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Exploratory discriminant validity issues of the Sport Motivation Scale-2

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Abstract
The current study aims to evaluate the factor structure of the 18-item Sport Motivation Scale-2 (SMS-2; Mallett, Kawabata, Newcombe, Forero, & Jackson, 2007) with an independent sample group. The population that participated on the study comprised of 105 participants who completed the SMS-2. Their responses were examined with confirmatory factor analysis and recent exploratory structural equation modelling. A six-factor confirmatory-factor-analysis model did not fit to the sample data adequately. Through examination of the corresponding exploratory-structural-equation-modelling solution, it was found that two items loaded on non-target factors poorly. This result was replicated by a published data set (Mallett, Kawabata, Newcombe, *et al*., 2007). The modified confirmatory-factor-analysis model with these two items removed fit to the present study's data satisfactorily and all 6 factors were adequately differentiated. These results generally validate the SMS-2 responses. Furthermore, this study demonstrated the usefulness of a comparison of confirmatory-factor-analysis and exploratory-structural-equation-modelling solutions for an accurate interpretation of individual parameters.

Keywords: Structural equation modelling, multidimensional motivation, integrated regulation, factorial validity, sports motivation

Introduction

Measurement is a critical issue in empirical research and attempts to progress measurement should be valued and encouraged. In an attempt to progress measurement in contextual sport motivation using self-determination theory (SDT; Deci & Ryan, 1985) [7], the Sport Motivation Scale (SMS; Pelletier, Vallerand, Tuson, Brière, & Blais, 1995) [24] was revised and a 6-factor 24-item scale (SMS-2; Mallett, Kawabata, Newcombe, Forero, & Jackson, 2007) [12] was developed by including integrated regulation. Consistent with SDT, the SMS-6 measures six forms of motivation: amotivation, external regulation, introjected regulation, identified regulation, integrated regulation, and intrinsic motivation. When Mallett, Kawabata, Newcombe, *et al*. (2007) [13] examined the SMS-6 factor structure using confirmatory factor analysis, however, Identified Regulation was not empirically distinguishable from Intrinsic Motivation and Integrated Regulation factors. They urged future researchers to examine the factor structure of the SMS-2 with different independent samples in order to know whether the problem was sample specific. Construct validation is an ongoing process (Marsh & Jackson, 1999) [15], and further examination of the SMS-2 is necessary to evaluate the efficacy of the SMS-2 in measuring contextual sport motivation.

Exploratory Structural Equation Modelling

The discriminant validity issue of the Identified Regulation found in the SMS-2 might be sample specific. If the issue is observed with different samples; however, it may be attributed to other reasons. One of the reasons could be related to an unrealistic methodological assumption required in confirmatory factor analysis (Asparouhov & Muthén, 2009; Marsh *et al*., 2009, 2010; Morin & Maïano, 2011; Myers, Chase, Pierce, & Martin, 2011) [2, 17, 16, 20, 23]. The confirmatory-factor-analysis measurement model has been used for the latent variable measurement specification in the framework of structural equation modelling (Bollen, 1989; Asparouhov & Muthén, 2009) [5, 17]. In typical confirmatory factor analysis, each indicator is required to load onto only one factor and no cross-loadings are allowed. This strict requirement, however, often produces poor fit of a priori model to the data (Asparouhov & Muthén, 2009) [2]. Furthermore, even when a confirmatory-factor-analysis model fits to the data well, misspecification of zero cross-loadings usually inflates factor correlations to some extent unless all non-target loadings are close to zero (Asparouhov & Muthén, 2009; Marsh *et al*., 2009, 2010) [2, 17, 16]. Consequently, inflated factor correlations lead to two key issues: the lack of discriminant validity and multicollinearity (Asparouhov & Muthén, 2009; Marsh *et al*., 2010) [17, 16]. Despite these methodological disadvantages of confirmatory factor analysis, the confirmatory-factor-analysis approach to factor analysis has been dominant for a decade over exploratory factor analysis in applied research (Marsh *et al*., 2009) [17]. Marsh and colleagues (2009, 2010) [17, 16] assumed that it is due to applied researchers' erroneous beliefs that exploratory factor analysis is outdated and no longer acceptable and methodological advantages related to confirmatory factor analysis (e.g., goodness-of-fit indices, latent mean structures) are not applicable to exploratory factor analysis.

