International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Impact Factor (2018): 7.426

Normative Data on Test of Visual Perceptual Skills in Indian Drivers

Swati Ashok Kurne[1], Anita Dipak Gupta[2]

[1]Master of Occupational Therapy, Designation– Occupational Therapist, Affiliation – AIIPMR, Mumbai

[2]Master of Occupational Therapy, Designation – HOD & Lecturer, Occupational Therapy, Affiliation – AIIPMR, Mumbai

Short Title- Norms of TVPS on Indian Drivers

Abstract: ***Introduction: The aim of the study was to provide normative data on Test of Visual Perceptual Skills-3 (TVPS) in Indian Drivers as well as to examine the effect of education, age and gender. Also to assess the clinical utility in Indian population. Methods: One hundred and seven participants -57 males and 50 females aged 25 to 54 years stratified into 3 age group and 3 educational level completed the TVPS-3. Mean, standard deviation and decile were calculated for TVPS overall score and mean, standard deviation, quartile were calculated for TVPS-3 subtest score. One way ANOVA and t test were used to analyze the data. Results: The analysis demonstrated that education has a significant effect on TVPS 3 score, as evidenced by increasing TVPS score with education. Lower education contributed to poor test performance. One-way ANOVA between three age group and three educational years showed that as the number of educational years increases in any group there is statistically significant interaction. No significant age and gender effect was noticed as age group studied was younger and middle age group. TVPS subtest accuracy score of 16 was obtained in all subtest by 12 + educational group. Conclusion: The findings indicated that education was associated with better performance on TVPS-3. We obtained normative references for the TVPS on an adult Indian driver's population. An accurate screening tool should lead to increased confidence for Occupational Therapists to assess visual perceptual skills for comprehensive driving assessments.***

Keywords: Visual perception, Norms, TVPS, Education, Driving

1. Declaration of authorship

We declare that we have contributed substantially in the conception and design of the work, analysis and interpretation of data, in revising the article critically for important intellectual content, as well as in approving final version to be published. We agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work were appropriately investigated and resolved.

2. Funding

Financial support was not required for the study.

3. Declaration of conflicting interest

There was no personal or institutional conflict for the study.

4. Ethics approval

Study was done on normal sample so participants who volunteer for the study were included.

5. Introduction

Driving as a means of community mobility is an activity highly valued by individuals. When a medical condition impacts a person's ability to drive, Occupational Therapy practitioners should address this instrumental task of daily living with the client in order for the client to know if and when return to driving might be possible (Rolland et al.,2013). Visual perception is critical to the safe operation of a motor vehicle. Visual perceptual deficits are known to have a negative impact on functional independence (Beaudoinet al., 2013), including driving ability. Driving is predominantly visually control action, about 90% of what a driver identifies in a driving environment is through his or her sense of vision. Visual perception is of vital significance for the road safety; error in visual perception causes the majority of reported road accidents. Visual perception in traffic is not only determined by visibility, but it also depends on perception (S.Pasagic et al., 2001). When one misinterpret visual clues, one's perception time increases and reduces the amount of time one have to react to a situation (New York Defensive Driving, 2016).

Key domains necessary to determine fitness to drive typically include visuospatial and visuo-constructional skills (Barco et al., 2014). To drive well you need to have strong visual processing skills which refers to brain's ability to translate images registered by your eyes, so that it can make sense of information such as distance, objects and symbols (Auto Loan Solution, 2017).Drivers should scan and check in –vehicle and response properly with quick and accurate judgment while processing the various stimulus in outside. Various factors affect driver performance, and one must constantly use perceptual skills for safe driving. For e.g., you need to be able to receive and interpret messages by sight, sound, touch and smell to determine a correct tactic (Newyork defensive driving, 2016).Driving skills rely on separating relevant stimuli from other objects in the field of view and when judging the speed and distance of moving objects. The visual perceptual abilities are categorized by Chalfant and Scheffelin as visual discrimination, spatial relationships, visual memory, figure ground and visual closure (Martin, 2006). In terms of driving, problems with visual discrimination could affect one's ability to see the differences in sign postage, traffic lights and road surface

types. Deficits in both short term and long term visual memory can make any decision or action risky, for e.g if a driver can't remember seeing a car in their rear view or blind spot a few seconds ago, they may steer right into another motorist while making a lane change. Spatial relation troubles make it hard to judge time, distances and interpret directions. This skill is critical when pulling into a parking space and when determining a safe gap in traffic to make a left turn. A deficit in visual sequencing could make it difficult for someone to read signs properly and make sense of directions, it will lead to difficulty to distinguish the order of images, symbols or words. In figure ground perception problem driver will likely have trouble separating objects from backgrounds. Objects in foreground could look more like background sights. A lack of visual closure on the road could lead to confusion when reading signs or trying to judge only partially visible objects or obstacles (Auto loan solutions, 2017).

Occupational therapists cite visual perceptual function as a major therapeutic focus. Assessment of perceptual processing is especially pertinent when tracking a client's progress within a therapeutic rehabilitation program, when analyzing skill strengths and weaknesses in order to plan remediation activities, and when recertifying adults for driving or returning to work after stroke or head injury (Martin, 2006)

Considering the importance of driving and the serious impact on the individual and family when a license is revoked, Occupational Therapists require a standardized assessment of ability to drive following a neurological event. It is imperative for the Occupational Therapist to have an accurate and reliable assessment of visual perceptual skills in drivers(Bitensky et.al., 1994). Keeping in mind cultural diversity and varying educational background in Indian drivers Test of visual perceptual skills -3 (TVPS) standardized scale should be tested to ensure its cultural appropriateness before adopting it on Indian drivers.

