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Testing for multigroup invariance of the perceived locus of causality in sport

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ABSTRACT

One popular scale in measuring motivation in sport is the perceived locus of causality (PLOC). While the scale has been widely utilized in sport, there is lack of empirical evidence to support the equivalence of the scale across diverse age groups. The Singapore government has recently initiated a new project to propel youths' participation in sport. For an effective implementation of the project, it is important to develop students' interests and motivation to continue their involvement and behavioural persistence for sport. The purpose of the study was to test the invariance of all PLOC items proposed to measure their respective factors across three age groups. A sample of 3289 students took part in the study. The results revealed that several items were perceived differently across the students in the three academic groups.

1. Introduction

A study of motivation of involvement in sport concerns questions such as "why do I take part in sport?" or "why I choose soccer rather than basketball?" These are fundamental questions to be answered since the reasons will affect the consequences of involvement in sport. People may be involved in sport with different types of motives. For example, a basketball player plays games because s/he truly loves basketball itself or another player plays the games because s/he strives to achieve status for representing a team. There is an assumption in the sport psychology literature that intrinsic motivation is more advantageous than is extrinsic motivation in sport involvement (McNeill & Wang, 2005; Standage, Duda, & Ntoumanis, 2005). Intrinsic motivation is defined as doing something for its own sake while extrinsic motivation is defined as doing something as a means to an end (Deci & Ryan, 1985).

1.1. Self-determination theory

According to the self-determination theory (SDT) proposed by Deci and Ryan (1985), intrinsic motivation refers to the behaviour that is undertaken solely for its own sake or enjoyment. When one says, "I run every day because I enjoy it", it is an example of intrinsic motivation. This is the highest level of self-determination whereby the behaviour emanates fully from the self.

The SDT views that extrinsic motivation varies regarding the degree to which they represent autonomous or self-determined (versus controlled) functioning (Deci & Ryan, 1985). The SDT suggests that there are at least three main types of extrinsic motivation, each reflecting a qualitatively different 'reason' for acting out the behaviour in the questions. The extrinsic motivation types are external, introjected, and identified. Deci and Ryan also included integrated regulation as the most self-determined form of extrinsic motivation in the continuum. However, this regulation has been mainly found in adult populations and therefore was not included in this study (Wang & Biddle, 2007). External regulation is the most externally controlled form of extrinsic motivation, and it refers to the behaviour controlled by external means, such as rewards or external authority. One example is that a soccer player comes to attend training sessions because s/he wants to avoid punishment from a coach. Introjected regulation refers to the behaviour internally controlled or self-imposed, with internal contingencies of reward and punishment, and is characterized by feelings of 'ought' or 'must'. A gymnast saying "I must complete the stretching routine otherwise I will feel bad about myself" might exhibit this regulation. Identified regulation is formed when an individual engages in an extrinsic behaviour because s/he identifies with its values and purposes. It is characterized by feelings of 'want' rather than 'ought' For example, a swimmer may say "I want to do weight training everyday because it will help me develop my leg power".

In addition to these four regulations, a state of amotivation exists where a person attends an activity literally without any motivation. An amotivated person has no personal causation and no intention to act. One can be amotivated due to feeling incompetent, perceiving lack of contingency between his or her own actions and outcomes, or the act has no value, whether extrinsic or intrinsic.

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1.2. Perceived locus of causality in physical education (PE) and sport

Using the Academic Self-Regulation Questionnaire (ASRQ), Ryan and Connell (1989) showed that the different types of behavioural regulations were correlated on a simplex-like or ordered correlation structure, supporting the underlying continuum of autonomy. This continuum from intrinsic motivation to amotivation may help researchers determine individuals' motivational orientation levels in sport and eventually predict important consequences, such as attitudes, intentions, and enjoyment. Goudas, Biddle, and Fox (1994) adapted the ASRQ and added the amotivation scale from the Academic Motivation Scale (AMS; Vallerand et al., 1992) to measure the five types of behavioural regulation in the PE/sport contexts. This questionnaire is named as the perceived locus of causality (PLOC).