To overcome these methodological issues related to the traditional confirmatory factor-analysis approaches and provide a richer set of a priori model alternatives, Asparouhov and Muthén (2009) [2] developed exploratory structural equation modelling that integrates the relative advantages of confirmatory factor analysis and exploratory factor analysis within the structural-equation-modelling framework. Exploratory structural equation modelling is a less restrictive measurement model in which factor loading matrix rotations can be used and all the common structural-equation-modelling parameters (e.g., residual correlations) and latent mean structures are available. The primary advantage of the exploratory-structural-equation modelling model over existing modelling practices is that it seamlessly includes exploratory factor-analysis and structural-equation-modelling models, making model testing sequences better (Asparouhov & Muthén, 2009) [2]. In most applications with multiple factors, the exploratory-factor-analysis approach is employed to identify factors and usually followed by an exploratory-factor-analysis-based confirmatory-factor-analysis model to specify a simple structure. However, the conversion of an exploratory-factor-analysis model into a confirmatory-factor-analysis model results in potential issues (e.g., poor model fit). On the other hand, the exploratory-structural-equation-modelling model carries out these tasks in a one-step approach by simultaneously estimating measurement and structural parts. Therefore, the exploratory-structural-equation-modelling approach is more precise because it evades the conversion problem. For these flexibilities and merits of exploratory structural equation modelling, Marsh and colleagues (2010) [16] recommended that, "subsequent CFA [confirmatory-factor-analysis] studies routinely consider ESEM [exploratory-structural equation-modelling] solutions as a viable alternative, even when the fit of CFA solutions is apparently acceptable" (p. 485).

The Present Study

Ryan (2011, April 22) [25], a founding father of SDT on which the SMS-2 is based, reported concerns about scale development through exclusive focus on independence of interrelated constructs, which could lead to distortion of the constructs themselves. Given that motivation is conceptualized along the self-determination continuum within SDT (Ryan & Deci, 2007) [26] and positive correlations between adjacent factors on the continuum are expected; it seems theoretically questionable to suppose all non-target cross-loadings are zero for the SMS-2. The discriminant validity issues of the SMS-2 responses could be due to their specific sample and/or the unrealistic methodological assumption of the typical confirmatory factor-analysis structure for the SMS-2. To examine these issues, therefore, the factor structure of the SMS-2 was re-assessed with an independent Kenyan sample using both confirmatory-factor-analysis and exploratory-structural-equation-modelling approaches and their solutions were compared.

Method

Participants and Procedure

A total of 105 male rugby players agreed to participate in the present study. Participants' ages ranged from 17 to 31 years (M = 19.7, SD = 4.3). They respondents were recruited from Kenya cup clubs. The study was approved by an institutional review committee and adhered to the guidelines for ethical practice. Participation was voluntary and informed consent was received from each participant. To be eligible for participation in this study, they were required to be injured during the period of the study.

Measures

Sport Motivation Scale-2 (SMS-2)

The SMS-2 consisted of the 18 items measuring several factors (three types of intrinsic motivation, four types of extrinsic motivation, and amotivation) as proposed by SDT. It is a measure of contextual motivation that is designed to identify the perceived reasons for participating in sport. Participants' motivation was assessed using a 7-point Likert scale ranging from 1 (Not at all true) to 7 (Very true) with the midpoint depicting Somewhat True.

