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The intellectual disability version of the very short form of the physical self-inventory (PSI-VS-ID): Cross-validation and measurement invariance across gender, weight, age and intellectual disability level

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ABSTRACT

Recently Maïano, Bégarie, Morin, and Ninot (2009) developed and validated an intellectual disability (ID) version of the very short form of the physical self-inventory (PSI-VS-ID). In a recent review of the various physical self-concept instruments Marsh and Cheng (in press) noted that the short and very short versions of the French PSI represent an important contribution to applied research but that further research was needed to investigate the robustness of their psychometric properties in new and diversified samples. Thus, this study is specifically designed to investigate the robustness of the PSI-VS-ID psychometric properties in a new independent sample of 248 adolescents and young adults with ID. In particular, tests of measurement invariance were conducted across the present sample and the original sample from Maïano et al. (2009) study in order to more precisely assess the degree of replication of the results. Overall, results from a series of confirmatory factor analyses of the PSI-VS-ID provided support for its: (i) factorial validity and reliability; (ii) factorial invariance across gender and weight status; (iii) partial (strict or strong) factorial invariance across age, ID level and samples; and (iv) latent mean differences across gender, weight status and ID level groups.

1. Introduction

In their classic review of self-concept research Shavelson, Hubner and Stanton (1976) represented the self-concept as a pyramid, with self-esteem at the apex and more specific constructs at the next-lower level, such as the academic self, the social self and the physical self. Specificity increases downward with the most situation-specific self-perceptions at the base. In line with this conception, Marsh (1997) defined self-concept as a multidimensional construct encompassing many characteristics, competencies and roles possessed or played by individuals. With the recognition of the multi-dimensionality

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of the self-concept, came more refined conceptualizations and studies of its sub-components (Fox, 2000). Thus, following Sonstroem's work (1976, 1978), Fox and Corbin (1989) developed a multidimensional and hierarchical model of the physical self-concept. In this model, the upper level is occupied by a generic construct representing global self-worth (GSW). GSW refers to the positive or negative way people feel about themselves as a whole, which is also often called global self-esteem (e.g. Brown, Dutton, & Cook, 2001). The intermediate level (i.e. the domain level) is occupied by a construct representing global physical self-worth (PSW; general feelings of happiness, satisfaction and pride in the physical self). Finally, the lower level (i.e. the sub-domain level), is occupied by four constructs: sport competence (SC: athletic ability, ability to learn sports, etc.), physical condition (PC: stamina, fitness, etc.), physical attractiveness (PA: physical attractiveness, ability to maintain an attractive body over time, etc.) and physical strength (PS: perceived strength, muscle development, etc.).

The clear advantage of this multidimensional and hierarchical model is that it enables the simultaneous consideration of several physical self-perceptions at different levels of specificity. Thus, the simultaneous assessment of these numerous physical self-perceptions would have the potential to (i) provide a fuller description of the physical self-perceptions that characterize individuals, (ii) assess their respective influence on physical activities and health-related behaviours, and (iii) detect mechanisms of change in relevance to specific interventions or to the practice of physical activities. To measure and validate this representation, two prominent instruments were successively developed: the*Physical Self-Perception Profile* (PSPP; Fox & Corbin, 1989) and the long and short-form of the*Physical Self-Description Questionnaire* (Marsh & Redmayne, 1994; Marsh, Martin, & Jackson, 2010)[2]. Both instruments are based on Fox and Corbin's (1989) theoretical model. However, since these developments, few scholars have examined the appropriateness of this theoretical model and of these instruments among individuals with an intellectual disability (ID). This is surprising as a balanced and realistic level of self concept, in general and physical self-concept in particular, as long been recognized as an important condition for the success of ID adolescents and young adults reinsertion into mainstream society (e.g. Bear, Clever, & Proctor, 1991; Butler & Marinov-Glassman, 1994). Indeed, sports and adapted physical activities represent one form of activities that is frequently used in interventions with youths with ID.

This recently led Maïano et al. (2009), to (i) examine the factor validity and reliability of a French adaptation of the PSPP for adolescents, namely the very short form of the physical self inventory (PSI-VS; Maïano et al., 2008), and (ii) develop and validate an ID version of this instrument (PSI-VS-ID). Their results clearly showed that the PSI-VS needed substantial adaptations to be clearly applicable to youths with ID. The resulting PSI-VS-ID instrument presents several advantage for ID adolescents, because it: (i) assesses all domains and sub-domains from Fox and Corbin (1989) model; (ii) can be rapidly completed; (iii) can be correctly understood by this population; (iv) requires a very short attention span; and (v) does not require elaborate reading skills (Maïano et al., 2009). Adolescents with ID answer each of the 12 PSI-VS-ID items using a six-point graphical ''facial'' rating scale, that Maïano et al. (2009) proposed as an easier to understand alternative to traditional strictly verbal Likert-type answering scales for youths with ID. Maïano et al. (2009) tested the factor validity and reliability of the PSI-VS-ID within a sample of 342 adolescents (212 boys and 130 girls), aged between 12 and 18 years, with mild to moderate ID. The results they obtained from a series of confirmatory factor analyses (CFA) confirmed the factor validity of the a priori six-factor model and the complete measurement invariance of this model across gender, age and ID level (mild vs. moderate). These, and subsequent analyses replicated those obtained by Maïano et al. (2008) on a sample of normal youths for the regular PSI-VS and indicate that the PSI-VS-ID was characterized by: (i) satisfactory internal consistency coefficients ranging from .70 to .74, especially given that there are only two items per domain (see Streiner, 2003); (ii) acceptable test–retest intraclass correlations ranging from .72 to .93; and (iii) elevated latent factor correlations (>.50). Nevertheless, SEM analyses failed to support the hierarchical structure of the physical self-concept proposed in Fox and Corbin's (1989) model, contrasting with the results from studies of non-ID adolescents answers to the PSI-VS (Maïano et al., 2008).

