Thematic Article

Cross Cultural Invariance and Comparisons of Hungarian-, Chinese-, and English-speaking Preschool Children Leading to the Revised Dimensions of Mastery Questionnaire (DMQ 18)

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Abstract

The Dimensions of Mastery Questionnaire (DMQ) was designed to measure children's mastery motivation, a multifaceted and psychological force that supports children's persistent interaction with and learning from their environment. DMQ 17 parent ratings of 2 to 6 year-old preschool children from English-speaking, Chinese-speaking, and Hungarian-speaking countries were used to check for measurement invariance. Confirmatory factor analyses were applied to validate the hypothesized 5-factor structure for the preschool version of the DMQ. Cross-cultural measurement invariance was found after several items with lower factor loadings and all the reversed items were deleted. A second order 5-factor structure was validated and supports the revision of the DMQ from version 17 to version 18 for this age group and these three cultures. Cultural differences were analyzed by latent mean scores. Among the three subsamples of children, there were no differences on the DMQ scales except for gross motor persistence, which was found to be lower in Chinese-speaking children than in English- and Hungarian-speaking children. These findings support the use of the DMQ 18 as a measure of young children's mastery motivation in at least these three cultures.

Keywords: motivation, preschool children, psychometrics, Dimensions of Mastery Questionnaire, persistence, DMQ17

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Introduction

Definition of Mastery Motivation

Mastery motivation stimulates children's independent attempts to master tasks that are moderately challenging for him or her (Morgan, Harmon, & Maslin-Cole, 1990). Mastery motivation focuses on the child's persistence, the process or motivation to master the task, rather than the child's ability to solve a problem (Busch-Rossnagel & Morgan, 2013). There are three domains of the mastery motivation construct. The cognitive/object domain includes children's attempts to master toys and cognitive problems; the social domain is children's attempts to interact effectively with others, and the gross motor domain focuses on children's attempt to master physical skills (Morgan, MacTurk, & Hrncir, 1995). Within each domain, there are two indicators: instrumental and expressive. The instrumental indicator is represented by persistence and the duration of task-directed behavior, and the expressive indicator is positive or negative affect during or immediately after task-directed behavior (Barrett & Morgan, 1995).

Mastery Motivation as a Predictor of Children's Achievement

Mastery motivation is important, in part, because it is a predictor of cognitive development and school success. Some classic studies demonstrated that early indicators of mastery motivation in infancy predicted children's IQ at 3 years (e.g., Yarrow, Klein, Lomonaco, & Morgan, 1975). More recently, Mercader, Presentación, Siegenthaler, Moliner, and Miranda (2017) found that persistence in completing a challenging task in preschool significantly predicted mathematics achievement in second grade. Gilmore, Cuskelly, and Purdie's (2003) and Jennings, Yarrow, and Martin's (1984) studies found longitudinally that the instrumental aspects of mastery motivation predicted school-related skills, but only for girls. Mokrova, O'Brien, Calkins, Leerkes, and Marcovitch (2013) studied the prediction of kindergarten academic skills (language and math). They did not find gender differences, but like Gilmore and colleagues, they found that the instrumental aspect of mastery motivation (persistence) longitudinally predicted both language and math skills. Józsa and Morgan (2014) found cognitive persistence in grade 4 predicted grade point average (GPA) in grade 8.

Berhenke, Miller, Brown, Seifer, and Dickstein (2011) studied the concurrent relation between instrumental and affective or expressive aspects of mastery motivation and school readiness. They found that shame and persistence were positively correlated with social competence and with math and reading skills. Similarly, Walker and MacPhee (2011) found that instrumental mastery motivation completely mediated the concurrent prediction of preschool children's developmental level from parents' coercive control. Józsa and Molnár (2013), in a cross-sectional study of third and sixth graders, also found an association between instrumental mastery motivation and both GPA and achievement in specific school subjects. All of these findings are suggestive that both instrumental and affective aspects of mastery motivation may be important predictors of cognitive development and school success.

Measures of Mastery Motivation

Both the Dimensions of Mastery Questionnaire (DMQ) and moderately challenging tasks (e.g., Józsa, Barrett, Józsa, Kis, & Morgan, 2017; Wang, Liao, & Morgan, 2017) are being used to measure mastery motivation. This paper uses DMQ parents' ratings of their preschool child's mastery motivation.

