APPLICABILITY OF DEVELOPMENTAL TEST OF VISUAL PERCEPTION 2ND EDITION (DTVP-2) IN ASSESSING VISUAL PERCEPTUAL ABILITY AMONG 5 TO 6 YEARS MALAYSIAN CHILDREN

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Abstract:

The Developmental Test of Visual Perception, Second Edition (DTVP-2), is widely used in Malaysia despite the release of the updated third edition in 2014. Its applicability in non-American populations has been questioned, particularly due to cultural and normative differences. This study aimed to examine the applicability of the DTVP-2 among 76 English-speaking Malaysian children aged 5 to 6 years. The study further explored gender bias and investigated whether the ceiling rules influenced test performance. The DTVP-2 was administered according to both the recommended procedure and a modified procedure in which ceiling rules were removed for motor-reduced subtests. Results showed no significant gender bias across most subtests and composite scores, except for a minor difference in the Position in Space subtest under modified procedures ($p = .025$). However, significant variations were found between the Malaysian children and the American normative sample across all subtests ($p < .001$). Paired t-test analysis revealed higher General Visual Perception (GVP) scores under the modified procedure ($M = 95.16$, $SD = 7.11$) compared to the recommended procedure ($M = 87.95$, $SD = 7.24$), $t(75) = -24.23$, $p < .001$. These findings suggest that while the DTVP-2 is free from gender bias in the Malaysian context, reliance on American norms may either overestimate or underestimate children's abilities. Additionally, ceiling rules may prematurely truncate assessment outcomes, masking true potential. The study highlights the need for cultural adaptation and re-standardisation of visual perceptual assessments in Malaysia.

Keywords: DTVP-2, visual perception, Malaysian children, gender bias, cross-cultural assessment.

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1. Introduction

Visual perception and integration of visual information is crucial as it has important implications on academic development and on recognizing social cues (Dutton, 2015; Lueck, 2015). Deficits in visual perceptions may go undetected in some children due to intricate structure of its constructs. Generally, it is now accepted that development of visual perception could be classified into categories by acknowledging the degree of motor involvement in it. Hence the terms "motor reduce visual perception" (MRVP) and "motor enhanced visual perception" (MEVP) are commonly seen in themes pertaining to test for visual perception development in literatures (Colarusso & Hammill, 1972; Hammill,1993; Gradner,1996). Researchers also use MEVP interchangeably with the term visual motor integration (VMI). It is important here to note that the debate on the interrelation between MRVP and MEVP are ongoing. The believe that that these two systems (categories) are autonomous lead to development of test that either measures MRVP or MEVP (Colarusso & Hammill: Gardner,1996). On the other hand, some test developers contemplate that both these constructs have profound effect on the functionality of an individual and opted to measure both these constructs within a single test. Developmental test of visual perceptual test (DTVP) is one such test that includes both these categories to reflect general visual perceptual (GVP) ability of the test taker (Hammill,1993). DTVP-2 consists of Position in space (PS), Figure ground (FG), Visual closure (VC) and Form constancy (FC) which represents MRVP domain. Where else Eye-hand coordination (EH), Copying (CO), Spatial relations (SR) and Visual-motor speed (VMS) falls under MEVP.

DTVP-2's characteristics of easy administration and its discriminative properties to clinical populations have been an appealing factor for its wide usage (Reid,1987; Burner et al,1997; Brown et al.2005: Diamantis, 2006; Brown& Rodger, 2007; Moryosef-Ittah & Hinojosa ,1996; Brown & Hockey,2013; Guntayuong, Chincai, Pongsaksri & Vittayokorns,2013). In Malaysia, DTVP-2 has been extensively used in clinical settings even though it's third edition was published in 2014. The researchers involved in this current study are affiliated to one of the biggest public institutions catering for undergraduate occupational therapy students in Malaysia, where DTVP-2 has been thought in their curriculum. DTVP-2 can guide Malaysian therapist to determine the existence of a visual perceptual deficits and thus can support the need for further assessment or treatment initiation (McCauley & Swisher, 1984). It is common for clinicians to assume that their client is comparable to the standardized population of the respective tests, an assumption that may have adverse effects when applied to another culture (Mushquash & Bova, 2007; Tan et al., 2020). Hence, it's imperative to obtain test scores which could reflect true level of developmental performance of Malaysian children on DTVP-2 subsets.