Data Analyses

Confirmatory factor analysis and exploratory structural equation modelling were conducted with *Amos* (Version 6.12; Muthén & Muthén, 2011) [22] based on *Amos* robust maximum likelihood estimation (MLR). An oblique geomin rotation was used because the SMS-6 factors are expected to covary and the geomin rotation criterion is the most effective criterion when the true factor loading structure is unknown (Asparouhov & Muthén, 2009) [17]. In the typical confirmatory-factor-analysis model, each item is allowed to load on only one target factor and all non-target cross-loadings are constrained to be zero. In contrast, all items are allowed to load on every factor and all factor loadings are estimated in the exploratory structural-equation-modelling model by imposing appropriate restrictions on the factor loading matrix and the factor covariance matrix (Marsh *et al*., 2009, 2010 [17, 16]; see also Asparouhov & Muthén, 2009 [2] for further details of the exploratory-structural-equation modelling approach and identification issues). For this reason, the confirmatory-factor analysis model is more parsimonious than the exploratory-structural-equation-modelling model. In the present study, the degrees of freedom for the 18-item SMS-2 are 237 and 147 for the confirmatory-factor-analysis and exploratory – structural – equation - modelling models, respectively. When the more parsimonious confirmatory-factor-analysis model adequately fits the data similar to the exploratory-structural-equation-modelling model, then the confirmatory-factor-analysis model should be used (Marsh *et al*., 2010) [16].

To assess overall model fit, several criteria were used: the MLR chi-square statistic

(Muthén & Muthén, 1998-2011) [23], the comparative fit index (CFI; Bentler, 1990) [4], the Tucker-Lewis index (TLI; Tucker & Lewis, 1973) [29], the root mean square error of approximation (RMSEA; Steiger, 1990) [28], and the standard root mean square residual (SRMR; Hu & Bentler, 1998) [9]. Values on the CFI and TLI that are greater than .90 and .95 are generally taken to reflect acceptable and excellent fits to the data (e.g., Marsh *et al*., 2009, 2010) [17, 16]. For the RMSEA, values of .05 or less indicate a close fit, and .08 or less indicate an adequate fit. Finally, values on the SRMR that are less than .08 indicate an adequate fit (Hu & Bentler, 1999) [10]. In a well-fitting model, this value should be small—.05 or less. Hu and Bentler (1999) [10] reported that mispecified models are unlikely to be accepted if models are rejected when a) the CFI or TLI is less than .95 and b) the SRMR is greater than .09 (or .10). Although Hu and Bentler (1998, 1999) [10] proposed the more stringent cut-off criteria and the two-index strategy, they and others have cautioned about potential overgeneralization of their findings (e.g., Fan & Sivo, 2005; Marsh, Hau, & Wen, 2004) [14].

Consistent with current research (e.g., Marsh *et al*., 2009, 2010; McLachlan, Spray, & Hagger, 2011) [17, 16], therefore, conventional multiple cut-off values (i.e., the CFI and TLI $\geq$ .90, the RMSEA $\leq$ .08, the SRMR $\leq$ .08) were considered minimum thresholds for accepting model fit and achievement of Hu and Bentler's (1999) [10] more stringent criteria for the CFI and TLI as evidence of an excellent fit.

Results

Descriptive Statistics

The means and standard deviations of the 18 item scores ranged as follows: from 1.62 to 5.24 for means and from 1.11 to 1.90 for standard deviations. The items with the lowest and highest mean scores were Item 17 (Amotivation: "It is not clear to me anymore; I don't really think my place is in sport") and Item 1 (Intrinsic Motivation: "For the excitement I feel when I am really involved in the activity"), respectively (item numbers are consistent with those listed in Mallett, Kawabata, Newcombe, *et al*., 2007) [12]. Cronbach's αs for the subscales of the SMS-6 ranged from .71 (Identified Regulation) to .84 (Integrated Regulation), with a mean of .80.