While the ASRQ was originally targeted for students in late primary and secondary schools, the AMS was designed for college students (Deci, Vallerand, Pelletier, & Ryan, 1991). Although the scales were initially developed for specific age groups, they were widely utilized for diverse student groups in the PE/sport contexts. Due to growing concern on its validation, there have been several researchers who tested the multigroup invariance of the PLOC across different groups (Ntoumanis, 2001; Standage et al., 2005; Wang, Hagger, & Liu, 2009). Ntoumanis and Standage et al. tested the multigroup invariance tests of the model with respect to gender of British school students. Wang et al. tested the equivalence of the measurement parameters across high school students in both Singapore and the United Kingdom to see whether the scale was workable in different cultural settings. Considering the popularity of research on motivations in various youth groups, however, there has been no attempt to test factorial invariance of the PLOC in sport across different age groups, particularly across primary, secondary, and junior colleges (namely high schools), which are all levels of educational institutes where sport is being included in the PE curriculum. The equivalence of the measurement model across the different age groups will grant justification of its validity of utilizing the PLOC scale. That is, it will address the concern that items used in survey-type instruments convey the same meaning to subjects in different age groups.

Therefore, the primary purpose of the present study was to test invariance of all PLOC items proposed to measure their respective factors across three student groups, primary, secondary, and junior college students. As an exploratory stage, we were interested in measuring the equivalence of factor loadings of the scale to validate the items across the groups.

2. Method

2.1. Participants

A sample of 3333 students between 10 to 18 years old from 28 schools in Singapore took part in the study. After 44 questionnaires were removed from the data pool due to incompleteness, 3289 questionnaires were utilized for further analyses. There were 1447 primary school students, 1440 secondary school students, and 4032 junior college students in the sample set. The participants consisted of 1233 boys and 1945 girls while 111 participants did not indicate their gender.

2.2. Measures

Ryan and Connell (1989) proposed a four-dimensional model of the PLOC for academic performance, and the four reasons for achievement related behaviour included external regulation, introjected regulation, identified regulation, and intrinsic motivation. Subsequent studies (Goudas et al., 1994; Wang et al., 2009) adopted the ASRQ and added the amotivation subscale to measure students' motivational orientations in the PE/sport settings. The proposed PLOC in sport showed an adequate fit to the data; NFI = .97 and .98, CFI = .98 and .98, and RMSEA = .06 and .06, for the Singaporean and the British samples, respectively (Wang et al., 2009). The current study included 17 items used in the PE/sport literature.

2.3. Data analysis

In order to test invariance of the patterns of factor loadings in the scale across the three groups, we relied heavily on Byrne's (2004) multisteps for testing multigroup invariance using the AMOS program. The analysis of the data was twofold; stage one for the identification of a baseline model which best fits to data of each group and stage two for further tests of invariance of the factor loadings across the three groups. All analyses were determined at the .01 probability level.

Stage one. As a prerequisite step for invariance testing, it is necessary to determine a baseline model driven from the perspectives of both parsimony and substantive meaningfulness (Byrne, 2004). Based on prior knowledge (Goudas et al., 1994; Wang et al., 2009), the five-factor measurement model of the PLOC was hypothesized. The measurement model was tested within each of the three groups using three independent confirmatory factor analyses (CFAs) to validate the baseline model.

Stage two. Prior to testing invariance of all loadings, the study again tested the overall model fit of the determined baseline model across the three groups simultaneously, rather than separately, for further comparisons. The reason was "...the fit of this simultaneously estimated model can provide the baseline value against which all subsequently specified models are compared" (Byrne, 2004, p. 279).

Second, given a finding that the model showed a good fit across the three student groups, a partially constrained model all of whose loadings were imposed to be equal was compared with the fully unconstrained model (i.e., baseline model) using a chi-square difference test across the three groups simultaneously. This comparative procedure can be utilized since the constrained model is nested in the baseline model (Byrne, 2004). If the test fails to reject the null of equality, it seems that all loadings are invariant across the three groups. However, if the test rejects the null of equality, it indicates that there is(are) certain loading(s) which is(are) variant between certain two groups.

