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ORIGINAL ARTICLE

Visual Perceptual Skills (non-motor) among Adults in Selangor of Malaysia

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ABSTRAK

Kemahiran persepsi visual adalah penting bagi golongan dewasa untuk menjalankan aktiviti harian mereka seperti membaca, menulis dan memandu. Kajian ini dijalankan untuk menentukan kemahiran persepsi visual (bukan motor) dalam kalangan golongan dewasa di Selangor, Malaysia. Seramai 120 subjek dari Selangor yang berumur 20 hingga 59 tahun telah dipilih secara rawak dalam kajian keratan rentas ini. Kajian ini melibatkan pengukuran akuiti visual jauh dan dekat menggunakan carta Snellen dan carta penglihatan dekat Universiti Kebangsaan Malaysia (UKM), ujian saringan kognitif menggunakan soal selidik Mini Mental State Examination (MMSE) serta penilaian kemahiran persepsi visual (bukan motor) menggunakan Ujian Kemahiran Persepsi Visual (Bukan Motor)-Revised (TVPS-R). Purata umur subjek ialah 39.41±11.81 tahun. Keputusan menunjukkan purata skor TVPS-R bagi setiap sub-ujian iaitu Visual Discrimination (VD), Visual Memory (VM), Visual-Spatial Relationships (VSR), Visual Form Constancy (VFC), Visual Sequential Memory (VSM), Visual Figure-Ground (VFG) dan Visual Closure (VC) adalah 14.12±1.10, 13.42±1.58, 14.53±1.26, 12.47±1.03, 12.35±2.26, 13.67±1.64 dan 13.73±2.23. Analisis ANOVA menunjukkan skor VD, VM dan VSM dipengaruhi oleh tahap pendidikan ($p<0.05$). Korelasi Pearson menunjukkan korelasi negatif yang signifikan antara semua skor sub-ujian TVPS-R dengan variasi umur ($p<0.05$) kecuali bagi sub-ujian VFC. Ujian regresi linear menunjukkan hubungan negatif yang signifikan antara VD, VM, VSR dan VSM dengan umur. Kajian ini memberikan data normatif ujian TVPS-R bagi golongan dewasa Malaysia untuk rujukan dan kajian pada masa depan.

Kata kunci: dewasa, penuaan, persepsi visual, TVPS-R

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ABSTRACT

Visual perceptual skills are important skills for an adult to carry out their daily activities such as reading, writing and driving, successfully. This study was conducted to determine the visual perceptual skills (non-motor) of a group of adults in Selangor, Malaysia. A total of 120 subjects from Selangor with the age ranging from 20 to 59 years were randomly recruited in this cross-sectional study. This study involved distance and near visual acuity measurements using Snellen chart and Universiti Kebangsaan Malaysia (UKM) near vision chart, cognitive screening tests using the Mini Mental State Examination questionnaire (MMSE) as well as visual perceptual skills assessment (non-motor) using the Test of Visual Perceptual Skills (Non-Motor)-Revised (TVPS-R). The mean age of the subjects was 39.41±11.81 years old. Results showed that the mean standard scored obtained for Visual Discrimination (VD), Visual Memory (VM), Visual-Spatial Relationships (VSR), Visual Form Constancy (VFC), Visual Sequential Memory (VSM), Visual Figure-Ground (VFG) and Visual Closure (VC) subtests were 14.12±1.10, 13.42±1.58, 14.53±1.26, 12.47±1.03, 12.35±2.26, 13.67±1.64 and 13.73±2.23, respectively. Analysis of ANOVA shows that the VD, VM, and VSM scores are influenced by educational level ($p<0.05$). Pearson correlation showed a significant negative correlation between all the sub-tests of TVPS-R scores with age variation ($p<0.05$) except the VFC. Linear regression showed significant negative relationship between VD, VM, VSR and VSM with age. This research provided normative data of TVPS-R test on Malaysian adults for future reference and study.

