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**The Psychobiosocial States (PBS-S) Scale: Factor Structure and Reliability**

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**Abstract**

This study examined the factor structure and reliability of the Psychobiosocial States (PBS-S) scale in the assessment of situational performance-related experiences. We administered the scale to 483 Finnish athletes before a practice session to assess the intensity and perceived impact of their performance-related feeling states. The hypothesised two-factor structure indicating functional effects (10 items) and dysfunctional effects (10 items) towards performance was examined via exploratory structural equation modelling (ESEM), and confirmatory factor analysis (CFA). Regarding the intensity and perceived impact dimensions of reported states, ESEM and CFA showed a good fit for a two-factor solution of a 14-item PBS-S scale (7 functional and 7 dysfunctional items). For both intensity and impact ratings, core state functional modalities were bodily, cognitive, and volitional, while core state dysfunctional modalities were volitional, operational, and anxiety. Findings support the use of a 14-item PBS-S scale to measure a range of pre-performance states.

*Keywords:* IZOF model, emotion, feelings, measure

## 24           The Psychobiosocial States (PBS-S) Scale: Factor Structure and Reliability

25           Emotion research in sport during the past 40 years has focussed on the impact of  
26 discrete emotions on athletic performance, mostly precompetitive anxiety (for reviews, see  
27 Hanton, Neil, & Mellalieu, 2008; Mellalieu, Hanton, & Fletcher, 2006). However, athletes  
28 typically experience several pleasant and unpleasant feeling states, some of which can aid  
29 sport performance while others can disrupt it. The study of athletes' performance related  
30 experiences has been guided by the individual zones of optimal functioning (IZOF) model  
31 (Hanin, 2000, 2007). The model uses a systems approach (Ganzen, 1984) in the description of  
32 athletes' experiences related to performance. A systems description comprises five basic  
33 defining characteristics (i.e., form, content, intensity, time, and context), which are referred to  
34 as penta-basis. The model holds that the form characteristic of a psychobiosocial state is a  
35 situational condition manifested in eight interrelated modalities including emotional, which is  
36 a central modality, cognitive, motivational, and volitional (psychological modalities); bodily  
37 and motor-behavioural (biological); operational and communicative (social modalities; Hanin,  
38 2000, 2007; Ruiz, Hanin, & Robazza, 2016). Form modalities together with content (quality),  
39 and intensity (quantity) describe the structure of the athlete's experiences, while time (e.g.,  
40 before, during, or after) and context (e.g., practice or competition) provide information about  
41 the dynamics of such experiences (for a detailed description, see Hanin, 2000). Other  
42 researchers also share the multiple-form notion. For example, Blascovich and Tomaka (1996)  
43 assume that emotional states result in a motivated response including emotional, cognitive,  
44 and behavioural factors.

45           Previous IZOF-based research indicated that athletes' descriptions of their  
46 performance related feeling states include emotion and non-emotion content. For instance,  
47 karate athletes' freely generated descriptions of their optimal performance states had emotion  
48 and non-emotion content connotations (Ruiz & Hanin, 2004a). Athletes' symbolic

49 descriptions of their states in most successful and unsuccessful performances also had direct  
50 emotion and non-emotion connotations (Hanin & Stambulova, 2002; Ruiz & Hanin, 2004b).  
51 Research using stimulus lists showed that athletes experienced a wide range of emotion and  
52 non-emotion descriptors for their optimal and dysfunctional feeling states accompanying  
53 successful and poor performances (Bortoli, Bertollo, & Robazza, 2009; Di Corrado, Vitali,  
54 Robazza, & Bortoli, 2015; Hanin & Stambulova, 2002; Ruiz & Hanin, 2004a, 2004b).  
55 Existing empirical evidence provides support for the validity and utility of the multimodal  
56 description of psychobiosocial states as conceptualized within the IZOF model (for an  
57 overview, see Ruiz, Raglin, & Hanin, 2017). A multidisciplinary approach integrating motor  
58 behaviour, sport psychology, and psychophysiology domains has been advocated for the  
59 assessment of performance-related experiences (Bertollo et al., 2013).