Culture and experience play a role in normal development (Koch, Eksteen & de Witt,2015). This was established by a study in Hong Kong with reference to VMI development. The researchers compared two hundred and eighty-eight of their preschool children with their counterparts in United States. The study indicated that the former showed significantly better performance than the later (Ng et al, 2015).

An interesting study was conducted by Lai and Koon using DTVP-2 to compare MRVP and MEVP among five years old typical Chinese speaking in Hong Kong with Chinese English-speaking children from Australia. The authors sighted the proficiency in Chinese writing skills contributed to the Chinese speaking children's better competency in MEVP subtests (Lai and Koon,2012). Since visual perceptual ability is a developmental process (Kramer & Hinojos,2010), thus DTVP-2 result's interpretation may lead to discrepancy with respect to relying on the normative data in the manual (Visser et al.,2012; Richmond& Holland,2011; Cheung et al,2006 Lai & Leung,2012; Guntayuong, Chincai, Pongsaksri & Vittayokorns,2013). Whether DTVP-2 is free of gender bias as claimed by its developer requires scrutiny considering cross-cultural empirical evidence.

Cheung and fellow researchers investigated performance on DTVP-2 of two hundred and eighty-nine Hong Kong school children between age ages six to seven. They found significance difference between the girls' and boys' performance in CO and FG subtests (Cheung et al.2006). Another study done on five years old children in South Africa found that the girls scored significantly higher in DTVP-2 FG's subtest compared to boys (Smith, Visser & Rita Van Heerden, 2017). This leads to the crucial issue of normative samples. The DTVP-2's U.S. standardization sample may have adequately controlled for gender differences within that specific population, but the recurring findings in international contexts highlight a significant limitation.

DTVP-2, has well-documented measurement limitations. Its subtests possess inherent scaling difficulties, which led its developers to implement specific ceiling rules (Hammill et al., 1993). Furthermore, the linearity of its item progression has been questioned in cross-cultural contexts. To examine the DTVP-2's validity, a South African study correlated it with the Test of Visual Perceptual Skills Revised (TVPS-R) in children aged 6 to 11. The TVPS-R was selected as a measure of visual perception without a motor response, making it a suitable benchmark for the Motor-Reduced Visual Perception (MRVP) subtests of the DTVP-2. This study found that the Visual Closure (VC) subscale within the MRVP displayed difficulties do not present on the TVPS-R, suggesting a specific anomaly (Richmond & Holland, 2011).Separately, a Canadian study investigating the dimensionality of the four MRVP subscales (Position in Space [PS], Figure-Ground [FG], Visual Closure [VC], and Form Constancy [FC]) with 356 children aged 5 to 11 identified further issues. The authors excluded 11 of the 83 items from their analysis because the sample achieved perfect scores on them, indicating these items have a low difficulty index and lack discriminative power for this age group. The study also raised a significant concern that the MRVP scale exhibited multi-dimensionality rather than the intended one-dimensionality. Consequently, the authors cautioned clinicians against using the DTVP-2's composite scores for intervention planning, as recommended in the manual, due to this psychometric limitation (Brown et al., 2008). The text cites studies in Hong Kong and South Africa that found significant differences in how children perform on the DTVP-2 compared to the U.S. sample. This proves that the phenomenon of cultural bias is real and established, making it imperative to investigate if the same is true for the unique cultural context of Malaysia. The persistent use of the

DTVP-2 in Malaysia and other countries, despite known limitations and the availability of a newer edition, underscores the need to critically evaluate its foundational assumptions in diverse settings. This is particularly important for ensuring accurate assessment and equitable intervention planning (Pfeiffer et al., 2015).