Keywords: adult, aging, TVPS-R, visual perception

INTRODUCTION

Visual perceptual skills refer to a wide range of skills such as visual-spatial, visual analysis (also known as visual information processing) and visual motor integration, which are required for interpreting and understanding visual information (Garzia et al. 2008). Visual perceptual skills are the ability of the brain to understand and process what the human eye sees (Koppitz 1970). This skill is a very important component in human life because it is required in many daily activities like reading, writing and driving (Brown et al. 2012). In other words, the human brain receives the visual information of the environment from the eyes, processes the information and then issues the action at the end of the process (Cooke et al. 2005). According to a research on visual perceptual skills in children, those with weak visual perceptual skills had difficulty in carrying out daily activities such as using a cutlery while eating, as well as slow in reading and writing (Guntayuong et al. 2013).

There are many assessment methods

used to test the visual perceptual skills such as Motor-Free Visual Perception Test-3 (MVPT-3) (Mercier 2001), Developmental Test of Visual Perception (Guntayuong et al. 2013), Loewenstein Occupational Therapy Cognitive Assessment (Katz et al. 1989) and Assessment of Motor and Process Skills (Bernspång & Fisher 1995). However, one of the most commonly used visual perceptual skills test is the Test of Visual Perceptual Skills (Non-Motor)-Revised (TVPS-R). TVPS-R is a test that has been revised to determine subject's visual perceptual strengths and weaknesses based on non-motor responses. It consists of 7 subtests, visual discrimination (VD), visual memory (VM), visual-spatial relationships (VSR), visual form constancy (VFC), visual sequential memory (VSM), visual figure-ground (VFG) and visual closure (VC) (Gardner 1996). There are several factors which were identified to affect the performance of visual perceptual skills of an individual such as culture, language, geographical region, academic performance, race and socioeconomic status (Chen et al. 2011; Dunn et al. 2006; Lai & Leung 2012; Shi 1995). Han et al. (2014) found that visual perceptual skills will decrease due to several factors, which include aging process, low level of education and low cognitive function. Lee et al. (2016) also found that the aging process can lead to decrease in visual perceptual skills and interfere with daily activities among adults. Refractive error also found to be one of the factors that reduces the performance of visual perceptual skills (Narayanasamy et al. 2014; Narayanasamy et al. 2015).

To date, the normative database for the TVPS-R test is only available for the Caucasian (Gardner 1996) and Chinese (Ho et al. 2015) children population. To our knowledge, there is no normative data of visual perceptual skills available for adult in Malaysia. Therefore, this study aimed to determine the normative data of the visual perceptual skills of adults for all the sub-tests.

MATERIALS AND METHODS

Subjects

This was a cross-sectional study conducted in Selangor, Malaysia. Subjects who fulfilled the following criteria were recruited: (i) aged 20 to 59 years, (ii) monocular habitual distance visual acuity (VA) of 6/12 or better and (iii) monocular habitual near VA of N6 or better. Whereas, the exclusion criteria were adults with cognitive problems, adults with brain and nerve disorders and adults who are taking psychotropic drugs. The target population of this study were adults residing in Selangor where data was collected from hospitals and other workplaces in areas which were randomly selected, Selayang, Batu Caves, Ampang, Petaling Jaya, and Bangi. The samples were divided into four subgroups and each contained 30 samples, according to their age group. Each group had the same number of the sexes with a total of 17 Malays, 11 Chinese and 2 Indians. This was based on the percentage representation of the three races in Selangor (Department of

Statistic Malaysia 2018). The sample size was determined based on Krejcie and Morgan's (1970) sample size calculation:

$$s = X^2 NP(1-P) \div d^2 (N-1) + X^2 P(1-P)$$

where s was the sample size, X was the table value of chi-square for 1 degree of freedom at the desired confidence level (1.96 for 95% confidence level), N was the population size (3,301,200 adults in Selangor in 2018 (Department of Statistics Malaysia 2018), P was the expected prevalence (0.50 for maximum sample size) and d was the degree of accuracy expressed as proportion (0.05). The calculated sample size was added with 20% drop out. Hence, the sample size required was 120. The study followed the tenets of the Declaration of Helsinki and was approved by the Universiti Kebangsaan Malaysia (UKM) Ethical Committee for medical research (UKM PP/111/8/JEP-2017-778).