Unfortunately, no attempt was made to replicate the results from this single study. This is unfortunate as a single study is clearly insufficient to reach clear conclusions regarding the psychometric properties of an instrument. Moreover, the methodological limitations mentioned by Maïano et al. (2009) reinforce this conclusion and the need for additional cross-validation efforts. First, the authors relied on a single sample of adolescents and in consequence their results must be interpreted with caution. Whether the factor validity, reliability and measurement invariance of the PSI-VS-ID will generalize to other samples of adolescents and adults with ID thus remains an open question that must be verified before the PSI-VS-ID can be confidently used among new samples adolescents and adults with ID.

Second, Maïano et al.'s (2009) study was a priori based on a mixed (boys and girls) sample of normal weight adolescents with ID. This represent an important limitation to the generalizability of these results given the elevated prevalence level of overweight (ranging from 13% to ~35%) and obesity (ranging from 3.8% to ~22%) in youths with ID (e.g. Bégarie, Maïano, Ninot, & Azéma, 2009; De, Small, & Baur, 2008; Frey & Chow, 2006; Lin, Yen, Li, & Wu, 2005; Marshall, McConkey, & Moore, 2003; Vélez et al., 2008; for a review see Maïano, 2011). In addition, scholars also recently showed that weight-based stigmatization and stereotypes toward overweight (for reviews see: Puhl & Brownell, 2003; Puhl & Latner, 2007; Puhl & Heuer, 2009) exerted an important negative impact on the physical self concepts of non-ID youths (e.g. Carr & Friedman, 2005; Davison, Schmalz, Young, & Birch, 2008; Friedman et al., 2005; Friedman, Ashmore, & Applegate, 2008; Myers & Rosen, 1999). Thus, when overweight and/or obese adolescents without ID are compared to normal weight counterparts, they exhibited a significantly lower level of GSW (for reviews see: French, Story, & Perry, 1995; Griffiths, Parsons, & Hill, 2010;

[2] For more details on the psychometric differences between the PSDQ and the PSPP see Marsh & Cheng (in press).

Wardle & Cooke, 2005), PSW (Hau, Sung, Yu, Marsh, and Lau, 2005; Marsh, Hau, Sung, & Yu, 2007; Sung, Yu, So, Lam, & Hau, 2005), and on sub-domains of the physical self concept (Braet, Mervielde, & Vandereycken, 1997; Burrows & Cooper, 2002; Franklin, Denyer, Steinbeck, Caterson, & Hill, 2006; Hau et al., 2005; Marsh et al., 2007; Morano, Colella, Robazza, Bortoli, and Capranica (in press); Phillips & Hill, 1998; Renman, Engström, Silfverdal, & Åman, 1999; Shin & Shin, 2008; Southall, Okely, & Steele, 2004; Sung et al., 2005). However, very few similar studies were conducted among overweight and/or obese ID adolescents. Until recently, only one such study was conducted among ID adolescents (Bégarie, Maïano, & Ninot, 2011). Obese adolescents with ID presented significantly lower levels of GSW, PSW and PA than normal weight counterparts. Thus, these results allow us to expect mean-level difference on the various PSI-VS-ID dimensions. However, in order to conduct meaningful group-based comparisons, the measurement invariance of the PSI-VS-ID across these groups must first be demonstrated to ensure that the meaning of the measured constructs remains comparable in these groups. Furthermore, the relationship between weight status and physical self-perceptions is so important that measurement invariance across weight-defined subgroups cannot be simply assumed but has to be more systematically verified (Hau et al., 2005; Marsh et al., 2007).

Third, Maïano et al. (2009) study did not examine the latent mean invariance of the PSI-VS-ID across the specific subgroups they considered (e.g. gender, age categories, and ID level) even though they did show that the PSI-VS-ID measurement model was invariant across these subgroups. Since physical self-concept levels are known to differ in non-ID, as well as ID, populations according to age (e.g. Bégarie et al., 2011; Keltikangas-Jarvinen, 1990; Marsh, 1989, 1998; Robins, Trzesniewski, Tracy, Gosling, & Potter, 2002), gender (e.g. Aşç1, 2002; Bégarie et al., 2011; Klomsten, Shaalvik, & Espnes, 2004; Maïano et al., 2008; Marsh et al., 2007), and weight status (see the previous section), such verification would represent an important test of the criterion-related validity of the PSI-VS-ID. Most importantly, it currently remains unknown whether Maïano et al. (2009) results could be generalized to young adult samples or if they are specific to adolescents. Finally, although no previous results allow us to propose clear hypotheses regarding possible variations in physical self-perceptions as a function of participants ID levels, ensuring that the PSI-VS-ID measurement model is fully invariant across ID levels and exploring potential mean-levels variations would also represent an important test of the generalizability of the PSI-VS-ID to ID populations.

In a recent review of the various instruments that may be used to assess the physical self-concept, Marsh and Cheng (in press) included a single non-English instrument, the PSI, and noted that the very short form of the PSI"*make a potentially important contribution to applied research. However, further research is needed to more fully evaluate the robustness of support for construct validity and application in non-French-speaking settings*." In the present study, we address the first of these objectives by verifying the robustness of the psychometric properties of the very short version of the French PSI for youths with ID (PSI-VS-ID) across multiple subgroups of French adolescents and young adults with ID. More specifically, this cross validation study will: (i) examine the factor validity and reliability of the PSI-VS-ID among a new independent sample of youths with ID, as well as various subsamples defined according to gender, age (adolescence or early adulthood), weight categories (underweight, normal-weight, and overweight/obese), and ID level (mild and moderate-severe); and (ii) investigate the extent to which Maïano et al. (2009) results can be replicated by conducting extended tests of measurement invariance between samples from both studies.

