

1 **Exploring Longitudinal Measurement Invariance and the Continuum Hypothesis in the**  
2 **Swedish Version of the Behavioral Regulation in Sport Questionnaire (BRSQ): An**  
3 **Exploratory Structural Equation Modeling Approach**

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13 Acknowledgements

14 We are grateful to Chris Lonsdale for sharing data that enabled us to perform cross-cultural  
15 equivalence testing. Andreas Stenling was supported by grants from Umeå School of Sport  
16 Sciences (Dnr: IH 5.3-12-2017) and the Swedish National Centre for Research in Sports  
17 (CIF), grant numbers P2014-0043 and P2015-0114. Daniel F. Gucciardi is supported by a  
18 Curtin Research Fellowship.

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20180307

*This is a manuscript accepted for publication in Psychology of Sport and Exercise (PSE).*

*This article may not exactly replicate to the final version published in the journal.*

<https://doi.org/10.1016/j.psychsport.2018.03.002>

## 43 Abstract

44 Objectives: The aims of the present study were to: (a) examine longitudinal measurement  
45 invariance in the Swedish version of the Behavioral Regulations in Sport Questionnaire  
46 (BRSQ) and (b) examine the continuum hypothesis of motivation as postulated within self-  
47 determination theory.

48 Design: Two-wave survey.

49 Method: Young competitive athletes ( $N = 354$ ) responded to the BRSQ early in the season  
50 (November) and at the end of the athletic season (April). Data were analyzed using  
51 exploratory structural equation modeling (ESEM) and bifactor ESEM.

52 Results: We found support for strict longitudinal measurement invariance in the BRSQ.

53 Latent mean comparisons showed an increase in external regulation and amotivation across  
54 the season. The latent factor correlations indicated some deviations from a simplex pattern  
55 related to amotivation, external regulation, and introjected regulation. In the bifactor model,  
56 intrinsic motivation items had negative factor loadings on the global factor, identified  
57 regulation items had factor loadings approaching zero, and introjected and external regulation  
58 and amotivation items all had moderate to strong positive factor loadings.

59 Conclusion: The present study adds longitudinal measurement invariance to the psychometric  
60 evidence of the BRSQ. Research on why the latent means of the behavioral regulations  
61 changed over the athletic season is warranted. The continuum hypothesis was partially  
62 supported. Latent factor correlations and factor loadings on the global factor in the bifactor  
63 ESEM highlighted that the discriminant validity of the controlled regulations and amotivation  
64 needs further investigation.

65

66 Keywords: latent mean changes; motivation continuum; self-determination theory; temporal  
67 stability

68 Motivation is a prominent area of research in sport and exercise psychology (Lindahl,  
69 Stenling, Lindwall, & Colliander, 2015) and one of the dominant theories in contemporary  
70 motivation research is self-determination theory (SDT; Ryan & Deci, 2017). Within the  
71 confines of SDT, motivation is conceptualized along a continuum specifying types of  
72 motivational regulations that varies according to the extent that they are self-determined.  
73 These motivational regulations ranges from autonomous/self-determined types (intrinsic  
74 motivation, integrated regulation, and identified regulation), controlled types (introjected  
75 regulation and external regulation) to amotivation and have shown different associations to  
76 various outcomes among athletes (e.g., Hagger & Chatzisarantis, 2007; Ntoumanis, 2012).  
77 Autonomous types of motivation have generally been associated with adaptive outcomes,  
78 such as mental and physical health (e.g., Li, Wang, Pyun, & Kee, 2013; Ng et al., 2012) and  
79 better performance (Cerasoli, Nicklin, & Ford, 2014), whereas the controlled types of  
80 motivation and amotivation often have been related to maladaptive outcomes, such as ill-  
81 being (Ng et al., 2012; Wang et al., 2013) and worse performance (Gillet, Vallerand, &  
82 Rosnet, 2009).

83 There are several SDT-based measures for athletes' motivational regulations (see  
84 Clancy, Herring, & Campbell, 2017 for a recent review) and one of the more recently  
85 developed, and well cited, is the Behavioral Regulation in Sports Questionnaire (BRSQ;  
86 Lonsdale, Hodge, & Rose, 2008) tapping the various types of motivational regulations  
87 towards athletes' sports participation. Although the psychometric properties of the BRSQ  
88 have been scrutinized psychometrically by several scholars (e.g., Lonsdale et al., 2008;  
89 Viladrich et al., 2013) and have been translated to several languages (e.g., Dutch: Assor,  
90 Vansteenkiste, & Kaplan, 2009; Chinese: Chan, Hagger, & Spray, 2011; Greek: Mouratidis,  
91 Lens, & Vansteenkiste, 2010), several psychometric issues still remain to be explored. In the  
92 present study, we continued the psychometric evaluation of the BRSQ and examined

93 longitudinal measurement invariance of the Swedish version of the BRSQ. Longitudinal  
94 measurement invariance has not been examined in previous research with any version of the  
95 BRSQ.

96         Scholars have in recent years have utilized advanced statistical methods (e.g., bifactor  
97 modeling and exploratory structural equation modeling) to examine the continuum hypothesis  
98 within SDT (Chemolli & Gagné, 2014; Guay, Morin, Litalien, Valois, & Vallerand, 2015;  
99 Howard, Gagné, Morin, & Forest, 2016; Litalien, Guay, & Morin, 2015; Litalien et al., 2017).  
100 According to the continuum hypothesis, the motivational regulations should form a  
101 continuum from highly autonomous types on the one end of the continuum to controlled types  
102 and amotivation on the other end (Ryan & Deci, 2017). As such, this hypothesis is also  
103 applicable to the BRSQ (Lonsdale et al., 2008). Given the recent interest in the continuum  
104 hypothesis in other domains (e.g., education, work, physical activity; Chemolli & Gagné,  
105 2014; Guay et al., 2015; Gunnell & Gaudreau, 2015; Howard et al., 2016; Litalien et al.,  
106 2017), it is essential to test SDT's continuum hypothesis also in measures developed for  
107 sports settings, which we aim to do in the present study.

### 108 **Motivation According to Self-Determination Theory**

109         People's choice to participate, put in effort, and sustain their engagement in an activity  
110 can be classified along a self-determination continuum representing different levels of  
111 internalization of the regulation of a behavior (Ryan & Deci, 2000). Intrinsic motivation  
112 represents peoples natural tendencies towards development and do not result from  
113 internalization. It is defined as engagement driven by the inherent joy in the activity itself  
114 characterized by volition and a sense of freedom without the necessity of separable  
115 consequences. At the other end of the continuum lies amotivation, defined as an absence of  
116 motivation towards the activity. Amotivated persons do not value the activity or the outcomes  
117 associated with it. Between these two extremes are different types of extrinsic motivation.

118 External regulation is the least self-determined type of those extrinsic motivational  
119 regulations and is defined as engagement in an activity for instrumental reasons where no  
120 internalization has occurred. Introjected regulation is when the reasons for engaging in the  
121 activity has been partially internalized but not accepted as one's own and is characterized by  
122 internal pressures to avoid shame and guilt or to enhance ego and self-worth. Identified  
123 regulation is largely internalized and is present when the person values the outcome of the  
124 activity as personally important. Integrated regulation—the most self-determined type of  
125 extrinsic regulation—is present when the person views the activity to be in line with his or her  
126 personal values and sense of self.

### 127 **The Continuum Hypothesis**

128         Within SDT, motivation is conceptualized as different regulations ordered along a  
129 continuum elucidating the degree of self-determination (Ryan & Deci, 2017). The  
130 qualitatively different types of motivation are also suggested to differ quantitatively along the  
131 single continuum of self-determination (Howard et al., 2016). Researchers have typically used  
132 factor correlations to examine the continuum hypothesis and argued that adjacent types of  
133 motivational regulations should correlate more strongly compared to more distal types (Li,  
134 1999; Li & Harmer, 1996; Ryan & Connell, 1989). Although past research has provided some  
135 support for the continuum hypothesis, recent research has cast doubts on this expectation,  
136 particularly when more advanced statistical techniques are used (Chemolli & Gagné. 2014;  
137 Guay et al., 2015). For example, Chemolli and Gagné (2014) argued that if the motivational  
138 regulations align along a continuum, a confirmatory factor analysis (CFA) should support a  
139 one-factor model with negative factor loadings on the least self-determined types and positive  
140 factor loading on the more self-determined types. Using Rasch analysis no support was found  
141 for a unidimensional model (i.e., items loading onto a single motivation factor); the results  
142 clearly supported a multidimensional model (i.e., items loading onto distinct subdimensions

143 of motivation; cf. Gagné et al., 2015; Mallet, Kawabata, Newcombe, Otero-Forero, &  
144 Jackson, 2007).

145 Others have taken a slightly different approach and used exploratory structural  
146 equation modeling (ESEM; Asparouhov & Muthén, 2009; Marsh, Morin, Parker, & Kaur,  
147 2014) to evaluate the continuum hypothesis. Using ESEM, researchers have for example  
148 examined the factor correlation pattern of academic motivation (Guay et al., 2015 in the  
149 Academic Motivation Scale), motivation for PhD studies (Litalien et al., 2015), and sport  
150 motivation (Viladrich et al., 2013 in the BRSQ). Given that ESEM provide more accurate  
151 factor correlations (Marsh et al., 2014), ESEM should result in a clearer simplex pattern  
152 compared to the independent clusters model (ICM) CFA. Viladrich et al. (2013) found  
153 support for a simplex pattern of sport motivation in the BRSQ, whereas deviations from a  
154 simplex pattern were observed in Litalien et al. (2015) and Guay et al. (2015).

155 Researchers have also operationalized motivation as consisting of a general factor  
156 representing motivation quantity and specific factors representing the different motivational  
157 regulations (i.e., motivation quality) in physical activity settings (Gunnell & Gaudreau, 2015).  
158 By specifying a bifactor ESEM, it was found that all types of motivation, including  
159 amotivation, were positively associated with the general motivation factor. The general  
160 motivation factor, identified motivation, and intrinsic motivation were also positively  
161 associated with physical activity and the general motivation factor longitudinally predicted  
162 goal progress. These findings suggest that all types of motivational regulations, including  
163 amotivation, contribute to peoples' pool of motivational resources (Gunnell & Gaudreau,  
164 2015). Furthermore, when examining the cross-loadings in the bifactor ESEM some support  
165 for the continuum hypothesis was shown by the stronger cross-loadings in the expected  
166 direction on more adjacent non-target factors. Howard et al. (2016), however, found a slightly  
167 different pattern in work settings where the factor loadings on the general motivation factor

168 supported the continuum hypothesis indicated by a shift in magnitude and sign from the  
169 autonomous types of motivation to the controlled types of motivation and amotivation.  
170 Similarly, Litalien and colleagues (2017) provided evidence of a continuum structure of  
171 academic motivation in two student samples and the results largely mirrored those presented  
172 by Howard et al. (2016) in work settings. With a simultaneous assessment of a global  
173 motivation factor and specific factors representing the behavioral regulations the factor  
174 loadings on the general factor shifted in magnitude along the continuum from the autonomous  
175 types of motivation to the controlled types of motivation and amotivation.

### 176 **The Present Study**

177 In the present study we build on and extend previous research by Chemolli and Gagné  
178 (2014), Guay et al. (2015), Gunnell and Gaudreau (2015), Howard et al. (2016), and Litalien  
179 et al. (2017) and apply longitudinal ESEM and bifactor ESEM to the BRSQ (Lonsdale et al.,  
180 2008). One important psychometric property of a measurement instrument is longitudinal  
181 stability or invariance (Meredith, 1993; Widaman, Ferrer, & Conger, 2010). As in multigroup  
182 analyses investigating whether people from different populations or subgroups interpret the  
183 items and latent constructs in a similar way, the same questions are addressed within groups  
184 over time by examining longitudinal measurement invariance (Vandenberg & Lance, 2000).  
185 With regard to the BRSQ, scholars have examined measurement invariance across age,  
186 culture, and sex in cross-sectional studies (Hancox, Quested, Viladrich, & Duda, 2015;  
187 Lonsdale et al., 2008; Viladrich et al., 2013), however, longitudinal stability of the BRSQ is  
188 still unexplored. A key assumption when conducting longitudinal research and investigating  
189 change or interrelationships across time is that we are measuring the same thing in the same  
190 metric at each time point, which is referred to as factorial invariance across time or  
191 longitudinal measurement invariance (Widaman et al., 2010). If factorial invariance  
192 constraints are satisfied, it can be assumed that the same latent construct is assessed at each



193 time points, thus ensuring more accurate conclusions about latent or observed mean changes.  
194 Although the BRSQ have been used to assess changes in motivation following an intervention  
195 among athletes (Langan, Blake, Toner, & Lonsdale, 2015), factorial invariance across time in  
196 the BRSQ is still unexplored.