Procedure

All subjects were given a short briefing on the study by the researchers. A consent form was distributed to the subjects. Only those who agreed were asked to participate in all the optometric examinations whereby the first parameters measured were habitual distance VA, using Snellen chart placed at 6 m from the subject and near VA measured at 40 cm using UKM near chart.

The visual perceptual skills were tested with the Test of Visual Perceptual Skills (Non-Motor)-Revised (TVPS-R). The test used 112 black and white designs and consisted of seven subtests namely visual discrimination, visual memory, visual-spatial relationships, visual form constancy, visual sequential memory, visual figure-ground and visual closure. Each sub-test in the TVPS-R test started with an example plate and was followed by 16 test plates with increasing difficulty. This test was in a multiple-choice format, where there were 4 or 5 answer options for each plate. Subsequently, the correct number of answers for each sub-test, which was known as raw score was calculated and recorded in the examination record form. The test was conducted in a well-illuminated, quiet and well-ventilated room that was free from any auditory and visual distractions following the instruction given on the manual on a one-to-one basis.

Data analysis

All the data were analysed using SPSS version 22.0. Descriptive analysis was used to determine mean and standard deviation of the standard scores of each TVPS-R subtest. ANOVA was used to analyse for any significant difference between visual perceptual skills among different races and level of education. Independent Sample T-Test was carried out to determine whether there is significant difference between visual perceptual skills in different gender. Pearson correlation and linear regression were also performed to determine the relationship between visual perceptual skills and age. A p-value of <0.05 was considered as

Table 1: Mean and standard deviation of the standard scores of each subtest

Subtest TVPS-R	N	Mean	Minimum	Maximum
VD	120	14.12±1.10	11	16
VM	120	13.42±1.58	10	16
VSR	120	14.53±1.26	9	16
VFC	120	12.47±1.03	5	16
VSM	120	12.35±2.26	2	16
VFG	120	13.67±1.64	8	16
VC	120	13.73±2.23	4	16

VD=Visual Discrimination, VM=Visual Memory, VSR=Visual-Spatial Relationships, VFC=Visual Form Constancy, VSM=Visual Sequential Memory, VFG=Visual Figure-Ground, VC=Visual Closure

statistically significant.

RESULTS

A total of 120 respondents living in Bandar Baru Selayang, Bandar Baru Bangi and Ampang participated in this study. The mean age of the subjects was 39.41±11.81 years. From the 120 subjects, 61 subjects were males (50.8%) while 59 were females (49.2%). The subjects comprised of the three major races in Malaysia, namely Malays with 75 subjects (62.5%), Chinese with 28 subjects (23.3%) and Indians with 17 subjects (14.2%). The subjects also made up from different education level groups which were 2 subjects with primary education (UPSR) (1.7%), 10 subjects with lower secondary education (PMR) (8.3%), 42 subjects with upper secondary education (SPM) (35.0%), 15 subjects with post-secondary education (STPM) (12.5%), 47 subjects with a bachelor's degree (39.2%) and 4 subjects with master's degree (3.3%).

Visual Perceptual Skills

The mean and standard deviation of the standard scores of each subtest are summarised in Table 1.

Comparison of Visual Perceptual Skills between Races, Genders and Level of Education

ANOVA showed that there was no significant difference in the all subtests score of TVPS-R among the races ($p>0.05$). Independent Sample T-Test showed that there was no significant differences in the all subtests score of TVPS-R with different gender ($p>0.05$). ANOVA tests were also conducted to compare TVPS-R test scores against different levels of education. The results showed that there were differences in the score for VD, VM, and VSM ($p<0.05$). However, the analysis found that there was no difference in the score for VSR, VFC, VFG and VC ($p>0.05$). Table 2 summarises the TVPS-R test scores among the different races, genders and levels of education.