Third, given a finding that the test rejected the null, we further investigated which factor(s) had problematic loading(s). For this, we attempted to detect problematic factor(s) in advance in each combination of group pairings (e.g., primary vs. secondary, secondary vs. junior college, and primary vs. junior college) by imposing constraints on all loadings within each factor in order. If a chi-square difference test fails to reject the null of equality of all loadings in a certain factor between certain two groups, it seems that all items in the factor were invariant between the student groups.

Finally, if any chi-square difference test rejected the null of equality of all loadings in a factor between two groups, we employed a series of analyses by placing constraints on individual loadings in sequence in the factor. We then compared chi-square values of constrained models with their respective rival models that showed insignificant differences in the previous tests. Through the multistep process, all tests for invariance of the 17 loadings across the three groups were completed.

3. Results

3.1. Stage one: testing for the validity of the PLOC model for each group

Three separate CFAs were conducted to see whether the PLOC model fitted to each data set as a prerequisite. The goodness-of-fit tests revealed that the model well fitted to each data: $\chi^2(109, n = 1447) = 1087.49$, RMSEA = .08, CFI = .94, and GFI = .91 for the primary group; $\chi^2(109, n = 1440) = 1331.06$, RMSEA = .09, CFI = .95, and GFI = .90 for the secondary group; $\chi^2(109, n = 402) = 588.31$, RMSEA = .10, CFI = .94, and GFI = .85 for the junior college group. Since the adequacy of the model was cross-validated for the three independent groups, the model was identically specified for each group as a baseline model for further invariance tests. All results done in the following section were presented in Table 1.

3.2. Stage two: testing for multigroup invariance

The global fit of the baseline model across the three groups. We repeated a test of the goodness-of-fit of the model across the three groups simultaneously. The test revealed that the determined baseline model still represented a fairly good fit: $\chi^2(327, N = 3289) = 3007.26$, RMSEA = .05, CFI = .90, and GFI = .90. The chi-square value and degree of freedom for this unconstrained multigroup model (Model 1) served as an initial baseline model for further subsequently constrained models.

Testing for invariance of loadings across the three groups. Since this study was interested in the equality of the factor patterns in the proposed model, a specified model where all loadings were constrained to be equal across the three groups was compared with Model 1. If a chi-square comparison test yields non significance, it can be concluded that all loadings were equivalent across the three groups. Unfortunately, the test rejected the null of equality of all loadings (Entry 2). Given the finding, it was assumed that there was non-invariance of loadings between certain pair(s).

Testing for invariance of loadings between primary and secondary groups. A series of chi-square difference tests were employed to detect any problematic item between primary and secondary groups. The previous Model 1 was utilized again to establish a comparative base. However, the model was tested across only the two groups at this point, denoted as Model 2, and its chi-square and degree of freedom values were reported on Entry 3. Then, a model constrain-

Table 1
Invariance tests for loadings across three groups.