197 In this study we examined four types of measurement invariance: configural, metric,  
198 scalar, and strict invariance (Horn & McArdle, 1992; Little, 2013; Lance & Vandenberg,  
199 2000; Meredith, 1993). With configural invariance we examine whether the same pattern of  
200 fixed and free factor loadings is specified at each time point. Configural invariance needs to  
201 be established before any additional invariance test can be deemed meaningful. A secondary  
202 step is to examine metric invariance, referring to invariant factor loadings across time, and  
203 indicates that the same meaning is ascribed to the latent construct across time. Scalar  
204 invariance refers to equality constraints on the intercepts and implies that the item scores have  
205 the same scaling across time (i.e., item scores share a common zero point). Strict invariance  
206 implies that the reliability of the items is invariant as indicated by the constraints of the items'  
207 uniqueness across time. Metric invariance is necessary to compare structural relations across  
208 time, scalar invariance is necessary to compare latent mean scores across time, whereas strict  
209 invariance is necessary to compare manifest scores over time (Little, 2013; Marsh et al.,  
210 2013).

211 A natural extension of measurement invariance testing as described in the previous  
212 paragraph is to examine changes in latent means across time. The data were collected early in  
213 the season (T1) and late in the season (T2) making it suitable to examine seasonal changes in  
214 the behavioral regulations. Studies on latent mean changes in behavioral regulations are  
215 scarce in the sport psychology literature. Minor decreases in intrinsic motivation across the  
216 athletic season have been reported among Division 1 collegiate athletes (Amorose & Horn,  
217 2001). Lonsdale and Hodge (2011) observed increases in amotivation, external regulation,

218 and introjected regulation, and decreases in identified regulation and intrinsic motivation  
219 across a four-month period in a varied sample of athletes in New Zealand. These studies did  
220 not, however, assess latent mean changes in longitudinally invariant models, and were  
221 therefore at risk of not measuring the same latent construct in the same metric at the each time  
222 point (cf. Widaman et al., 2010). Findings from the educational domain suggest that academic  
223 motivation decreases across adolescence and research examining latent mean changes show  
224 that intrinsic motivation and all of the extrinsic regulations decreases from age 11 to age 16  
225 (Gnamb & Hanfsting, 2016; Otis et al., 2005). Based on these previous findings we expect  
226 that the behavioral regulations towards sport might change across an athletic season and  
227 estimate latent mean changes in a longitudinally invariant measurement model to assess true  
228 changes in the latent constructs over time in an athletic sample. We did not have specific  
229 hypothesis about the behavioral regulations because of the unavailability of previous research  
230 on latent mean changes over time in athletes.

231 Building on previous research we also examined the continuum hypothesis in the  
232 present study (Chemolli & Gagné, 2014; Guay et al., 2015; Gunnell & Gaudreau, 2015;  
233 Howard et al., 2016; Litalien et al., 2017). We used ESEM models to examine the simplex  
234 pattern of factor correlations where stronger factor correlations between more adjacent factors  
235 would support the notion of a continuum structure (Ryan & Connell, 1989). We also specified  
236 a bifactor ESEM model (Morin, Arens, & Marsh, 2016) to simultaneously conceptualize  
237 motivation as unidimensional (i.e., motivation quantity) and multidimensional (i.e.,  
238 motivation quality; cf. Gunnell & Gaudreau, 2015; Howard et al., 2016; Litalien et al., 2017).  
239 By accounting for two types of construct-relevant psychometric multidimensionality as  
240 specified by the global and the specific factors, both motivation quantity and quality can be  
241 assessed in the same model. Because of the inherent orthogonality in bifactor models, the  
242 global factor will capture athletes' overall quantity of motivation whereas the specific factors

243 will reflect the motivation quality of athletes' motivation profiles (Howard et al., 2016). A  
244 shift in magnitude and sign of the factor loadings on the global factor along the SDT  
245 continuum would support the continuum hypothesis (Chemolli & Gagné, 2014). To  
246 summarize, the specific aims of the present study were to: (a) examine longitudinal  
247 measurement invariance in the BRSQ and (b) examine SDT's continuum hypothesis of  
248 motivation in a sport context.

## 249 **Methods**

### 250 **Participants and Procedure**

251 A convenience sample of 354 (48% females) young competitive athletes (skiers  
252 [alpine, biathlon, cross-country] = 46%; floorball players = 54%) ranging from 15 to 21 years  
253 of age ( $M = 17.2$ ;  $SD = 1.16$ ) was included in the present study. The competitive level ranged  
254 from regional to international level. The athletes had on average been competing in their sport  
255 for 9 years ( $SD = 2.8$ ).

256 The head coach of each team was contacted and informed about the purpose of the  
257 study and asked for permission to approach the athletes with an invitation to participate in the  
258 study. When permission was granted, an information meeting was scheduled and the athletes  
259 were invited to participate. The first questionnaire was administered approximately two  
260 months into the competitive season (November), and the second at the end of the competitive  
261 season (April). Ethical approval was obtained from the Regional Ethical Review Board at the  
262 first author's university prior to data collection.

### 263 **Measures**

264 **Behavioral regulations.** A Swedish version of the Behavioral Regulation in Sport  
265 Questionnaire (BRSQ, Lonsdale, Hodge, & Rose, 2008) was used to assess athletes'  
266 behavioral regulations toward their sports participation. Participants were asked to indicate  
267 how well the items corresponded to their reasons for participating in sports, responding on a

268 seven-point Likert scale from 1 (*not true at all*) to 7 (*very true*). The item stem was “I  
269 participate in my sport...”. The version of BRSQ used in this study included five four-item  
270 subscales designed to measure amotivation (e.g., “but I question why I continue”), external  
271 regulation (e.g., “in order to satisfy people who want me to play”), introjected regulation (e.g.,  
272 “because I would feel like a failure if I quit”), identified regulation (e.g., “because I value the  
273 benefits of my sport”), and intrinsic motivation (e.g., “because I enjoy it”). We used a five-  
274 factor version of the BRSQ because of the known problems with the integrated regulation  
275 subscale, such as lack of discriminant validity and that a questionnaire format may not be well  
276 suited to assess integrated regulation (Lonsdale et al., 2008; see also Viladrich et al., 2013),  
277 and the assertion that this type of regulation is not prevalent until adulthood (Vallerand,  
278 1997).

279         The BRSQ was translated into Swedish using a forward-translation approach  
280 (Hambleton, Merenda, & Spielberger, 2004). The English version was translated into Swedish  
281 by the first author and then the translation was reviewed by three bilingual members of the  
282 research group with expertise in sport psychology, motivation, and psychometrics.  
283 Disagreements regarding the translation were discussed until consensus was reached. The  
284 translated version was also subjected to pilot testing with a small group of sport psychology  
285 students ( $N = 3$ ) who provided comments on Swedish version that were taken into  
286 consideration before the final version was determined. To further examine the psychometric  
287 properties of the BRSQ we performed a comparison between the Swedish sample and a New  
288 Zealand-based sample (an age-matched sample collapsed across Study 1, 2, and 3 in Lonsdale  
289 et al., 2008) responding to the original English version of the BRSQ. The results showed  
290 partial scalar invariance (i.e., three intercepts were freely estimated) across the two samples.  
291 Details of the measurement invariance testing are outlined in Supplementary Materials  
292 Appendix 2.0.

## 293 **Statistical Analysis**

294           We used Mplus version 8.0 (Muthén & Muthén, 1998-2017) and the robust full  
295 information maximum likelihood estimator (MLR) to analyze the data. All 354 athletes  
296 responded to the questionnaire at both time points and there were less than 2% missing data at  
297 the item level across the two time points, which was accounted for by the full information  
298 MLR (Enders, 2010). Items were treated as continuous, which is reasonable with seven  
299 response categories (Rhemtulla, Brosseau-Liard, & Savalei, 2012).

300           All analyses were conducted within an ESEM framework (Asparouhov & Muthén,  
301 2009; Marsh, Morin, Parker, & Kaur, 2014; Morin, Arens, & Marsh, 2016). Recent research  
302 indicates that the specification of zero cross-loadings on non-target latent factors in the ICM-  
303 CFA often renders poor model fit and attenuated factor correlations (Asparouhov & Muthén,  
304 2009; Marsh et al., 2014). Morin et al. (2016) refers to this as the fallible nature of indicators,  
305 meaning that there is most often some systematic association between indicators and non-  
306 target latent factors. Most items are imperfect to some degree and have some systematic  
307 association with other constructs (Morin et al., 2016), hence, cross-loadings can typically be  
308 justified based on substantive theory or item content in multidimensional measures  
309 (Asparouhov & Muthén, 2009). That factor correlations are more accurately estimated in  
310 ESEM but likely to be positively biased in ICM-CFA have consistently been shown in both  
311 simulated data (e.g., Asparouhov & Muthén, 2009) and empirical data (Marsh, Lüdtke,  
312 Nagengast, & Morin, 2013). We used target rotation (Browne, 2001; Asparouhov & Muthén,  
313 2009) in the ESEM models that allows for the specification of factor loadings on target and  
314 non-target latent factor in a confirmatory manner. All cross-loadings were specified to be  
315 close to zero but not exactly zero, whereas the main factor loadings were freely estimated  
316 (Morin et al., 2016).

317           Although most longitudinal measurement invariance studies have been performed  
318 within a CFA framework, the same logic applies when testing longitudinal invariance within  
319 the ESEM framework (cf. Marsh et al., 2010). We specified increasingly constrained models  
320 to examine temporal invariance in the BRSQ following the Meredith (1993) tradition. First, a  
321 configural model is estimated, which evaluates the similarity in the overall pattern of  
322 parameters across time. Note, however, that no equality constraints are imposed in the  
323 configural model, it provides a test of the a priori model at each time point and how it fits the  
324 data against which subsequent models with constraints can be compared. Second, a metric  
325 invariance model is estimated, in which the factor loadings are constrained to be invariant  
326 across time. Third, a scalar invariance model is estimated where the item intercepts and factor  
327 loadings are constrained to be invariant across time. By establishing scalar invariance  
328 researchers can reasonably interpret changes in the latent factor means as changes in the latent  
329 constructs (Marsh et al., 2010). Fourth, we assessed strict measurement invariance by  
330 constraining the items' uniquenesses to equality across time. Strict measurement invariance is  
331 an important prerequisite for testing mean differences in manifest scale scores (or factor  
332 scores) because differences in reliability could distort mean differences on the observed  
333 scores (Marsh et al., 2013). Finally, we estimated latent mean changes in the behavioral  
334 regulations across time. Composite reliability was computed according to McDonald's (1970)  
335  $\omega = (\sum \lambda_i)^2 / (\sum \lambda_i^2 + \sum \delta_i)$  using the standardized parameters from the most invariant  
336 longitudinal model where  $\lambda_i$  are the factor loadings and  $\delta_i$  are the error variances.

337           The bifactor ESEM was specified with a general motivation factor alongside five  
338 specific factors representing the different behavioral regulations according to the recently  
339 proposed bifactor ESEM framework by Morin et al. (2016). The specific factors in bifactor  
340 models explains item variance unaccounted for by the general factor and the general factor  
341 explains variance shared across all items. To ensure interpretability and adhering to bifactor

342 assumptions the specific and general factors were specified as orthogonal (Chen, West, &  
343 Sousa, 2006; Reise, 2012). The ESEM and bifactor ESEM are graphically depicted in Figure  
344 1.

345 Model fit was evaluated with conventional fit indices such as the comparative fit index  
346 (CFI), the Tucker-Lewis Index (TLI), the standardized root mean residual (SRMR), and the  
347 root mean square error of approximation (RMSEA). CFI and TLI values around 0.90 and  
348 SRMR and RMSEA values around 0.08 indicated acceptable model fit (Marsh, 2007). The  
349 nested longitudinal invariance models were evaluated using Chen's (2007) recommendations  
350 that change in CFI ( $\Delta$ CFI) of less than 0.01 and change in RMSEA ( $\Delta$ RMSEA) of less than  
351 .015 or a change in SRMR ( $\Delta$ SRMR) of less than 0.030 would support metric invariance. For  
352 scalar and strict invariance a change in CFI ( $\Delta$ CFI) of less than 0.01 and change in RMSEA  
353 ( $\Delta$ RMSEA) of less than .015 or a change in SRMR ( $\Delta$ SRMR) of less than 0.010 would  
354 indicate invariance across time. It is important to remember that these are all rough  
355 guidelines, not "golden rules" (Marsh, Hau, & Wen, 2004), developed within a CFA  
356 framework; it is still unclear how relevant they are for ESEM applications (Marsh et al.,  
357 2009). As noted by Marsh et al. (2010) "Ultimately, however, an evaluation of goodness of fit  
358 must be based upon a subjective integration of many sources of information, including fit  
359 indices, a detailed evaluation of parameter estimates in relation to a priori hypotheses,  
360 previous research, and common sense" (p. 477). Mplus syntax for all analyses can be found in  
361 Appendix 1.1 to 1.6 in the Supplemental Materials.

## 362 Results

### 363 Descriptive Statistics and Preliminary Analyses

364 Item statistics are displayed in Table 1, showing means, standard deviations,  
365 skewness, and kurtosis of each item at T1 and T2. Some items, particularly those with very  
366 high or low mean values, displayed non-normal response patterns as indicated by the

367 skewness and kurtosis values. The participants reported high levels on the intrinsic motivation  
368 items ( $M > 6.0$ ), moderate levels on the identified regulation items ( $M \approx 4.5$  to  $5.6$ ), and low  
369 levels on the introjected regulation, external regulation, and amotivation items ( $M < 2.1$ ).