Confirmatory Factor Analysis and Exploratory Structural Equation Modelling

Factor structure

The six-factor confirmatory-factor-analysis model did not fit to the data adequately (MLRχ^2 [237, N = 437] = 712.68, p < .001; CFI = .889, TLI = .871, RMSEA = .068, SRMR = .059). Although values on the RMSEA and SRMR were acceptable, values on the CFI and TLI were below minimum acceptable levels. Apparent problems were also observed with individual parameters. All factor loadings were substantial and statistically significant (range = .52–.84); however, inter-factor correlations ranged from -.25 to .95 and caused concerns about the discriminant validity of highly correlated factors. Identified Regulation was highly correlated with Intrinsic Motivation (.92) and Integrated Regulation (.95), which was consistent with the findings reported in Mallett, Kawabata, Newcombe, *et al*. (2007) [13]. Bagozzi and Kimmel (1995) [1] proposed adding 1.96 times the standard error of the correlation to the correlation in order to construct the upper bound of a 95% confidence interval for the correlation. If the upper bound is less than 1, this is considered as evidence of discriminant validity. Based on Baggozzi and Kimmel's (1995) [1] approach, the upper bounds of the two correlations were less than 1 (viz., .973 between Identified Regulation and Intrinsic Motivation and .998 between Identified Regulation and Integrated Regulation). Although these factors were highly correlated, they were found empirically distinct for the current sample.

The six-factor exploratory-structural-equation-modelling provided an excellent fit to the data (MLRχ^2 [147, N = 437] = 336.82, p < .001; CFI = .961, TLI = .927, RMSEA = .054, SRMR = .023). Compared to the corresponding confirmatory-factor-analysis model, it fit to the data much better. The size of correlations among the six factors was also considerably smaller for the exploratory-structural-equation-modelling solution, ranging from -.18 to .46.

Identified Regulation correlated with Intrinsic Motivation (.37) and Integrated Regulation (.42) and there was no concern about the discriminant validity issue between them. Examination of factor loadings, however, revealed that three items poorly loaded on their target factors. They were Items 4 (External Regulation: "Because it allows me to be well regarded by people that I know"), 15 (Identified Regulation: "Because it is one of the best ways to maintain good relationships with my friends"), and 20 (Identified Regulation: "Because training hard will improve my performance"). Items 4 and 15 were from the original SMS and Item 20 was from the revised SMS-6. None of these cross-loadings were surprisingly detected with modification indexes in the confirmatory-factor-analysis procedure. Given that Item 20 loaded on Intrinsic Motivation (.41) and Integrated Regulation (.34), it was apparent that these cross-loadings contributed to the unsatisfactory overall fit and the high correlation of Identified Regulation with Intrinsic Motivation and Integrated Regulation. These three items were highly problematic because they loaded on non-target factors more strongly than hypothesized target factors. Nevertheless, these poor loadings might be specific to the present sample. These findings were, therefore, cross-examined by conducting exploratory structural equation modelling on a data set used in Mallett, Kawabata, Newcombe, *et al*. (2007) [12]. The data were collected from 557 undergraduates (44.2% men) studying at the same university as the present study. Their ages ranged from 16 to 43 years (M = 20.0, SD = 3.5). This sample was involved in 49 different sport activities. Comparing the demographic characteristics of this sample with the sample of the present study, these two samples were considered independent samples representing the same population.

The six-factor exploratory-structural-equation-modelling model also fit to the crossexamination data well (MLRχ^2 [147, N = 557] = 343.74, p < .001; CFI = .967, TLI = .938, RMSEA = .049, SRMR = .021). The correlations among the six factors ranged from -.08 to .43. An examination of the factor loadings revealed that Items 15 and 20 inadequately loaded on their target factor again (their loadings on Identified Regulation factor were .23 and .04 for Items 15 and 20, respectively), whereas Item 4 loaded well on External Regulation (.62). Because the poor loadings of Items15 and 20 were consistently observed across two samples, confirmatory factor analysis and exploratory structural equation modelling were conducted again excluding these two items.