Relationship between Visual Perceptual Skills and Age

Table 2: Comparison of TVPS-R test scores with races, genders and different levels of education

Subtest TVPS-R	N	Races†		Genders‡			Education†	
		F	P	df	t	P	F	p
VD	120	0.03	0.97	118	-0.10	0.92	4.13	0.00**
VM	120	2.68	0.73	118	1.11	0.27	3.46	0.00**
VSR	120	1.11	0.33	118	-0.22	0.83	1.22	0.30
VFC	120	0.82	0.44	118	-2.44	0.05	2.14	0.07
VSM	120	0.54	0.58	118	-1.83	0.07	2.34	0.04*
VFG	120	0.66	0.52	118	-1.76	0.08	2.25	0.06
VC	120	0.84	0.43	118	-1.94	0.06	1.93	0.10

*P<0.05 **P<0.001
† ANOVA compared TVPS-R test scores among different races and level of education.
‡ Independent Sample T-Test compared TVPS-R test scores among different gender.
VD=Visual Discrimination, VM=Visual Memory, VSR=Visual-Spatial Relationships, VFC=Visual Form Constancy, VSM=Visual Sequential Memory, VFG=Visual Figure-Ground, VC=Visual Closure

Pearson correlation showed all TVPS-R subtests were significantly associated with age ($p<0.05$) except the VFC. However, the coefficient of correlation (r) indicated a weak relationship (approximately 0.1 to 0.3) between age with VD, VFG and VC. Linear regression analysis was carried out to determine the relationship between age changes and TVPS-R test score. The analysis found significant inverse relationship between age with VD, VM, VSR and VSM ($p<0.05$). Table 3 summarises the correlation coefficient and linear regression for the seven sub-tests of TVPS-R and age.

DISCUSSION

The TVPS-R normative data is based on the mean scores for VD, VM, VSR, VFC, VSM, VFG, and VC. The mean score obtained from this study was different compared to the mean score obtained by Su et al. (1995) in Taiwan, which showed the mean score of this study for all seven TVPS-R sub-tests was higher. The mean score obtained was also higher compared to the study by Ho et al. (2015). This difference was due to the selection of different age groups of subjects as visual status varied among different age group (Naufal et al. 2020; Rahman et al. 2020; Zainal et al. 2002). Previous study by Su et al. (1995) chose subjects aged 45 to 84 years which was much older than the subject chosen for this study whereas study by Ho et al. (2015) chose subjects aged 4 to 7 years which was much younger than the subjects in this study. In addition, previous visual perceptions theory stated that age factor was one of the differences in visual perception score (Han et al. 2014; Lee et al. 2016; Mercier et al. 2001). The differences in findings could also due to other factors such as geographical region, culture and language (Lai & Leung 2012; Shi 1995).

The present study found that there was no significant difference in the

Table 3: Pearson correlation and linear regression for the seven sub-tests of TVPS-R and age

Subtest TVPS-R	N	Pearson correlation			Linear Regression		
		r_s	R^2	p	r	df	p
VD	120	-0.21	0.04	0.03*	-0.18	115	0.04*
VM	120	-0.58	0.34	0.00**	-0.57	115	0.00**
VSR	120	-0.38	0.14	0.00**	-0.36	115	0.00**
VFC	120	-0.09	00.8	0.36	-0.60	-	-
VSM	120	-0.47	0.22	0.00**	-0.47	115	0.00**
VFG	120	-0.18	0.03	0.04*	-0.16	115	0.08
VC	120	-0.19	0.04	0.04*	-0.16	115	0.06