370 As recommended by Marsh and colleagues (e.g., Marsh et al., 2009, 2010), we  
371 compared the ICM-CFA model with the ESEM model at T1 and T2 (see Table 2). The ESEM  
372 models displayed a better fit to the data at both time points (e.g.,  $> CFI$ ,  $< SRMR$ ) but the  
373 difference in model fit was more pronounced at T2. As expected the magnitude of the  
374 correlations between the latent factors were larger in the ICM-CFA models ( $r$  range at T1 -  
375  $0.72$  to  $0.90$ ;  $r$  range at T2  $-0.71$  to  $0.88$ ) compared to the ESEM models ( $r$  range at T1  $-0.65$   
376 to  $0.64$ ;  $r$  range at T2  $-0.62$  to  $0.67$ ). Latent factor correlations of this magnitude in the ICM-  
377 CFA call into question the instruments ability to discriminate between the factors. Taken  
378 together, these findings suggest that the ESEM provide a better fit to the data and we  
379 therefore relied on ESEM in the remaining analyses.

### 380 **Longitudinal Measurement Invariance and Latent Mean Changes**

381 Model fit of the increasingly constraint models compared in the longitudinal  
382 invariance testing are displayed in Table 2. Model fit of the configural model was acceptable,  
383 making it adequate to examine metric invariance as a second step. The model fit of the metric  
384 invariance model, with the factor loadings constraint to equality over time, did not display a  
385 decrease in any of the model fit indices that would suggest non-invariance ( $\Delta CFI = -0.06$ ;  
386  $\Delta RMSEA = 0.00$ ;  $\Delta SRMR = 0.012$ ). In the third step, we estimated the scalar invariance  
387 model where the intercepts were constraint to equality over time. The change in CFI,  
388 RMSEA, and SRMR ( $\Delta CFI = -0.04$ ;  $\Delta RMSEA = 0.00$ ;  $\Delta SRMR = 0.03$ ) indicated that the  
389 model was fully invariant over time. Finally, the strict invariance model also indicated full  
390 invariance of the items' uniquenesses over time ( $\Delta CFI = -0.04$ ;  $\Delta RMSEA = -0.01$ ;  $\Delta SRMR =$   
391  $0.06$ ). These results suggest full longitudinal measurement invariance in the BRSQ over a



392 five-month period. The standardized factor loadings of the strict invariance model are  
393 displayed in Table 3 and shows well defined target factors and relatively weak cross-loadings  
394 ( $< 0.30$ ). The ESEM-based composite reliability coefficients ( $\omega$ ) ranged from 0.72 to 0.83  
395 ( $M_{\omega} = 0.77$ ). The latent mean comparisons showed that the changes in intrinsic motivation ( $-$   
396  $0.108, p = 0.081$ ), identified regulation ( $0.032, p = 0.617$ ), and introjected regulation ( $0.140, p$   
397  $= 0.097$ ) were not statistically significant, whereas changes in external regulation ( $0.230, p =$   
398  $0.007$ ) and amotivation ( $0.194, p = 0.019$ ) were statistically significant and increased across  
399 the season.

#### 400 **The Continuum Hypothesis**

401 The latent factor correlations generally supported a simplex pattern with stronger  
402 factor correlations between more adjacent factors and weaker factor correlations between  
403 more distal factors both within and across time points (Table 4). There were, however, minor  
404 deviations from a simplex pattern. The association between amotivation at T1 and introjected  
405 regulation (T1  $r = 0.63$ , T2  $r = 0.38$ ) was slightly larger than the association between  
406 amotivation at T1 and external regulation (T1  $r = 0.58$ , T2  $r = 0.29$ ). Amotivation at T2 also  
407 showed a slightly stronger association with introjected ( $r = 0.43$ ) than external regulation ( $r =$   
408  $0.41$ ) at T1.

409 Inspection of the pattern in the bifactor ESEM at T1 showed a shift in the factor  
410 loadings sign and magnitude on the global factor when moving from intrinsic motivation to  
411 amotivation (Table 5). Whereas the intrinsic motivation items show negative factor loadings  
412 on the global factor ( $\lambda$  ranging from  $-0.352$  to  $-0.618$ ), identified regulation items shows  
413 factor loadings approaching zero ( $\lambda$  ranging from  $-0.005$  to  $0.180$ ), and introjected and  
414 external regulation and amotivation items all had positive and moderate to strong factor  
415 loadings ( $\lambda$  ranging from  $0.514$  to  $0.778$ ) on the global factor. The factor loading pattern on  
416 the global factor did not indicate a continuous shift along the continuum, but rather a shift

417 between intrinsic motivation and identified regulation, and also between identified regulation  
418 and introjected regulation. The factor loading pattern at T2 was similar to the pattern at T1,  
419 but we had to remove one identified regulation item (“*because the benefits of sport are*  
420 *important to me*”) from the analysis of the T2 data due to a negative error variance estimate  
421 (see Table 5). Taken together, these results show somewhat mixed support for the continuum  
422 hypothesis but seem to indicate qualitative differences between intrinsic motivation, identified  
423 regulations, and the controlled regulations and amotivation.

## 424 Discussion

425 The aims of the present study were (a) to examine longitudinal measurement invariance in the  
426 BRSQ and (b) to examine SDT’s continuum hypothesis of motivation in a sport context. To  
427 summarize, we found support for strict longitudinal measurement invariance in the BRSQ in a  
428 sample of young competitive athletes and observed statistically significant latent mean  
429 changes in external regulation and amotivation across the season. In addition, the results  
430 showed some support for a sport motivation continuum.

### 431 Longitudinal Measurement Invariance of the BRSQ

432 Previous research has demonstrated measurement invariance of the BRSQ across  
433 different groups, such as age, sex, and cultural (e.g., Hancox et al., 2015; Lonsdale et al.,  
434 2008; Viladrich et al., 2013). This is the first study demonstrating longitudinal measurement  
435 invariance of any version of the BRSQ further adding to the psychometric evidence of the  
436 instrument in sport settings. According to the model fit criteria both metric, scalar, and strict  
437 invariance were supported, indicating that the athletes ascribe the same meaning to the latent  
438 constructs, that the item scores have the same scaling (i.e., item scores share a common zero  
439 point), and that the reliability of the items are equal across time. Establishing measurement  
440 invariance over time is a crucial step in a psychometric evaluation because it implies that the  
441 same latent construct is measured in the same metric across time (Widaman et al., 2010). If

442 measurement invariance across time is not achieved, observed changes may be caused by a  
443 recalibration of the metric or by a redefinition or reconceptualization of the latent construct,  
444 referred to as beta and gamma change (Golembiewski, Billingsley, & Yeager, 1976; Millsap  
445 & Hartog, 1988), respectively. In other words, when longitudinal measurement invariance  
446 constraints are not satisfied, researchers faces the risk of comparing apples and oranges across  
447 time. Satisfying measurement invariance constraints allows for comparisons of means (latent  
448 and observed) across time because if changes are observed they can be interpreted as “true”  
449 changes in the underlying latent construct, not as changes in the interpretation of the items or  
450 latent construct (Golembiewski et al., 1976; Marsh et al., 2010; Millsap & Hartog, 1988). As  
451 such, it is reassuring that the accumulating evidence of the psychometric properties of the  
452 BRSQ now also includes a solid base for conducting longitudinal research and examining  
453 mean comparisons of the regulations across time. However, we encourage researchers  
454 collecting longitudinal data to assess measurement invariance across time in their samples  
455 whenever possible.

#### 456 **Latent Mean Changes in the Behavioral Regulations**

457         The latent mean comparisons indicated an increase in external regulation and  
458 amotivation towards the end of the season. This may reflect that the athletes perceive an  
459 increased pressure (particularly external) towards the end of the season when competitions  
460 deemed more important are held and their performances over the season are being  
461 summarized. The increase in amotivation may also reflect a devaluation of the sport  
462 engagement or potentially a decrease in perceived competence as the season progresses.  
463 Exploring changes in behavioral regulations as a consequence of performance outcomes,  
464 activity participation, or across critical or naturally occurring events would aid our  
465 understanding of the complex interactions between behavioral regulations and activity  
466 participation. For example, in a recent two-wave study children’s school- and leisure-time,

467 physical activity prospectively predicted autonomous motivation towards physical education,  
468 but not vice versa (Taylor, 2017). These results suggest that common outcomes in SDT  
469 research, such as physical activity or performance in competitive sports (see e.g., Blanchard,  
470 Mask, Vallerand, de la Sablonnière, & Provencher, 2007), may influence if and how people  
471 internalize the reasons for partaking in these activities. Researching if and how engaging in  
472 different activities influences behavioral regulations and internalization is an interesting area  
473 for future research.

#### 474 **The Continuum Hypothesis**

475 We also examined the continuum hypothesis proposed within SDT by examining the  
476 pattern of latent factor correlations and by simultaneously examining motivation quality and  
477 motivation quantity in a bifactor ESEM model. The general pattern of correlations between  
478 the latent factors suggested a simplex pattern with stronger correlations between more  
479 adjacent factors and weaker correlations between more distal factors. However, we did  
480 observe some deviations from the simplex pattern related to the associations between  
481 amotivation, external regulation, and introjected regulation. Similar deviations from a simplex  
482 pattern in the BRSQ have been reported in previous research (see Hancox et al., 2015;  
483 Lonsdale et al., 2008). We also observed high latent factor correlations, particularly between  
484 external and introjected regulation but also between external regulation and amotivation,  
485 despite using ESEM that is known to reduce attenuated correlations in measurement models  
486 (Marsh et al., 2014). These observations also mirror previous findings showing that the  
487 discriminant validity of the BRSQ sub-dimensions, particularly of the controlled types of  
488 motivation and amotivation, needs further investigation (e.g., Hancox et al., 2015; Lonsdale et  
489 al., 2008).

490 The fact that the factor loadings onto the global factor in the bifactor ESEM model suggested  
491 two shifts along the continuum—between intrinsic motivation and identified regulation and

492 between identified regulation and introjected regulation—is partly in line with the continuum  
493 of relative autonomy as outlined within SDT (Ryan & Deci, 2017). When comparing the  
494 results from the present study with similar studies in other domains, there are some noticeable  
495 differences. Results from two recently published bifactor ESEM studies in the educational  
496 (Litalien et al., 2017) and work (Howard et al., 2016) domain showed a shift in magnitude and  
497 sign along the continuum from intrinsic motivation to amotivation. Both these studies found  
498 decreases in the magnitude of factor loadings from intrinsic motivation to external regulation,  
499 whereas a shift in sign from positive to negative loadings was observed between external  
500 regulation and amotivation. There were, however, some inconsistencies regarding the  
501 magnitude of the factor loadings that are worth mentioning. In Howard et al. (2016), there  
502 was not a clear distinction in magnitude of the factor loadings between intrinsic motivation  
503 ( $M\lambda = .73$ ) and identified regulation ( $M\lambda = .69$ ). In Litalien et al. (2017) there was not a clear  
504 distinction in the magnitude of the factor loadings between identified (Study 1  $M\lambda = .46$ ,  
505 Study 2  $M\lambda = .33$ ) and introjected regulation (Study 1  $M\lambda = .52$ , Study 2  $M\lambda = .37$ ). A third  
506 bifactor ESEM study, in a physical activity context, showed a slightly different pattern of  
507 factor loadings onto the general factor where all items (including the amotivation items) had  
508 moderate and positive loadings (Gunnell & Gaudreau, 2015). These previous findings  
509 combined with the results from the present study do to some extent support a continuum  
510 structure using measures of academic (Academic Motivation Scale [AMS]; Litalien et al.,  
511 2017), exercise (Behavioral Regulation in Exercise Questionnaire-2 [BREQ-2]; Gunnell &  
512 Gaudreau, 2015), sport (BRSQ; the present study), and work (Multidimensional Work  
513 Motivation Scale [MWMS]; Howard et al., 2016) motivation, but they also show  
514 inconsistencies between these studies that needs further investigation. Although a recent  
515 meta-analysis showed that the continuum structure appears to be relatively stable across  
516 domain, scale used, nationality, age, and gender, heterogeneity remained that was not

517 explained by these moderators (Howard, Gagné, & Bureau, 2017). Researchers have  
518 suggested that the associations between the regulations may be inherently heterogeneous  
519 (Chatzisarantis, Hagger, Biddle, Smith, & Wang, 2003), however, that does not rule out the  
520 possibility that other moderators (e.g., contextual factors) may be causing (at least some) of  
521 the heterogeneity (Howard et al., 2017).

### 522 **Limitations and Suggestions for Future Research**

523         Some limitations are noticeable in the present study. First, the sample was restricted to  
524 young athletes in Sweden representing a narrow range of sports (floorball and skiing).  
525 Whether these results replicate to other settings, such as older or younger athletes, other  
526 sports, levels, and cultures should be examined in future research. As highlighted in previous  
527 research (e.g., Chemolli & Gagné, 2014; Howard et al., 2016), there appear to be more  
528 variability in the pattern of correlations between the motivation subscales across studies than  
529 what is outlined in SDT, and the results from the present study further adds to that variability.  
530 The causes of this variability are important to tease out in future research, by examining  
531 potential moderating factors within and across domains. Second, we did not address the  
532 potential causes of the latent mean changes in the behavioral regulations across the season.  
533 Using various data sources, preferably objective data on individual and team performance,  
534 injuries, and data on other influential sources such as coach, peer, and parental behaviors  
535 could potentially increase our understanding of changes in motivation across the athletic  
536 season. Third, we were unable to examine longitudinal measurement invariance in the bifactor  
537 ESEM model due to estimation problems and inadmissible solutions. Whether the *quantity* of  
538 motivation, as defined by the global factor in the bifactor ESEM model, changes across the  
539 athletic season (or across some other meaningful time span) would be interesting to explore in  
540 future research.