2. Method

2.1. Participants, measures and procedures

Participants were 248 adolescents and young adults (145 boys, M_{age} = 16.26 years, SD_{age} = 2.47; 103 girls, M_{age} = 16.57 - years, SD_{age} = 2.46), aged between 12 and 20 years (M_{age} = 16.39 years, SD_{age} = 2.47) and identified as having mild to severe ID by the Departmental Commission for the Right of Self-sufficiency of People with Disabilities (DCRSPD). This overall sample comprised[3]: (i) 131 adolescents and young adults with mild ID (IQ between 50 and 70), (ii) 81 adolescents and young adults with moderate ID (IQ between 35 and 49), and 11 with adolescents and young adults with severe ID (IQ between 20 and 34) enrolled full time in a specialized school with other individuals with ID. Weight categories were determined on the basis of participants body mass index (BMI = weight/height × height; Cole, 1979) and of gender-specific cut-off scores provided by Cole, Bellizzi, Flegal and Dietz (2000), Cole, Flegal, Nicholls and Jackson (2007) and by the World Health Organisation (2000). Four separate groups were thus identified: (i) underweight (n = 23), (ii) normal weight (n = 173), (iii) overweight (n = 36), and obese (n = 16). Parents and participants gave written informed consent and none declined to participate or dropped out of the study.

2.2. Data analysis

The analyses were conducted in several stages. Because of the significant multivariate non-normality of the data (the normalized kurtosis coefficient is 38.76), the analyses were performed using Bootstrapped Maximum Likelihood estimation with AMOS 7.0 (Arbuckle, 2006). Thus, all fit values provided in this study are based on AMOS 7.0 Bollen-Stine bootstrap p-

[3] 25 participants with mild to severe ID but whose exact ID level could not be obtained were also included in this study.

value and bootstrap adjusted chi-square and goodness of fit indexes. In the first stage, two first-order CFA models were used to test the factor structure of the PSI-VS-ID. The first model (i.e. 1-factor) a priori hypothesized that the answers to the PSI-VS-ID could be explained by one factor, and that the measurement error terms would be uncorrelated. The second model (i.e. 6-factor) a priori hypothesized that the answers to the PSI-VS-ID could be explained by six factors, that each item would have a non-zero loading on the PSI-VS-ID factor it was designed to measure and zero loadings on all other factors, that the six factors would be correlated, and that the measurement error terms would be uncorrelated. In the second stage, structural equation modeling (SEM) analyses were conducted to test the hypothesized hierarchical relationships among the PSI-VS-ID factors (Fox & Corbin, 1989). This model a priori hypothesized that GSW predict PSW which in turns predict SC, PC, PA, and PS and that no other relationship among those dimensions is significant (for more details on this model see Maïano et al., 2008, 2009).

In the four following stages, the PSI-VS-ID was used to test the invariance of the six-factor CFA model across age category (stage 3), gender (stage 4), weight status (stage 5) and level of ID (stage 6). Regarding the aim of the study and the low overall sample size, the age of the participants was dichotomized in two categories representing adolescence (12–17 years old; $n = 153$) and early adulthood (18–20 years old; $n = 95$) years old. Additionally, considering the low sample size of adolescents in three of the four weight categories (i.e. underweight, $n = 23$; overweight, $n = 36$; obesity, $n = 16$), only two weight categories groups were examined in the subsequent invariance analyses: underweight-normal weight ($n = 196$) and overweight-obese ($n = 52$). For similar reasons only two ID categories were examined: mild ($n = 131$) and moderate-severe ($n = 92$). The models were first estimated separately in the various subsamples and then measurement invariance tests were directly conducted across age categories, gender groups, weight status and levels of ID in the sequential order recommended by Meredith (1993): (i) invariance of the factor structure, or configural invariance (hypothesis A), (ii) equality constraints on the factor loadings, or weak invariance (hypothesis B), (iii) equality constraints on items' intercepts, or strong invariance (hypothesis C), (iv) equality constraints on items' uniquenesses, or strict invariance (hypothesis D), (v) equality constraints on the variances and covariances of the latent factors (hypothesis E) and (vi) equality constraints on the latent factors means (hypothesis F). In these analyses, each model was compared to the preceding one that served as a reference model (Vandenberg & Lance, 2000). Finally, in the last stage (stage 7), a multi-group CFA was conducted to similarly test the invariance of the measurement model of the PSI-VS-ID between the samples from this study and from Maïano et al.'s (2009) study.

Assessment of fit for the CFA and SEM models was based on multiple indicators (Byrne, 2005; Hu & Bentler, 1999; Vandenberg & Lance, 2000): the Chi-square statistic (χ^2), the comparative fit index (CFI), the Tucker–Lewis index (TLI), the standardized root mean square residual (SRMR), the root mean square error of approximation (RMSEA) and the 90% confidence interval of the RMSEA. Values greater than .90 for CFI and TLI are considered to be indicative of adequate model fit (Byrne, 2005; Hu & Bentler, 1999; Vandenberg & Lance, 2000), although values approaching .95 are preferable. Values smaller than .08 or .06 for the RMSEA and smaller than .10 and .08 for the SRMR support respectively acceptable and good model fit (Hu & Bentler, 1999; Vandenberg & Lance, 2000). Concerning the RMSEA 90% CI, values of less than .05 for the lower bound (left side) and less than .08 for the upper bounds (right side) or containing 0 for the lower bound and less .05 for the upper bounds (right side) indicate respectively acceptable and good model fit (MacCallum, Browne, & Sugawara, 1996). Critical values for the tests of multi-group invariance in CFAs models were evaluated by the examination of several criterions: χ^2 difference tests and changes in CFI and RMSEA (Chen, 2007; Cheung & Rensvold, 2002; Vandenberg & Lance, 2000). A CFI difference of .01 or less and a RMSEA difference of .015 or less between a reference model and the following model indicate that the measurement invariance hypothesis should not be rejected. Finally, reliability was computed using Cronbach's alpha (Cronbach, 1951).