Dimensions of Mastery Questionnaire (DMQ)

Initially the DMQ was developed for mothers or caregivers to rate preschool children (Morgan et al., 1993). Over the years, the DMQ was expanded to include infant and school-age versions; the later had a by-self as well as a parent or teacher version. The DMQ was also expanded to include four scales of the instrumental/persistence aspects of mastery motivation and two of the expressive or affect aspects. In addition, there were items about the child's general competence or ability in comparison to same-age peers. The competence items were not considered aspects of mastery motivation and the negative reaction items in DMQ 17 had inadequate internal consistency. Thus, only the four persistence scales and mastery pleasure were used as indexes of mastery motivation in this study. Review articles by Józsa and Molnár (2013) and Morgan, Wang, Liao, and Xu (2013) provide summaries of the extensive data and studies using DMQ 17, which is the version analyzed in this paper.

To enhance the generalization of the use of the Dimensions of Mastery Questionnaire (DMQ) across cultures, English-speaking, and Chinese-speaking children have been examined using the preschool DMQ 17 (Morgan et al., 2013). Similarly, Józsa, Wang, Barrett, and Morgan (2014) used the school-age DMQ 17 to study mastery motivation in English-, Chinese- and Hungarian-speaking countries.

For parent-rated preschool version, the findings of exploratory factor analysis (EFA) showed a clear 5-factor structure for 457 English-speaking children (Morgan et al., 2013), with cross loading on only one item (item 21: Is pleased when solves a hard problem), and one reversed item (item 33: Gives up quickly when playing with adults) did not load on any factor. However, the factor structure for 299 Chinese preschool age children was less clear. The Chinese-speaking parents tended to cluster preschool children's cognitive/object persistence with gross motor persistence. Józsa et al. (2014) used the school-age DMQ 17 to study 7- to 19-year-old children in Hungary, China, and the US. They reported a clear 5-factor structure without the reversed items, competence, or negative reactions. Similar 5-factor structures were found for the whole/combined samples and for the Hungarian, Chinese, and American samples separately.

For DMQ 17 one item in each scale was negatively worded so it needed to be reversed when scoring. The reversed items were originally designed to help prevent rater response set. However, 10-20% of the respondents seemed to misread the reversed items, which led to lower internal consistencies and presumably less valid scores for those children (Józsa & Morgan, 2017). Thus, we decided to not score the reversed items in later DMQ 17 papers (e.g., Józsa et al., 2014).

Morgan et al. (2013) compared mean DMQ 17 scale scores for English- and Chinese-speaking preschool children. The Chinese children had significantly higher scores on social persistence with adults and negative reaction to failure, but lower scores for social persistence with children compared to the English-speaking preschool children. Morgan et al. argued that these small but significant differences are consistent with what would have been predicted about child-rearing in the two cultures. In the same paper, Morgan et al. (2013) also compared parent ratings of English- and Chinese-speaking elementary school children. These English speaking adults rated their children substantially higher on all the DMQ scales, except negative reactions to failure. It may well be that by elementary school Chinese-parents have higher expectations, so they rate their children lower than American parents rate theirs.

Although the DMQ 17 data provided good evidence for reliability and validity of the scores and useful results in a number of studies, feedback received from researchers and practitioners encouraged the developers to revise the DMQ 17 to make improvements in several aspects. These revisions included increasing item clarity in different samples, dropping consistently problematic items, especially the reversed items, and ensuring linguistic equivalence of the items across cultures so that the items are age and culturally appropriate.

Numerous theoretical and empirical studies have been conducted on mastery motivation using the DMQ over the years, but only two studies used confirmatory factor analysis (CFA) and both were with school-age children. Wang, Józsa, and Morgan (2014) found a good fit for a 5-factor model with DMQ 17 self-ratings of school-age children in three countries. This multiple-group confirmatory factor analyses examined measurement invariance among American, Chinese, and Hungarian children and also among elementary, middle, and high school children from the Chinese and Hungarian samples. Measurement invariance was established in each of the analyses. A few latent mean differences in each of the five scales were found among the subsamples. Józsa and Kis (2016) analyzed students' self-ratings with CFA in a different Hungarian school-age sample. The study verified the structural validity of the DMQ 17. However, the authors pointed out that the model fit indexes and the scale reliabilities could be improved by omitting some reversed items.