2. Materials and Methods

2.1 Sample Selections

Visual perceptual skills is a developmental process, and some literature supports that these skills increase in development from 5years of age (Koch, Eksteen, &de Witt,2015; Colarusso & Hammill ,2003). American normative references for age 5years in the DTVP-2 manual, were separated into two age band 5-0 through 5-5 years and 5-6 through 5-11 years. However, since this is a preliminary study to explore the suitability of this instrument, recruiting samples and comparing performance of children within these two bands of classification is beyond the scope of this study. Hence, we opted for samples from 5-0 through 5-11 years old only. Thus the aim of this study was to compare the performance of 5 to 6 years old Malaysian with American norms in DTVP-2. Purposeful sampling was used to enroll samples who can comprehend English well. The selection was done in four Montessori programs around Putra Jaya. Montessori system uses English as a main medium. This system has been acknowledged to prepare children more effectively for early mainstream schooling, particularly through its emphasis on hands-on, visual, and spatial learning materials which may directly influence visual-perceptual development (Ansari & Winsler, 2014; Kaya & Yildiz, 2019; Marshall, 2017).

2.2 Instrument

The Developmental Test of Visual Perception–Second Edition (DTVP-2; Hammill et al., 1993) was administered to assess visual perceptual abilities. This standardized instrument is designed for children aged 4 through 10 years and standardized in 1992 on 1,972 American children. The normative sample consist of 3% children with disabilities (Hammill et al. 1993).

This test has eight subtests under two categories, MRVP and MEVP. Administration was conducted in the standardized sequence specified in the manual: EH, PS, CO, FG, SR, VC, VMS, and FC. All these subtests have no basal level and require to begins with item one on all respective subtests. All subtest however observes the ceiling rules except for EH and VMS (MEVP subtests). It should be noted that different ceiling rules apply for the remaining six subtests. The ceiling for PS, FG, VC and FC is the point where the child misses three out of five items in a row. On the other hand, CO and SR are tested until a ceiling when the child scores zero on three items in a row (Hammill et al. 1993).

Scoring followed the recommended procedure: raw scores were first calculated for each of the eight subtests, representing the total number of items correctly completed. These raw scores were then converted to age-based standard scores (M=10, SD=3) using the manual's normative tables. Finally,

these standard scores were summed to generate three composite quotient scores (M=100, SD=15): a General Visual Perception (GVP) quotient, a Motor-Reduced Perception (MRP) quotient (derived from subtests like Figure-Ground and Visual Closure), and a Visual-Motor Integration (VMI) quotient (derived from subtests like Copying and Eye-Hand Coordination), providing a comprehensive profile of visual perceptual functioning.

2.3 Study's Procedures

This study procedure was adopted by Smith, Visser, Heerden and Raunchier (2017).

Data collection followed a dual approach, incorporating both recommended and modified procedures following the framework of Smith et al. (2017). The administration of the motor-enhanced subtests adhered strictly to the recommended protocol outlined in the DTVP-2 examiner's manual. For the motor-reduced subtests (Figure-Ground, Visual Closure, Form Constancy, and Spatial Relations), the standardized instructions were delivered as prescribed; however, the administration was modified by omitting the ceiling (discontinue) rules. This modification procedures ensured that all participants attempted all items within these subtests. Following data collection, two separate raw scores were calculated for the motor-reduced subtests: one reflecting the recommended procedure scoring practice as if the ceiling rules had been applied, and another representing the total score based on all items administered (modified procedures).

3. Results

3.1 Demographics

76 children from four Montessori schools participated in this performance-based assessment. There were slightly more male children (55.3%) then female (44.7%) with mean age of 65.7 months (s= 3.41 months). Most children were from Malay race (93,4%).