60         From a methodological perspective, researchers have paid most attention to the  
61 emotional modality. Existing measures of athletes' emotions are framed in group-oriented or  
62 individualized approaches. Traditionally, standardized emotion instruments in sport used two  
63 perspectives: global affect or discrete emotions. A global affect approach (Watson &  
64 Tellegen, 1985) is based on hedonic tone (pleasant–unpleasant) distinctions, while a discrete  
65 emotion approach (e.g., Lazarus, 2000), advocates the study of basic emotion syndromes,  
66 such as happiness, anxiety, joy, fear, or anger. In the sport context, for example, the latter  
67 approach was used in the development of the Sport Emotion Questionnaire (SEQ; Jones,  
68 Lane, Bray, Uphill, & Catlin, 2005). In the IZOF model, both global affect and discrete  
69 emotions approaches are combined using idiosyncratic items conceptualized in terms of  
70 hedonic tone and functionality distinctions (Hanin, 2000, 2007; Hanin & Syrjä, 1995; Ruiz &  
71 Hanin, 2004a). In line with Jones et al.'s (2005) call to assess a broader range of emotional  
72 states, Ruiz et al. (2016) developed an individualized procedure to measure each of the eight  
73 form modalities of a psychobiosocial state. A nomothetic version of the scale was then

74 developed and validated in a trait-like format in which the items were rated in terms of  
75 intensity, frequency, and perceived impact (Robazza, Bertollo, Ruiz, & Bortoli, 2016).  
76 However, the reliability and item characteristics of a state-like version of the scale remained  
77 unexplored. Therefore, the Psychobiosocial States (PBS-S) scale was proposed to measure the  
78 intensity and functional impact of athletes' current feeling states.

79         Functionality or perceived impact, oftentimes termed “direction”, has been examined  
80 on separate scales in particular as applied to anxiety (e.g., Jones & Swain, 1992). In the PBS-  
81 S scale, athletes identify qualitatively different items that are functional or dysfunctional. In  
82 addition, athletes provide information about the perceived impact of their feeling states on  
83 their performance. Empirical qualitative evidence supports the practical utility of the  
84 individualized profiling before most successful and unsuccessful performances. For instance,  
85 the PBS-S scale has been successfully applied, using an individualized approach, to measure  
86 athletes' states before their most successful and poor performances (Ruiz et al., 2016).  
87 Findings indicate that descriptors selected by the participants reflected several modalities of a  
88 state including a wide range of emotional and non-emotional experiences associated with their  
89 performances. Participants chose different words to describe their states before their most  
90 successful performances compared to poor performances, as well as in describing multiple  
91 successful or poor achievements. High variability in the intensity of these experiences was  
92 found in competitions, with high intensity of functional states and low intensity of  
93 dysfunctional states reported for successful performances, while the opposite was true for  
94 unsuccessful performances.

95         Drawing on the IZOF model perspective, the purpose of the current study was to  
96 examine the structural properties of the PBS-S scale as administered to a large sample of  
97 participants. Assessment included the intensity and perceived impact (functionality) of  
98 athletes' current states. In particular, we explored the item characteristics, factor structure, and

99 reliability of the scale for the assessment of the eight form modalities of a state (i.e.,  
100 emotional, cognitive, motivational, volitional, bodily-somatic, motor-behavioural,  
101 operational, and communicative).

## 102 **Materials and Methods**

### 103 **Participants**

104 We purposefully involved in the study athletes having a wide experiential knowledge.  
105 Participants were 483 Finnish athletes (277 men and 206 women; mean age =  $20.27 \pm 4.23$   
106 years) involved in team sports ( $n = 357$ ; e.g., floorball, basketball, volleyball, futsal) and  
107 individual sports ( $n = 126$ ; e.g., figure skating, gymnastics, orienteering). One hundred and  
108 ninety-eight participants were competing at the first national divisions or at international level  
109 (e.g., European or World Championships), while 285 took part in regional level competitions.