3. Results

Stage 1. The goodness-of-fit statistics and factor loadings-uniquenesses of the one- and six-factor CFA measurement models of the PSI-VS-ID are presented in Tables 1 and 2. The results first show that the one-factor CFA model provides poor

Table 1
Goodness-of-fit statistics of PSI-VS-ID models.[a].

Stages	Description	χ^2(B-S)	df	CFI	TLI	SRMR	RMSEA	RMSEA 90% CI	$\Delta\chi^2$	Δdf	ΔCFI	ΔRMSEA
Stage 1	1-factor CFA	67.75*	54	.787	.752	.089	.147	.132–.162				
	6 correlated factors CFA	47.32*	39	.975	.957	.041	.061	.040–.082				
Stage 2	Hierarchical SEM	59.05*	49	.915	.886	.069	.100	.084–.117				
Stage 3	12–17 years old subgroup ($n = 153$)	46.45	39	.964	.940	.054	.068	.038–.095				
Age	18–20 years old subgroup ($n = 95$)	54.36	39	.939	.896	.077	.109	.057–.156				
	A – no invariance	98.16	78	.976	.959	.054	.041	.022–.058	–	–	–	–
	B – λs invariant	104.44	84	.975	.961	.054	.040	.021–.057	6.28	6	–.001	–.001
	C – λs, τs invariant	112.60	90	.966	.949	.091	.045	.024–.063	8.16	6	–.009	+.005
	D – λs, τs, δs invariant	128.14	102	.979	.973	.058	.034	.011–.050	15.54	12	+.013	–.011
	D' – λs, τs, δs (δ3, 4, 6, 9, 12 free)	119.88	97	.976	.967	.058	.037	.017–.053	7.28	7	+.010	–.008

Table 1 (*Continued*)

Stages	Description	χ^2(B-S)	df	CFI	TLI	SRMR	RMSEA	RMSEA 90% CI	$\Delta\chi^2$	Δdf	ΔCFI	ΔRMSEA
	E – λs, τs, δs (δ3, 4, 6, 9, 12 free), ξs/φs invariant	148.32	118	.967	.963	.074	.040	.024–.054	28.44	21	−.009	+.003
	F – λs, τs, δs (δ3, 4, 6, 9, 12 free), ξs/φs, ηs invariant	154.49	124	.956	.954	.081	.044	.030–.057	6.17	6	−.011	+.004
Stage 4	Boys subgroup (n = 145)	51.37	39	.949	.914	.057	.080	.052–.107				
Gender	Girls subgroup (n = 103)	45.25	39	.985	.975	.042	.048	.000–.088				
	A – no invariance	96.49	78	.966	.943	.042	.049	.031–.064	–	–	–	–
	B – λs invariant	102.24	84	.967	.949	.043	.046	.029–.061	5.75	6	+.001	−.003
	C –λs, τs invariant	108.62	90	.967	.951	.045	.045	.028–.060	6.38	6	.000	−.001
	D – λs, τs, δs invariant	125.71	102	.957	.944	.054	.048	.033–.062	17.09	12	−.010	+.003
	E – λs, τs, δs, ξs/φs invariant	153.29*	123	.929	.924	.073	.056	.044–.068	27.58	21	−.028	+.008
	E' – λs, τs, δs, ξs (ξ GSW, PSW, PA free)/φs invariant	147.28	120	.947	.941	.089	.049	.036–.062	21.57	18	−.010	+.001
	F – λs, τs, δs, ξs (ξ GSW, PSW, PA free)/φs, ηs invariant	153.19*	126	.930	.927	.078	.055	.042–.067	5.91	6	−.017	+.006
Stage 5	Underweight-normal weight (n = 196)	48.35	39	.981	.967	.047	.053	.024–.078				
Weight	Overweight-obese (n = 52)	52.99	39	.953	.921	.076	.084	.000–.136				
	A – no invariance	103.03	78	.975	.957	.047	.043	.024–.060	–	–	–	–
	B – λs invariant	108.82	84	.973	.957	.046	.043	.025–.059	5.79	6	−.002	.000
	C – λs, τs invariant	114.63	90	.966	.950	.046	.047	.030–.062	5.81	6	−.007	+.004
	D – λs, τs, δs invariant	133.40	102	.965	.955	.047	.044	.028–.059	18.77	12	−.001	−.003
	E – λs, τs, δs, ξs/φs invariant	162.53	123	.954	.950	.051	.047	.033–.059	29.13	21	−.011	+.003
	E' – λs, τs, δs, ξs (ξ GSW free)/φs invariant	160.10	122	.965	.962	.051	.041	.025–.054	26.70	20	.000	−.003
	F – λs, τs, δ, ξs (ξ GSW free)/φs, ηs invariant	166.60	128	.947	.945	.052	.049	.036–.061	6.50	6	−.018	+.008
Stage 6	Mild ID (n = 131)	47.36	39	.984	.973	.049	.048	.000–.082				
ID level	Moderate-severe ID (n = 92)	51.33	39	.966	.942	.058	.076	.031-.113				
	A – no invariance	99.34	78	.976	.959	.049	.043	.022–.061	–	–	–	–
	B – λs invariant	106.07	84	.969	.952	.050	.047	.028–.064	6.73	6	−.007	+.004
	C – λs, τs invariant	112.49*	90	.951	.928	.052	.057	.041–.072	6.42	6	-.018	+.010
	C' – λs, τs (τ7free)/ invariant	111.28	89	.961	.942	.051	.051	.034–.067	5.21	5	−.008	+.004
	D – λs, τs (τ7free), δs invariant	130.72	101	.956	.942	.055	.051	.036–.066	19.44	12	−.005	.000
	E – λs, τs (τ7free), δs, ξs/φs invariant	160.27*	122	.922	.916	.059	.062	.049–.074	29.55	21	−.034	+.011
	E' – λs, τs (τ7free), δs, ξs (ξ GSWfree)/φs (φ PSW-PA, PC-PA, GSW-PS free) invariant	154.21	118	.947	.941	.061	.052	.038–.066	23.49	17	−.009	+.001
	F – λs, τs (τ7free), δ, ξs (ξ GSW free)/φs (φ PSW-PA, PC-PA, GSW-PS free), ηs invariant	160.60	124	.932	.932	.062	.057	.044–.070	6.39	6	−.015	+.005
Stage 7	A – no invariance	97.76*	78	.962	.936	.049	.048	.039–.057	–	–	–	–
Samples	B – λs invariant	103.94*	84	.961	.939	.050	.047	.038–.055	6.18	6	−.001	−.001
	C – λs, τs invariant	109.98*	90	.959	.940	.050	.046	.038–.055	6.04	6	−.002	−.001
	D – λs, τs, δs invariant	127.94*	102	.940	.922	.055	.053	.045–.061	17.97	12	−.019	+.007
	D' – λs, τs, δs(δ1, 4, 8 free) invariant	123.31*	99	.952	.937	.053	.048	.040–.056	13.34	9	−.007	+.002
	E – λs, τs, δs(δ1, 4, 8 free), ξs/φs invariant	150.68*	120	.948	.942	.062	.045	.038–.053	27.37	21	−.004	−.003
	F – λs, τs, δs(δ1, 4, 8 free), ξs/φs, ηs invariant	156.59*	126	.945	.943	.061	.045	.038–.053	5.91	6	−.003	.000