Entry	Model description	Groups	Rival model	χ^2	*df*	$\Delta\chi^2$	Δdf	Significance
1	Baseline model (Model 1)	Primary, secondary, junior college	–	3007.3	327	–	–	–
2	All loadings constrained to be equal		Model 1	3173.4	351	166.1	24	$p < .01$
3	Baseline model (Model 2)	Primary, secondary	–	2418.6	218	–	–	–
4	All loadings constrained to be equal		Model 2	2486.2	230	67.6	12	$p < .01$
5	Loadings on INTRJ constrained to be equal (Model 2a)		Model 2	2427.8	221	9.2	3	N.S.
6	Model 2a with loadings on EXT constrained to be equal (Model 2b)		Model 2a	2438.5	224	10.7	3	N.S.
7	Model 2b with loadings on IDEN constrained to be equal (Model 2c)		Model 2b	2446.9	226	8.4	2	N.S.
8	Model 2c with loadings on IM constrained to be equal		Model 2c	2473.5	228	26.6	2	$p < .01$
9	Model 2c with loading of im2 constrained to be equal		Model 2c	2470.1	227	23.2	1	$p < .01$
10	Model 2c with loading of im3 constrained to be equal (Model 2d)		Model 2c	2448.0	227	1.1	1	N.S.
11	Model 2d with loadings on AM constrained to be equal		Model 2d	2461.2	229	13.2	2	$p < .01$
12	Model 2d with loading of am2 constrained to be equal (Model 2e)		Model 2d	2453.1	228	5.1	1	N.S.
13	Model 2e with loading of am3 constrained to be equal		Model 2e	2461.2	229	8.1	1	$p < .01$
14	Baseline model (Model3)	Primary, junior college	–	1676.2	218	–	–	–
15	All loadings constrained to be equal		Model 3	1817.3	230	141.1	12	$p < .01$
16	Loadings on INTRJ constrained to be equal		Model 3	1732.2	221	56.0	3	$p < .01$
17	Loading of intrj2 constrained to be equal		Model 3	1721.0	219	44.8	1	$p < .01$
18	Loading of intrj3 constrained to be equal (Model 3a)		Model 3	1676.3	219	.1	1	N.S.
19	Model 3a with loading of intrj4 constrained to be equal		Model 3a	1723.4	220	47.1	1	$p < .01$
20	Model 3a with loadings on EXT constrained to be equal		Model 3a	1691.4	222	15.1	3	$p < .01$
21	Model 3a with loading of ext2 constrained to be equal (Model 3b)		Model 3a	1676.8	220	.5	1	N.S.
22	Model 3b with loading of ext3 constrained to be equal		Model 3b	1690.7	221	13.9	1	$p < .01$
23	Model 3b with loading of ext4 constrained to be equal (Model 3c)		Model 3b	1677.8	221	1.0	1	N.S.
24	Model 3c with loadings on IDEN constrained to be equal		Model 3c	1695.4	223	17.6	2	$p < .01$
25	Model 3c with loading of iden2 constrained to be equal (Model 3d)		Model 3c	1681.3	222	3.5	1	N.S.
26	Model 3d with loading of iden3 constrained to be equal		Model 3d	1695.4	223	14.1	1	$p < .01$
27	Model 3d with loadings on IM constrained to be equal		Model 3d	1703.2	224	21.9	2	$p < .01$
28	Model 3d with loading of im2 constrained to be equal		Model 3d	1701.8	223	20.5	1	$p < .01$
29	Model 3d with loadings of im3 constrained to be equal		Model 3d	1693.0	223	11.7	1	$p < .01$
30	Model 3d with loadings on AM constrained to be equal		Model 3d	1712.3	224	31.0	2	$p < .01$
31	Model 3d with loading of am2 constrained to be equal		Model 3d	1696.8	223	15.5	1	$p < .01$
32	Model 3d with loading of am3 constrained to be equal		Model 3d	1712.0	223	30.7	1	$p < .01$
33	Baseline model (Model 4)	Secondary, junior college	–	1919.7	218	–	–	–
34	All loadings constrained to be equal		Model 4	1981.6	230	61.9	12	$p < .01$
35	Loadings on INTRJ constrained to be equal		Model 4	1957.4	221	37.7	3	$p < .01$
36	Loading of intrj2 constrained to be equal		Model 4	1945.7	219	26.0	1	$p < .01$
37	Loading of intrj3 constrained to be equal (Model 4a)		Model 4	1919.8	219	.1	1	N.S.
38	Model 4a with loading of intrj4 constrained to be equal		Model 4a	1954.9	220	35.1	1	$p < .01$
39	Model 4a with loadings on EXT constrained to be equal (Model 4b)		Model 4a	1922.2	222	2.4	3	N.S.
40	Model 4b with loadings on IDEN constrained to be equal (Model 4c)		Model 4b	1927.8	224	5.6	2	N.S.
41	Model 4c with loadings on IM constrained to be equal (Model 4d)		Model 4c	1936.0	226	8.2	2	N.S.
42	Model 4d with loadings on AM constrained to be equal		Model 4d	1944.2	228	8.2	2	N.S.