541 Finally, the negative error variance of the identified regulation item 9 (“*because the*  
542 *benefits of sport are important to me*”) in the bifactor ESEM at T2 warrants further attention.  
543 Researchers have proposed several potential causes of “Heywood cases” or negative variance  
544 estimates in factor analysis and structural equation modeling, such as nonconvergence,  
545 outliers, underidentification, empirical underidentification, structural misspecification, or  
546 sampling fluctuations (e.g., Chen, Bollen, Paxton, Curran, & Kirby, 2001; Kolenikov &  
547 Bollen, 2012). Different remedies have been proposed to deal with Heywood cases. For  
548 example, when certain conditions are met, such as when the negative variance estimate is  
549 small, not statistically significant, and its confidence interval (CI) encompasses zero, it can be  
550 constrained to zero or a small positive value (Chen et al., 2001; Kolenikov & Bollen, 2012).  
551 Although the negative error variance estimate was not statistically significant and its CI  
552 encompassed zero, the error variance estimate ( $\delta = -1.093$ ) and the standardized factor  
553 loading on the specific factor ( $\lambda = 1.336$ ) was large. We constrained the negative residual  
554 variance to zero or a small positive value but the estimation problem persisted despite these  
555 constraints. It may be that the general factor did not account for unique variance in the  
556 indicator when the domain-specific factor was partialled out; that is, the negative residual  
557 variance estimate may be a consequence of empirical underidentification due to weak factor  
558 loadings (Brown, 2015).

### 559 **Conclusions**

560 The present study contributes to the ongoing psychometric evaluation of the BRSQ  
561 and adds longitudinal measurement invariance as another piece of evidence for this tool.  
562 These results are reassuring as they suggest that researchers can use the BRSQ to address  
563 complex questions about changes in the behavioral regulations over time, for example in  
564 interventions studies. Furthermore, we observed changes in the latent means of the behavioral  
565 regulations (i.e., increases in external regulation and amotivation) across the athletic season,

566 which previously have been found in other domains, (e.g., education, Gnamb & Hanfstingl,  
567 2016), but not in the sports domain. An important avenue for future research is to understand  
568 why these changes occur by including important predictors (cf. Gnamb & Hanfstingl, 2016)  
569 as well as the consequences of these changes (cf. Otis et al., 2005). Such research could  
570 potentially prevent or minimize the negative effects of increased external regulation and  
571 amotivation as well as find ways to optimize young athletes' motivation throughout an  
572 athletic season.

573         As previously demonstrated in the educational (Litalien et al., 2017), physical activity  
574 (Gunnell & Gaudreau, 2015), and work (Howard et al., 2016) domains, the present study also  
575 highlights the usefulness of the bifactor ESEM framework to test SDTs continuum hypothesis  
576 in the sports domain. The bifactor ESEM framework allows for a more rigorous test of the  
577 continuum hypothesis compared to many other techniques, such as ICM-CFA (e.g., Hancox et  
578 al., 2015; Lonsdale et al., 2008) or Rasch modeling (e.g., Chemolli & Gagne, 2014). With a  
579 bifactor ESEM model, we can simultaneously take into account motivation *quantity* (i.e., the  
580 global factor) and motivation *quality* (i.e., the specific motivation factors). Many researchers  
581 have used the relative autonomy index (RAI), which is calculated by weighting the behavioral  
582 regulations according to their placement of the continuum resulting in a single construct  
583 representing quantity of self-determined motivation. The RAI is a difference score, which  
584 encompasses problems that are well documented in the literature (e.g., Edwards, 2001), and  
585 the commonly applied weighting formula (i.e., the “distance between the regulations) have  
586 been criticized for its lack of validity evidence (Chemolli & Gagne, 2014). In addition,  
587 previous research has shown that a single construct representing quantity of self-determined  
588 motivation is insufficient to explain motivational covariates (Howard et al., 2016). The  
589 orthogonality of the bifactor ESEM model allows for simultaneously test how motivation  
590 *quantity* and *quality* are associated with covariates without the risk of multicollinearity



591 between the motivation subscales, which is one of the key advantages of the bifactor model.  
592 Finally, the present research provide evidence of the psychometric properties of the Swedish  
593 version of the BRSQ, thus contributing to the ability to conduct cross-cultural studies.

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805

806 Figure Caption

807

808 *Figure 1.* ESEM (left) and bifactor ESEM (right) of the behavioral regulations. The dashed  
809 lines indicate non-target factor loadings.

810 Table 1

811 *Means, Standard Deviations, Skewness, and Kurtosis of all Items at T1 and T2*

|      | T1       |           |          |          | T2       |           |          |          |
|------|----------|-----------|----------|----------|----------|-----------|----------|----------|
|      | <i>M</i> | <i>SD</i> | Skewness | Kurtosis | <i>M</i> | <i>SD</i> | Skewness | Kurtosis |
| IM1  | 6.72     | 0.66      | -2.99    | 10.48    | 6.68     | 0.68      | -2.70    | 8.52     |
| IM11 | 6.69     | 0.82      | -3.73    | 17.13    | 6.58     | 0.89      | -2.72    | 8.70     |
| IM15 | 6.68     | 0.73      | -2.61    | 7.10     | 6.60     | 0.85      | -2.47    | 6.13     |
| IM18 | 6.50     | 0.95      | -2.65    | 8.49     | 6.46     | 0.90      | -1.75    | 2.46     |
| ID9  | 4.72     | 1.82      | -0.48    | -0.66    | 4.82     | 1.86      | -0.57    | -0.62    |
| ID16 | 4.49     | 1.74      | -0.31    | -0.72    | 4.53     | 1.82      | -0.37    | -0.73    |
| ID20 | 5.63     | 1.57      | -1.18    | 0.71     | 5.53     | 1.64      | -1.15    | 0.69     |
| ID22 | 4.85     | 1.82      | -0.51    | -0.68    | 4.94     | 1.78      | -0.58    | -0.43    |
| IJ4  | 1.79     | 1.41      | 2.10     | 3.92     | 2.09     | 1.62      | 1.48     | 1.31     |
| IJ6  | 1.96     | 1.52      | 1.76     | 2.30     | 1.95     | 1.46      | 1.69     | 2.24     |
| IJ12 | 1.73     | 1.34      | 2.20     | 4.59     | 1.99     | 1.52      | 1.59     | 1.73     |
| IJ17 | 1.93     | 1.53      | 1.72     | 2.01     | 1.97     | 1.50      | 1.65     | 1.91     |
| EX10 | 1.80     | 1.38      | 1.99     | 3.28     | 1.97     | 1.41      | 1.52     | 1.63     |
| EX14 | 1.46     | 0.98      | 2.76     | 8.69     | 1.72     | 1.28      | 2.06     | 3.74     |
| EX19 | 1.46     | 1.04      | 2.97     | 9.54     | 1.68     | 1.30      | 2.34     | 5.14     |
| EX23 | 1.60     | 1.22      | 2.40     | 5.42     | 1.83     | 1.46      | 1.97     | 3.18     |
| AM5  | 1.56     | 1.15      | 2.38     | 5.29     | 1.80     | 1.39      | 1.94     | 3.10     |
| AM7  | 1.58     | 1.20      | 2.49     | 5.95     | 1.74     | 1.30      | 2.00     | 3.54     |
| AM13 | 1.64     | 1.20      | 2.28     | 5.18     | 1.82     | 1.41      | 1.92     | 3.12     |
| AM21 | 1.74     | 1.33      | 2.03     | 3.73     | 1.78     | 1.32      | 1.93     | 3.41     |

812 *Note.* IM = intrinsic motivation, ID = identified regulation, IJ = introjected regulation, EX =  
813 external regulation, AM = amotivation.



814 Table 2

815 *Longitudinal Measurement Invariance and Bifactor ESEM of the Swedish Version of the Five-*  
 816 *Factor BRSQ. ESEM With Target Rotation was Used in all Analyses Except the ICM-CFA (N*  
 817 *= 354)*

| Model                    | $\chi^2$ | <i>df</i> | <i>p</i> | RMSEA [90%CI]        | CFI   | TLI   | SRMR  |
|--------------------------|----------|-----------|----------|----------------------|-------|-------|-------|
| <b>ICM-CFA</b>           |          |           |          |                      |       |       |       |
| T1                       | 260.060  | 160       | 0.000    | 0.042 [0.033, 0.051] | 0.948 | 0.939 | 0.048 |
| T2                       | 337.408  | 160       | 0.000    | 0.056 [0.048, 0.064] | 0.919 | 0.904 | 0.054 |
| <b>ESEM</b>              |          |           |          |                      |       |       |       |
| T1                       | 169.799  | 100       | 0.000    | 0.044 [0.033, 0.056] | 0.964 | 0.931 | 0.021 |
| T2                       | 174.685  | 100       | 0.000    | 0.046 [0.034, 0.057] | 0.966 | 0.935 | 0.022 |
| Configural               | 854.424  | 555       | 0.000    | 0.039 [0.034, 0.044] | 0.946 | 0.924 | 0.031 |
| Metric                   | 960.830  | 630       | 0.000    | 0.039 [0.034, 0.043] | 0.940 | 0.926 | 0.043 |
| Scalar                   | 1006.231 | 650       | 0.000    | 0.039 [0.035, 0.044] | 0.936 | 0.923 | 0.046 |
| Strict                   | 1004.389 | 670       | 0.000    | 0.038 [0.033, 0.042] | 0.940 | 0.930 | 0.052 |
| Latent Means             | 992.742  | 665       | 0.000    | 0.037 [0.032, 0.042] | 0.941 | 0.931 | 0.051 |
| Bifactor T1              | 146.299  | 85        | 0.000    | 0.045 [0.032, 0.057] | 0.968 | 0.929 | 0.019 |
| Bifactor T2 <sup>a</sup> | 96.613   | 72        | 0.028    | 0.031 [0.011, 0.046] | 0.988 | 0.970 | 0.015 |

818 <sup>a</sup>Identified regulation item 9 excluded due to negative error variance (*“because the benefits of*  
 819 *sport are important to me”*).

820

Table 3

*Standardized ESEM Factor Loadings and Uniquenesses From the Most Invariant Longitudinal ESEM Model*

|      | T1               |                  |                  |                  |                  |          | T2               |                  |                  |                  |                  |          |
|------|------------------|------------------|------------------|------------------|------------------|----------|------------------|------------------|------------------|------------------|------------------|----------|
|      | IM ( $\lambda$ ) | ID ( $\lambda$ ) | IJ ( $\lambda$ ) | EX ( $\lambda$ ) | AM ( $\lambda$ ) | $\delta$ | IM ( $\lambda$ ) | ID ( $\lambda$ ) | IJ ( $\lambda$ ) | EX ( $\lambda$ ) | AM ( $\lambda$ ) | $\delta$ |
| IM1  | <b>0.707</b>     | 0.039            | -0.060           | 0.053            | -0.046           | 0.448    | <b>0.740</b>     | 0.038            | -0.063           | 0.065            | -0.054           | 0.396    |
| IM11 | <b>0.731</b>     | -0.039           | 0.070            | -0.088           | -0.078           | 0.371    | <b>0.752</b>     | -0.038           | 0.072            | -0.107           | -0.090           | 0.317    |
| IM15 | <b>0.875</b>     | -0.027           | 0.019            | -0.044           | -0.033           | 0.181    | <b>0.887</b>     | -0.026           | 0.019            | -0.053           | -0.038           | 0.149    |
| IM18 | <b>0.624</b>     | 0.101            | 0.047            | -0.010           | -0.145           | 0.454    | <b>0.651</b>     | 0.100            | 0.049            | -0.012           | -0.169           | 0.398    |
| ID9  | -0.048           | <b>0.679</b>     | 0.056            | 0.007            | -0.062           | 0.541    | -0.052           | <b>0.691</b>     | 0.059            | 0.008            | -0.075           | 0.504    |
| ID16 | -0.057           | <b>0.609</b>     | 0.128            | -0.036           | -0.047           | 0.615    | -0.062           | <b>0.622</b>     | 0.137            | -0.046           | -0.058           | 0.577    |
| ID20 | 0.105            | <b>0.667</b>     | -0.083           | 0.011            | 0.051            | 0.526    | 0.115            | <b>0.691</b>     | -0.091           | 0.014            | 0.063            | 0.508    |
| ID22 | 0.024            | <b>0.773</b>     | -0.077           | 0.006            | 0.055            | 0.407    | 0.026            | <b>0.796</b>     | -0.083           | 0.007            | 0.067            | 0.389    |
| IJ4  | 0.008            | 0.075            | <b>0.687</b>     | -0.065           | 0.079            | 0.508    | 0.008            | 0.075            | <b>0.720</b>     | -0.081           | 0.094            | 0.457    |
| IJ6  | 0.067            | 0.034            | <b>0.429</b>     | 0.139            | 0.236            | 0.508    | 0.070            | 0.033            | <b>0.442</b>     | 0.171            | 0.275            | 0.442    |
| IJ12 | -0.037           | -0.019           | <b>0.735</b>     | 0.000            | 0.035            | 0.411    | -0.039           | -0.018           | <b>0.763</b>     | 0.000            | 0.041            | 0.363    |
| IJ17 | -0.027           | -0.022           | <b>0.646</b>     | 0.210            | -0.075           | 0.378    | -0.029           | -0.022           | <b>0.670</b>     | 0.259            | -0.089           | 0.333    |
| EX10 | -0.028           | -0.017           | 0.294            | <b>0.520</b>     | -0.032           | 0.403    | -0.028           | -0.016           | 0.291            | <b>0.614</b>     | -0.036           | 0.325    |
| EX14 | -0.077           | -0.007           | 0.123            | <b>0.591</b>     | 0.094            | 0.366    | -0.073           | -0.007           | 0.116            | <b>0.666</b>     | 0.100            | 0.268    |
| EX19 | 0.024            | -0.065           | -0.045           | <b>0.684</b>     | 0.109            | 0.512    | 0.023            | -0.058           | -0.041           | <b>0.755</b>     | 0.114            | 0.361    |
| EX23 | -0.046           | 0.061            | -0.071           | <b>0.749</b>     | -0.015           | 0.494    | -0.043           | 0.054            | -0.066           | <b>0.834</b>     | -0.016           | 0.355    |
| AM5  | -0.101           | -0.030           | 0.105            | -0.120           | <b>0.716</b>     | 0.391    | -0.100           | -0.028           | 0.104            | -0.141           | <b>0.797</b>     | 0.310    |
| AM7  | 0.015            | -0.086           | 0.120            | -0.007           | <b>0.659</b>     | 0.475    | 0.014            | -0.080           | 0.117            | -0.008           | <b>0.729</b>     | 0.371    |
| AM13 | -0.126           | 0.049            | -0.051           | 0.131            | <b>0.631</b>     | 0.406    | -0.121           | 0.044            | -0.049           | 0.149            | <b>0.681</b>     | 0.302    |
| AM21 | -0.011           | 0.090            | 0.057            | 0.145            | <b>0.469</b>     | 0.603    | -0.011           | 0.086            | 0.057            | 0.173            | <b>0.533</b>     | 0.498    |