Note. CFA: confirmatory factor analytic model; SEM: structural equation modeling; χ^2 (B–S): Bollen–Stine chi-square; df: degrees of freedom; CFI: comparative fit index; TLI: Tucker–Lewis index; SRMR: standardized root mean square residual; RMSEA: root mean square error of approximation; RMSEA 90% CI = 90% confidence interval for the RMSEA point estimate; λ: factor loading; τ: factor intercepts; δ: uniquenesses; ξ: factor variance; φ: factor covariance; η: factor latent means; GSW: global self-worth; PSW: physical self-worth; PC: physical condition; PA: physical attractiveness; PS: physical strength; $\Delta\chi^2$: change in goodness-of-fit χ^2 relative to the preceding model; Δdf: change in degrees of freedom relative to the preceding model; ΔCFI: change in comparative fit index relative to the preceding model; ΔRMSEA: change in root mean square error of approximation relative to the preceding model.

[a]Bootstrapped goodness of fit indexes are reported in this table because of the significant multivariate non-normality within these data.

* $p < .05$.

Table 2
CFA and SEM's factor loadings and uniquenesses for the total sample.[a]

PSI-VS-ID						
1-factor			6-factor			Hierarchical model
Factor	Item no	λ(δ)	Factor	Item no	λ(δ)	λ(δ)
Global			GSW			
	1	.670(.449)†		1	.874(.764)†	.860(.739)†
	12	.607(.369)		12	.743(.552)	.755(.571)
			PSW			
	2	.532(.283)		2	.633(.400)†	.560(.313)†
	9	.660(.436)		9	.803(.645)	.716(.512)
			PC			
	6	.695(.483)		6	.888(.788)†	.897(.805)†
	10	.605(.365)		10	.793(.629)	.765(.585)
			SC			
	7	.740(.548)		7	.823(.677)†	.800(.640)†
	11	.766(.587)		11	.819(.671)	.843(.710)
			PA			
	4	.690(.476)		4	.846(.715)†	.789(.623)†
	8	.676(.457)		8	.714(.510)	.765(.586)
			PS			
	3	.692(.479)		3	.787(.620)†	.805(.648)†
	5	.555(.308)		5	.651(.423)	.636(.405)
Latent constructs						
GSW →	PSW					.780(.608)
PSW →	PC					.675(.455)
PSW →	SC					.878(.771)
PSW →	PA					.852(.725)
PSW →	PS					.875(.766)

Note: †: item that was set to be 1.0; λ: factor loading; δ: uniquenesses; GSW: global self-worth; PSW: physical self-worth; PC: physical condition; SC: sport competence; PA: physical attractiveness; PS: physical strength.
[a] All loadings are significant ($p < .001$).

Table 3
Descriptive statistics and latent factors correlations of the PSI-VS-ID version.

Scale	Mean (SD)	α	GSW	PSW	PC	SC	PA	PS
GSW	4.84 (1.35)	.77	1.00					
PSW	4.94 (1.10)	.67	.658*	1.00				
PC	3.99 (1.61)	.82	.468*	.634*	1.00			
SC	4.38 (1.34)	.80	.606*	.698*	.762*	1.00		
PA	4.66 (1.34)	.75	.901*	.691*	.487*	.745*	1.00	
PS	3.94 (1.41)	.67	.585*	.748*	.737*	.800*	.654*	1.00

Note: GSW: global self-worth; PSW: physical self-worth; PC: physical condition; SC: sport competence; PA: physical attractiveness; PS: physical strength; SD: standard deviation; α = Cronbach's alpha.
* $p < .01$.

goodness of fit indices (see Table 1). Inversely, the results from the six-correlated factors model revealed significant bootstrapped χ^2 values, but acceptable goodness of fit indices (CFI and TLI > .95; RMSEA and SRMR < .07) and substantial significant loadings (see Table 2). The descriptive statistics for the six-factor model of the PSI-VS-ID are provided in Table 3. The six scales of this instrument presented acceptable internal consistency coefficients given the reduced length of these scales (i.e. α: ranging from .67 to .82, see Table 3; also see Streiner, 2003). Finally, all of the latent variables intercorrelations are statistically significant and quite elevated (i.e. ranging from .487 to .901).