Despite the fact that DMQ has been used in a variety of samples from infancy to adolescence (e.g., with typical and atypical populations and with participants from different cultures), measurement invariance across different cultures has never been examined for preschool-age children. This is necessary to justify whether the scale items and underlying mastery constructs are interpreted in a conceptually similar manner by different groups of respondents. The study presented in this paper uses CFA techniques to test the construct structure of the DMQ, identify problematic items from DMQ 17, and examine measurement invariance of the DMQ across three countries (Hungary, Taiwan, and the US) for a preschool population rated by a parent.

The two main objectives of this study are: 1) To validate the hypothesized 5-factor structure of the DMQ 17, and examine measurement invariance across English-speaking, Chinese-speaking, and Hungarian-speaking preschool-age versions; and 2) To provide support for revisions leading to the DMQ 18.

Methods

Participants

A total of 1582 children aged 24–72 months from Chinese-speaking, English-speaking, and Hungarian-speaking countries were rated by their parents with the DMQ-17 preschool version. The Chinese and American samples were mostly middle-class children; the Hungarian sample had a wide range of socio-economic status (SES). Chinese-speaking children (n = 389) were from Taiwan (the Taipei birth panel study, 2008; Hsieh et al., 2011). English-speaking children (n = 353) were from America and Australia. The number of Hungarian-speaking children (n = 840) was much larger than the other two samples.

Instrument

DMQ 17 used in this study had 35 items, with each rated on a five-point Likert scale from 1 = not typical at all to 5 = very typical (Morgan, 1997). The instrumental aspects of mastery motivation are assessed on four scales: cognitive/object persistence (COP, 9 items, e.g., tries to complete things, even if it takes a long time), gross motor persistence (GMP, 8 items, e.g., tries to do well in physical activities even when they are hard), social persistence with adults (SPA, 6 items, e.g., tries hard to get adults to understand), and social persistence with children (SPC, 6 items, e.g., tries to get included when other children are playing). We also used one scale for assessing the expressive aspect of mastery motivation: mastery pleasure (MP, 6 items, e.g., smiles after finishing something). The score of each scale is the average of the items in that scale. Therefore, the score range of each scale is from 1 to 5. Except for the negative reaction scale, a higher score indicates higher mastery motivation. DMQ 17 has acceptable internal consistency ($\alpha > .7$) and evidence to support validity (Józsa & Molnár, 2013; Morgan et al., 2013).

Procedures

The data from all the 1582 children were randomly separated into two subsets: sample 1 (n = 791) and sample 2 (n = 791). The initial confirmatory factor analysis (CFA) model was explored with sample 1 to test for the 5-factor structure, using the four instrumental/persistence scales (COP, GMP, SPA, and SPC) and the expressive scale (MP) as used by Józsa and Molnár (2013), and Morgan et al. (2013). If any revision of the proposed 5-factor structure model was needed, sample 2 was used to cross-validate the final model (Bollen, 1989). For sample 1, the assessment of convergent and discriminative validity of the 5 latent variables was tested individually (Schumacker & Lomax, 2004). The factor loadings, Cronbach's alphas, and composite reliability scores (reliability estimation with measurement errors accounted for, see Bacon, Sauer, & Young, 1995) were used to examine the convergent validity for each factor. Item with loadings less than 0.45 were removed (Hooper, Coughlan, & Mullen, 2008). Composite reliabilities over 0.6 (Fornell & Larcker, 1981), and Cronbach's alphas greater than 0.7 (Andresen, 2000) are considered adequate. Discriminant validity was assessed using bootstrapping approaches with 1000 samples (Nevitt & Hancock, 2001) to test the standard error of correlation coefficients between the five latent variables. The 95% confidence interval was calculated for the upper and lower bounds of the correlation coefficients. If the 95% confidence interval does not contain 1.0, the pair of latent variables is considered discriminative.