*Note.* Target factor loadings are highlighted in bold. IM = intrinsic motivation, ID = identified regulation, IJ = introjected regulation, EX = external regulation, AM = amotivation,  $\lambda$  = factor loadings,  $\delta$  = uniquenesses

Table 4

*Latent Factor Correlations from the Strict Invariance Model and Internal Consistency ( $\omega$ )*

|      | T1IM     | T1ID    | T1IJ     | T1EX     | T1AM     | T2IM     | T2ID    | T2IJ    | T2EX    | T2AM |
|------|----------|---------|----------|----------|----------|----------|---------|---------|---------|------|
| T1IM | 0.80     |         |          |          |          |          |         |         |         |      |
| T1ID | 0.23***  | 0.72    |          |          |          |          |         |         |         |      |
| T1IJ | -0.32*** | 0.19*** | 0.74     |          |          |          |         |         |         |      |
| T1EX | -0.44*** | 0.11    | 0.84***  | 0.74     |          |          |         |         |         |      |
| T1AM | -0.64*** | 0.07    | 0.63***  | 0.58***  | 0.73     |          |         |         |         |      |
| T2IM | 0.63***  | 0.15*   | -0.26*** | -0.37*** | -0.43*** | 0.83     |         |         |         |      |
| T2ID | 0.10     | 0.55*** | 0.13*    | 0.06     | -0.01    | 0.19**   | 0.74    |         |         |      |
| T2IJ | -0.27*** | 0.14*   | 0.62***  | 0.50***  | 0.38***  | -0.34*** | 0.21*** | 0.77    |         |      |
| T2EX | -0.29*** | -0.07   | 0.41***  | 0.60***  | 0.29**   | -0.40*** | 0.07    | 0.66*** | 0.81    |      |
| T2AM | -0.38*** | -0.06   | 0.43***  | 0.41***  | 0.47***  | -0.59*** | -0.08   | 0.55*** | 0.68*** | 0.79 |

*Note.* IM = intrinsic motivation, ID = identified regulation, IJ = introjected regulation, EX = external regulation, AM = amotivation,

\* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$ .

Omega coefficients ( $\omega$ ) are displayed in the diagonal.

Table 5

*Bifactor ESEM Factor Loadings and Uniquenesses*

|      | T1              |                  |                  |                  |                  |                  |          | T2 <sup>a</sup> |                  |                  |                  |                  |                  |          |
|------|-----------------|------------------|------------------|------------------|------------------|------------------|----------|-----------------|------------------|------------------|------------------|------------------|------------------|----------|
|      | G ( $\lambda$ ) | IM ( $\lambda$ ) | ID ( $\lambda$ ) | IJ ( $\lambda$ ) | EX ( $\lambda$ ) | AM ( $\lambda$ ) | $\delta$ | G ( $\lambda$ ) | IM ( $\lambda$ ) | ID ( $\lambda$ ) | IJ ( $\lambda$ ) | EX ( $\lambda$ ) | AM ( $\lambda$ ) | $\delta$ |
| IM1  | -0.454          | <b>0.633</b>     | 0.118            | -0.016           | 0.016            | -0.153           | 0.356    | -0.432          | <b>0.591</b>     | 0.101            | -0.014           | 0.040            | 0.008            | 0.452    |
| IM11 | -0.618          | <b>0.573</b>     | 0.043            | 0.206            | 0.309            | 0.116            | 0.136    | -0.520          | <b>0.667</b>     | 0.047            | 0.029            | -0.041           | -0.108           | 0.268    |
| IM15 | -0.547          | <b>0.703</b>     | 0.139            | 0.052            | -0.064           | -0.140           | 0.161    | -0.550          | <b>0.686</b>     | 0.054            | 0.036            | 0.033            | -0.072           | 0.217    |
| IM18 | -0.352          | <b>0.642</b>     | 0.134            | -0.029           | -0.183           | -0.156           | 0.387    | -0.502          | <b>0.573</b>     | 0.185            | 0.074            | 0.061            | -0.122           | 0.360    |
| ID9  | -0.005          | 0.039            | <b>0.679</b>     | 0.126            | 0.161            | -0.030           | 0.495    |                 |                  |                  |                  |                  |                  |          |
| ID16 | 0.180           | 0.138            | <b>0.559</b>     | 0.026            | -0.065           | -0.016           | 0.632    | 0.062           | 0.039            | <b>0.631</b>     | 0.130            | -0.031           | -0.076           | 0.572    |
| ID20 | -0.009          | 0.147            | <b>0.701</b>     | 0.037            | -0.060           | -0.040           | 0.480    | -0.065          | 0.205            | <b>0.490</b>     | 0.011            | 0.067            | 0.021            | 0.709    |
| ID22 | 0.048           | 0.105            | <b>0.733</b>     | -0.003           | -0.024           | 0.068            | 0.444    | -0.022          | 0.118            | <b>0.930</b>     | 0.050            | 0.014            | 0.004            | 0.118    |
| IJ4  | 0.514           | 0.056            | 0.101            | <b>0.520</b>     | -0.007           | -0.004           | 0.452    | 0.572           | 0.060            | 0.147            | <b>0.505</b>     | -0.020           | 0.037            | 0.391    |
| IJ6  | 0.547           | 0.091            | 0.124            | <b>0.534</b>     | -0.021           | 0.087            | 0.383    | 0.842           | 0.093            | 0.024            | <b>0.004</b>     | -0.082           | -0.051           | 0.273    |
| IJ12 | 0.778           | 0.105            | 0.016            | <b>0.082</b>     | 0.089            | -0.057           | 0.365    | 0.598           | 0.067            | 0.056            | <b>0.560</b>     | -0.064           | 0.028            | 0.316    |
| IJ17 | 0.718           | 0.143            | 0.015            | <b>0.279</b>     | 0.132            | -0.044           | 0.366    | 0.655           | 0.024            | 0.066            | <b>0.436</b>     | 0.197            | -0.058           | 0.334    |
| EX10 | 0.712           | 0.048            | 0.029            | 0.096            | <b>0.324</b>     | -0.102           | 0.365    | 0.788           | 0.119            | 0.003            | 0.101            | <b>0.135</b>     | -0.083           | 0.329    |
| EX14 | 0.778           | 0.082            | -0.001           | 0.079            | <b>0.274</b>     | 0.039            | 0.305    | 0.851           | -0.009           | 0.021            | -0.077           | <b>0.151</b>     | -0.107           | 0.236    |
| EX19 | 0.647           | -0.030           | -0.053           | -0.054           | <b>0.344</b>     | -0.019           | 0.456    | 0.645           | 0.041            | -0.010           | 0.084            | <b>0.529</b>     | 0.114            | 0.283    |
| EX23 | 0.610           | -0.008           | 0.065            | -0.014           | <b>0.337</b>     | -0.075           | 0.504    | 0.692           | 0.054            | 0.086            | -0.022           | <b>0.322</b>     | -0.031           | 0.405    |
| AM5  | 0.620           | -0.193           | -0.046           | 0.012            | -0.090           | <b>0.581</b>     | 0.231    | 0.627           | -0.206           | -0.049           | 0.071            | -0.076           | <b>0.429</b>     | 0.367    |
| AM7  | 0.614           | -0.106           | -0.058           | 0.050            | -0.076           | <b>0.377</b>     | 0.457    | 0.669           | -0.082           | -0.108           | 0.018            | -0.046           | <b>0.352</b>     | 0.407    |
| AM13 | 0.645           | -0.144           | 0.070            | -0.009           | 0.045            | <b>0.345</b>     | 0.437    | 0.723           | -0.182           | 0.000            | -0.120           | 0.038            | <b>0.417</b>     | 0.255    |
| AM21 | 0.532           | -0.165           | 0.102            | 0.032            | 0.068            | <b>0.166</b>     | 0.646    | 0.644           | 0.017            | 0.063            | 0.056            | 0.142            | <b>0.392</b>     | 0.403    |

*Note.* Target factor loadings are highlighted in bold. G = general factor, IM = intrinsic motivation, ID = identified regulation, IJ = introjected regulation, EX = external regulation, AM = amotivation,  $\lambda$  = factor loadings,  $\delta$  = uniquenesses. <sup>a</sup>Identified regulation item 9 (“*because the benefits of sport are important to me*”) was excluded due to negative error variance.

**SUPPLEMENTARY MATERIALS APPENDIX 1.1****MPLUS SYNTAX FOR THE CONFIGURAL INVARIANCE MODEL**

TITLE: Longitudinal measurement invariance

DATA:

FILE IS "C:\Users\anslil01\Documents\Longitudinal approximate MI (BRSQ, BNSSS)\Long MI BRSQ.dat";

VARIABLE:

NAMES ARE

ORGFpNr Dataset T1Sex T1Age T1Sport  
T1StAge YiSp T1Level T1PrHw T1YwC  
T1INJ  
T1\_IM1 T1\_IM11 T1\_IM15 T1\_IM18  
T1\_IG2 T1\_IG3 T1\_IG8 T1\_IG24  
T1\_ID9 T1\_ID16 T1\_ID20 T1\_ID22  
T1\_IJ4 T1\_IJ6 T1\_IJ12 T1\_IJ17  
T1\_EX10 T1\_EX14 T1\_EX19 T1\_EX23  
T1\_AM5 T1\_AM7 T1\_AM13 T1\_AM21  
T2INJ  
T2\_IM1 T2\_IM11 T2\_IM15 T2\_IM18  
T2\_IG2 T2\_IG3 T2\_IG8 T2\_IG24  
T2\_ID9 T2\_ID16 T2\_ID20 T2\_ID22  
T2\_IJ4 T2\_IJ12 T2\_IJ6 T2\_IJ17  
T2\_EX10 T2\_EX14 T2\_EX19 T2\_EX23  
T2\_AM5 T2\_AM7 T2\_AM13 T2\_AM21;

USEVARIABLES ARE

!T1  
T1\_IM1 T1\_IM11 T1\_IM15 T1\_IM18  
T1\_ID9 T1\_ID16 T1\_ID20 T1\_ID22  
T1\_IJ4 T1\_IJ6 T1\_IJ12 T1\_IJ17  
T1\_EX10 T1\_EX14 T1\_EX19 T1\_EX23  
T1\_AM5 T1\_AM7 T1\_AM13 T1\_AM21  
!T2  
T2\_IM1 T2\_IM11 T2\_IM15 T2\_IM18  
T2\_ID9 T2\_ID16 T2\_ID20 T2\_ID22  
T2\_IJ4 T2\_IJ6 T2\_IJ12 T2\_IJ17  
T2\_EX10 T2\_EX14 T2\_EX19 T2\_EX23  
T2\_AM5 T2\_AM7 T2\_AM13 T2\_AM21;

MISSING ARE ALL (-999);

ANALYSIS:

ESTIMATOR IS MLR; !maximum likelihood parameter estimates with standard errors and a chi-square test statistic (when applicable) that are robust to non-normality. The MLR standard errors are computed using a sandwich estimator.

ROTATION = TARGET; !specifies target rotation (default is oblique target rotation).