Stage 2. The results from the SEM hierarchical model of the PSI-VS-ID showed a significant bootstrapped χ^2 value as well as poor goodness of fit indices (TLI < .90, SRMR > .07, RMSEA > .10), confirming Maïano et al. (2009) observation that this model does not provide an adequate representation of the data in ID populations. For comparison purposes, the parameters from this model are also reported in Table 2).

Stage 3. The 6-factor CFA model was first estimated separately in the two age groups. The results from these initial analyses revealed non-significant bootstrap χ^2 and acceptable goodness of fit indices in the adolescent group (see Table 1) and marginally acceptable goodness of fit indices in the adult group (i.e. a non-significant bootstrap chi square, SRMR = .077 and CFI = .939, but suboptimal results for fit indices that incorporate a control for parsimony – TLI = .896 and RMSEA = .109 – suggesting that this model may lack parsimony but still fit the data when parsimony is not taken into account). The first steps of invariance testing (hypothesis A: no invariance) resulted in non-significant bootstrap χ^2 and acceptable goodness of fit-indices. The two following levels of measurement invariance added equality constraints on items' loadings (hypothesis B) and intercepts (hypothesis C) resulted in a non-significant bootstrap χ^2, acceptable goodness of fit indices, a non-significant $\Delta\chi^2$, and equivalent goodness of fit indices (ΔCFI $\leq$ .010, ΔRMSEA $\leq$ .015). The fourth level of measurement invariance added equality constraints on items' uniquenessess (hypothesis D) and resulted in a non-significant bootstrap χ^2, acceptable goodness of fit indices, a non-significant $\Delta\chi^2$, and equivalent RMSEA (ΔRMSEA $\leq$ .015). However, this model resulted in a ΔCFI exceeding .010. Modification indices for this model suggested that the equality constraint should be relaxed for the uniqueness of items no. 3, 4, 6, 9 and 12 (revealing higher levels of measurement errors in the older group). The next model (hypothesis D') freely estimated these five uniquenesses across age groups while keeping the other constraints and provided evidence of partial strict measurement invariance. The sixth level of measurement invariance (hypothesis E) added equality constraints on factors' variances/covariances and confirmed their invariance across age groups (a non-significant $\Delta\chi^2$, ΔCFI $\leq$ .010, ΔRMSEA $\leq$ .015). Finally, the last model (hypothesis F) failed to support the invariance of the latent means across age categories (ΔCFI > .010). Post hoc probing of this difference revealed that 18–20 years old subgroup (latent mean fixed to zero to act as reference) presented significantly lower scores than 12–17 years old subgroup on the GSW (latent mean = .54, t = 3.36, p < .001, d = .44), PSW (latent mean = .39, t = 3.12, p < .01, d = .41), SC (latent mean = .69, t = 3.70, p < .001, d = .49), PA (latent mean = .59, t = 3.16, p < .01, d = .42). However, no differences were found in PC (latent mean = .36, t = 1.79, p > .05, d = .23) and PS scales (latent mean = .33, t = 1.77, p > .05, d = .23).

Stage 4. Initial analyses were first performed separately within both gender-related subgroups and resulted in a non-significant bootstrap χ^2 and acceptable goodness of fit indices in both groups. The results from hypotheses A through D of the gender-related measurement invariance tests all resulted in non-significant bootstrap χ^2, acceptable goodness of fit indices, non-significant $\Delta\chi^2$, and equivalent fit indices. These results thus confirm the strict measurement invariance of the PSI-VS-ID across gender groups. The fifth model added equality constraints on factors' variances/covariances (hypothesis E) and resulted in a significant bootstrap χ^2, acceptable goodness of fit indices, and a ΔCFI exceeding .010. Modification indices for this model suggested that the equality constraint should be relaxed for the variances on GSW, PSW and PA factors (revealing higher variances for girls). The next model (hypothesis E') freely estimated these variances across gender groups while keeping the other constraints and resulted in a non-significant bootstrap χ^2, acceptable goodness of fit indices and equivalent fit indices, supporting the partial invariance of the PSI-VS-ID variances across gender. Finally, the last model (hypothesis F) failed to support the invariance of the latent means across gender (ΔCFI > .010). Post hoc probing of this difference revealed that ID boys (latent mean fixed to zero to act as reference) presented significantly higher scores than ID girls on the GSW (latent mean = −.44, t = −2.75, p < .05, d = .36), PSW (latent mean = −.28, t = −2.12, p < .05, d = .27), PC (latent mean = −.80, t = −4.09, p < .05, d = .53), SC (latent mean = −.74, t = −4.04, p < .05, d = .52), PA (latent mean = −.67, t = −3.62, p < .05, d = .47) and PS scales (latent mean = −.82, t = −4.70, p < .05, d = .61).

Stage 5. Initial analyses were first performed separately within the two weight-related groups and resulted in a non-significant bootstrap χ^2 and acceptable goodness of fit indices (see Table 1). The four first levels of measurement invariance (hypotheses A through D) resulted in non-significant bootstrap χ^2, acceptable goodness of fit indices, non-significant $\Delta\chi^2$, and equivalent fit indices. These results confirm the strict measurement invariance of the PSI-VS-ID across weight-related groups. The fifth model added equality constraints on factors' variances/covariances (hypothesis E) and resulted in non-significant bootstrap χ^2, acceptable goodness of fit indices, a non-significant $\Delta\chi^2$ but in a ΔCFI exceeding .010. Modification indices for this model suggested that the equality constraint should be relaxed for the variances on GSW factor (revealing higher variability for the overweight-obese group). The next model (hypothesis E') freely estimated this parameter across weight-related groups while keeping the other constraints and resulted in a non-significant bootstrap χ^2, acceptable goodness of fit indices and equivalent fit indices, supporting the partial invariance of the PSI-VS-ID variances across weight categories. Finally, the last model (hypothesis F) failed to support the invariance of the latent means across weight categories (ΔCFI > .010). Post hoc probing of this difference revealed that underweight-normal weight adolescents with ID (latent mean fixed to zero to act as reference) presented significantly higher scores than overweight-obese adolescents with ID on the GSW (latent mean = −.70, t = −3.23, p < .05, d = .51), PSW (latent mean = −.33, t = −2.23, p < .05, d = .35), PC (latent mean = −.58, t = −2.40, p < .05, d = .38), and PA scales (latent mean = −.70, t = −3.14, p < .05, d = .49). Nevertheless, no significant differences were found for SC (latent mean = −.43, t = −1.94, p > .05, d = .30) and PS (latent mean = .22, t = 0.99, p > .05, d = .16).