Several normative studies highlight the importance of age, education, gender, cultural and socioeconomic variables and their impact on the neuropsychological tests. According to recent cross cultural studies there exist culturally based differences between visual perception and the related cognitive processes (attention, memory). According to current research, East Asian and Westerners perceive and think about the world in very different way. Westerners are inclined to attend to some focal object focusing on and analyzing its attributes. East Asians on the other hand are more likely to attend to a broad perceptual field, noticing relationships and changes (Cenek S and Cenek J,2015). Research team led by Kyoto University (2017) shows that an ability to perceive differences between similar images may depend on the cultural background of the viewer. If cross cultural differences are found, separate norms may be required as significant performance differences may justify culturally specific norms for Indian adults so as to ensure no misinterpretation of ability. Cognitive test performance is affected not only by abnormal conditions affecting mental state but also by demographic factors such as age, gender and education and cultural factors including comprehensibility, acceptability, perceived relevance of test content and familiarity with the language and with testing situations, concepts, procedures and materials (Ganguli et al., 1995).

TVPS-3 is the latest revision of the family of visual perceptual tests. It is a standardized test that assesses an individual's visual perceptual abilities without requiring motor response. It is designed for both diagnostic and research purpose TVPS has been standardized on 2008 normal children aged 4 through 19 years and the norms are available for western population (Martin 2006). It assesses 7 components of visual perception namely visual discrimination, visual memory, spatial relation, form constancy which are basic perceptual skills and complex perceptual skills which are sequential memory, figure ground perception and visual closure. TVPS is an instrument used by Occupational Therapists to evaluate children and youth presenting with visual perceptual dysfunction. Norms foradults 19 yrs. and above are not available for Indian population to compare people with neurological deficit. In the past it has been studied that adults and children perceive visual information differently (Pappas 2010), so normative values for adults on TVPS test should be available to accurately compare with neurological deficit clients. Recently there has been growing concern to develop culturally specific norms for Asian population including India. Normative values for adults differ as many factors contribute such as age, educational level, gender, cultural, environmental and socioeconomic. Pilot study needs to be conducted to analyze the clinical utility of this test and to derive preliminary norms for the Indian drivers. The aim of the study is to 1) develop norms for TVPS test on Indian drivers between the age group of 25-34 yrs., 35-44yrs, and 45-54 yrs. To compile data on drivers of various age-groups, gender and educational background. 2) To analyze clinical utility of TVPS as a screening tool during certifying fitness to drive.

6. Methodology

Design - A quantitative descriptive research design was used.

Participants - The data on normal population selected by convenience sampling was based on 107 subjects (57 males and 50 females).The sample was stratified by age and educational level. The participants included individuals with mixed educational background viz. those who were, with low literacy (i.e. number of educational 0-8 years), those with medium literacy (number of educational years 9-12 years), and those with a high level of literacy (number of educational years 12 and above.). To evaluate if the gender influences test performance, separate data was calculated for males and females in each age group. After meeting the inclusion criteria informed consent was taken from the participants. The research work was conducted as per 'Declaration of Helsinki' guidelines.
Selection of sample**:**

Inclusion criteria

1) To develop the norms for this study it was decided to take the **age group between 25 to 54 yrs.**

2) Indian drivers were selected from residents of various localities in Mumbai, who were either
   - Staff of the hospital or attendant of patients who could communicate, understand the given commands, and give their verbal assent for the participation of the study.
   - No visual difficulties,the defect of the visual field and motor disturbance that could affect response.
   - No history of taking any medication for psychological problem.

Exclusion Criteria
Not able to continue with the performance of test for more than one session.

TVPS – 3 Subtest Descriptions
TVPS – 3 assess an individual's visual perceptual abilities without requiring (as much as possible) motor involvement when making a response. It utilizes 112 black and white designs. It is in multiple - choice format; the participant merely needs to indicate an answer choice verbally or by pointing. Each of the seven subtest starts with two example items (not scored) that are followed by 16 test items arranged in order of difficulty. The presentation of the items and the responses are mostly untimed. Visual Memory and Sequential Memory, are the only 2 items which are timed. It assesses a broad variety of areas of visual perception ,consisting of 7 subtests viz. visual discrimination, visual memory, spatial relationships, form constancy, sequential memory, visual-figure ground and visual closure.

Each subtest has its own specific directions for administration, with the items being arranged in order of complexity from easy to more difficult. 2 example items for each subtest are provided to ensure that the subject understood the directions (Martin NA, 2006).

- **Visual discrimination**: the subject is shown a design and is then asked to point to the matching design among the choices shown.
- **Visual memory**: the subject is shown (for 5 seconds) a design on one page, the page is turned, and the subject is asked to choose the same design from among the choices shown on the following page.
- **Spatial relationships**: the subject is shown a series of designs on a page and then asked to choose the one that is different from the rest; it may differ in a small way or in a big way like the rotation of all or part of the design.
- **Form constancy**: the subject is asked to find one design among others on the page; the design can be larger, smaller, or rotated upside down or left to right, etc.
- **Sequential memory**: the subject is shown (for 5 seconds) design sequences comprising increasing numbers of elements, the page is turned, and the subject is asked to choose the matching design from among the choices on the following page.
- **Visual Figure ground**: the subject is asked to find one design among many within a complex background.
- **Visual closure**: the subject is shown a completed design on the page and is asked to match it to one of the incomplete patterns shown on the page.

