadings and theoretical importance. The average variance extracted (AVE) values for each construct were above the threshold of .5 (Fornell & Lacker, 1981), indicating convergent validity was acceptable (see Table

X). Further, discriminant validity was established, as the AVE values exceeded the corresponding squared correlations of all pairs of constructs (Fornell & Larcker, 1981). See Table 6 for the factor loadings and CR.

Table 6. Regression weight estimates standardized and unstandardized, along with internal reliability scores of the PEPS.

Items	Subdimension	Standardized regression weight	Unstandardized regression weight	Standard Error	Ordinal $\alpha_o$
SB10	Support Behaviour	0.57	0.83	0.10	0.83
SB4		0.68	0.72	0.06	
SB12		0.67	0.63	0.06	
SB2		0.89	1.00		0.82
SB8		0.79	0.93	0.07	
ARA11	Hierarchy Focus	0.50	0.57	0.07	
ARA1		0.85	0.92	0.06	
ARA8		0.83	0.94	0.06	
ARA7		0.89	1.00		
ARC15	Teammate Performance	0.60	0.74	0.08	0.81
ARC4		0.66	0.73	0.07	
ARC22		0.80	0.95	0.08	
ARC20		0.86	1.00		
CH6	Challenge	0.74	1.00		0.75
CH5		0.80	0.94	0.09	
CH7		0.67	0.90	0.10	
CH2		0.38	0.48	0.09	
TG3	Team-Focused Goals	0.69	0.88	0.13	0.69
TG11		0.80	1.00		
TG99		0.48	0.40	0.07	
ARB99	Effort Changes	0.81	0.941	0.076	0.85
ARB13		0.739	0.791	0.07	
ARB5		0.901	1		
PR6	Preparation	0.779	0.916	0.087	0.79
PR99		0.614	0.549	0.065	
PR5		0.872	1		

## DISCUSSION

Initial validity evidence for the internal structure of the Performance Environment of Practice Scale (PEPS) has been provided for use with groups of individuals who regularly train within a practice environment to develop their performance and compete in sport. This study followed recommendations and guidance from scale development literature (MacKenzie et al., 2011; Boateng et al., 2018) while integrating theory (i.e., practice environment, performance environment and motivational climate research) and primary research to develop and provide the initial validation of the PEPS structure. Transparency allows readers to pass judgement on the methodological rigor and validity of a scale (Flake & Fried, 2020), therefore, this discussion details decision-making processes for clarity to present an accurate representation of the scale development

process. The data collection and analysis of the PEPS has been reported as a simple and linear process which does not reflect the complexities of scale development. During the validation of the PEPS, one theorized factor split, and two factors were removed. The following section aims to provide an honest discussion of the decision-making process while validating the PEPS and highlighting the tension between achieving statistical benchmarks and preserving underpinning theory.

### ***Splitting of the ability rank subscale***

Following the EFA, the Ability Ranking factor was split into three separate factors: Teammate Performance, Effort Changes and Hierarchy Focus. While this decision was data-led, reflecting on the underpinning research of the PEPS provides an explanation as to why the subscale was divided into three distinct factors. The ability ranking factor was shown by Smith et al. (2019) to hold a complex and dynamic relationship with performance expectations. The presence of strong comparisons within a practice environment, such as those found within an ego-orientated peer climate (Ingrell et al., 2016), can create performance expectations that are primarily influenced by perceived ability status within a group (Smith, 2003). Perceived performance outcome is, therefore, judged against comparison to others rather than other performance indicators, which provides the need for an isolated measure from other aspects of ability ranking and produced the Hierarchy Focus sub-dimension.

Effort is a particularly unique influencing factor due to its controllability (Douglas & Carless, 2006) and domain-wide impact within a performance climate (Hodge et al., 2014). Effort levels during intrateam competition in practice have been reported to differ depending on the perceived ability of the opposition (Smith et al., 2020a). Therefore, applied effort in practice can be an outcome of the status perceptions created (e.g., lower effort against lower ability opposition) and should hold its own distinctive sub-dimension factor, which was labelled Effort Changes.