*P<0.05 **P<0.001
VD=Visual Discrimination, VM=Visual Memory, VSR=Visual-Spatial Relationships, VFC=Visual Form Constancy, VSM=Visual Sequential Memory, VFG=Visual Figure-Ground, VC=Visual Closure

mean value of all the TVPS-R sub-tests between the Malays, Chinese and Indians. However, in a study conducted by Guntayuong et al. (2013) in Thailand, found that the test scores had significant differences between Thai and American population. Even the study concluded that the significant differences were attributed to the different culture as well as the geographical region. The visual perceptual skills were shown to be influenced by geographical region (Shi 1995) and Dunn et al. (2006) also found that visual perceptual skills scores had significant differences between races using The Developmental Test of Visual-Motor Integration and the Copying Test due to cultural factors. In all the three major races in Malaysia, only the elderly still maintained their ancestral entities. The younger generations today have prominently changed and no longer practiced this heritable way of life (Zainal Abidin et al. 2016). They only practiced a part of this culture by observing their parents. This is because they were comfortable with the modern way of life today in comparison to the traditional ways. This explained why there was no difference in the mean value of all the TVPS-R sub-tests between the different races in this study.

In addition, both genders were seen to have no significant effect on the visual perception skills. The findings were different from the results of the study conducted by Su et al. (1995). They found that gender differences affect scores for visual memory sequence sub-tests and also visual backgrounds. However, this study agreed with the previous studies' findings which noted that gender did not affect visual perceptual skills (Farver & Farver 1982; Kaplan & Hier 1982; Mercier et al. 2001).

In terms of different levels of education, this factor only affected the score for VD, VM and VSM sub-tests. Previous study showed that visual perception varies according to educational level (Han et al. 2014).

The study found that there was a significant difference in the MVPT-3 score for all sub-tests according to the level of education. Groups with a low education level showed lower scores in all sub-tests as compared to a higher education level group. In addition, Cooke et al. (2005) and Mercier et al. (2001) obtained the same conclusion using the MVPT-V test. However, this study did not find any significant difference in scores among the groups based on level of education in VSR, VFC and VFG, which was contrary to the findings of studies conducted by Cooke et al. (2005), Mercier et al. (2001) and Han et al. (2014). However, there were studies which have also concluded a similar result of no significant difference between educational level and scores for several sub-tests such as VSR sub-tests (Gupta et al. 1978; Keen & Lovegrove 2000; Vellutino et al. 1977). They explained that subjects with high or low level of education did not show a difference in doing activities such as printing non-verbal symbols in the correct sequence and orientation after brief disclosure to distinguish abstract figures where they were presented in various sizes and locations.

The results showed negative correlation between the TVPS-R sub-tests with age changes. This negative correlation indicates that an increase in age will decrease TVPS-R score. Similar findings were also reported by Han et al. (2014) i.e. the younger subjects had higher visual perception scores than the older subjects. This was evidenced in the study by Brown and Elliott (2011) which stated that individual visual perceptions grew up to the age 39 years and then began to declined gradually. Other studies also revealed that visual perception decreased due to the aging process (Brown & Elliott 2011; Han et al. 2014). A study conducted on senior citizens to see visual perception performance through TVPS-R test, found that age factor influenced visual perception skill performance on all TVPS-R sub-tests (Su et al. 1995). This was caused by the decline of cognitive function which was often associated with the aging process and indirectly leads to a decrease in visual perception (Mercier et al. 2001; Su et al. 1995). This study was first of its kind that involved adult population in Malaysia. As it was only carried out in Selangor state, further studies to include other states to represent complete picture of adult population in Malaysia, should be considered.

CONCLUSION

There was a difference in mean score of visual perceptual skills score in this study compared to previous studies and it also showed the scores decreased with age. This study provided normative data for all the TVPS-R subtests for Malaysian adults and it is important to develop population-based normative data for TVPS-R test. These reference values for TVPRS-R test may enable practitioner to distinguish between normal and pathological of visual perception.

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