Test Administration
The data for this study was collected at AIIPMR, Mumbai from December 2016 to October 2017.The test was carried out in a quiet room with minimal distractions and with good light and ventilation. The test was individually administeredwith therapist sitting across the table. Participants were instructedto point or indicate to a design they think is the correct answer. The test administrator encouraged the subject to look carefully at all the four alternatives, before making a final decision. The TVPS was administered with one modification, all items of the TVPS were administered regardless of the number of consecutive errors. The reason for continuing the administration beyond three consecutive errors for each item was to maximize the probability that the TVPS score would discriminate between the differentage, gender and educational groups.

Scoring
Responses were marked on a scoring sheet by circling the answers given by the participants. Examples are not included. Correct answers are added to obtain the raw score. The participant obtains a score of one for each correct answer and a score of zero for each incorrect answer. Scores are calculated for each of the seven subscales as well as an overall visual perceptual ability score. The maximum raw score for each of the seven TVPS–3 subscales is 16. For each subtest of the TVPS, accuracy scores (the number of correct answers) were recorded.

Data Analysis

Data analysis was conducted using Statistical Package for the Social Services (SPSS). To provide normative values, means and standard deviations were calculated for TVPS total score and subtest score. One way ANOVA was used to determine the effect of age, educational level and sex on TVPS score. All assumptions regarding ANOVA were checked before performing data analysis. In addition t test was used to determine the educational effect in male and female and age effect in male and female.

7. Results

Study population and normative data. This study included 107 participants -57 males and 50 females aged 25 to 54 years stratified into 3 age group and 3 educational level.

For descriptive purpose , years of education was divided into 3 groups viz; group I -0-8, group II - 9-12 and group III - 12+ and ages were divided into 3 age ranges group 1 -25-34, group 2- 35-44,group 3 - 45-54. All subjects completed all subtests on average in one hour and maximum consecutive errors were made by the 0-8 educational year group and minimum consecutive errors by 12+ educational years. **Table 1** provides demographic information of study participants. The majority of the participants were in the 25 year age range - 37.38%, above 12 years educational level participants were more -69.15% and males were 53.27 % as compared to females 46.72%.

Table 1: TVPS-3 Overall descriptive statistic and result of one way ANOVA, and t test

	TVPS Overall score							One way ANOVA	
Category	n	%	Mean	Median	SD	Variance	Min-Max	F ratio	P value
Education (years)									
Group I 0-8	10	9.34	69.5	70	9.80	96	55-83	39.99247	<.00001
Group II 9-12	23	21.49	80.95	82	12.04	145.13	61-99		Sig at p<.05
Group III 12 +	74	69.15	95.18	98	9.38	88.12	66-110		
Age									
Group 1) 25-34 yrs.	40	37.38	90.82	95	13.31	177	61-110	0.23216	0.793233
Group 2) 35-44 yrs.	37	34.57	88.81	93	14.47	209	55-110		Not sig at p <0.05
Group 3) 45-54 yrs.	30	28.03	88.4	93.5	11.77	138	57-110		
								t Test	
Gender								T value	P value
Male	57	57.23	88.54	94	13.66	186	57-106	0.98908	0.162448
Female	50	46.72	91.08	93.5	12.71	161	55-110		Not sig at p<0.05

Table 1 shows the mean value, standard deviation and min-max overall score of visual perception on TVPS of different ages, educational groups and as well as for gender. Inspection of **table 2** shows that visual perception scores tended to increase with increasing education, with highest score in educational group of 12 + years and least score with educational years 0-8. TVPS score did not change with increasing age (age group was younger and middle age) and closely resembled in all three age group. One way ANOVA showed p value significant at <0.05 in three educational level but not in three different age group. Females generated slightly more score on TVPS than males. t test was performed to determine the difference between genders which revealed no significant difference at 0.05. Normative data including decile, mean, standard deviation on overall TVPS score in three educational levels, three age group are reported in **table-2.** As number of educational years increases in three age group visual perception score also increases. Mean value of different educational level are statistically significant. Inspection of table shows mean values of TVPS total score closely resembles in 3 different age group as the age group studied were in the young and mid adult age group. There is no significant difference between increasing age group in any educational level. Gender comparison (**see table-3**) did not showedstatistically significant difference except in lower educational years category (0-8) males score was more (p<0.05) and in age group of 45-54 females generated higher score (p<0.05).

Table 2: Normative data stratified by level of education and age of overall TVPS-3 score.