The newly created Teammate Performance factor was rooted in the conflict between the success of the self against that of the team, which was exacerbated by intra-team competition (Mills et al., 2012). The impact of others' performance outcomes within the practice environment interacts with the direction of one's goals (individual vs team) and can influence practice performance (Smith et al., 2021). The perceptions of ability status within a team (i.e., Hierarchy Focus factor) and the influence of teammate performance have distinct differences (Koster & Aven, 2018), so should be measured separately.

### ***Removal of two subscales: Expected performance and control***

Two sub-dimensions were removed, Expected Performance and Control, due to poor internal reliability. This outcome may be attributed to ambiguity or a lack of explicit definition of these sub-dimensions, or the influence of various factors like situational anxiety, emotion, and confidence on performance expectations (Stamenković & Vesković, 2022). Performance expectations have also been found to be independent from previous performance (Feltz et al., 2008) but related to intra-team comparison (Smith et al., 2020a). The influence of ability status perceptions on performance expectations can be seen in the newly created Hierarchy Focus sub-dimension above, but as a stand-alone sub-dimension it seems Expected Performance could not be reliably measured and was removed.

The Control sub-dimension was similar to Expected Performance in such that when given further distinction its presence could be seen within the newly created sub-dimension Effort Changes. In fact, Smith et al. (2021) did not distinguish between effort and control when reporting findings. Effort has been described as more controllable than situational ability or talent (Douglas & Carless, 2006), with participants in the Smith et al.

(2021) study stating effort to be the only factor within the practice environment to be controllable. Therefore, the Control sub-dimension required further distinction and was removed.

### ***Team-focused goals: Reliability***

Scale development literature advocates for sub-dimensions to have at least three items per subscale for the dimension to be accurately represented in a scale (Carpenter, 2018). The resulting EFA included two items for the subscale Team-focused Goals. Based on MacKenzie et al. (2011) guidance of a minimum of three items per subscale, a third item was developed for the CFA which reflected the two remaining items. While the internal reliability score fell just short of the statistical benchmark ( $\alpha = 0.69$ ) and removing the newly developed item that had a lower loading (0.47) would have rectified this ( $\alpha = 0.74$ ), the researchers wanted to meet scale structure guidance over statistical benchmarks. The theoretical grounding that team-focused goals are a key element to the practice performance environment (e.g., Smith et al., 2020b), justify the retention of this factor and its items.

### ***Scale limitations***

While samples for the EFA and the CFA met the required practice involvement criteria, no further demographic data were collected, and the sample size for the CFA ( $n = 198$ ) fell just short of Harrington's (2009) sample size recommendation ( $n = 200$ ). Future research should test the PEPS with larger and more diverse sport populations where demographic data is collected. Populations such as individual and team sports, competition levels (e.g., elite and non-elite), and different cultures would improve the diversity of the data collected. Practice perceptions are highly unstable, and the cross-sectional study design does not allow for the determination of causal relationships (Morgado et al., 2017). Future longitudinal study can evaluate PEPS validity across different time points and compare against further measures of practice and competition performance (e.g., objective match results and subjective coach performance ratings). It is possible that researcher bias occurred during literature review interpretations to conceptualize the construct (Fisher et al., 2014). Further, practice environment research is a burgeoning field of study, and the PEPS may require updating.

### ***Practical implications***

A recent evaluation of questionnaire length conducted by Eisele et al. (2022) found a 60-item questionnaire led to increased perceived burden, lower compliance, increased careless responding, and decreased data quality and quantity when compared to a 30-item questionnaire. Galesic & Bosnjak (2009) also reported increased completion rates when participants believed the questionnaire to be shorter. From a practical perspective, the 26-item PEPS provides a performance environment measure with potentially lower response burden that can be used at higher frequencies with athletes by being quicker and less arduous to complete (Eisele et al., 2022). The lower response burden is created from a scale that has a specific domain focus (i.e., practice). Having a high frequency measure is particularly important due to practice environment perceptions having been conceptualized as unstable (Smith et al., 2019). The authors recommend that the measure may be suitable for daily use, or as and when required, and with competitive team sport athletes aged >16 years old. A version of the PEPS for practical use can be found in Appendix 3. The PEPS total score can be used to monitor the performance environment of practice in a group over time. Future research should aim to deliver PEPS normative data.