### 110 **Instrument**

111 The PBS-S scale was derived from the Individualized Emotion Profiling developed by  
112 Ruiz et al. (2016). As described in the Ruiz et al.'s study, the following steps were taken to  
113 capture idiosyncratic relevant content and to generate synonym adjectives forming each  
114 specific item of the scale: selection of descriptors contained in existing individualized scales,  
115 item revision by a panel of experts, and scale validation with two groups of athletes. The scale  
116 consists of 20 rows of 74 descriptors (3-4 per row) assessing eight modalities of a  
117 performance state (i.e., emotional, cognitive, motivational, volitional, bodily-somatic, motor-  
118 behavioural, operational, and communicative). A row of synonym descriptors formed an item.  
119 Each modality is assessed by two rows of items, one categorized as functional and the other  
120 as dysfunctional for performance. As an exception, the emotional modality is assessed on six  
121 rows of functional (+) and dysfunctional (-) items assessing pleasant, anxiety-related, and  
122 anger-related emotions. First, athletes select one word answering the question "how do you  
123 feel right now in relation to your forthcoming performance?" Second, they rate the intensity

124 on a scale ranging from 0 (*nothing at all*) to 4 (*very much*). Third, in line with previous  
125 research assessing functional impact of anxiety (Jones & Swain, 1992; see Hanton et al., 2008  
126 for review) athletes assess the anticipated impact on performance on a scale ranging from +3  
127 (*very helpful*) to -3 (*very harmful*), with 0 indicating no effect. Participants are first asked to  
128 consider whether the impact of their states is helpful (+) or harmful (-) and then to rate the  
129 magnitude of the impact.

130         Back translation procedures and expert review were conducted to develop the Finnish  
131 version of the PBS-S scale. First, a bilingual person translated the items from English into  
132 Finnish. Second, a panel of three academics whose first language was Finnish, competent in  
133 written and spoken English and familiar with the instrument, examined the translated version.  
134 Third, the panel evaluated the items and discussed possible discrepancies making efforts to  
135 ensure that the underlying item meaning remained unchanged. Fourth, the modified Finnish  
136 version was back translated into English. Fifth, the translated English version was compared  
137 to the original to ensure that meaning and intent of the original items were maintained (the  
138 PBS-S items are included in the Electronic Supplementary Material 1).

### 139 **Procedure**

140         Participants were contacted through training centres, sport schools and clubs in five  
141 cities in Northern, Central, and Southern parts of Finland. Following approval from the local  
142 institution review board, written consent was obtained from all participants. Athletes under 18  
143 years of age gave their assent and a guardian provided written consent. The questionnaire was  
144 administered 30 min before a practice session, either individually or in small groups, in a  
145 quiet place, close to the participants' training facilities. Questionnaire administration took  
146 approximately 15-20 minutes.

## 147 **Data analysis**

148           Prior to conducting the main analyses, data were screened for missing values,  
149 distribution, and multivariate outliers as recommended by Tabachnick and Fidell (2013).  
150 Eight cases were identified as outliers and were removed from further analyses. Missing data  
151 were below the recommended 5% (i.e., 1.9%), thus, not problematic. The internal structure of  
152 the PBS-S scale was examined with *Mplus 7.31* (Muthén & Muthén, 2012) for reported  
153 intensity and functional impact separately, using the missing-data function and adjusting for  
154 non-normality with the robust full information maximum likelihood estimator. In line with  
155 previous research (Marsh et al., 2009; Morin & Maïano, 2011), the analytic strategy involved  
156 exploratory structural equation modelling (ESEM), where factor loadings for each item were  
157 estimated (see Asparouhov & Muthén, 2009), and confirmatory factor analysis (CFA), where  
158 all cross-loadings were constrained to zero. Specifically, the whole sample was divided into  
159 two subsamples (sample 1,  $n = 238$ ; sample 2,  $n = 237$ ), which were homogeneous in terms  
160 of age, gender, sport type practiced, and competitive level. ESEM using bi-geomin orthogonal  
161 rotation for uncorrelated factors was conducted on a first subsample. Based on these findings,  
162 CFA was performed on the second subsample restricting loadings to influence resulting latent  
163 factors. The comparative fit index (CFI), the Tucker-Lewis Index (TLI), the standardized root  
164 mean square residual (SRMR) and the root mean square error of approximation (RMSEA)  
165 were examined. A good model fit is inferred when values of CFI, and TLI are close to .95; the  
166 SRMR is smaller than .08; and the RMSEA is smaller than .06 (Hu & Bentler, 1999).