Stage 6. Initial analyses were first performed separately within the two ID level groups and resulted in a non-significant bootstrap χ^2 and acceptable goodness of fit indices (see Table 1). Hypotheses A and B of the measurement invariance tests resulted in non-significant bootstrap χ^2, acceptable goodness of fit indices, non-significant $\Delta\chi^2$, and equivalent fit indices. However, the third model (hypothesis C) in which equality constraints were added on items' intercepts resulted in a significant bootstrap χ^2 and in a ΔCFI exceeding .010. Modification indices for this model suggested that the equality constraint should be relaxed for the intercept of items no. 7 (revealing a higher intercept in the moderate-severe group). The next model (hypothesis C') freely estimated this parameter across ID-level groups while keeping the other constraints and provided evidence of partial strong measurement invariance of the PSI-VS-ID. The next model added equality constraints on items' uniquenessess (hypothesis D) and resulted in a non-significant bootstrap χ^2, acceptable goodness of fit indices, non-significant $\Delta\chi^2$, and equivalent fit indices, thus confirming providing evidence of partial (due to item 7 intercept) strict invariance of the PSI-VS-ID. Then, equality constraints were added on the factors' variances/covariances (hypothesis E). This model resulted in a non-significant bootstrap χ^2, acceptable goodness of fit indices, a non-significant $\Delta\chi^2$, but a ΔCFI exceeding .010. Modification indices for this model suggested that the equality constraint should be relaxed for the variance of the GSW factor (revealing higher variability in the mild ID group) and the covariances between PSW and PA (revealing a higher level of covariation in the moderate-severe ID group), PC and PA (revealing a higher level of covariation in the moderate-severe ID group), and GSW and PS (revealing a higher level of covariation in the mild-ID group). Finally, the last model (hypothesis F) failed to support the invariance of the PSI-VS-ID latent means across ID-level (ΔCFI > .010). Post hoc probing of this difference revealed that the moderate-severe ID group (latent mean fixed to zero to act as reference) presented significantly higher scores than the mild ID group on the GSW (latent mean = −.39, $t = -2.41$, $p < .05$, $d = .33$), PA (latent mean = −.55, $t = -2.91$, $p < .05$, $d = .40$) and PS scales (latent mean = −.61, $t = -3.02$, $p < .05$, $d = .41$). No difference was found on PSW (latent mean = .001, $t = 0.09$, $p > .05$, $d = .001$), PC (latent mean = −.37, $t = -1.75$, $p > .05$, $d = .24$) and SC (latent mean = −.07, $t = -0.37$, $p > .05$, $d = .05$).

Stage 7. In this last stage, the measurement and latent mean invariance of the PSI-VS-ID model was verified across the sample used in this study and the original sample from Maïano et al. (2009) study. The three first steps of measurement invariance testing (hypotheses A through C) resulted in a significant bootstrap χ^2 but acceptable goodness of fit-indices, non-significant $\Delta\chi^2$, and equivalent fit indices, supporting the strong measurement invariance of the PSI-VS-ID across samples. The fourth level of measurement invariance (hypothesis D) added equality constraints on items' uniquenesses and failed to support the full strict measurement invariance across samples (ΔCFI > .010). Modification indices for this model were inspected and suggested that the equality constraint should be relaxed for the uniquenesses of the items no. 1, 4, 8. The next model (hypothesis D') freely estimated these three uniquenesses across samples while keeping the other constraints and provided evidence of partial strict measurement invariance. Finally, the last two models (hypotheses E and F) added equality constraints on factors' variances/covariances and means and resulted in non-significant bootstrap χ^2, acceptable goodness of fit indices, non-significant $\Delta\chi^2$, and equivalent fit indices.

4. Discussion

The objective of this study was to cross-validate the factor structure of the PSI-VS-ID and to verify its measurement and latent mean invariance (across gender, age, weight categories and ID levels) in a sample of adolescents and young adults with ID. First, the a priori six-factor CFA model presented an acceptable fit in the overall sample, as well as in all sub samples considered here. These results thus clearly replicate those obtained by Maïano et al. (2009) and support the adequacy of the Fox and Corbin (1989) multidimensional model of the physical self-concept among ID individuals. However, the results from the SEM analysis failed to support Fox and Corbin (1989) hierarchical model and confirmed, as already demonstrated by Maïano et al. (2009), that ID adolescents' physical self-concept, although multidimensional, possess a simpler structure than what is observed in "normal" adolescents. Additionally, as already found in previous psychometric studies (e.g. Hagger, Asç1, & Lindwall, 2004; Hagger, Biddle, Wang, 2005; Marsh, Richards, Johnson, Roche, & Tremayne, 1994; Marsh, Asç1, & Marco, 2002; Marsh, Bar-Eli, Zach, & Richards, 2006), these results revealed that: (i) the latent factor correlations are elevated (i.e. >.50); (ii) the GSW scale exhibited a stronger relationship with PA than with PSW; (iii) all of the subscales were significantly and positively correlated with PSW and exhibited stronger relationships with PSW than with GSW (with the exception of PA). The strength of those relations that "*brings into question the real independence of physical self dimensions*" (Maïano et al., 2009, p. 784) may be due to (i) the format of the PSI-VS-ID that attempt to cover a broad range of dimensions with few items (Marsh et al., 1994, 2002, 2006); and (ii) ID individuals' "*ability to discriminate between those various dimensions of their physical self-concept may be more limited*" (Maïano et al., 2009, p. 784). However, all latent factor correlations provide evidence of the discriminant validity of the PSI-VS-ID factors, according to Bagozzi and Kimmel's (1995) criteria[4].