The PEPS is comparable to other short-form scales, such as the trait emotional intelligence questionnaire short-form that has 30 items (Laborde et al., 2017). The PEPS, therefore, could be used by coaches at regular intervals to measure the psychological performance climate of their practice environment. However, sports programs tend to favour very brief measures due to their ease of use and automation capacity (Duignan et

al., 2020). Longitudinal measures in sport are sought after (e.g., intra- and inter-season) but are often without high data collection frequency (e.g., Simms et al., 2021). Importantly, coaches have acknowledged the need for psychological measures but lack the understanding and time to invest in complicated and extensive measurement tools (Brink et al., 2018). Measures with items as few as five (e.g., Zsiso et al., 2020) and six (e.g., Andreassen et al., 2012) items have been developed and validated, and reduced item data collection methods should be the goal of future sport psychology research.

## CONCLUSION

The current study undertook an initial development and validation of the PEPS by integrating theory and primary data to measure the performance environment of practice among competitive sport athletes. The factor analysis confirmed the structure of the model and that the scale has good internal reliability. Transparency in the reporting of the scale development and validation highlighted that changes to the scale structure were in accordance with underpinning theory. To continue building evidence of validity, future research should be conducted to evaluate the test-retest reliability and predictive validity of the PEPS. Future research should also assess PEPS accuracy against coach performance perceptions and whether the PEPS responds to implemented psychological climate changes.

## AUTHOR CONTRIBUTIONS

Steve Smith conceptualised the study, led the scale development process, conducted data collection, contributed to data analysis and interpretation, and drafted the manuscript. Ellie Gennings led the statistical analyses (EFA and CFA), contributed to scale development, supported methodological design, assisted with data interpretation, and critically reviewed and revised the manuscript. Nayoung Ahn contributed to the statistical analyses (EFA and CFA), contributed to data interpretation and critically revised the manuscript for intellectual content. Paul Sowden provided theoretical and methodological oversight and supported data interpretation. All authors approved the final version of the manuscript and agree to be accountable for all aspects of the work.

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## DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

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## APPENDIX 1

Sub-Dimension	Description
Control	Athletes who do not aim to directly influence all performance outcomes may perceive less negativity. A focus on the elements that an athlete can have direct influence over in the practice environment (e.g., effort) can lead to perceived positivity and is not affected by performance or outcome
Expected Performance	Athletes who are aware of and reflect on their physical or mental fatigue create more accurate short-term performance goals. Unrealistic short-term goals not adjusted for the current athlete state can cause negativity through realized performance that is lower than the usual standard. Performance goals that are informed by the current state will buffer lower than standard performance causing a decrease in negativity
Support Behaviour	Athletes who feel aided by others within the practice environment will experience greater positivity. Positive communication (e.g., encouragement after failure) leads to greater positivity. Critical communication from teammates and coaches will increase negativity
Team-focused Goals	Athletes who have an individual orientation will experience negativity through a lack of togetherness. Athletes who have a team orientation will benefit from the success of teammates, perceive intra-team competition as challenging rather than threatening, and be able to access support from others in the environment
Ability Ranking	Athletes who create internal skill rankings of all players can cause maladaptive intra-team competition behaviours. Responses to success and failure outcomes against teammates will differ depending on the perceived position of that player in the team
Preparation	Athletes that make life-style decisions based on enhancing performance in practice will experience positivity within the practice environment. A failure to ensure adequate actions are undertaken to recover physically and psychologically from fatigue can cause negative effects.
Challenge	Athletes require both performance success and failure. Following those moments of performance failure, the athlete can reflect and build resilience towards tasks in the future that provide difficulty. Athletes who seek to develop and improve their performance through accepting failure as a process will experience positivity.

## APPENDIX 2

### Item Rating Task to Assess Content Validity of the *Perceived Performance Climate in Team Practice Scale (PPCTPS)*

Perceived performance climate is defined as the psychological factors perceived by an athlete to influence performance in the team sport practice environment. Performance perceptions are gained from an athlete's identification of both the positive (beneficial) and negative (harmful) influences on performance. The perceived factors of influence are generated from both internal (self) and external (social) sources. Perceptions are unstable and can be affected by time (e.g., different practice sessions), situation (e.g., different practice activities), and case (e.g., different practice environment).