Decile	Education 0-8			Education 9-12			Education 12+			Age group 25-34			Age group 35-44			Age group 45-54		
	25-34 N=3	35-44 N=3	45-54 n=4	25-34 N=13	35-44 N=8	45-54 N=2	25-34 N=24	35-44 N=26	45-54 N=24	0-8 n-3	9-12 n-13	12+ n-24	0-8 n-3	9-12 n-8	12+ n-26	0-8 n-4	9-12 n-2	12+ n-24
1st	69.5	57.5	63.5	66.5	67	80	92	77	83.5	34.5	63.5	86	27.5	67	77	28.5	35	81.5
2nd	69.5	57.5	63.5	67	71.5	80	95.5	88	86.5	69.5	67	95.5	57.5	71.5	87.5	63.5	35	86.5
3rd	69.5	57.5	63.5	71	75.5	80	97.5	91	90	69.5	71	97.5	57.5	71.5	91	63.5	80	90
4th	69.5	57.5	70.5	78.5	75.5	80	98.5	93	94	69.5	78.5	98.5	57.5	75.5	93	70.5	80	94
5th	70	60	70.5	84	76.5	80	99	96.5	95	70	84	99	60.5	76.5	96.5	70.5	80	95
6th	75.5	69.5	70.5	87	84.5	80	100.5	99	96	75.5	87	100.5	69.5	84.5	99.5	70.5	80	96
7th	75.5	69.5	77	91	84.5	80	103	101.5	98	75.5	91	103	69.5	93	101.5	77	80	98
8th	75.5	69.5	77	93.5	93	80	103.5	103	100	75.5	93.5	103.5	69.5	93	103	77	45	100
9th	75.5	69.5	77	95	96.5	80	106	104.5	102	40.5	96	108	39.5	96.5	104.5	41.5	45	102.5
Mean	73.33	64.66	70.25	81.15	80.87	80	98.25	94.03	93.37	73.33	81.15	98.66	64.66	80.87	94.03	70.25	80	93.37
Standard deviation	6.65	12.6610.33	10.62	12.60	12.44	14.14	7.96	11.27	7.96	5.436	12.10	7.49	10.33	11.64	11.05	9.20	10	7.79
One way ANOVA-F Value	0.54467			0.00749			2.38585			19.95729			10.98787			13.67886		
P value	0.602764			0.992542			0.99351			<0.00001			0.000209			0.000079		

Table 3: Normative data for gender stratified by level of education and age of overall TVPS-3 score

Decile			Education wise				Age wise					
	M	F	M	F	M	F	M	F	M	F	M	F
	0-8 n-7	0-8 n-3	9-12 n-14	9-12 n-9	12+ n-36	12+ n-38	25-34 n-20	25-34 n-19	35-44 n-20	35-44 n-18	45-54 n-18	45-54 n-12
1st	63	27.5	63.5	70.5	81	83.5	66.5	76	71	63	70	83.5
2nd	63	57.5	67	75	87	90.5	68	81.5	77.5	72.5	71.5	88.5
3rd	69.5	57.5	67.5	76	93.5	92.5	82.5	86.5	83.5	76	77	94
4th	70.5	57.5	73	79.5	94.5	94	95	90	91	89	84	95.5
5th	71	60	80	82	98.5	96.5	97	93	93	92.5	88	96
6th	75	65	87	83.5	100	98.5	99	95.5	96.5	94	92	97

Decile			Education wise				Age wise					
	M	F	M	F	M	F	M	F	M	F	M	F
	0-8 n-7	0-8 n-3	9-12 n-14	9-12 n-9	12+ n-36	12+ n-38	25-34 n-20	25-34 n-19	35-44 n-20	35-44 n-18	45-54 n-18	45-54 n-12
7th	80	65	93	87	101.5	100	101.5	98	99	100	94.5	98
8th	82	65	95	91	103	102.5	103	99	101	102	96.5	102
9th	82	35	97.5	93.5	103	107	103.5	108	102.5	105	100	103
Mean	72.85	61.66	80.42	81.77	94.75	95.60	89.9	91.75	89.94	87.61	85.55	95.16
Standard Deviation	8.322	6.236	13.31	8.82	9.81	8.81	15.06	10.80	12.19	16.10	12.60	6.42
t value	-1.87015		-0.2565		0.3894		-0.43492		0.48531		-2.3563	
P value	0.049192		0.400029		0.349053		0.33304		0.315241		0.12845	
	Sig at p <0.05		Not sig at p <0.05		Not sig at p<0.05		Not sig at p <0.05		Not sig at p <0.05		Sig at p < 0.05	

An analysis of variance (one- way ANOVA) between three age group and three educational years showed that as the number of educational years increases in any age group there is statistically significant interaction but there is no statistically significant interaction between the three-increasing age group and any particular educational years. Analysis of variance between three different age group and gender showed no significant statistically interaction except in age group 45-54 females scored more than males due to higher education of all the participants. Analysis of variance between three different educational groups and gender did not show statistically significant interaction.

The subtest accuracy scores for all subjects were first categorized into the following three categories: a) score was below nine, subject passed 50% or fewer of the subtest items; b) score was between 9 and 15, subject passed more than 50% of the items but did not reach the upper limit of the subtest; and c) score was 16, subject reached the upper limit of the subtest. After analyzing the data following was revealed;(Shah H et al 1987).

1) Accuracy score of 16 was obtained by 12+ educational group in all subtest; 55% in spatial relation, 30% in visual discrimination, 25% in figure ground, 15% in visual closure, 8% in form constancy and 1% in sequential memory. 95 % subjects scored between 9 to16 in all subtest and 4% scored less than 9 specifically in form constancy and sequential memory subtest.
2) Accuracy score of 16 was obtained by 9-12 educational years group; 8% in spatial relation, 4% in form constancy and figure ground subtest.90% scored between 9 to 15 in all subtests. 30% scored less than 9 in form constancy subtest, 24% subjects scored less than 9 in figure ground and visual closure, 16% scored less than 9 in visual discrimination and visual memory.
3) Accuracy score of 16 was not obtained by 0-8 educational year's group in any subtest. 60% of subjects scored between 9-15, 35% scored less than 9 in sequential memory subtest.