## 167 **Results**

### 168 **Preliminary Analysis**

169           A multivariate analysis of variance (MANOVA) was preliminary conducted to  
170 examine possible differences across athletes' competitive level (international/national vs.  
171 regional) on psychobiosocial modality scores. Results indicated that the two subsamples were

172 homogeneous in regards to both intensity and perceived impact ( $p > .05$ ). All adjectives  
173 included in each item were selected by the participants to describe their feeling states prior to  
174 performance. Top 10 most selected descriptors were: relaxed-movement [Motor-  
175 behavioural(+), 68.9%], fighting spirit [Anger(+), 68.2%], ineffective-task execution  
176 [Operational(-), 59.0%], worried [Anxiety(-), 49.6%], sociable [Communicative(+), 48.4%],  
177 calm [Pleasant(-), 47.0%], sluggish movement [Motor-behavioural(-), 46.3%], motivated  
178 [Motivational(+), 46.2%], uninterested [Motivational(-), 46.2%], and energetic [Bodily(+),  
179 43.1%]. Top-10 least selected descriptors were: nervous [Anxiety(+), 13.0%], troubled  
180 [Anxiety(-), 11.3%], aggressive [Anger(+), 11.2%], exhausted [Bodily(-), 11.0%],  
181 uncommitted [Motivational(-), 11.0%], coordinated-movement [Motor-behavioural(+), 9.9%],  
182 furious [Anger(-), 9.3%], uncoordinated [Motor-behavioural(-), 9.3%], sharp [Cognitive(+),  
183 7.6%], and effortless-movement [Motor-behavioural(+), 5.0%]. Descriptive statistics for  
184 reported intensity and functional impact for the whole sample are presented in Table 1. Item  
185 intercorrelations can be found in the Electronic Supplementary Material 2. Participants  
186 reported moderate intensity values for functional modalities (e.g., motivational, pleasant, and  
187 communicative). Perceived impact ratings were reversed for the Anxiety(+) item, which was  
188 perceived as dysfunctional (instead of functional), and the Pleasant(-) item, which was  
189 perceived as functional (instead of dysfunctional). These incongruous effects have also been  
190 found in previous research (Ruiz & Hanin, 2004b).

### 191 **Factor Analysis**

192 To examine dimensionality of the PBS-S scale, ESEM of 2-factor models was  
193 conducted in the first subsample independently for intensity and functional impact.  
194 Problematic items, based on high cross-loadings ( $> .30$ ) on hypothesized factors, or high  
195 values of the modification indices ( $> 20$ ), were progressively removed. A 14-item solution

196 [excluding Anxiety(+), Pleasant(-), Communicative(+), Communicative(-), Motivational(+),  
197 Motivational(-) items] showed acceptable fit to the data (see Table 2).

198 A CFA of the 14-item model, conducted on the second subsample independently for  
199 intensity and functional impact, fitted data well, allowing the correlation of residuals [Motor-  
200 behavioural(-) with Bodily(-), Motor-behavioural(-) with Operational(-), and Volitional(+)  
201 with Anger(+)] in the case of states intensity. Figure 1 presents CFA results for the whole  
202 sample. Mplus input and output data are contained in the Electronic Supplementary Material  
203 3.

204 Using the whole sample, the ratio of the factor loading to the standard error was  
205 examined to identify best markers, or core modalities of a state. In the case of states intensity,  
206 core functional state modalities were: bodily (factor loading to standard error ratio of 21.27),  
207 cognitive (17.59), pleasant (12.10), and volitional (11.87). The following were core  
208 dysfunctional modalities: volitional (19.06), anger (19.29), anxiety (16.38), and operational  
209 (14.66). Regarding perceived impact ratings, core functional state modalities were: bodily  
210 (ratio of 15.14), motor-behavioural (13.09), volitional (13.04), and cognitive (12.75).  
211 Dysfunctional state modalities were: volitional (21.45), operational (17.27), anxiety (14.91),  
212 and motor-behavioural (12.50).