ing all loadings to be identical across the two groups was compared with Model 2. The comparison test showed evidence of the inequality of the loadings (Entry 4). To detect the invariance of loadings in specific factors, we constrained loadings in each factor separately (Model 2a, 2b, 2c, 2d, and 2e for introjected, external, identified, intrinsic, and amotivation, respectively) and compared them with relative rival models. While the chi-square tests failed to reject the nulls related to introjected (Entry 5), external (Entry 6), and identified (Entry 7), the tests rejected the nulls of intrinsic (Entry 8) and amotivation (Entry 11). It seemed there were some non-equivalent items in intrinsic motivation and amotivation. Thus, individual loadings in the two factors were subsequently constrained to pinpoint the problematic items. One item in intrinsic motivation and one item in amotivation were non-invariant across the groups (Entry 9 and 12, respectively).

Testing for invariance of factor loadings between primary and junior college groups. Next, we tested the invariance across the primary and junior college groups. An unconstrained baseline model (Model 3) was compared with a model all whose loadings were constrained to be equal. Since the test showed a significant result (Entry 15), we constrained loadings in each factor separately (Model 3a, 3b, 3c, 3d, and 3e) and compared them with their rival models. The results showed that all factors had problematic items (Entry 16, 20, 24, 27, and 30). Further chi-square difference tests revealed that two introjected items on Entry 17 and 19, one external item on Entry 22, one identified item on Entry 26, two intrinsic items on Entry 28 and 29, and two amotivation items on Entry 31 and 32 failed to show equivalence across the groups.

Testing for invariance of loadings between secondary and junior college groups. Finally, we repeated the same tests performed in the previous sections to examine the equality of loadings across the secondary and junior college groups. After obtaining a significant difference from the overall test on Entry 34, the individual tests for each factor indicated that only introjected regulation had problematic items (Entry 35). The further subsequent analyses showed that two introjected items failed to show invariance across the groups (Entry 36 and 38).

4. Discussion

Many researchers assume that the contents of all items in the PLOC are identically perceived by different subgroups of students (e.g., Ntoumanis, 2001; Wang et al., 2009). That is, "the instrument of measurement is operating in exactly the same way, and that the underlying construct being measured has the same theoretical structure for each group under study" on multigroup comparisons (Byrne, 2004, p. 272). However, it is possible that students from different age groups could perceive the contents of the items differently, given that educational systems, PE curricular, and dispositions of PE teachers could be all variable across the three levels. It is worthwhile to examine validity of the measures using the simultaneous test of factorial invariance across the different academic settings.

The common findings from this study were that several items in the PLOC were problematic between the primary and secondary groups as well as between the primary and junior college groups. In particular, two items in introjected regulation (intrj2 and intrj4), one item in intrinsic motivation (im2) and one in amotivation (am3) needed close examinations. The introjected items were "I take part in sport because I would feel bad about myself if I didn't" (intrj2), and "I take part in sport because it bothers me when I don't" (intrj4). The primary students may have misinterpreted the phrases, "I would feel bad about myself" and "it bothers me". This could be because primary students are at the age where they are not mature enough to develop their own introjected regulations, controlled by self-imposed sanctions such as guilt or shame. In addition, the students may have a problem to understand the phrase, "it bothers me", as this may be a difficult word for them. Another reason is that introjected regulation may be differently perceived by primary, secondary, and junior college students. Unlike secondary and junior college students, primary students' behaviours may not be affected by internal, esteem-based pressures to act. The Singapore education incorporates the Co-Curricular Activities (CCAs) scheme to encourage students to be well balanced in both academics and sport. While the CCAs are compulsory in all secondary schools and junior colleges, they are optional in primary schools. Thus, primary students may not feel guilty or shameful although they do not participate in any sporting activity.