The confirmatory-factor-analysis model with 22 items provided a satisfactory fit to the data (MLRχ^2 [194, N = 437] = 511.71, p < .001; CFI = .918, TLI = .902, RMSEA = .061, SRMR = .055). Furthermore, no problems were observed with individual parameters. All factor loadings were statistically significant (range = .59–.83) and inter-factor correlations ranged from -.25 to .77. The corresponding exploratory structural equation modelling also provided an excellent fit to the data (MLRχ^2 [114, N = 437] = 243.31, p < .001; CFI = .970, TLI = .940, RMSEA = .051, SRMR = .020). All items, except for Item 4, loaded on their target factors more than non-target factors (the range of factor loadings on target factors = .37–.88), and inter-factor correlations ranged from -.19 to .44. The sizes of factor loadings on target factors were comparable between the confirmatory-factor-analysis and exploratory structural-equation-modelling solutions, but the sizes of inter-factor correlations were different. By comparison with the exploratory-structural-equation-modelling solutions, the size of relations among the factors was found somewhat distorted in the confirmatory-factor analysis solution by fixing all cross-loadings to be zero.

Correlations among the SMS-2 factors

The correlation matrix of the SMS-6 factors was analyzed to determine whether the self-determination continuum postulated by Deci and Ryan (1985) [7] emerged for the present sample. This continuum would be supported when a simplex pattern is displayed in which adjacent factors have positive correlations and the factors at the opposite end of continuum (i.e., Intrinsic Motivation and Amotivation) have a negative correlation. In both confirmatory-factor-analysis and exploratory-structural equation-modelling solutions, correlations among the six latent factors demonstrated the simplex pattern in general (see Table 1). External Regulation, however, did not follow the expected simplex pattern, as reported in the study by Standage, Duda, and Ntoumanis (2003) [27].

Concurrent validity

Latent factor correlations between the SMS-2 was assessed to examine the concurrent validity of the SMS-6 responses (18 items). For the comparison between confirmatory-factor-analysis and exploratory-structural-equation modelling solutions, two models were analyzed. In the first model, both SMS-2 were specified as confirmatory-factor-analysis factors. In the second model, the SMS-2were specified as exploratory-structural-equation-modelling and confirmatory-factor-analysis factors, respectively. Considering individuals who are intrinsically motivated are likely to experience flow (Deci & Ryan, 1985) [7], it was assumed that the SMS-2 factors more correlated with Intrinsic Motivation in a positive direction, but negatively correlated with Amotivation. Both models provided an acceptable fit to the data (the first model: MLRχ^2 [1490, N = 437] = 2520.01, p < .001; CFI = .911, TLI = .901,

RMSEA = .040, SRMR = .049; the second model: MLRχ^2 [1410, N = 437] = 2416.53, p < .001; CFI = .921, TLI = .908, RMSEA = .040, SRMR = .041). Inter-factor correlations between the SMS-6 and DFS-2 factors ranged from -.45 to .69 for the first model and from .41 to .65 for the second model. The size of correlations among the factors was found comparable between both the models. In the both models, Intrinsic Motivation positively correlated with DFS-2 factors, whereas Amotivation provided negative correlations with the dispositional flow factors (see Table 2). These results supported the concurrent validity of the SMS-2 responses.

Summary and Implications

The factor structure of the SMS-2 was examined in the present study for an independent Australian sample by using confirmatory-factor-analysis and exploratory-structural-equation modelling approaches to investigate its discriminant validity issues. The confirmatory-factor analysis model with all 24 items did not fit to the sample data adequately, and Identified Regulation was highly correlated with Intrinsic Motivation and Integrated Regulation. Through examination of the corresponding exploratory-structural-equation-modelling solution, it was found that Items 4, 15, and 20, which were not detected with modification indexes in the confirmatory-factor-analysis procedure, loaded on non-target factors more than target factors. This finding was cross-examined by conducting exploratory structural equation modelling on a published data set and the poor loadings of Items 15 and 20 on Identified Regulation were consistently observed across the independent samples. By eliminating the items, the confirmatory-factor-analysis model fit to the data satisfactorily and all six factors were adequately differentiated even though the size of inter-factor correlations in confirmatory-factor-analysis was somewhat inflated compared to the exploratory-structural equation-modelling solutions. These results, together with the findings of the concurrent validity analyses, generally supported the validity of the SMS-2 responses.