3.2 Comparison of performance between Malaysian boys and girls in DTVP-2

To thoroughly investigate the potential for gender bias in the DTVP-2 within the Malaysian context, this study employed both the recommended and a modified administration for the motor-reduced subtests. An independent samples t-test was conducted to compare the raw scores (RS) and standard scores (SS) of male (n=42) and female (n=34) participants across all eight subtests and three composite quotients. Refer to Table 1.

Table 1. Comparison of Gender Performance in DTVP-2

DTVP-2 Subtests and composites	Score	**Recommended**				**Modified**			
		Means		Comparison		Means		Comparison	
		Male	Female	*t*	*p*	Male	Female	*t*	*p*
EH	RS	125.57	126.06	-.109	.569				
	SS	9.79	9.94	-.485	.890				

PS	RS	14.52	13.59	1.363	.331	17.19	16.29	1.616	.083
	SS	10.67	10.12	1.417	.044	12.19	11.38	2.057	**.025***
CO	RS	19.55	17.59	1.707	.912				
	SS	11.57	10.97	1.431	.280				
FG	RS	9.62	9.26	.760	.369	11.76	11.94	-.536	.876
	SS	10.12	9.79	.704	.452	12.21	12.29	-.210	.405
SR	RS	32.07	31.06	.508	.973				
	SS	13.14	12.79	.559	.586				
VC	RS	5.98	6.53	-.954	.516	9.29	9.94	-1.410	.298
	SS	9.31	9.88	-1.216	.971	12.05	12.65	-1.426	.490
VMS	RS	8.14	9.24	-1.575	.048				
	SS	12.19	12.76	-1.551	.346				
FC	RS	8.64	9.12	-.953	.082	10.43	10.94	-1.142	.135
	SS	11.14	11.38	-.786	.020	12.05	12.29	-.943	.214
GVP	SS	87.93	87.97	-.025	.913	95.19	95.12	.044	.970
	Q	106.93	106.65	.193	.894	113.33	113.21	.087	.902
MRP	SS	41.24	41.18	.064	.491	48.29	48.62	-.358	.807
	Q	102.43	102.06	.228	.360	114.14	114.41	-.178	.822
VMI	SS	46.69	46.47	.189	.929				
	Q	111.14	110.79	.180	.929				

*RS =raw score; SS = standard score; MRP = motor-reduced perception; MRPQ = motor-reduced perceptual quotient; VMI = visual-motor integration; VMIQ = visual-motor integration quotient; GVP = general visual perception; GVPQ = general visual perceptual quotient; *p≤0.05 statistically significant*

Analysis using independent sample t-test shows that there both male and female perform similarly in all subtests (p> 0.05) on both methods except for there is significant differences (p=0.025) in SS means using the modified procedures in PS subcomponent. Hence male participants outperform female in this component. A single exception to this overall trend was observed. Under the modified administration of the Position in Space (PS) subtest, a statistically significant difference was found in the standard scores (Male: M=12.19, Female: M=11.38; t (74) = 2.057, p = 0.025), with boys outperforming girls. It is critical to interpret this result with caution. Firstly, this difference was not present in the PS raw scores under the modified procedure (p=0.083), nor was it evident in the PS standard scores under the standard administration procedure (p=0.044, but the mean difference is very small: 10.67 vs. 10.12). The fact that the significance only appears in one specific score type (SS) under one specific administration method (modified) suggests it may be an outlier finding. Refer to Table 1 for the more elaborations.

3.3 Comparison of the American normative sample and the Malaysian sample's mean raw scores analysed according to the recommended and modified procedures.

The raw score (RS) of each subtest is calculated as the sum of the correct answered items (Hammil et al. 1993). Accordingly, Table 2 presents the DTVP-2 subtest' mean RS of Malaysian sample (n =76) in comparison to the mean RSs of the 5 years 6 months to 5 years 11 months American normative sample. The Scores are presented in the same sequences in which the DTVP-2 is administered and reported. In comparison to the 5 years 6 months to 5 years 11 months American age norms, the Malaysian sample (n = 76) obtained lower mean RSs for VC and higher mean RSs for EH, PS, CO,

FG, SR, VMS and FC. In comparison to the 5 years 6 months to 5 years 11 months American age norms, the Malaysian sample (n = 76) obtained lower mean RSs for VC and higher mean RSs for EH, PS, CO, FG, SR, VMS and FC.