213 Composite reliability (CR) scores for 14-item PBS-S scale, two-factor models were  
214 above .70 for states intensity (functional, CR = .738; dysfunctional, CR= .810) and perceived  
215 impact ratings (functional, CR = .782; dysfunctional, CR= .770) indicating good construct  
216 reliability. Cronbach's alpha coefficients were above .70 for states intensity (functional  $\alpha$  =  
217 .742, dysfunctional  $\alpha$  = .810) and perceived impact (functional  $\alpha$  = .780, dysfunctional  $\alpha$  =  
218 .767) showing adequate internal consistency. As expected, significant inter-factor correlations  
219 were found for intensity (functional and dysfunctional, value of -.299,  $p < .001$ ) and perceived  
220 impact (functional and dysfunctional, value of -.529,  $p < .001$ ).

## 221 **Discussion**

222 This study examined the factor structure and reliability of the Finnish version of the  
223 PBS-S scale assessing situational intensity and perceived functional impact of performance-  
224 related experiences. The PBS-S scale has been previously administered to high-level athletes  
225 using an individualized approach (Ruiz et al., 2016) and in a trait-like format (Robazza et al.,  
226 2016). However, no evidence about factor structure or reliability of a state-like version of the  
227 scale exists. This study extends literature on the assessment of athletes' performance states by  
228 examining *form*, *intensity*, and *content* of psychobiosocial states before (*time*) practice  
229 performance (*context*), as well as their perceived impact on performance.

230 As expected, athletes selected all adjectives included in the items representing eight  
231 form manifestations of a psychobiosocial state: emotional, cognitive, motivational, volitional,  
232 bodily, motor-behavioural, operational, and communicative. This finding concurs well with  
233 the Ruiz et al.'s study (2016) and with IZOF-based research (Hanin & Stambulova, 2002;  
234 Ruiz & Hanin, 2004b) indicating that athletes' descriptions of their states reflect emotion and  
235 non-emotion content. Athletes reported high intensities of functional states and low intensities  
236 of dysfunctional states before their practices. Overall, functional items were perceived as  
237 helpful for performance, while dysfunctional modalities were perceived as detrimental except  
238 for two items that showed reverse effects.

239 Poor fit to the data (CFIs and TLIs < .90) was found for a 20-item scale regarding  
240 reported intensity (see Table 2). However, after exclusion of communicative and motivational  
241 items an adequate fit (CFIs and TLIs > .90 and RMSEAs < .06, on both ESEM and CFA) was  
242 obtained for a 14-item solution for situational intensity and impact ratings. There are several  
243 possible explanations for the poor fit of a 20-item scale. First, athletes might have different  
244 perceptions of the impact (i.e., functional or dysfunctional) of anxiety, pleasant states, and  
245 motivation on performance (see Ruiz et al., 2017, for a review). For example, an athlete may

246 experience a certain level of anxiety (pleasant state or motivation) as helpful while another  
247 athlete may perceive the same state as harmful. The perceived impact of the communicative  
248 modality was also found to be idiosyncratic. Some athletes tend to isolate themselves to avoid  
249 distractions, while some others prefer to communicate with their coach or peers to deal with  
250 situational demands (Rees & Freeman, 2012).

251         A second explanation for the poor fit of a 20-item solution could be related to the  
252 inclusion of several items per row. Although it is expected that when the participants read all  
253 items in a row they consider them as synonyms, there may be different interpretations of the  
254 meaning for each word. The inclusion of several descriptors per row aims at providing  
255 athletes choices to best describe their individual experiences, and it is in line with previous  
256 individualized assessments (for a review, see Ruiz et al., 2017). This is considered an  
257 advantage over existing instruments, and the present results indicate that the PBS-S scale,  
258 which includes person and task-relevant items, can be used for intra-individual as well as for  
259 inter-individual analysis of athletes' functional and dysfunctional states. A third explanation  
260 may be related to athletes' degree of (or lack of) awareness of the functional impact of their  
261 experiences (meta-experiences). For instance, some athletes may develop a negative meta-  
262 experience (preference or attitude) of anxiety based on common beliefs that unpleasant states  
263 are always harmful for performance and that pleasant states are always helpful. In this view,  
264 the hedonic experience would determine the individual's perception of performance effects  
265 [i.e., anxiety(+) and pleasant(-) states can be perceived as exerting dysfunctional and  
266 functional effects, respectively, because of the unpleasant and pleasant hedonic experience].  
267 Further research with participants possessing high experiential knowledge is warranted to  
268 better understand individual differences in experiences and meta-experiences.