To identify the best fitting model for the data of sample 1, we also conducted confirmatory factor analyses (CFAs) to compare a first order model with a second order model. The first-order CFA was estimated by allowing the five latent variables to be freely correlated. The second–order CFA was a more parsimonious model with the five latent variables loaded onto one second-order factor (See Figure 1). The target coefficient (T), which is the ratio of the chi-square of the first order model to the chi-square of the higher order (more restrictive) model, was used to evaluate whether the first or second order model is preferable for the data (Marsh & Hocevar, 1985). A value of T of 1 represents a perfect fit. There is no clear cut-point for T values, but > .75 would suggest that the second order model is reasonable.

After the optimal structural model of DMQ was identified with needed revisions, samples 1 and 2 were merged. Measurement invariance was examined between samples 1 and 2, and among Chinese-, English-, and Hungarian-speaking groups. The criteria used to justify measurement invariance include Δ CFI $\leqq$ 0.01, Δ GFI $\leqq$ 0.01, or ΔTLI $\leqq$ 0.05 in model comparisons (Little, 1997).

Data Analysis

This is a secondary data analysis, with children rated by their primary caregivers. The Chinese and Hungarian translation processes have been described elsewhere by Józsa et al. (2014). Considerable preschool DMQ 17 data from different cultures have been cumulated over the last decade or so (Józsa & Molnár, 2013; Morgan et al., 2013). The samples are now sufficient to conduct a rigorous validation with CFA for the preschool-version of the DMQ. CFA is a statistical technique to test the fitness between hypothesized models and empirical data; it allows estimation of measurement errors to achieve a more precise estimation of loadings, which led to the revision of DMQ 17 by deleting items with lower loadings. In addition, CFA conducted with multiple samples simultaneously can be used to check measurement invariance, the establishment of which ensures that comparisons across groups with the same measure are meaningful (Schumacker & Lomax, 2004).

The data were analyzed using SPSS 19.0 and AMOS 20.0 (IBM, Inc., Armonk, NY, USA, 2012). CFA using the structural equation modeling (SEM) technique with maximum likelihood (ML) was applied. Fit indexes with their cutoff criteria (RMSEA < 0.08, GFI ≥ 0.90, NFI ≥ 0.90, CFI ≥ 0.90) (Cheung & Rensvold, 2002; Schreiber, Nora, Stage, Barlow, & King, 2006; Schumacker & Lomax, 2004) were used for assessing the model fit. Because of the strong assumption of normality in ML, the normality of each variable was judged by skewness ≦ 2.0 and kurtosis ≦ 7.0, and Mardia's coefficients of multivariate Kurtosis and its critical ratios < 5.0. However, when sample size increases or there is a violation of normality, the ML chi-square would inflate the significant *p* value to reject the model, then the Bollen-Stine bootstrap chi-square (Enders, 2005) was used to correct the fit indexes.

Results

According to the examination of construct validity, there were 5 items with loadings lower than .45 (See Table 1) in sample 1: three COP items, one SPA item, and one MP item. Two out of the 5 items were reversely-coded items. After deleting these 5 items, we used sample 2 to confirm the model. Factor loadings, Cronbach's alphas, and composite reliabilities were all acceptable for each of the five scales: Cronbach's alphas for COP, GMP, SPA, SPC, and MP were (0.783, 0.869, 0.782, 0.812, 0.791, respectively). Composite reliabilities were (0.788, 0.897, 0.787, 0.819, 0.790). There were still three reversed items (item 3, 9, and 39) with modest loadings (0.472-0.566) in the model. Because of known problems in other samples with the reversed items (Józsa & Morgan, 2017), it had been decided not to use them in DMQ 18 and final publications with DMQ 17 (Józsa et al., 2014). Thus, these three items were omitted for the final confirmatory model with sample 2, which now had 27 items (RMSEA = 0.08, GFI = 0.96, NFI = 0.96, CFI = 0.96 with Bollen-Stine bootstrap chi-square correction). The five scales had acceptable Cronbach's alphas (0.783, 0.887, 0.768, 0.788, 0.808) and Composite reliabilities (0.804, 0.889, 0.776, 0.831, 0.851). Discriminant validity with bootstrapping suggested that the five factors are discriminative between each other. The value of coefficient (T) was 0.78. Therefore, the second order model, which modeled the 5 domain-specific mastery dimensions under a broader mastery motivation construct, fit the data as well as the first order model. Because the second order factor structure is more closely aligned with our current theoretical conceptualization of mastery motivation, we retained the second order model for the remaining analyses.