OUTPUT: SAMPSTAT STDYX TECH1 TECH4 CINTERVAL MODINDICES(ALL);

MODEL:

!MODEL T1

!Freely estimated main loadings. The ~0 after the non-target loadings specifies cross-loadings that are “targeted” to be close to zero. The (\*1) indicates that IM1, ID1, IJ1, EX1, and AM1 are a set of EFA factors.

IM1 BY T1\_IM1 T1\_IM11 T1\_IM15 T1\_IM18  
T1\_ID9~0 T1\_ID16~0 T1\_ID20~0 T1\_ID22~0  
T1\_IJ4~0 T1\_IJ6~0 T1\_IJ12~0 T1\_IJ17~0  
T1\_EX10~0 T1\_EX14~0 T1\_EX19~0 T1\_EX23~0  
T1\_AM5~0 T1\_AM7~0 T1\_AM13~0 T1\_AM21~0(\*1);

ID1 BY T1\_ID9 T1\_ID16 T1\_ID20 T1\_ID22  
T1\_IM1~0 T1\_IM11~0 T1\_IM15~0 T1\_IM18~0  
T1\_IJ4~0 T1\_IJ6~0 T1\_IJ12~0 T1\_IJ17~0  
T1\_EX10~0 T1\_EX14~0 T1\_EX19~0 T1\_EX23~0  
T1\_AM5~0 T1\_AM7~0 T1\_AM13~0 T1\_AM21~0(\*1);

IJ1 BY T1\_IJ4 T1\_IJ6 T1\_IJ12 T1\_IJ17  
T1\_IM1~0 T1\_IM11~0 T1\_IM15~0 T1\_IM18~0  
T1\_ID9~0 T1\_ID16~0 T1\_ID20~0 T1\_ID22~0  
T1\_EX10~0 T1\_EX14~0 T1\_EX19~0 T1\_EX23~0  
T1\_AM5~0 T1\_AM7~0 T1\_AM13~0 T1\_AM21~0(\*1);

EX1 BY T1\_EX10 T1\_EX14 T1\_EX19 T1\_EX23  
T1\_IM1~0 T1\_IM11~0 T1\_IM15~0 T1\_IM18~0  
T1\_ID9~0 T1\_ID16~0 T1\_ID20~0 T1\_ID22~0  
T1\_IJ4~0 T1\_IJ6~0 T1\_IJ12~0 T1\_IJ17~0  
T1\_AM5~0 T1\_AM7~0 T1\_AM13~0 T1\_AM21~0(\*1);

AM1 BY T1\_AM5 T1\_AM7 T1\_AM13 T1\_AM21  
T1\_IM1~0 T1\_IM11~0 T1\_IM15~0 T1\_IM18~0  
T1\_ID9~0 T1\_ID16~0 T1\_ID20~0 T1\_ID22~0  
T1\_IJ4~0 T1\_IJ6~0 T1\_IJ12~0 T1\_IJ17~0  
T1\_EX10~0 T1\_EX14~0 T1\_EX19~0 T1\_EX23~0(\*1);

!MODEL T2

!Freely estimated main loadings. The ~0 after the non-target loadings specifies cross-loadings that are “targeted” to be close to zero. The (\*2) indicates that IM2, ID2, IJ2, EX2, and AM2 are a set of EFA factors.

IM2 BY T2\_IM1 T2\_IM11 T2\_IM15 T2\_IM18  
T2\_ID9~0 T2\_ID16~0 T2\_ID20~0 T2\_ID22~0  
T2\_IJ4~0 T2\_IJ6~0 T2\_IJ12~0 T2\_IJ17~0  
T2\_EX10~0 T2\_EX14~0 T2\_EX19~0 T2\_EX23~0  
T2\_AM5~0 T2\_AM7~0 T2\_AM13~0 T2\_AM21~0(\*2);

ID2 BY T2\_ID9 T2\_ID16 T2\_ID20 T2\_ID22  
T2\_IM1~0 T2\_IM11~0 T2\_IM15~0 T2\_IM18~0

T2\_IJ4~0 T2\_IJ6~0 T2\_IJ12~0 T2\_IJ17~0  
T2\_EX10~0 T2\_EX14~0 T2\_EX19~0 T2\_EX23~0  
T2\_AM5~0 T2\_AM7~0 T2\_AM13~0 T2\_AM21~0(\*2);

IJ2 BY T2\_IJ4 T2\_IJ6 T2\_IJ12 T2\_IJ17  
T2\_IM1~0 T2\_IM11~0 T2\_IM15~0 T2\_IM18~0  
T2\_ID9~0 T2\_ID16~0 T2\_ID20~0 T2\_ID22~0  
T2\_EX10~0 T2\_EX14~0 T2\_EX19~0 T2\_EX23~0  
T2\_AM5~0 T2\_AM7~0 T2\_AM13~0 T2\_AM21~0(\*2);

EX2 BY T2\_EX10 T2\_EX14 T2\_EX19 T2\_EX23  
T2\_IM1~0 T2\_IM11~0 T2\_IM15~0 T2\_IM18~0  
T2\_ID9~0 T2\_ID16~0 T2\_ID20~0 T2\_ID22~0  
T2\_IJ4~0 T2\_IJ6~0 T2\_IJ12~0 T2\_IJ17~0  
T2\_AM5~0 T2\_AM7~0 T2\_AM13~0 T2\_AM21~0(\*2);

AM2 BY T2\_AM5 T2\_AM7 T2\_AM13 T2\_AM21  
T2\_IM1~0 T2\_IM11~0 T2\_IM15~0 T2\_IM18~0  
T2\_ID9~0 T2\_ID16~0 T2\_ID20~0 T2\_ID22~0  
T2\_IJ4~0 T2\_IJ6~0 T2\_IJ12~0 T2\_IJ17~0  
T2\_EX10~0 T2\_EX14~0 T2\_EX19~0 T2\_EX23~0(\*2);

!correlate the item's uniqueness across time  
T1\_IM1-T1\_AM21 PWITH T2\_IM1-T2\_AM21;

**SUPPLEMENTARY MATERIALS APPENDIX 1.2****MPLUS SYNTAX FOR THE METRIC INVARIANCE MODEL**

MODEL:

!MODEL T1

!Freely estimated main loadings. The ~0 after the non-target loadings specifies cross-loadings that are “targeted” to be close to zero. The (\*1) indicates that IM1, ID1, IJ1, EX1, and AM1 are a set of EFA factors. The second digit in the parentheses places equality constraints on the factor loadings. For example, the (\*1 1) and (\*2 1) specifies equal factor loadings for IM1 and IM2.

```
IM1 BY T1_IM1 T1_IM11 T1_IM15 T1_IM18
T1_ID9~0 T1_ID16~0 T1_ID20~0 T1_ID22~0
T1_IJ4~0 T1_IJ6~0 T1_IJ12~0 T1_IJ17~0
T1_EX10~0 T1_EX14~0 T1_EX19~0 T1_EX23~0
T1_AM5~0 T1_AM7~0 T1_AM13~0 T1_AM21~0(*1 1);
```

```
ID1 BY T1_ID9 T1_ID16 T1_ID20 T1_ID22
T1_IM1~0 T1_IM11~0 T1_IM15~0 T1_IM18~0
T1_IJ4~0 T1_IJ6~0 T1_IJ12~0 T1_IJ17~0
T1_EX10~0 T1_EX14~0 T1_EX19~0 T1_EX23~0
T1_AM5~0 T1_AM7~0 T1_AM13~0 T1_AM21~0(*1 2);
```

```
IJ1 BY T1_IJ4 T1_IJ6 T1_IJ12 T1_IJ17
T1_IM1~0 T1_IM11~0 T1_IM15~0 T1_IM18~0
T1_ID9~0 T1_ID16~0 T1_ID20~0 T1_ID22~0
T1_EX10~0 T1_EX14~0 T1_EX19~0 T1_EX23~0
T1_AM5~0 T1_AM7~0 T1_AM13~0 T1_AM21~0(*1 3);
```

```
EX1 BY T1_EX10 T1_EX14 T1_EX19 T1_EX23
T1_IM1~0 T1_IM11~0 T1_IM15~0 T1_IM18~0
T1_ID9~0 T1_ID16~0 T1_ID20~0 T1_ID22~0
T1_IJ4~0 T1_IJ6~0 T1_IJ12~0 T1_IJ17~0
T1_AM5~0 T1_AM7~0 T1_AM13~0 T1_AM21~0(*1 4);
```

```
AM1 BY T1_AM5 T1_AM7 T1_AM13 T1_AM21
T1_IM1~0 T1_IM11~0 T1_IM15~0 T1_IM18~0
T1_ID9~0 T1_ID16~0 T1_ID20~0 T1_ID22~0
T1_IJ4~0 T1_IJ6~0 T1_IJ12~0 T1_IJ17~0
T1_EX10~0 T1_EX14~0 T1_EX19~0 T1_EX23~0(*1 5);
```

!MODEL T2

!Freely estimated main loadings. The ~0 after the non-target loadings specifies cross-loadings that are “targeted” to be close to zero. The (\*2) indicates that IM2, ID2, IJ2, EX2, and AM2 are a set of EFA factors. The second digit in the parentheses places equality constraints on the factor loadings. For example, the (\*1 1) and (\*2 1) specifies equal factor loadings for IM1 and IM2.

```
IM2 BY T2_IM1 T2_IM11 T2_IM15 T2_IM18
```



T2\_ID9~0 T2\_ID16~0 T2\_ID20~0 T2\_ID22~0  
T2\_IJ4~0 T2\_IJ6~0 T2\_IJ12~0 T2\_IJ17~0  
T2\_EX10~0 T2\_EX14~0 T2\_EX19~0 T2\_EX23~0  
T2\_AM5~0 T2\_AM7~0 T2\_AM13~0 T2\_AM21~0(\*2 1);

ID2 BY T2\_ID9 T2\_ID16 T2\_ID20 T2\_ID22  
T2\_IM1~0 T2\_IM11~0 T2\_IM15~0 T2\_IM18~0  
T2\_IJ4~0 T2\_IJ6~0 T2\_IJ12~0 T2\_IJ17~0  
T2\_EX10~0 T2\_EX14~0 T2\_EX19~0 T2\_EX23~0  
T2\_AM5~0 T2\_AM7~0 T2\_AM13~0 T2\_AM21~0(\*2 2);

IJ2 BY T2\_IJ4 T2\_IJ6 T2\_IJ12 T2\_IJ17  
T2\_IM1~0 T2\_IM11~0 T2\_IM15~0 T2\_IM18~0  
T2\_ID9~0 T2\_ID16~0 T2\_ID20~0 T2\_ID22~0  
T2\_EX10~0 T2\_EX14~0 T2\_EX19~0 T2\_EX23~0  
T2\_AM5~0 T2\_AM7~0 T2\_AM13~0 T2\_AM21~0(\*2 3);

EX2 BY T2\_EX10 T2\_EX14 T2\_EX19 T2\_EX23  
T2\_IM1~0 T2\_IM11~0 T2\_IM15~0 T2\_IM18~0  
T2\_ID9~0 T2\_ID16~0 T2\_ID20~0 T2\_ID22~0  
T2\_IJ4~0 T2\_IJ6~0 T2\_IJ12~0 T2\_IJ17~0  
T2\_AM5~0 T2\_AM7~0 T2\_AM13~0 T2\_AM21~0(\*2 4);

AM2 BY T2\_AM5 T2\_AM7 T2\_AM13 T2\_AM21  
T2\_IM1~0 T2\_IM11~0 T2\_IM15~0 T2\_IM18~0  
T2\_ID9~0 T2\_ID16~0 T2\_ID20~0 T2\_ID22~0  
T2\_IJ4~0 T2\_IJ6~0 T2\_IJ12~0 T2\_IJ17~0  
T2\_EX10~0 T2\_EX14~0 T2\_EX19~0 T2\_EX23~0(\*2 5);

!correlate the item's uniqueness across time  
T1\_IM1-T1\_AM21 PWITH T2\_IM1-T2\_AM21;

**SUPPLEMENTARY MATERIALS APPENDIX 1.3****MPLUS SYNTAX FOR THE SCALAR INVARIANCE MODEL**

MODEL:

!MODEL T1

!Freely estimated main loadings. The ~0 after the non-target loadings specifies cross-loadings that are “targeted” to be close to zero. The (\*1) indicates that IM1, ID1, IJ1, EX1, and AM1 are a set of EFA factors. The second digit in the parentheses places equality constraints on the factor loadings. For example, the (\*1 1) and (\*2 1) specifies equal factor loadings for IM1 and IM2.

```
IM1 BY T1_IM1 T1_IM11 T1_IM15 T1_IM18
T1_ID9~0 T1_ID16~0 T1_ID20~0 T1_ID22~0
T1_IJ4~0 T1_IJ6~0 T1_IJ12~0 T1_IJ17~0
T1_EX10~0 T1_EX14~0 T1_EX19~0 T1_EX23~0
T1_AM5~0 T1_AM7~0 T1_AM13~0 T1_AM21~0(*1 1);
```

```
ID1 BY T1_ID9 T1_ID16 T1_ID20 T1_ID22
T1_IM1~0 T1_IM11~0 T1_IM15~0 T1_IM18~0
T1_IJ4~0 T1_IJ6~0 T1_IJ12~0 T1_IJ17~0
T1_EX10~0 T1_EX14~0 T1_EX19~0 T1_EX23~0
T1_AM5~0 T1_AM7~0 T1_AM13~0 T1_AM21~0(*1 2);
```

```
IJ1 BY T1_IJ4 T1_IJ6 T1_IJ12 T1_IJ17
T1_IM1~0 T1_IM11~0 T1_IM15~0 T1_IM18~0
T1_ID9~0 T1_ID16~0 T1_ID20~0 T1_ID22~0
T1_EX10~0 T1_EX14~0 T1_EX19~0 T1_EX23~0
T1_AM5~0 T1_AM7~0 T1_AM13~0 T1_AM21~0(*1 3);
```

```
EX1 BY T1_EX10 T1_EX14 T1_EX19 T1_EX23
T1_IM1~0 T1_IM11~0 T1_IM15~0 T1_IM18~0
T1_ID9~0 T1_ID16~0 T1_ID20~0 T1_ID22~0
T1_IJ4~0 T1_IJ6~0 T1_IJ12~0 T1_IJ17~0
T1_AM5~0 T1_AM7~0 T1_AM13~0 T1_AM21~0(*1 4);
```

```
AM1 BY T1_AM5 T1_AM7 T1_AM13 T1_AM21
T1_IM1~0 T1_IM11~0 T1_IM15~0 T1_IM18~0
T1_ID9~0 T1_ID16~0 T1_ID20~0 T1_ID22~0
T1_IJ4~0 T1_IJ6~0 T1_IJ12~0 T1_IJ17~0
T1_EX10~0 T1_EX14~0 T1_EX19~0 T1_EX23~0(*1 5);
```

!MODEL T2

!Freely estimated main loadings. The ~0 after the non-target loadings specifies cross-loadings that are “targeted” to be close to zero. The (\*2) indicates that IM2, ID2, IJ2, EX2, and AM2 are a set of EFA factors. The second digit in the parentheses places equality constraints on the factor loadings. For example, the (\*1 1) and (\*2 1) specifies equal factor loadings for IM1 and IM2.

```
IM2 BY T2_IM1 T2_IM11 T2_IM15 T2_IM18
```

T2\_ID9~0 T2\_ID16~0 T2\_ID20~0 T2\_ID22~0  
 T2\_IJ4~0 T2\_IJ6~0 T2\_IJ12~0 T2\_IJ17~0  
 T2\_EX10~0 T2\_EX14~0 T2\_EX19~0 T2\_EX23~0  
 T2\_AM5~0 T2\_AM7~0 T2\_AM13~0 T2\_AM21~0(\*2 1);

ID2 BY T2\_ID9 T2\_ID16 T2\_ID20 T2\_ID22  
 T2\_IM1~0 T2\_IM11~0 T2\_IM15~0 T2\_IM18~0  
 T2\_IJ4~0 T2\_IJ6~0 T2\_IJ12~0 T2\_IJ17~0  
 T2\_EX10~0 T2\_EX14~0 T2\_EX19~0 T2\_EX23~0  
 T2\_AM5~0 T2\_AM7~0 T2\_AM13~0 T2\_AM21~0(\*2 2);

IJ2 BY T2\_IJ4 T2\_IJ6 T2\_IJ12 T2\_IJ17  
 T2\_IM1~0 T2\_IM11~0 T2\_IM15~0 T2\_IM18~0  
 T2\_ID9~0 T2\_ID16~0 T2\_ID20~0 T2\_ID22~0  
 T2\_EX10~0 T2\_EX14~0 T2\_EX19~0 T2\_EX23~0  
 T2\_AM5~0 T2\_AM7~0 T2\_AM13~0 T2\_AM21~0(\*2 3);

EX2 BY T2\_EX10 T2\_EX14 T2\_EX19 T2\_EX23  
 T2\_IM1~0 T2\_IM11~0 T2\_IM15~0 T2\_IM18~0  
 T2\_ID9~0 T2\_ID16~0 T2\_ID20~0 T2\_ID22~0  
 T2\_IJ4~0 T2\_IJ6~0 T2\_IJ12~0 T2\_IJ17~0  
 T2\_AM5~0 T2\_AM7~0 T2\_AM13~0 T2\_AM21~0(\*2 4);

AM2 BY T2\_AM5 T2\_AM7 T2\_AM13 T2\_AM21  
 T2\_IM1~0 T2\_IM11~0 T2\_IM15~0 T2\_IM18~0  
 T2\_ID9~0 T2\_ID16~0 T2\_ID20~0 T2\_ID22~0  
 T2\_IJ4~0 T2\_IJ6~0 T2\_IJ12~0 T2\_IJ17~0  
 T2\_EX10~0 T2\_EX14~0 T2\_EX19~0 T2\_EX23~0(\*2 5);

!correlate the item's uniqueness across time  
 T1\_IM1-T1\_AM21 PWITH T2\_IM1-T2\_AM21;

!equality constrains on the intercepts  
 [T1\_IM1-T1\_AM21](I1-I20);  
 [T2\_IM1-T2\_AM21](I1-I20);

**SUPPLEMENTARY MATERIALS APPENDIX 1.4****MPLUS SYNTAX FOR THE STRICT INVARIANCE MODEL**

MODEL:

!MODEL T1

!Freely estimated main loadings. The ~0 after the non-target loadings specifies cross-loadings that are “targeted” to be close to zero. The (\*1) indicates that IM1, ID1, IJ1, EX1, and AM1 are a set of EFA factors. The second digit in the parentheses places equality constraints on the factor loadings. For example, the (\*1 1) and (\*2 1) specifies equal factor loadings for IM1 and IM2.

```
IM1 BY T1_IM1 T1_IM11 T1_IM15 T1_IM18
T1_ID9~0 T1_ID16~0 T1_ID20~0 T1_ID22~0
T1_IJ4~0 T1_IJ6~0 T1_IJ12~0 T1_IJ17~0
T1_EX10~0 T1_EX14~0 T1_EX19~0 T1_EX23~0
T1_AM5~0 T1_AM7~0 T1_AM13~0 T1_AM21~0(*1 1);
```

```
ID1 BY T1_ID9 T1_ID16 T1_ID20 T1_ID22
T1_IM1~0 T1_IM11~0 T1_IM15~0 T1_IM18~0
T1_IJ4~0 T1_IJ6~0 T1_IJ12~0 T1_IJ17~0
T1_EX10~0 T1_EX14~0 T1_EX19~0 T1_EX23~0
T1_AM5~0 T1_AM7~0 T1_AM13~0 T1_AM21~0(*1 2);
```

```
IJ1 BY T1_IJ4 T1_IJ6 T1_IJ12 T1_IJ17
T1_IM1~0 T1_IM11~0 T1_IM15~0 T1_IM18~0
T1_ID9~0 T1_ID16~0 T1_ID20~0 T1_ID22~0
T1_EX10~0 T1_EX14~0 T1_EX19~0 T1_EX23~0
T1_AM5~0 T1_AM7~0 T1_AM13~0 T1_AM21~0(*1 3);
```

```
EX1 BY T1_EX10 T1_EX14 T1_EX19 T1_EX23
T1_IM1~0 T1_IM11~0 T1_IM15~0 T1_IM18~0
T1_ID9~0 T1_ID16~0 T1_ID20~0 T1_ID22~0
T1_IJ4~0 T1_IJ6~0 T1_IJ12~0 T1_IJ17~0
T1_AM5~0 T1_AM7~0 T1_AM13~0 T1_AM21~0(*1 4);
```

```
AM1 BY T1_AM5 T1_AM7 T1_AM13 T1_AM21
T1_IM1~0 T1_IM11~0 T1_IM15~0 T1_IM18~0
T1_ID9~0 T1_ID16~0 T1_ID20~0 T1_ID22~0
T1_IJ4~0 T1_IJ6~0 T1_IJ12~0 T1_IJ17~0
T1_EX10~0 T1_EX14~0 T1_EX19~0 T1_EX23~0(*1 5);
```

!MODEL T2

!Freely estimated main loadings. The ~0 after the non-target loadings specifies cross-loadings that are “targeted” to be close to zero. The (\*2) indicates that IM2, ID2, IJ2, EX2, and AM2 are a set of EFA factors. The second digit in the parentheses places equality constraints on the factor loadings. For example, the (\*1 1) and (\*2 1) specifies equal factor loadings for IM1 and IM2.

```
IM2 BY T2_IM1 T2_IM11 T2_IM15 T2_IM18
```

T2\_ID9~0 T2\_ID16~0 T2\_ID20~0 T2\_ID22~0  
 T2\_IJ4~0 T2\_IJ6~0 T2\_IJ12~0 T2\_IJ17~0  
 T2\_EX10~0 T2\_EX14~0 T2\_EX19~0 T2\_EX23~0  
 T2\_AM5~0 T2\_AM7~0 T2\_AM13~0 T2\_AM21~0(\*2 1);

ID2 BY T2\_ID9 T2\_ID16 T2\_ID20 T2\_ID22  
 T2\_IM1~0 T2\_IM11~0 T2\_IM15~0 T2\_IM18~0  
 T2\_IJ4~0 T2\_IJ6~0 T2\_IJ12~0 T2\_IJ17~0  
 T2\_EX10~0 T2\_EX14~0 T2\_EX19~0 T2\_EX23~0  
 T2\_AM5~0 T2\_AM7~0 T2\_AM13~0 T2\_AM21~0(\*2 2);

IJ2 BY T2\_IJ4 T2\_IJ6 T2\_IJ12 T2\_IJ17  
 T2\_IM1~0 T2\_IM11~0 T2\_IM15~0 T2\_IM18~0  
 T2\_ID9~0 T2\_ID16~0 T2\_ID20~0 T2\_ID22~0  
 T2\_EX10~0 T2\_EX14~0 T2\_EX19~0 T2\_EX23~0  
 T2\_AM5~0 T2\_AM7~0 T2\_AM13~0 T2\_AM21~0(\*2 3);

EX2 BY T2\_EX10 T2\_EX14 T2\_EX19 T2\_EX23  
 T2\_IM1~0 T2\_IM11~0 T2\_IM15~0 T2\_IM18~0  
 T2\_ID9~0 T2\_ID16~0 T2\_ID20~0 T2\_ID22~0  
 T2\_IJ4~0 T2\_IJ6~0 T2\_IJ12~0 T2\_IJ17~0  
 T2\_AM5~0 T2\_AM7~0 T2\_AM13~0 T2\_AM21~0(\*2 4);

AM2 BY T2\_AM5 T2\_AM7 T2\_AM13 T2\_AM21  
 T2\_IM1~0 T2\_IM11~0 T2\_IM15~0 T2\_IM18~0  
 T2\_ID9~0 T2\_ID16~0 T2\_ID20~0 T2\_ID22~0  
 T2\_IJ4~0 T2\_IJ6~0 T2\_IJ12~0 T2\_IJ17~0  
 T2\_EX10~0 T2\_EX14~0 T2\_EX19~0 T2\_EX23~0(\*2 5);

!correlate the item's uniqueness across time  
 T1\_IM1-T1\_AM21 PWITH T2\_IM1-T2\_AM21;

!equality constrains on the intercepts  
 [T1\_IM1-T1\_AM21](I1-I20);  
 [T2\_IM1-T2\_AM21](I1-I20);

!equality constrains on the item's uniqueness  
 T1\_IM1-T1\_AM21(rv1-rv20);  
 T2\_IM1-T2\_AM21(rv1-rv20);

**SUPPLEMENTARY MATERIALS APPENDIX 1.5****MPLUS SYNTAX FOR THE STRICT INVARIANCE MODEL FREELY ESTIMATING THE LATENT MEANS AT T2**

MODEL:

!MODEL T1

!Freely estimated main loadings. The ~0 after the non-target loadings specifies cross-loadings that are “targeted” to be close to zero. The (\*1) indicates that IM1, ID1, IJ1, EX1, and AM1 are a set of EFA factors. The second digit in the parentheses places equality constraints on the factor loadings. For example, the (\*1 1) and (\*2 1) specifies equal factor loadings for IM1 and IM2.

```
IM1 BY T1_IM1 T1_IM11 T1_IM15 T1_IM18
T1_ID9~0 T1_ID16~0 T1_ID20~0 T1_ID22~0
T1_IJ4~0 T1_IJ6~0 T1_IJ12~0 T1_IJ17~0
T1_EX10~0 T1_EX14~0 T1_EX19~0 T1_EX23~0
T1_AM5~0 T1_AM7~0 T1_AM13~0 T1_AM21~0(*1 1);
```

```
ID1 BY T1_ID9 T1_ID16 T1_ID20 T1_ID22
T1_IM1~0 T1_IM11~0 T1_IM15~0 T1_IM18~0
T1_IJ4~0 T1_IJ6~0 T1_IJ12~0 T1_IJ17~0
T1_EX10~0 T1_EX14~0 T1_EX19~0 T1_EX23~0
T1_AM5~0 T1_AM7~0 T1_AM13~0 T1_AM21~0(*1 2);
```

```
IJ1 BY T1_IJ4 T1_IJ6 T1_IJ12 T1_IJ17
T1_IM1~0 T1_IM11~0 T1_IM15~0 T1_IM18~0
T1_ID9~0 T1_ID16~0 T1_ID20~0 T1_ID22~0
T1_EX10~0 T1_EX14~0 T1_EX19~0 T1_EX23~0
T1_AM5~0 T1_AM7~0 T1_AM13~0 T1_AM21~0(*1 3);
```

```
EX1 BY T1_EX10 T1_EX14 T1_EX19 T1_EX23
T1_IM1~0 T1_IM11~0 T1_IM15~0 T1_IM18~0
T1_ID9~0 T1_ID16~0 T1_ID20~0 T1_ID22~0
T1_IJ4~0 T1_IJ6~0 T1_IJ12~0 T1_IJ17~0
T1_AM5~0 T1_AM7~0 T1_AM13~0 T1_AM21~0(*1 4);
```

```
AM1 BY T1_AM5 T1_AM7 T1_AM13 T1_AM21
T1_IM1~0 T1_IM11~0 T1_IM15~0 T1_IM18~0
T1_ID9~0 T1_ID16~0 T1_ID20~0 T1_ID22~0
T1_IJ4~0 T1_IJ6~0 T1_IJ12~0 T1_IJ17~0
T1_EX10~0 T1_EX14~0 T1_EX19~0 T1_EX23~0(*1 5);
```