269         Regarding the motivational modality, the volitional modality items, to a certain extent,  
270 yield information about aspects associated with decision-making processes also related to

271 motivation (Kuhl, 1987). In line with previous qualitative reports of participants (Ruiz et al.,  
272 2006), the perceptions of the impact of the communicative modality are related to being  
273 focused or distracted. Thus, an athlete reporting feeling alone or withdrawn may perceive this  
274 state as helpful for performance in terms of being focused and avoiding distractions.  
275 However, a detrimental interpretation of the same state may be due to a perceived lack of  
276 support from significant others (e.g., the coach). Similarly, an athlete may perceive being  
277 outgoing, or sociable as either helpful or distracting from the task at hand. Thus, from an  
278 applied perspective it is important to assess the intensity of athletes' feeling states and the  
279 perceived impact.

280         An examination of factor loading to standard error ratios revealed that bodily,  
281 cognitive, volitional, and pleasant functional items, and volitional, anger, anxiety, and  
282 operational dysfunctional items were core markers for feeling states intensity. Similarly,  
283 athletes' impact ratings indicated bodily, motor-behavioural, volitional, and cognitive to be  
284 core functional items, while volitional operational, anxiety, and motor-behavioural were core  
285 dysfunctional items. These results are in line with previous qualitative research showing  
286 cognitive, emotional, and operational as most relevant modalities in athletes-generated  
287 descriptors of their optimal states (Ruiz & Hanin, 2004a). This finding accords well with the  
288 IZOF model conceptualization of a psychobiosocial state as a constellation of individually  
289 optimal and dysfunctional emotion and non-emotion content, described by athlete-generated  
290 idiosyncratic markers (Hanin, 2000, 2007). The identification of the core elements is  
291 important for an understanding of athletes' psychobiosocial states. Using the analogy of  
292 degrees of freedom, we contend that the identification of core modalities is similar to the  
293 notion of dimensional compression, drawn from motor learning literature and applied to the  
294 description of inter-personal coordination (Riley, Richardson, Shockley, & Ramenzoni,  
295 2011). Dimensional compression refers to the reduction of degrees of freedom or elements

296 and serves to describe collective effects of state modalities. This notion can also be used to  
297 “compress” or identify core descriptors within the same modality. A second key feature in the  
298 understanding of psychobiosocial states involves information on how state modalities are  
299 interrelated. Information about the interrelationships among the key elements is akin to  
300 reciprocal compensation, which refers to the ability of one form modality to react to changes  
301 in others. For instance, functional psychological modalities (e.g., emotional, volitional,  
302 cognitive) are interrelated amongst them, and negatively related to dysfunctional modalities  
303 (see Electronic Supplementary Material 2). Thus, both dimensional compression and  
304 reciprocal compensation provide important information on psychobiosocial states.

### 305 **Limitations and Future Research**

306         The inclusion of multiple adjectives in each item may be seen as a limitation. With this  
307 procedure, indeed, each psychobiosocial modality is measured by a single adjective rather  
308 than by multiple descriptors, thereby resulting in functional and dysfunctional global  
309 categories. Asking athletes to rate separately the adjectives forming an item would enable the  
310 identification of discrete categories of psychobiosocial states. Future research is warranted to  
311 address this limitation. A second limitation is that we assessed athletes’ experiences before a  
312 practice session rather than before competition. However, and especially with top level  
313 athletes, the assessment of performance states before competition may have a detrimental  
314 effect of their performance, and it is not always recommended. Retrospective evaluation of  
315 pre-competitive states can be a feasible option in future studies. Another limitation is that we  
316 did not assess performance in our study, and thus we do not know whether the reported states  
317 were associated to successful, average, or poor performances. This issue could be addressed  
318 in future research including performance and outcome measures in practice and competition.  
319 In addition, qualitative research is needed to shed more light on the individual perceptions of  
320 descriptors tapping anxiety, pleasant, motivational, and communicative modalities. Future

321 research, including psychophysiological indices, is needed to establish the criterion validity of  
322 the scale in comparison with other emotion measures.

323

324 **Electronic Supplementary Material**

325 *ESM 1.* Psychobiosocial States (PBS-S) scale items.

326 *ESM 2.* Item intercorrelations.

327 *ESM 3.* Factor analysis input and output data.

328

329

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