Table 1. Construct Validity for Individual DMQ 17 Scales Using Confirmatory Factor Analysis

	DMQ scales/items	Standardized loading (sample 1)	Standardized loading [a] (Sample 2)	Standardized loading [c] (Sample 2)
Cognitive/Object Persistence (COP)				
01	Repeats a new skill until he or she can do it well.	.592	.602	.733
09	If a toy or task is hard to do, stops trying after a short time. [b]	.460	.473	
14	Tries to do things, even if it takes a long time.	.664	.668	.810
17	Explores all parts of an object or toy with many parts.	.316*	-	
23	Works for a long time trying to do something hard.	.795	.779	.810
24	Tries hard to do cause and effect toys such as a busy box.	.440*	-	
27	Likes to try hard things instead of easy ones.	.435*	-	
29	Will work for a long time trying to get something open.	.622	.627	.772
31	Tries to complete toys like puzzles even if they are hard.	.534	.545	.570
Gross Motor Persistence (GMP)				
03	Gives up if he or she cannot do physical skills well. [b]	.566	.566	
12	Tries to do well in physical activities even when they are hard.	.704	.704	.656
16	Likes physical activities and tries to do them well.	.754	.754	.748
26	Repeats skills related to moving around until he or she can do them. well.	.818	.818	.804
27	Tries hard to throw or roll balls to do it well.	.772	.772	.786
36	Repeats motor skills in order to do them well.	.707	.707	.660
40	Tries to do well at physical activities.	.742	.742	.777
45	Tries hard to get better at catching or retrieving things.	.696	.696	.676
Social Persistence with Adults (SPA)				
08	Enjoys "talking" to adults, and tries to keep them interested.	.628	.630	.599
15	Tries hard to interest adults in playing with him or her.	.742	.747	.730
19	Likes to play actively with me or other adults.	.714	.708	.671
22	Tries very hard to get adults to understand him or her.	.626	.630	.638
33	Gives up quickly when playing with adults. [b]	.319*	-	
37	Enjoys playing peek-a-boo with adults.	.546	.538	.553
Social Persistence with Children (SPC)				
25	Gets very involved looking at other children.	.468	.468	.622
28	Tries hard to touch other children when near them.	.678	.678	.664
30	Likes to "talk" to other children.	.806	.806	.780
32	Tries to get included when other children are playing.	.744	.744	.799
35	Tries to keep play going for a long time when around other kids.	.661	.661	.649
39	Avoids getting involved with other children. [b]	.555	.555	
Mastery Pleasure (MP)				
02	Smiles broadly after finishing something.	.633	.619	.730
11	Does not smile after he or she makes something happen. [b]	.322*	-	
18	Gets excited when he or she figures something out.	.586	.600	.639
21	Is pleased when solves a hard problem	.674	.667	.765
41	Smiles when he or she makes something happen.	.687	.681	.783
43	Shows excitement when he or she is successful.	.695	.708	.728

*Note. *Items loadings < 0.45; a standardized weight after deletion of items loading <.45; b reversed items; a standardized weight after deletion all the reversed items*

In addition, measurement invariance was established between sample 1 and 2, and among the Chinese-, English-, and Hungarian-speaking groups. Table 2 lists the goodness-of-fit statistics when models with increased constraints were compared with each other, using language spoken as the grouping variable. Each successive model included the previous model's restrictions plus additional constraints and served as the comparison standard for the subsequent model. As Table 2 shows, measurement invariance was obtained at every step when the equality constraints were set progressively on factor loadings, structural weights, and structural covariances.