Table 2. Comparison of the American normative sample and the Malaysian study sample's mean raw scored according to the prescribed method

DTVP-2 Subtests	American mean Raw Score	Malaysian sample (n = 76)		
		Mean Raw Score[a]	Comparison	
			t-value	*p*
Motor- reduced subtests				
PS	13	14.11(s=2.991)	3.221	.002*
FG	9	9.46(s=2.016)	1.991	.050*
VC	7	6.22(s=2.512)	-2.694	.009*
FC	8	8.86(s=2.158)	3.455	.0001*
Motor- enhanced subtests				
EH	126	125.79(s=19.323)	-.095	.925
CO	16	18.67(s=5.04)	4.621	.000*
SR	21	31.62(s=8.595)	10.771	000*
VMS	6	8.63(s=3.037)	7.554	.000*

PS =position in space; FG= figure ground; VC= visual closure; FC= form constancy; EH =eye hand coordination; CO= copying; SR= spatial relation; VMS=visual motor integration. *p≤0.001 statistically significant

3.4 DTVP-2 scores of the Malaysian study sample, scored according to the modified scoring method in comparison to the 5 years 6 months to 5 years 11 months age interval of the American normative sample

First, this section presents the RSs of the motor-reduced subtest of the Malaysian sample (n = 76), after which the SS distribution of the motor-reduced subtests scores were generated offered. Refer to Table 3.

Table 3. Mean Raw Scores on DTVP-2 Motor-Reduced Subtests using recommended and modified procedures of the Malaysian Sample vs. U.S. Normative Sample (5y6m - 5y11m).

	USA	Malaysian recommended procedures			Malaysian modified procedures			Recommended-Modified procedures difference		
	Mean	Mean[a]	*t*	*p*	Mean[a]	*t*	*p*	Mean Diff	*t*[b]	*p*
PS	13	14	41.106	<.0001*	17	60.249	<.0001*	-2.684	-14.037	<.0001*
FG	9	10	40.906	<.0001*	12	71.558	<.0001*	-2.382	-15.310	<.0001*
VC	7	6	21.601	<.0001*	10	41.173	<.0001*	-3.355	-15.155	<.0001*
FC	8	9	35.766	<.0001*	11	47.655	<.0001*	-1.803	-13.887	<.0001*
MRPQ		107	127.502		113	153.395		-6.474	-24.656	<.0001*

GVPQ		102	148.459		114	157.054		-12.000	-24.353	<.0001*

[a] = Values rounded to the nearest integer since the DTVP-2 reports rounded values, t-test
[b] = Paired t-test between prescribed and adapted Malaysian scores. * = <0.05 statically significant

4. Discussion

This study aimed to evaluate the applicability of the DTVP-2 for assessing visual perceptual abilities in 5- to 6-year-old Malaysian children by examining gender bias, comparing performance to U.S. norms, and investigating the impact of ceiling rules. The finding that there were no significant gender differences in the vast majority of DTVP-2 subtests and composite scores supports the test developer's claim that the instrument is free from gender bias (Hammill et al., 1993). This is a crucial finding for clinicians, as it suggests that a single set of norms can be used for both boys and girls, simplifying interpretation. The single exceptional significant difference in the Position in Space (PS) subtest under the modified administration where boys outperformed girls—is an isolated result. Given that 20 separate statistical comparisons were made for gender differences (across subtests and composites under two procedures), the probability of finding at least one statistically significant result by chance (a Type I error) increases. Applying a stricter statistical correction for multiple comparisons (e.g., a Bonferroni correction) would likely render this single p-value of 0.025 non-significant. Therefore, while this result merits a mention for academic transparency, it should not be overemphasized. It does not constitute a consistent pattern of gender difference and is insufficient to invalidate the overarching conclusion that the DTVP-2 is effectively free from gender bias in this sample. This overall lack of gender bias aligns with the developer's intent and is supported by some subsequent studies (Brown & Hockey, 2013), but contrasts with findings in Hong Kong (Cheung et al., 2006) and South Africa (Smith et al., 2017). This discrepancy highlights that gender effects may be culturally or contextually dependent (Visser et al., 2019). This discrepancy highlights that gender effects may be culturally or contextually dependent and cannot be universally assumed. This isolated finding could be explored in future studies with larger sample sizes to determine if it represents a subtle, real effect or is merely a statistical artifact.