When completing the PPCTPS, each item is anchored by '*Within my current practice environment I...*'

### How to Complete the Item Rating

Participants are required to rate the extent to which each item captures each aspect of the domain using a five-point Likert scale ranging from 1 (not at all) to 5 (completely). The top of all columns contains the domain definition with items listed on the left-hand side. An example of a completed item rating task is shown below. In the nutrition example below a banana has been given a rating of 1 (not at all) for 'junk food' but a 5 (completely) for 'healthy snack'. It is recommended you take regular breaks when completing this task over the two-week period.

Example matrix.

Item	<i>Junk food</i> is food that has very little nutritional value.	<i>Dairy products</i> are foods made from animal products.	Foods with <b>sources of fibre</b> are required for healthy gut.	A <i>healthy snack</i> food offers good nutrition.	A <b>high sugar</b> content food raises blood sugar levels.	A <b>high fat</b> content food can raise cholesterol.
Banana	1	1	4	5	4	1
Cake	5	2	3	1	5	5
Fizzy drink	5	1	1	1	5	1

Please indicate on the form (by circling the item) if you believe there to be a spelling or grammar error in an item

Each question item below follows '*Within my current practice environment I...*'

Item	The elements of practice performance that an athlete attempts to <b>control</b> .	The extent to which an athlete thinks about how they <b>expect to perform</b> .	The <b>supportive behaviour</b> received from others.	The extent that performance goals are <b>team-focused goals</b> .	The extent that athletes will <b>ability-rank</b> themselves against teammates.	An environment that creates <b>challenge</b> to build resilience and improve performance.	The life-style behaviours undertaken in <b>preparing</b> to enter the practice environment.
Get annoyed if a teammate makes a mistake							
Prepare by getting adequate sleep							
Cope well with adversity							
Make my teammates feel good							
Work with the team to achieve high performance							
Have team goals that we all work towards							
Criticise my teammates if they make mistakes							
Cheer on my teammates if they do well							
Try to control things I cannot							
Judge my performance against teammate performance							
Ensure I am mentally ready to practise							
Want the team to do well							

## APPENDIX 3

## Practice Performance Environment Scale

**Directions**

Thinking about the practice and training activities you undertake for your sport, read the following statements carefully and circle the number that best represents how you feel right now.

Each question begins with: Within my Practice Environment I...	Strongly Disagree	Strongly Agree	Direction
1	1 2 3 4 5 6 7		Positive
2	1 2 3 4 5 6 7		Negative
3	1 2 3 4 5 6 7		Negative
4	1 2 3 4 5 6 7		Negative
5	1 2 3 4 5 6 7		Negative
6	1 2 3 4 5 6 7		Negative
7	1 2 3 4 5 6 7		Positive
8	1 2 3 4 5 6 7		Positive
9	1 2 3 4 5 6 7		Positive
10	1 2 3 4 5 6 7		Negative
11	1 2 3 4 5 6 7		Negative
12	1 2 3 4 5 6 7		Positive
13	1 2 3 4 5 6 7		Positive
14	1 2 3 4 5 6 7		Positive
15	1 2 3 4 5 6 7		Positive
16	1 2 3 4 5 6 7		Positive
17	1 2 3 4 5 6 7		Positive
18	1 2 3 4 5 6 7		Negative
19	1 2 3 4 5 6 7		Negative
20	1 2 3 4 5 6 7		Negative
21	1 2 3 4 5 6 7		Negative
22	1 2 3 4 5 6 7		Positive
23	1 2 3 4 5 6 7		Positive
24	1 2 3 4 5 6 7		Positive
25	1 2 3 4 5 6 7		Positive
26	1 2 3 4 5 6 7		Positive

**Scoring**

**Total Practice Performance Environment Score:** Reverse negative direction scores. Add up all question scores and divide by 26.

**Specific Sub-Dimension Scoring:** Reverse negative direction scores (Teammate Performance, Effort Changes, Hierarchy Focus).

*Support Behaviour:* Q1+Q9+Q12+Q17+Q25 / 5. *Teammate Performance:* Q2+Q3+Q6+Q21 / 4. *Effort Changes:* Q4+Q10+Q18 / 3.

*Hierarchy Focus:* Q5+Q11+Q19+Q20 / 4. *Challenge:* Q7+Q16+Q24+Q26 / 4. *Preparation:* Q8+Q14+Q22 / 3. *Team-Focused Goals:* Q13+Q15+Q23 / 3.