Next, the item in intrinsic regulation, "I take part in sport because I enjoy learning new skills" (im2) may be also subject to different interpretations. This is because the item does not reflect intrinsic motivation in its original sense. The self-determined behaviours by intrinsic motivation refer to the extent that the behaviours were autonomously initiated from one's sense of self, which is the regulatory process of choice (Deci et al., 1991). For instance, a student who perceives intrinsic motivation usually attends activities with the beliefs that sport itself is enjoyable and exciting. The issue is that items measuring intrinsic motivation should be regarded as summary evaluations (i.e., affective outcomes) of sport. However, the problematic item explicates an affective outcome of a utilitarian function of sport (i.e., learning new skills). The heterogeneous items measuring the different objectives might produce lack of validation. Thus, future revisions of the PLOC may seek to strengthen the scale by adding a more homogenous item referring to the same objective such as, "I take part in sport because I enjoy it".

Finally, the item in amotivation, "I take part in sport but I really feel I'm wasting my time in sport" (am3) was problematic among primary students. Deci and Ryan (1985) introduced the concept of amotivation representing the absence of motivation. Amotivated people do not perceive contingencies between their behaviours and the desired outcomes (Ryan & Deci, 2000). That means, amotivated primary students perceive no point of continuing in sport since they are not achieving anything. An inclusion of a certain specific reason for non-participation such as a waste of time into the item may be confusing the students with its traditional manner. Thus, they could differently perceive this item from the other two, "I take part in sport but I really don't know why", and "I take part in sport but I don't see why we should have sport". One possible alternative reflecting homogeneity with the other items is "I take part in sport but I don't know sport is important".

4.1. Practical implications

Understanding various reasons why students participate in sport may provide fundamental knowledge for the governmental and school administrators when designing effective programs to promote sporting culture. Recently, the Singapore government initiated a new project to achieve strong sporting culture in the nation. One specific objective is 'generating sporting opportunities for youth', and its relevant plan is 'to teach every child at least four sports' (Ministry of Community Development & Sports, 2008). One critical factor practitioners should consider is students' motivations in attending sport. A governmental report indicated that if youths are not available to learn four sports until they finish primary schools, they will be provided further opportunities from their secondary schools or junior colleges (Ministry of Community Development, Youth & Sports, 2008). Prior literature however revealed that as students grow older, their interests and motivations in sport were steadily declining (Sallis, 2000; Van Wersch, Trew, & Turner, 1992). Therefore, it is a prerequisite to develop students' interests and motivations to continue their involvement and behavioural persistence for sport. A successful promotion of sport to a diverse range of students could be derived from an accurate measurement of their motivations in sport. In accordance with this, the current study will provide a cornerstone to the governmental bodies and school administrators when designing a reliable and valid scale for the measurement of motivational orientations of youths in various age groups.

4.2. Limitations and future directions

Testing measurement invariance is important in psychological research because a factorial structure of a measurement instrument may have a similar pattern when tested within each of two or more groups. However, there is no guarantee that the instrument operates equivalently across these groups (Bentler, 2004). Therefore, there is a need to establish consistency with respect to the relationship between the construct (e.g., a belief in the stable nature of physical ability) under research and its corresponding indicators (e.g., items measuring a stable belief) across different populations (e.g., country, age, gender, and ability levels). In other words, the measurement items should be equally valid across different groups before conducting comparative research. This study has shown that some of the items in the PLOC did not operate in exactly the same way for the students in the diverse academic groups, showing different perceptions toward the items. These findings call for further psychometric examinations of the PLOC when used in different age groups. In addition, this study concerned the invariance of the factor loadings, which has been considered a minimum condition for multigroup invariance tests (Byrne, Shavelson, & Muthén, 1989). It would be insightful in future work to include testing for equivalence of factor covariances and error covariances (testing of error covariance seems too strict; see Bentler, 2004) to achieve a full test for invariance of the PLOC scale.

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