The most significant result of this study is the consistent and substantial difference found between the recommended scores of the Malaysian sample and the American normative sample across all subtests. This finding strongly suggests that the U.S. norms are not appropriate for this population. Using these norms would likely lead to the misclassification of Malaysian children, potentially underestimating their true visual perceptual abilities on the MRVP subtests and leading to inaccurate conclusions about their developmental status. This result is consistent with a growing body of international literature questioning the cross-cultural validity of Western-developed assessments and reinforces the call for local norms to avoid misdiagnosis (Mushquash & Bova, 2007; Richmond & Holland, 2011; Koch et al., 2021).Cultural and linguistic factors, educational experiences (such as the Montessori method's

emphasis on visual and hands-on learning), and early exposure to English and specific visuospatial tasks likely contribute to a different developmental trajectory and performance profile than that of the American standardization sample (Lai & Koon, 2012; Ng et al., 2015). For instance, the Malaysian children's performance patterns may be influenced by their specific preschool curriculum, which aligns with findings that environmental and instructional factors can significantly impact visual-perceptual development.

Furthermore, this study provides compelling evidence that the recommended administration rules of the DTVP-2, specifically the ceiling rules for the motor-reduced subtests, may be suppressing the scores of Malaysian children. The significantly higher General Visual Perception (GVP) quotient obtained when the ceiling rule was removed (*t*(75) = -24.23, *p* < .001) indicates that many children were capable of correctly answering more items than the standard procedure allowed. This suggests that the predetermined ceiling criteria are met prematurely for this population. This finding resonates with longstanding psychometric concerns about the DTVP-2. It supports the work of Brown et al. (2008) regarding item difficulty and Richmond and Holland (2011) on dimensionality, suggesting that the ceiling rules and item progression may not be universally applicable and can suppress scores in non-standardized populations (Capio et al., 2018). The ceiling rules, designed based on the American sample's performance, may not accurately reflect the ability range of Malaysian children, leading to an artificial truncation of scores and an underestimation of their visual perceptual capabilities.

5. Conclusion

This study investigated the applicability of the DTVP-2 for assessing visual perceptual abilities in a sample of 5- to 6-year-old Malaysian children. The findings indicate that the DTVP-2 is free from significant gender bias, supporting the developer's claims, with only one minor exception in a single subtest under a modified administration. This is a positive finding for its clinical use in this context. However, the study raises critical concerns regarding the use of American norms. The significant differences found between the standard scores of the Malaysian sample and the U.S. normative data across all subtests suggest that the test may not accurately reflect the true visual perceptual abilities of Malaysian children. Using the U.S. norms could lead to either an overestimation or underestimation of a child's abilities, potentially resulting in misdiagnosis or a failure to identify needs.

Furthermore, the study demonstrates that the application of the test's ceiling rules has a substantial impact on scores. The significantly higher General Visual Perception (GVP) scores achieved under the modified procedure (without ceiling rules) suggest that the ceiling rules may be prematurely truncating the assessment for this population, preventing a full demonstration of their capabilities. This indicates that the difficulty level and item sequencing of the motor-reduced subtests may not be optimally calibrated for Malaysian children. While limited to English-speaking, urban children

predominantly from a Malay ethnic background, this study concludes that the direct application of DTVP-2 with its American norms is not appropriate for the Malaysian context without further adaptation and validation.

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