Table 2. Model Fit Indices for Measurement Invariance among the Chinese-, English-, and Hungarian-speaking groups

Model	$BS\chi^2$	df	p	GFI	NFI	CFI	TLI	RMSEA	$\Delta BS\text{-}\chi^2$	ΔTLI	ΔCFI
Configural invariance	1201.4	957	<.001	0.94	0.94	0.99	0.99	0.01			
Factor loading invariance	1245.4	122	<.001	0.93	0.93	0.99	0.99	0.01	43.9	<.001	<.001
Factor loading and structure weight invariance	1253.6	125	<.001	0.93	0.92	0.99	0.99	0.01	8.14	<.001	<.001
Factor loading, structure weight and structural covariance invariance	1255.7	123	<.001	0.93	0.92	0.99	0.99	0.01	2.19	<.001	<.001

Note. CFI = comparative fit index; TLI = Tucker-Lewis index; RMSEA = root mean error of approximation; $BS\chi^2$ = Bollen-Stine-χ^2

Figure 1 also presents the second order confirmatory factor analysis (CFA) model with the equality constraints set on factor loadings, structure weights, and structural covariances for the three language groups. In this second order CFA model, mastery motivation was modelled as a latent variable which was not observable directly but can be inferred from the shared variance (the conceptual and empirical overlap) of the five mastery motivation dimensions, COP, SPA, SPC, GMP, and MP. Each of these five dimensions of mastery are also latent variables themselves which cannot be observed directly but can be inferred from the shared variance of a subset of the 27 items, such as inferring COP from items 1, 14, 23, 29, and 31. Besides the shared variances, each of the 27 items and the five mastery dimensions were allowed to have measurement errors (e), which were also modelled in the CFA. Such a modeling technique allows for a more accurate estimation of the latent constructs. Measurement invariance was examined by forcing the factor loadings, structure weights, and structural covariances of the same items or constructs in each language sample to be the same across each of the English, Chinese, and Hungarian language samples. In Figure 1, the corresponding loadings for each of the 27 items and for the 5 DMQ scales are shown, and are all acceptable.