Secondly, subsequent results supported the full or partial strict measurement invariance (e.g. invariance of the configural models and of the factor loadings, items' intercepts and items' uniquenesses) of the PSI-VS-ID across age, gender, weight status and ID severity. Consequently, these results are consistent with those from Maïano et al. (2009) that they also extend, and demonstrated that the PSI-VS-ID may be confidently used in research or practice to assess the physical self-concept in French adolescents with ID similar to those used in the present study and in group-based comparisons based on gender, age, weight status, and ID severity. Notwithstanding this optimistic conclusion, the present results regarding the applicability of the PSI-VS-ID to young adults and to participants of various weight statuses still need to be replicated as this is the first study in which the applicability of the PSI-VS-ID to these subgroups is systematically investigated.

Thirdly, girls with ID have a lower latent mean score on GSW and on all physical self-perceptions (PSW, PC, SC, PA, PS) than did boys with ID as indicated by the analysis of invariance of the latent mean structure. This finding is consistent with those from previous studies based on adolescents with and without ID (e.g. Asç1, 2002; Bégarie et al., 2011; Klomsten et al., 2004; Maïano et al., 2008; Marsh et al., 2007). Similarly, adolescents with moderate-severe ID presented significantly higher latent mean score on GSW and on two physical self-perceptions (PA and PS) than did adolescents with mild ID. This result is highly interesting as this is the first study that addresses this issue. This suggests that some form of positive "distortion" may

[4] To assess the discriminant validity of the different factors forming an instrument, Bagozzi and Kimmel (1995) suggest computing the 95% confidence intervals for the standardized factor correlations (+/− 1.96 times the standard error of the correlation). In the present study, these confidence intervals confirm the discriminant validity of the a priori CFA model. In addition, this a priori CFA model was compared to a series of post hoc alternative models in which highly correlated factors were combined by pairs. None of these models provided a better fit to the data than the a priori model, and thus they are not reported.

be at play in the physical self-perceptions of adolescents with elevated levels of ID. In fact, previous studies (e.g. Ninot & Maïano, 2007; Renick & Harter, 1989) suggest that, since adolescents with more severe levels of ID tend to be more frequently regrouped in self-contained classes than adolescents with milder levels of ID. This self-contained educational context may serve as a kind of protective shell against negative social feedback and downward social comparisons for adolescents with ID. This possibility should be more thoroughly investigated in the context of future studies. Additionally, the results showed that overweight-obese adolescents with ID presents significantly lower latent mean scores on GSW, PSW, PC and PA than did the underweight-normal weight group. Once again, these results are consistent with those from previous studies of overweight/obese adolescents with or without ID (e.g. Bégarie et al., 2011; Burrows & Cooper, 2002; Franklin et al., 2006; French et al., 1995; Griffiths et al., 2010; Hau et al., 2005; Marsh et al., 2007; Phillips & Hill, 1998; Renman et al., 1999; Shin & Shin, 2008; Sung et al., 2005; Wardle & Cooke, 2005). Finally, the results revealed that adolescents with ID presented significantly higher latent mean scores than young adults with ID on GSW, PSW, SC and PA. These findings are consistent to those obtained for older adolescents and young adults with and without ID (e.g. Bégarie et al., 2011; Keltikangas-Jarvinen, 1990; Marsh, 1998; Marsh et al., 2007; Robins et al., 2002). This observation may be explained by the fact that the transition to early adulthood is characterized by new professional responsibilities – particularly for youths with ID who tend to have few opportunities to pursue extended academic tracks – with few opportunities for structured athletic activities with other youths with ID. It is thus possible that this situation may negatively influence their physical self-perceptions. Although very promising, these results nevertheless should be interpreted with caution as these analyses were performed on a cross-sectional sample that precludes the generalizability of the results and the verification of the developmental change of GSW and physical self-perceptions from early adolescence to early adults' years. The main limitation of the cross-sectional studies is that they focused on age-group differences without examining the overall pattern of intra-individual longitudinal evolution.

Some additional limitations of the current study must also be taken into account in the interpretation of the findings. First, this instrument was developed and validated among French adolescents and young adults with ID. Thus, as pointed out by Marsh and Cheng (in press), the next step in evaluating the robustness and generalizability of the PSI-VS-ID, would be to verify its applicability and validity with non-French-speaking populations. Secondly, the PSI-VS-ID was also designed to be used in the context of in-depth longitudinal or idiographic studies, but it was never tested in this context. In fact, there is actually no data available to support the usefulness of this instrument in a real idiographic setting. Consequently, the next steps would be to verify the sensitivity of the PSI-VS-ID to intra-individual changes in the context of in-depth longitudinal or idiographic assessment, especially in populations with ID who may not be able to assess momentary fluctuations in their self-perceptions as precisely as youths without ID. Finally, the criterion-related validity of both instruments was not evaluated with regard to: (i) other physical self-concept instruments that may also or not be adapted for populations with ID (e.g. PSDQ); (ii) instruments adapted for populations with ID and measuring other relevant concepts (i.e. body image, social physique anxiety, depression, etc.); and (iii) multiple external criterions (e.g. fitness examinations, physical activity level, modality of physical activity, etc.). These issues should clearly be addressed in the context of future studies.

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