Adults with less number of educational years demonstrated more incorrect responses and took longer time than did the subjects with more number of educational years. The group with less years of education demonstrated lower total TVPS accuracy subtest scores and had significantly lower accuracy subtest scores on Visual form constancy, visual sequential memory, figure-ground and visual closure. Most of the participants with 12+ educational years successfully completed more than half of the items in each subtest and ceiling effect was predominantly observed in 0-8 educational year group in all the subtest and 12 + educational years had particularly in sequential memory subtest.

Table 4 give normative data including mean value, standard deviation, min-max, variance and quartiles of TVPS subtest score in different educational level and age group. It was found that mean value of females in all subtest were slightly higher than males but not statistically significant. Inspection of **table 4** shows mean values of all subtest closely resembles in 3 different age groups as the age group studied were in young and mid adult age group. Mean values in all age group is more in spatial relations subtest and less in sequential memory subtest.Table 4 indicates that visual perception scores tended to increase with increasing education, with highest score in educational group of 12 + years and least score with educational years 0-8. Mean score of spatial relation is higher than mean values of other subtest. Mean score of sequential memory is lesser as compared to other subtest.

Table 4: Normative Data of TVPS Subtest Stratified By Level of Education and Age Group

	Educ. years	Mean	SD	Min-Max	Variance	Q1	Q2	Q3
VD	0-8	9.9	2.13	5-13	4.54	9	10	10
	9-12	12	2.35	7-15	5.54	11	13	13.5
	12+	14.06	2.02	8-16	4.11	13	14.5	16
VM	0-8	10.6	1.64	7-12	2.71	9.5	11	12
	9-12	11	2.43	5-15	5.90	9.5	12	13
	12+	13.36	1.96	5-16	3.87	12	14	15
SR	0-8	12.4	1.07	10-14	1.15	12	12.5	13
	9-12	14.26	1.54	10-16	2.38	13	15	15
	12+	15.27	1.12	9-16	1.26	15	16	16
FC	0-8	10.4	2.17	7-14	4.71	9	10	12
	9-12	10.34	3.15	5-16	9.96	8	10	12.5

	Educ. years	Mean	SD	Min-Max	Variance	Q1	Q2	Q3
	12+	12.81	2.67	6-16	7.14	11	13.5	15
SM	0-8	8	2.10	4-11	4.44	6.5	8	9.5
	9-12	10.82	2.34	4-15	5.51	8	10	11
	12+	12.24	1.84	7-16	3.39	11	12	13
FG	0-8	9.2	2.57	4-14	6.62	8	9.5	10
	9-12	10.86	3.62	3-16	13.11	8	10	13.5
	12+	13.90	2.02	8-16	4.114	12	14	15
VC	0-8	9	2.98	4-13	8.88	7	9.5	11
	9-12	11.39	2.65	5-15	7.06	10	12	14
	12+	13.68	1.79	8-16	3.23	12	14	15
AGE GROUP								
VD	25-34	13.2	2.35	8-16	5.56	12	14	15
	35-44	12.91	2.89	5-16	8.35	11	13	14.5
	45-54	13.6	2.15	9-16	4.65	12	14	16
VM	25-34	12.7	2.25	7-16	5.06	11	13	14
	35-44	12.67	2.73	5-16	7.511	11	13	15
	45-54	12.33	1.89	7-16	3.60	12	12.5	14
SR	25-34	14.77	1.44	10-16	2.07	14	15	16
	35-44	14.72	1.72	9-16	2.98	13	15	16
	45-54	14.86	1.27	12-16	1.63	13	15	15
FC	25-34	12.2	2.85	6-16	9.07	9	12	14.5
	35-44	11.91	3.01	6-16	9.07	9	12	14.5
	45-54	12.03	3.06	5-16	9.41	9	13	14
SM	25-34	11.95	2.58	4-16	6.66	10	13	14
	35-44	11.37	3.25	4-15	5.07	10	12	13
	45-54	11.2	2.10	6-15	4.44	8.5	11	12
FG	25-34	13.22	2.92	6-16	8.53	10	14	15
	35-44	12.72	3.11	3-16	9.70	11	14	15
	45-54	12.36	2.98	4-16	8.98	10	13	14
VC	25-34	12.9	2.74	5-16	7.5	11	14	15
	35-44	12.43	2.43	5-15	5.91	11	13	14
	45-54	12.96	2.07	4-16	7.3	12	13	15

8. Discussion

The results from the present study provide norms for TVPS test that has clinical utility but have not been adequately normed in adult Indian population. By recruiting individuals with wide range in (0-21) years of education and age ranges (25 to 54 yrs.) with driving as a leisure instrumental activity of daily living, the present set of norms represent a substantial improvement over those previously available in western population .Visual perception is necessary for independent activities of daily living and gait function (L.Calvo et.al., 2013). Driving requires adequate reliable perception of a rapidly changing environment, blending both cognitive and visual perceptual skills. These norms will be useful for recertifying adults in fitness to drive after neurological impairments (Pedretti 1996).