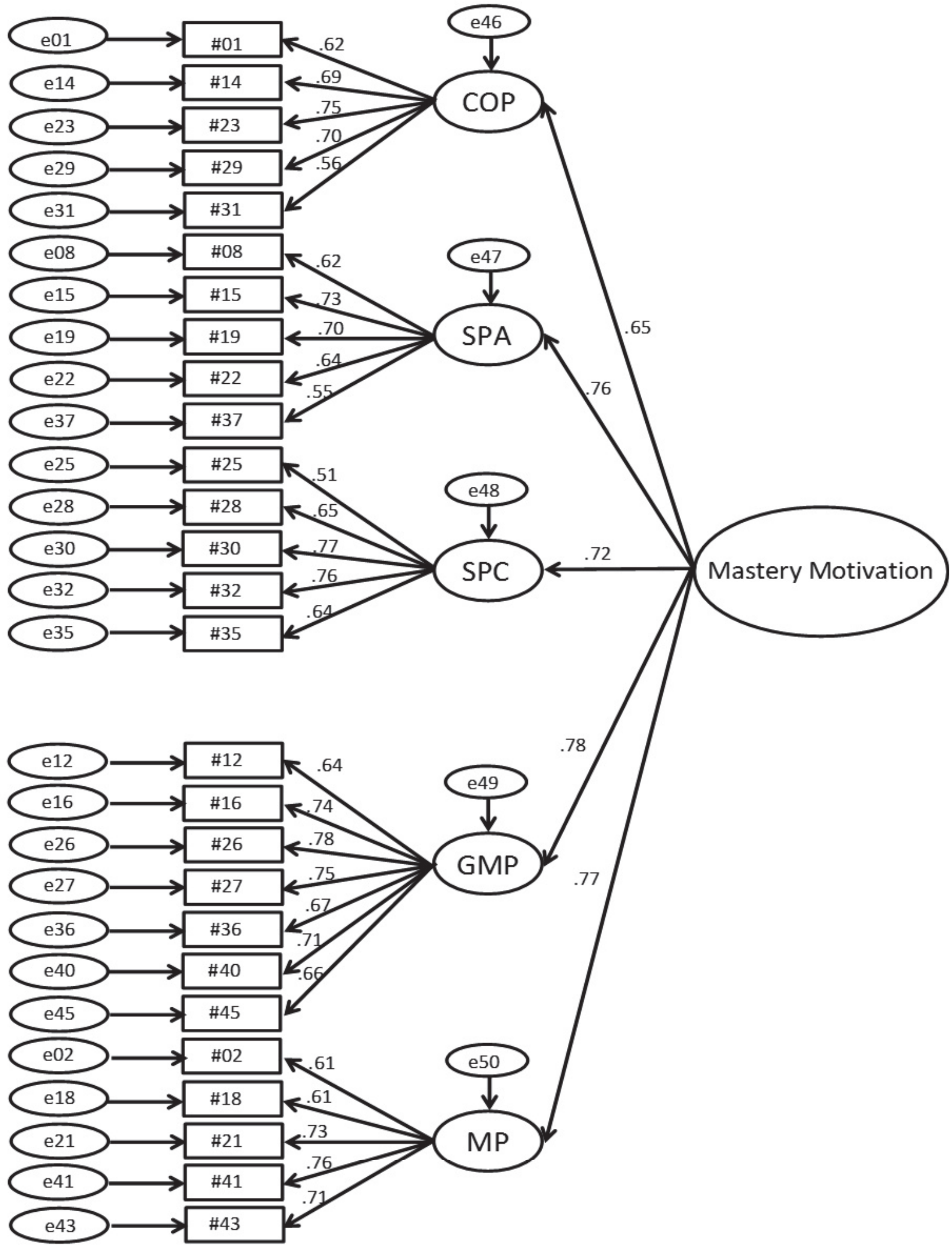

Figure 1. The Confirmatory Factor Analysis of the Second-order Factor Structure of the DMQ preschool Version. Note: COP: Cognitive/object persistence; SPA: Social persistence with adults; SPC: Social persistence with children; GMP: Gross motor persistence; MP: Mastery pleasure.

As measurement invariance across the three language groups was established, latent mean differences were examined across the three groups. Table 3 presents the differences for the estimated mean factor scores from the CFA for the three language groups. Because the sample size is large and multiple comparisons were done, we set the alpha at 0.01 for the post hoc comparisons for each of the five domains as scales of the DMQ. There were no differences between the three language groups except that the

Chinese-speaking preschool children were rated lower than the other two groups on gross motor persistence by their parents.

Table 3. Latent Mean Scores and Differences in DMQ Scales among Three Subsamples of Children

Scale	Chinese-speaking		English-speaking		Hungary-speaking		Multiple comparisons
	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.	
COP	3.58	0.05	3.70	0.05	3.58	0.03	Chinese = English = Hungary
SPA	4.09	0.05	4.00	0.05	3.92	0.04	Chinese = English = Hungary
SOC	3.88	0.05	4.00	0.06	3.95	0.04	Chinese = English = Hungary
GMP	3.13	0.05	3.37	0.06	3.44	0.03	Chinese < English = Hungary
MP	4.50	0.04	4.37	0.04	4.37	0.03	Chinese = English = Hungary

Note. COP: Cognitive/object persistence; SPA: Social persistence with adults; SPC: Social persistence with children; GMP: Gross motor persistence; MP: Mastery pleasure; Post-hoc alpha <0.01 (Two-tailed).

Discussion

Measurement Properties

Confirmatory factor analysis (CFA) is an essential step in measurement development, through which the structure of the measure is tested against a prior theoretical conceptualization of the construct. The DMQ was developed to measure different dimensions of mastery motivation and has been used widely among different groups of participants. The current study used a preschool sample gathered from three different cultures to test a 5-factor model with items from the five DMQ scales that have been used for factor analyses in other studies (e.g., Józsa et al., 2014). The negative reaction scale items were not included because those items lack good reliability with young children. The competence scale items were not used because they are not considered aspects of mastery motivation and are relatively highly correlated with the persistence subscales, especially for teacher and parent ratings of young children. This study provides support that the DMQ appropriately represents the underlying factor structure of five dimensions of mastery motivation, cognitive/object persistence, gross motor persistence, social persistence with adults, social persistence with children, and mastery pleasure. Desirable validity and model fit indices were obtained for the preschool DMQ after filtering some problematic items. These findings provided support for the revision of the DMQ. Recently, Józsa and Morgan (2015) investigated the exploratory factor structure of the new Hungarian DMQ 18 in 211 Hungarian preschool children rated by the teacher. They found a clear 5-factor structure without any cross loadings.