!MODEL T2

!Freely estimated main loadings. The ~0 after the non-target loadings specifies cross-loadings that are “targeted” to be close to zero. The (\*2) indicates that IM2, ID2, IJ2, EX2, and AM2 are a set of EFA factors. The second digit in the parentheses places equality constraints on the factor loadings. For example, the (\*1 1) and (\*2 1) specifies equal factor loadings for IM1 and IM2.

```

IM2 BY T2_IM1 T2_IM11 T2_IM15 T2_IM18
T2_ID9~0 T2_ID16~0 T2_ID20~0 T2_ID22~0
T2_IJ4~0 T2_IJ6~0 T2_IJ12~0 T2_IJ17~0
T2_EX10~0 T2_EX14~0 T2_EX19~0 T2_EX23~0
T2_AM5~0 T2_AM7~0 T2_AM13~0 T2_AM21~0(*2 1);

```

```

ID2 BY T2_ID9 T2_ID16 T2_ID20 T2_ID22
T2_IM1~0 T2_IM11~0 T2_IM15~0 T2_IM18~0
T2_IJ4~0 T2_IJ6~0 T2_IJ12~0 T2_IJ17~0
T2_EX10~0 T2_EX14~0 T2_EX19~0 T2_EX23~0
T2_AM5~0 T2_AM7~0 T2_AM13~0 T2_AM21~0(*2 2);

```

```

IJ2 BY T2_IJ4 T2_IJ6 T2_IJ12 T2_IJ17
T2_IM1~0 T2_IM11~0 T2_IM15~0 T2_IM18~0
T2_ID9~0 T2_ID16~0 T2_ID20~0 T2_ID22~0
T2_EX10~0 T2_EX14~0 T2_EX19~0 T2_EX23~0
T2_AM5~0 T2_AM7~0 T2_AM13~0 T2_AM21~0(*2 3);

```

```

EX2 BY T2_EX10 T2_EX14 T2_EX19 T2_EX23
T2_IM1~0 T2_IM11~0 T2_IM15~0 T2_IM18~0
T2_ID9~0 T2_ID16~0 T2_ID20~0 T2_ID22~0
T2_IJ4~0 T2_IJ6~0 T2_IJ12~0 T2_IJ17~0
T2_AM5~0 T2_AM7~0 T2_AM13~0 T2_AM21~0(*2 4);

```

```

AM2 BY T2_AM5 T2_AM7 T2_AM13 T2_AM21
T2_IM1~0 T2_IM11~0 T2_IM15~0 T2_IM18~0
T2_ID9~0 T2_ID16~0 T2_ID20~0 T2_ID22~0
T2_IJ4~0 T2_IJ6~0 T2_IJ12~0 T2_IJ17~0
T2_EX10~0 T2_EX14~0 T2_EX19~0 T2_EX23~0(*2 5);

```

```

!correlate the item's uniqueness across time
T1_IM1-T1_AM21 PWITH T2_IM1-T2_AM21;

```

```

!equality constrains on the intercepts
[T1_IM1-T1_AM21](I1-I20);
[T2_IM1-T2_AM21](I1-I20);

```

```

!equality constrains on the item's uniqueness
T1_IM1-T1_AM21(rv1-rv20);
T2_IM1-T2_AM21(rv1-rv20);

```

```

!latent means set to zero at T1 and freely estimated at T2
[IM1-AM1@0];
[IM2-AM2];

```

**SUPPLEMENTARY MATERIALS APPENDIX 1.6****MPLUS SYNTAX FOR THE BIFACTOR EXPLORATORY STRUCTURAL EQUATION MODEL****ANALYSIS:**

ESTIMATOR IS MLR; !maximum likelihood parameter estimates with standard errors and a chi-square test statistic (when applicable) that are robust to non-normality. The MLR standard errors are computed using a sandwich estimator.

ROTATION = TARGET(ORTHOGONAL); !specifies target rotation. Specifying orthogonal in the parenthesis overrides the default oblique rotation.

**MODEL:**

!Freely estimated main loadings. The ~0 after the non-target loadings specifies cross-loadings that are “targeted” to be close to zero. The (\*1) indicates that IM1, ID1, IJ1, EX1, AM1, and G1 are a set of EFA factors.

```
IM1 BY T1_IM1 T1_IM11 T1_IM15 T1_IM18
T1_ID9~0 T1_ID16~0 T1_ID20~0 T1_ID22~0
T1_IJ4~0 T1_IJ6~0 T1_IJ12~0 T1_IJ17~0
T1_EX10~0 T1_EX14~0 T1_EX19~0 T1_EX23~0
T1_AM5~0 T1_AM7~0 T1_AM13~0 T1_AM21~0(*1);
```

```
ID1 BY T1_ID9 T1_ID16 T1_ID20 T1_ID22
T1_IM1~0 T1_IM11~0 T1_IM15~0 T1_IM18~0
T1_IJ4~0 T1_IJ6~0 T1_IJ12~0 T1_IJ17~0
T1_EX10~0 T1_EX14~0 T1_EX19~0 T1_EX23~0
T1_AM5~0 T1_AM7~0 T1_AM13~0 T1_AM21~0(*1);
```

```
IJ1 BY T1_IJ4 T1_IJ6 T1_IJ12 T1_IJ17
T1_IM1~0 T1_IM11~0 T1_IM15~0 T1_IM18~0
T1_ID9~0 T1_ID16~0 T1_ID20~0 T1_ID22~0
T1_EX10~0 T1_EX14~0 T1_EX19~0 T1_EX23~0
T1_AM5~0 T1_AM7~0 T1_AM13~0 T1_AM21~0(*1);
```

```
EX1 BY T1_EX10 T1_EX14 T1_EX19 T1_EX23
T1_IM1~0 T1_IM11~0 T1_IM15~0 T1_IM18~0
T1_ID9~0 T1_ID16~0 T1_ID20~0 T1_ID22~0
T1_IJ4~0 T1_IJ6~0 T1_IJ12~0 T1_IJ17~0
T1_AM5~0 T1_AM7~0 T1_AM13~0 T1_AM21~0(*1);
```

```
AM1 BY T1_AM5 T1_AM7 T1_AM13 T1_AM21
T1_IM1~0 T1_IM11~0 T1_IM15~0 T1_IM18~0
T1_ID9~0 T1_ID16~0 T1_ID20~0 T1_ID22~0
T1_IJ4~0 T1_IJ6~0 T1_IJ12~0 T1_IJ17~0
T1_EX10~0 T1_EX14~0 T1_EX19~0 T1_EX23~0(*1);
```

G1 by

```
T1_IM1 T1_IM11 T1_IM15 T1_IM18
T1_ID9 T1_ID16 T1_ID20 T1_ID22
```



T1\_IJ4 T1\_IJ6 T1\_IJ12 T1\_IJ17  
T1\_EX10 T1\_EX14 T1\_EX19 T1\_EX23  
T1\_AM5 T1\_AM7 T1\_AM13 T1\_AM21(\*1);

**SUPPLEMENTARY MATERIALS APPENDIX 2.0**  
**CROSS-CULTURAL EQUIVALENCE OF THE BRSQ**

To further test the psychometric properties of the Swedish version of the BRSQ we examined cross-cultural equivalence by means of measurement invariance testing. We included data collected from New Zealand-based athletes ( $N = 529$ ) reported in a previously published paper (Lonsdale et al., 2008) who responded to the original English version of the BRSQ. We collapsed the samples from Study 1, 2, and 3 reported in Lonsdale et al. (2008) and only included athletes in the same age range as the Swedish sample (i.e., 15-21 years). The mean age of the New Zealand sample was 18.9 ( $SD = 1.39$ ) and comprised 230 males (43.6%) and 297 females (56.4%); 2 athletes did not report sex. A more detailed description of the different sports and competitive levels covered in the sample is provided in Lonsdale et al. (2008). The New Zealand sample was compared to the Swedish sample at T1 to examine cross-cultural equivalence of the BRSQ using ESEM.

We specified increasingly constrained models to examine measurement invariance in the BRSQ following the Meredith (1993) tradition. First, a configural model is estimated, which evaluates the similarity in the overall pattern of parameters between the two groups. No equality constraints are imposed in the configural model; it provides a test of the a priori model in each group and how it fits the data against which subsequent models with constraints can be compared. Second, a metric invariance model is estimated in which the factor loadings are constrained to be invariant across groups. Third, a scalar invariance model is estimated where the item intercepts and factor loadings are constrained to be invariant across groups. Model fit was evaluated with conventional fit indices such as the comparative fit index (CFI), the Tucker-Lewis Index (TLI), the standardized root mean residual (SRMR), and the root mean square error of approximation (RMSEA). CFI and TLI values around 0.90 and SRMR and RMSEA values around 0.08 indicated acceptable model fit (Marsh, 2007). The nested

invariance models were evaluated using Chen's (2007) recommendations that change in CFI ( $\Delta$ CFI) of less than 0.01 and change in RMSEA ( $\Delta$ RMSEA) of less than 0.015 or a change in SRMR ( $\Delta$ SRMR) of less than 0.030 would support metric invariance. For scalar invariance a change in CFI ( $\Delta$ CFI) of less than 0.01 and change in RMSEA ( $\Delta$ RMSEA) of less than 0.015 or a change in SRMR ( $\Delta$ SRMR) of less than 0.010 would indicate invariance across groups.

As seen in Table S1, configural and metric invariance were supported, whereas scalar invariance was not according to the decrease in CFI ( $\Delta$ CFI = 0.019). Hence, we inspected the modification indices (MI) for non-invariant intercepts. The MI provides an approximation of how much the overall  $\chi^2$  will decrease if a fixed or constrained parameter is estimated freely (Brown & Moore, 2012). The MI can be conceptualized as a  $\chi^2$  statistic with 1 df; as such, a critical value of 3.84 is statistically significant at  $p < 0.05$ . We inspected constrained intercepts with MI values larger than 10 (the default in Mplus) because these are more likely to reflect changes that will substantially improve the model fit. Three potentially non-invariant intercepts were identified regulation item 9 (*"because the benefits of sport are important to me"*), identified regulation item 22 (*"because it is a good way to learn things which could be useful to me in my life"*), and external regulation item 10 (*"because if I don't other people will not be pleased with me"*)—with MI values ranging from 20.08 to 42.67. Freely estimating these intercepts did result in a model that supported partial scalar invariance in the BRSQ. A closer look at the intercept values show that the New Zealand athletes scored higher on identified regulation item 9 (6.13 vs 5.42) and lower on identified regulation item 22 (5.06 vs 5.63) and external regulation item 10 (2.43 vs. 2.84) compared to the Swedish athletes. These results tentatively suggest that the meaning of these items may differ between athletes in these two cultures.

Table S1

*Cross-cultural Equivalence of the BRSQ Based on ESEM Models*

| Model                       | $\chi^2$ | <i>df</i> | <i>p</i> | RMSEA [90%CI)        | CFI   | TLI   | SRMR  |
|-----------------------------|----------|-----------|----------|----------------------|-------|-------|-------|
| New Zealand sample          | 276.657  | 100       | 0.000    | 0.058 [0.050, 0.066] | 0.967 | 0.937 | 0.022 |
| Swedish sample              | 169.799  | 100       | 0.000    | 0.044 [0.033, 0.056] | 0.964 | 0.931 | 0.021 |
| Configural                  | 450.572  | 200       | 0.000    | 0.053 [0.047, 0.060] | 0.964 | 0.931 | 0.022 |
| Metric                      | 540.810  | 275       | 0.000    | 0.047 [0.041, 0.053] | 0.962 | 0.947 | 0.050 |
| Scalar                      | 683.365  | 290       | 0.000    | 0.055 [0.050, 0.061] | 0.943 | 0.925 | 0.055 |
| Partial scalar <sup>a</sup> | 600.939  | 287       | 0.000    | 0.050 [0.044, 0.055] | 0.955 | 0.940 | 0.052 |

*Note.* <sup>a</sup>Intercepts of identified regulation item 9 (“because the benefits of sport are important to me”), 22 (“because it is a good way to learn things which could be useful to me in my life”), and external regulation item 10 (“because if I don’t other people will not be pleased with me”), were freely estimated.

### References

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