The current set of norms were stratified over age and years of Education and Decile 1 to 9 were determined. The major clinical utility of these norms is that they will increase the ability of Occupational therapist to determine more precisely the degree to which visual perception is impaired in patients of varying educational level and ages. Moreover, provision of norms for both TVPS total score and TVPS subtest score offers the additional advantage of allowing the Occupational therapists to determine if TVPS overall score or subtest score is more affected than the other. Subtest score highlights the deficit in an area of visual skills thus guiding the therapist to work in that area. Whereas total score helps in determining the overall performance at a glance for comparison.

Evidence from a variety of sources shows that visual perception measures are sensitive to the effect of years of education but relatively insensitive to gender (Tom N 2004). Our study showed higher visual perception score in participants with more number of educational years. Levels of education have proven to have an important role in the cerebral development and organization of cognitive skills and consequently on performance on neuropsychological tests (Wajman et al., 2015). Solisa et al., (1998) studied the effects of education across different age ranges on neuropsychological test performance and their results indicated a significant educational effect on most of the tests. Largest educational effect was noted in constructional abilities, language, phonological verbal fluency and conceptual functions. The present study confirms and extends these findings by showing that measures of visual perception are differentially sensitive to education. The influence of educational variables on test performance represents a well-established observation in psychological measurement (Anastasi,1988; Cronbach, 1990).It has been suggested that illiterate individuals solve cognitive problems functionally and specifically, and respond better to the perceptual and functional attributes of stimuli, whereas educated participants respond better to abstract concepts and to logic relations between stimuli (Jose RW et al 2015). It clearly indicates the enhanced precision of visual perception of normal individuals with education, as those compared with less years of education. This may be explained by the possibility that as an individual is trained to read and write, the functions of the brain become increasingly specialized

and it is then able to attend to details or the different aspects of visual stimuli. Difficulty with certain cognitive tasks is attributable to lack of practice, lack of education and not due to any essential difference in brain functions (Ganguli., et al 1995). The very low scores observed in neuropsychological tests in illiterate subjects can be also due to the fact that these subjects are not used to being tested i.e. they have not learned how to behave in a testing situation (Solisa et al., 1998).

The study found nostatistical significant difference in visual perceptual score between men and women which are not similar to previous research. Men are significantly better than women at mental rotation, particularly in three dimensions. Bia Kim et al (2007) investigated the gender differences in spatial navigation using the tasks of 2- D matrix navigation and recognition of real driving scene and suggested that female drivers missed the vehicles travelling next lanes more frequently than male drivers, which imply female driver's potential difficulty in lane changes and higher risks of road accidents to this type of tasks. The results of meta-analysis by Voyer D and Voyer S (1995) who reviewed the results of 286 papers from 1974 to 1993, showed that there is distinctive gender differences in spatial cognition ability.The reason for not finding difference in gender could be the lack of 3 dimensional design on TVPS-3.With respect to age our study is supported by Kim et al., (2014) study on influence of aging on visual perception and visual motor integration in Korean adults. He found that the mean score of the VMI-3R and K-DTVP-2 were significantly decreased in participants in their 50s compared to those in their 20s. The participants in our study were young and middle age in whom age related decline in cognitive function is not attributable.

Cultural variability also influence scores of psychometric test. Scientist have long recognized that the mental processes behind thinking and reasoning differ between people raised in western and eastern cultures. Those in the west tend to use analytical processing- analyzing objects independently of context while those in the East see situations and objects as a whole, which is known as holistic processing(Kyoto University research news,2017). Among the few examples of cross cultural studies in South America is an evaluation of Auca Indians from the Ecuadorian basin conducted by Pontius (1989). Pontius administered a four colored Kohs Block Design test and found deficits in block design, particularly related to representations and construction of certain spatial relations and graphic representational skills. Study on cultural differences in visual search for geometric figures indicate that at least some cultural differences reflect different ways of processing early level of features, possibly in response to environmental factors (Ueda et.al. 2017). Studies on illiteracy associated with poverty and low socioeconomic status indicate that development in an impoverished social environments results in insufficient stimulation, which in turn alters the development of central nervous system (Solisa et al., 1998).

Most of the participant took longer time to make response on Form constancy, Figure ground subtest and shorter time on Visual memory, and Sequential memory these result are supported by Hung et al. (1987).Longer time to respond may have been required on the former two subtests because they measure more complex skills. Both subtests include embedded and distractive features. Shorter time may have been required on the latter two subtests because they involve only the recall of simple designs from immediate or short-term memory, irrespective of correct response. In visual memory and sequential memory subtest, sequential memory was more affected than visual memory in most of the participants. Visual sequential memory is more challenging than just visual memory as it involves looking at and then recalling multiple chunks of visual information in correct order, this finding is supported by Brown et al., 2012.Klein et al (2002) found a low relationship between the subtests visual memory and sequential memory, possibly due to the visual sequential memory tasks enlisting verbal strategies for recall. Le Carret et.al (2003)examined the influence of educational level on visual working memory, evaluated by the Benton Visual Retention test (BVRT) in 829 elderly participants and suggested that the effect of education on BVRT performance was not mediated by visual discrimination abilities suggesting that it was mainly supported by better executive abilities. The ability of high educational level subjects to use more efficient strategies may participate to the cognitive reserve capacity.