The study did identify some problematic items from DMQ 17, the removal of which helped increase the psychometric qualities of the measure. Reversely coded items have been consistently identified in previous analyses to show relatively low loadings on the corresponding factors and caused problems for scale reliabilities and model fit indices. The problem of reversely coded items in DMQ has been reported in prior studies (e.g. Józsa & Morgan, 2017; Morgan et al., 2013), and reversed items were omitted from later analyses of some studies with DMQ 17 (e.g., Józsa et al., 2014) and in the revised DMQ 18 (Józsa & Morgan, 2015; Morgan et al., 2015, Morgan et al., 2017). The current study again provided evidence to support the deletion of reversed items in DMQ 18. However, DMQ 18 included 8 revised and new negative response items. These negative response items served the same purpose as the reversed items in the DMQ 17, namely to assure that the readers are paying attention and not reading too fast. The revised DMQ 18 has the same general competence scale and six motivation scales as did DMQ 17, with a few new or revised items.

Measurement invariance is also a key quality that needs to be examined during measurement development to ensure that items and constructs are perceived in the same way and relationships between the indicators and the underlying constructs are the same across different groups. Otherwise, between-group comparison using the same measure is not meaningful. In the current study, measurement invariance for the preschool sample was achieved among three different language-speaking groups (i.e., Chinese-speaking, English-speaking, and Hungarian-speaking samples), suggesting the cross-cultural appropriateness of the DMQ. The establishment of measurement invariance gives researchers and practitioners the confidence to use the DMQ to compare mastery motivation across different samples.

Group Mean Comparisons

There were no significant latent mean differences between the three language groups on four of the five DMQ scales. However, the Chinese-speaking preschool children had significantly lower gross motor persistence than English- and Hungarian-speaking preschool children. Wang et al. (2014) also found that Chinese-speaking school children had significantly lower gross motor persistence than English- or Hungarian-speaking children. In the Wang et al. study, the data were from school age children's self-ratings rather than parent ratings of preschool children as in this study. In addition, Józsa et al. (2014) found several significant differences, but with small effect sizes when comparing large samples of Hungarian, Chinese, and American 7- to 19-year-old children's DMQ 17 self-ratings. Again, the Chinese children rated themselves lowest on gross motor persistence, but only at age 11, not age 16. Thus, we found a common trend of lower gross motor persistence among Chinese-speaking children, young and older. In the Chinese culture, gross motor related and physical fitness related skill practices are not emphasized as much as in western cultures (Singer, Singer, Agostino, & DeLong, 2009). In mainland China and Taiwan, parents' emphasis on and expectation for academically-oriented performance is high. A lot of Asian children go to preschools between 3–6 years, and structured classrooms provide more limited outdoor activities than in western countries (Singer et al., 2009). Hence Asian children would get fewer opportunities to have practice and feedback to encourage their persistence in mastering gross motor activities.

Implications in cultural comparisons

With caution about differences in age levels and respondents, applying DMQs in diverse cultures or different language-speaking countries should be meaningful in future research on DMQ 18. Culture represents the context in which children experience their learning opportunities. The mastery motivation scores of children in different learning contexts provide normative data across cultures. With this normative data, professionals can allow for cultural diversity when tracking children's mastery motivation as an important indicator for later development and provide culturally appropriate strategies to promote learning. When the context changes with time, continuously monitoring mastery motivation based on proxy or self-reports would be crucial to identify possible barriers to learning and development. As a limitation and suggestion for further study, the Hungarian subsample was much larger than the other two. Thus, it would be reasonable to select only the middle class children from Hungary to make the three subsamples more completely similar in socio-economics and compare the cultures again.

Conclusion

This study provided the evidence for deletion of some items and revision of the DMQ17. The revised preschool DMQ 17 version produced here in Figure 1 was found to have good validity and measurement invariance across three cultural groups. DMQ 18, based on the revisions in this paper, includes items with sound measurement properties to collect information of children's mastery motivation across respondents in different cultures for children from 2 to 6 years. With complex constructs, such as mastery motivation, which has multiple dimensions, it is critical to develop a psychometrically sound measure so as to both capture the comprehensiveness of the construct and allow reliable, valid, and meaningful assessments across ages and groups. The development of such a measure and the accumulation of data and empirical evidence with the measure will help advance the associated theory and produce valuable scientific evidence for practice.

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