The present study revealed that the discriminant validity issue of Identified Regulation was attributable to Items 15 and 20. Identified Regulation is internally regulated or self-determining because the person considers the behaviour as important and endorsed even though the individual pursues particular valued outcomes. Item 20 ("Because training hard will improve my performance") loaded onto Intrinsic Motivation and Integrated Regulation. This item was developed from previous research (Mallett & Hanrahan, 2004) [11] that reflected a strong behaviour of elite athletes. Perhaps part of Item 20 "improving performance" was associated with a sense of accomplishment – a form of intrinsic motivation. Replacing "will" with 'is necessary' in Item 20 might emphasize its instrumental aspect. Item 15 ("Because it is one of the best ways to maintain good relationships with my friends") from the original SMS loaded onto External Regulation. Perhaps the participants perceived little autonomy in this statement. To lessen the aspect of external contingencies and emphasize partial internalization, it is suggested to insert the phrase 'I have chosen' to Item 15, thus reading, "Because I have chosen it to be one of the best ways to maintain good relationships with my friends." Considering the inadequate loading on their target factor (i.e., Identified Regulation) was observed in exploratory-structural-equation-modelling solutions across two independent Australian samples (i.e., the present study and Mallett, Kawabata, Newcombe, *et al*., 2007) [13], it could be suggested to exclude these two items from analyses when data are collected from Australian samples or to modify the two items as mentioned above. Further research would be required to determine if the items are problematic for samples from other English-speaking communities.

With regard to the correlations among the SMS-6 factors, External Regulation did not follow the expected simplex pattern, consistent with the study by Standage, Duda, and Ntoumanis (2003) [27]. They suggested that the four items of the original SMS measuring External Regulation did not map well onto this form of motivation as conceptualised in SDT (Deci & Ryan, 1985) [7]. Specifically, they argued that the items are not reflecting the controlling aspects of External Regulation. For example, the item proposed as measuring

External Regulation, "For the prestige of being an athlete" might reflect a sense of accomplishment (Intrinsic Motivation) and relate to the psychological need of competence.

The perceived need of competence is related to self-determined forms of motivation (Deci & Ryan, 1985) [7]. For the revised SMS-2, three of four items measuring External Regulation were from the original SMS, including Item 4. The positive relationships between External Regulation and the three subscales of self-determined motivation in this study support the findings of Standage *et al.* and the lack of clarity around the controlling nature of External Regulation as measured by the items may explain these unexpected positive relationships. In contrast, some recent measures of External Regulation highlight the controlling nature of this non-self-determined form of motivation associated with coaching practice. For example, the following items reflect the controlling aspect of External Regulation: "Because I want to be appreciated by others" in the Coach Motivation Questionnaire (McLean, Mallett, & Newcombe, in press) and "My coach tries to motivate me by promising to reward me if I do well" in the Controlling Coach Behaviors Scale (Bartholomew, Ntoumanis, & Thøgersen Ntoumani, 2010) [3].

As for the concurrent validity of the SMS-2 responses (18-items), latent factors ON SMS-22 were correlated in the expected way. Intrinsic Motivation was substantially positively correlated with the flow factors. Vallerand, Donahue, and Lafrenière (2012) [30] concerned that the Integrated Regulation factor of the SMS-2 may lack discriminant validity because the correlations between Integrated Regulation and flow factors reported in Mallett, Kawabata, Newcombe, *et al*., (2007) [12] were highly similar to Intrinsic Motivation and Identified Regulation. With the present sample, however, the correlations between Integration Regulation and flow factors were different from those of Intrinsic Motivation and Identified Regulation. These results supported the concurrent validity of the SMS-2 responses as well as the discriminant validity of the Integrated Regulation factor.

Finally, the current study indicated that a comparison of the confirmatory-factor analysis and exploratory-structural-equation-modelling solutions is most useful to interpret individual parameters in the quest for the development of valid measures in sport psychology. Construct validation is an ongoing process and it is proposed that those developing measures continue to examine relevant validity issues to ensure the research undertaken has integrity. Although exploratory structural equation modelling is currently only available in the Amos statistical package, it is recommended considering exploratory – structural – equation - modelling solutions as a part of multivariate strategies for construct validity assessment.

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