Furthermore, it is interesting to note that out of the 107 participants none of the participants obtained a perfect total TVPS accuracy score (112). This could be explained as subjects have to sit continuously for 45 to 60 minutes continuously which can result in fatigue. Also maximum attention span in adult is approximately 30 minutes were complex demands or mental flexibility is worked out. An inappropriate level of difficulty was thought to affect the motivation of subject to engage in the test. In general, it was felt that some of the test plates were not appropriate for all educational categories, being too simple for 12 + educational years and too complex for 0-8 educational years. Participants with no to less number of educational years are rarely been exposed to testing situations and often lack test – taking attitude, which can result in lack of cooperation as well as poor test performance(Tripathi et al.,2014)

9. Future Implications

The results of this research will be useful for therapists in India in that it provides them with a standardized assessment methodology to accurately evaluate the perceptual abilities of Indian drivers. In future, the researcher may study the norms in Indian adults and other tests of the validity of this assessment tool, such as predictive validity, construct validity and concurrent validity. A revised version would have the advantage of being a shorter test while retaining all the time and accuracy scores that were found to differ significantly between groups. However, before a shortened version is used, an item analysis should be conducted to exclude redundant items.

10. Limitations

Convenience sampling was used which limits the degree to which results obtained may be generalized to the greater population of interest. The age and education stratified subgroups utilized in the study were not balanced in size

which limits generalizability of the present results. Participant's perceptual skills was not correlated with level of intelligence. In addition, some domains were not studied that would have affected score e.g., test anxiety, personality traits, driving habits.

11. Conclusion

In summary, it was found that educational level has an impact on visual perceptual skills. We obtained normative references for the TVPS on an adult Indian driver's population. The wide age and educational years covered in this research was felt to impact upon the clinical utility of the test items. An accurate screening tool should lead to increased confidence for Occupational therapist to assess visual perceptual skills for comprehensive driving assessments. Accurate off road estimation of driving ability can minimize the number of on –road assessments of patients who will almost definitely fail, as well as minimizing on roads assessment of patients who are safe to drive. Our results could be utilized to evaluate visual perception in patients with brain disorders. They will also help to plan a rehabilitation program for visual perceptual dysfunction and to assess clinical progress after treatment.

12. Author Contributions

We declare that we have contributed substantially in the conception and design of the work, analysis and interpretation of data, in revising the article critically for important intellectual content, as well as in approving final version to be published.

Funding

Funding was not required for the study.

Declaration of interest

The authors confirm no specific interests which might be perceived as posing a conflict or bias.

13. Acknowledgements

The authors acknowledge with gratitude Director of AIIPMR-Mumbai, Ex-Director of AIIPMR, Mumbai, and to Ex-HOD Occupational Therapy Dept. AIIPMR-Mumbai for their advice and support in completing research. The participants who volunteered their time to take part are thanked for their valuable contribution towards this study.

14. Key Points

- All the visual perceptual components showed significant differences between the educational groups.
- In terms of clinical utility of TVPS-3 cultural factors like familiarity with the test items affects performance on visual perceptual skills.
- Normative data of TVPS-3 will assist Occupational therapist to closely examine for comprehensive driving assessment in Indian drivers.

References

[1] Anastasi A (1988), Psychologicaltesting, Macmillan, New York (1988).
[2] Ardila A, Rosselli M, Rosas P (1989)Neuropsychological Assessment in Illiterates: visuospatial and memory abilities. Brian and Cognition, 11(2), 147-166.PMID:2803759.
[3] Auto loan solutions (2017).What science has to say about men and women drivers.Retrieved fromhttp://www.autoloansolutions .ca.
[4] Beaudoin AJ, B Fournier, Caron LJ et.al. (2013) Visuoperceptual deficits and participation in older adults after stroke. Australian Occupational Therapy Journal, 60(4), 260-266.https://doi.org/10.3109/07380577.2013.820995.
[5] Bitensky N K, Sofer S, Kaizer F et al.(1994) Assessing ability to drive following an acute neurological event: Are we on the Right Road? Canadian J Occup Ther, 61(3), 141-8.http://doi.org/10.1177100084714906100303.
[6] Barco PP, Wallendorf MJ, Snellgrove CA, et al.(2014) Predicting road test performance in Drivers with stroke. Am J Occup Ther, 68(2), 221-229 . DOI:10.5014/ajot.2014.008938 PMID: PMC4012570.
[7] Brown T, Elliot S, Bourne R, et al.(2012) The convergent validity of the Development al test of Visual Perception –Adolescent and adult, Motor free visual perception test- third edition and test of Visual perceptual skills (non – motor)-third edition when used with adults. British J of Occup Ther, 75(3), 134-143.https://DOI.org/10.4276/030802212x13311219571783.
[8] Calvo L, Quintana M, Manero RM, et al. (2013) Spanish normative studies in young adults (NEURONORMA young adult's project): Norma for the visual object and space Perception Battery and Judgment of Line Orientation tests. NEUROLOGIA, 28(3), 153-159.https://doi.org/10.1016/j.nrleng.2012.03.015.
[9] Carol J.Wheatley (2001) Visual Perceptual Aspects of Driving. Physical Disabilities, 24(3).
[10] Cenek S, Cenek J (2015) Cross cultural differences in visual perception. The journal of education, culture and society, 1: 187-206.DOI:10.15503/jecs20151.187.206.
[11] Cote CA (2011) an external validity study of the Visual Memory subtest of the test of Visual Perceptual skills, third edition. British Journal of Occupational Therapy, 74(10), 484-488.https://doi.org/10.4276/030802211x13182481841985.
[12] Cronbach LJ.1990 Essentials of psychological testing (5), Harper and Row, New York (1990).
[13] Ganguli M, Ratcliff G, Chandra V et.al (1995) A Hindi version of the MMSE: The development of a cognitive screening instrument for a largely illiterate rural elderly population in India. International journal of geriatric Psychiatry, 10(5), 367-377.DOI:10.1002/gps.930100505.
[14] Hung SS, Fisher AG, Cermak SA (1987) the performance of learning disabled and normal young men on the test of visual perceptual skills, 41(12), 790-796. Doi:10.5014/ajot.4112.790. PMID:3503598.

[15] Kim B, Lee S and Lee J (2007) Gender differences in spatial navigation, Int.journal of Social, Behavioral, Educational, Economic, Business and Industrial Engineering, 7(1), 311-314. Scholar. waset.doi.org/1999.10/5947.
[16] Kim E, Park YK, Kim H et al. (2014) Influence of aging on visual perception and visual motor integration in Korean adults. Journal of Exercise Rehabilitation, 10(4), 245-250. doi:10.12965/jer.140147,PMCID:PMC4157933.
[17] Klien S, Solleredes P, Gierl M (2002) Examining the factor structure and psychometric properties of the TVPS.OTJR: Occupation,participation and Health, 22(1), 16-24.htpps://doi.org/10.1177/153944920202200103.
[18] Kyoto University (2017).You don't see what I see. Available at http://.kyoto-u.ac.jp/en/research/research_results/2017/17035-1.html.
[19] Le Carret N, Rainville C, Lechevallier N, Fabrigoule C et al. (2003) Influence of education on the Benton visual retention ,test performance as mediated by a strategic search component. Brain and Cognition, 53(2):408-411. https://doi.org/10.10161s0278-2626(03)00155-6.PMID:14607192.
[20] Martin NA (2006). Test of visual perceptual skills - 3rd edition. Novato: Academic Therapy Publications.
[21] New York defensive driving (2017).Perceptual skills needed for driving. Retrieved fromhttp://www.newyorkdefensive driving.com.
[22] Pedretti LW (1996)Practice skills for Physical Dysfunction. In: Lillie S. 4th ed.Activities of Daily Living, driving with a physical dysfunction St.Louis, Mosby Elseveir pp.500-501.
[23] Peter Cheney (2010) Road Rush, Men Vs Women: who are better drivers? The Globe and Mail Inc. March 26, 2017.
[24] Pontius AA. (1989) Color and spatial error in block design in Stone Age Auca Indians: ecological underused occipital-parietal system in men and frontal lobes in women. Brain Cognition, 10 (1):54-75.PMID:2713145.
[25] Rolland B, Dickerson AE, Brooks J (2013) Meeting the Occupational needs of a neurogically impaired client for driving: A case review. Occupational Therapy in Health care, 27(4), 308-322.https://doi.org/10.31090107380577.2013.820995.
[26] S.Pasagic, J.Pasagic, M.Lovretic (2001) Increased Visual Perception in Night –Time Driving Conditions and /or Reduced optical Visibility. Traffic Safety,13(5):293-297. U.D.C:612.843.364:654.91.
[27] Solisa FO, Mendozad, Ardila A et al. (1998) Neuropsychological test performance in illiterate subjects. Archives of clinical Neuropsychology, 13(7):645-660.http://doi.org/10.1016/60887-6177 (97)00094-2.
[28] Sung-Bom Pyun, A-Reum Han, Doo-Yung Kim, Tae-Woong Choi et.al.(2014) Characteristics of visual perceptual function measured by the Motor free visual perception test-3 in Korean adults. Ann Rehabil Med, 38(4), 548-53.DOI:10.5535/arm.201438.4.548,PMCID:PMC4163595.
[29] Tombaugh TN, Kozak J, Laura Rees L (1999) Normative data stratified by age and education for two measures of verbal fluency: FAS and Animal Naming. Archives of Clinical Neuropsychology, 14(2):167-177.PMID:14590600.
[30] Tripathi R, Kumar K, Bharath S et.al. (2014) Age, education and gender effects on neuropsychological functions in healthy older adults. Dement Neuropsychology, 8(2):148-154.DOI:10.1590/51980-57642014DN82000010 PMCID: PMC5619122.
[31] Ueda Y, Chen L, Kopecky J, Cramer ES et.al (2017) Cultural differences in Visual Search for Geometric figures. Cognitive Science Journal, doi:10.1111/cogs.12490.PMID:7724690.
[32] Unsworth CA, Baker A, Taitz C, et al.(2012) Development of a standardized Occupational Therapy-Driver off –Road Assessment Battery to assess older and /or functionally impaired drivers. Australian Occ.Therapy Journal, 59(1), 23-36.http://dx.doi.org/10.1111/j.1440-1630.2011.00979.X.
[33] Voyer D,Voyer S, Bryden MP(1995) Magnitude of sex differences in spatial abilities: a meta-analysis and consideration of critical variables. Psychol Bull, 117 (2):250-70.PMID:7724690.
[34] Wajman JR, Henrique P, Bertolucci F et.al (2015)Culture as a variable in neuroscience and cultural neuropsychology,acomprehensive review. Dementia and Neuropsychologia,9(3):203-205.DOI:10.1590/1980-57642015DIV93000002.PMCID:PMC5619361.