OCULAR STATUS OF A SAMPLE OF PUBLIC BUS DRIVERS IN THE KLANG VALLEY

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ABSTRACT

Objective: To determine the distance and near visual acuity (VA), near point of accommodation (NPA) and convergence (NPC), distance and near phoria, stereopsis and colour vision of a sample of public bus drivers in the Klang Valley.
Methodology: A total of 52 bus drivers from a randomly chosen public bus operating company in the Klang Valley were examined. The optometric examinations carried out were measurement of visual acuity for distance using the Snellan chart, measurement of near acuity using a reading chart, measurement of near point of accommodation and convergence using the RAF rule, measurement of distance phoria using the Maddox cross, measurement of near phoria using the Maddox wing, measurement of stereopsis using the TNO and assessment of colour vision using the Zshihara plates, SPP2 plates, D15 panel and FM100 Hue test.
Results: The study showed that 100% of the drivers had distance VA better than 6/12. For near VA, 57.7% of drivers could read N6 or better while 26.9% and 15.4% could only read N10 or N12 respectively. Their mean NPA and NPC were 19.00 ± 8.26 cm and 13.00 ± 7.30 cm respectively. Phoria testing revealed that the bus drivers had a mean exophoria for distance of 0.33 ± 0.18 prism diopters and a mean right hypophoria for distance of 0.06 ± 0.22 prism diopters. For near vision, these drivers had a mean exophoria of 0.69 ± 2.59 prism diopters and a mean right hyperphoria of 0.04 ± 0.20 prism diopters. Stereoacuity test found that 65.4% of the bus drivers had stereopsis in the normal range, that is 30 to 60 second of arc. Colour vision tests showed that percentage of subjects that passed were high, that is 92.3% using the Zshihara plates, 61.5% using the SPP2 plates, 53.8% using D-15 and 53.8% using the FM 100-Hues tests. Drivers that failed SPP2 plates had tritan types of defects (30.8%) and mixed type of defects (7.7%). Testing colour vision with D-15 test showed that 19.2% of the bus drivers had tritan type of defects, 15.4% had non-polar arrangement type of defects whereas 7.7% were protans and 3.8% were deutans. FM 100-Hue testing revealed that 19.2% of these bus drivers had tritan type of defects, 23.1% had non-polar arrangement type of defects whereas 3.8% were protans. Square root of the total error score (√TES) were calculated from the FM 100-Hue test. The √TES of the bus drivers in this study was calculated to be 9.47 ± 4.68 whereas the √TES of normals subjects in the same age range collected by Verriest et al. (1982) is 8.23 ± 2.44. There was no statistically significant difference between the √TES of bus drivers in this study and the √TES of normal subjects in the same age range.
Conclusion: It can be concluded that the visual status of the bus drivers is good but the colour vision status is not very satisfactory.

Key words : bus drivers, visual acuity, distance and nearphoria, stereopsis, colour vision

INTRODUCTION

Vision is the primary sensory input used in the operation of a motor vehicle. As such, vision plays an important role in driving. In order to provide for the public safety, minimal vision requirements have been established for driver licensure.

Vision is obviously a requirement for driving. A person with 'normal' vision has the visual skills to drive, whereas a totally blind person does not. All of the states in the United States and most countries in the world like United Kingdom and Canada have established minimal vision standards that are required for driving. Vision standards for occupational driving licenses need to be more stringent as they are intended to protect the safety of the public and the driver. In the United States, occupational drivers must have a minimum vision of 6112. Studies have shown that there is a positive correlation between vision (dynamic vision) and driving performance (Burg & Hills 1977, Davidson 1985, Hofstetter 1976, Liesmaa 1973, Shinar 1977).

As detection and identification of objects with peripheral vision is an essential element of the driving task, visual fields are also related to driving performance. Steel et al. (1996) have recommended that for safe driving, a driver's horizontal visual field should be at last 120 degrees. Studies have shown that there is a positive correlation between visual fields and accident rates (Elkington & MacKean, 1982, Johnson & Keltner, 1983).

Colour vision is also considered important in driving. Traffic lights and coloured signboards require good colour vision for its recognition. Red and green colour defect individuals (protanopes and deuteranopes) tend to confuse red, yellow and

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green traffic signals and hence be at a greater risk for accidents. However, the green traffic signal has been standardized to a bluish green colour, which allows these dichromats to distinguish it from the red and yellow signals. Cole (1970) has stressed that protanopic and protanomalous drivers have poor responsiveness to red signals, tail lights and brake lights, and as such may have difficulty driving. However, colour vision defects have not been shown to be associated with higher accident rates.

Humphriss (1987) has suggested that there is a correlation between stereopsis and accident rate. But, stereopsis is not very important while looking at objects further than 500 meter. However, it comes into play when looking at near objects, for example during parking the vehicle (Allen 1969).

Phoria is the natural position assumed by the 2 eyes when dissociated. Studies by Davidson (1985) and Humphriss (1987) could not find any correlation between horizontal phoria and accidents. However, Davidson (1985) showed that there was a slight correlation between vertical phoria (greater than I prism diopter) and accidents for drivers of age 55 years and above.

Contrast sensitivity is now being shown to be important in driving. Some researchers have found a high correlation between driving performance and contrast sensitivity (Wood & Troutbeck 1995, Rubin et al. 1994).

Task analysis shows that numerous visual skills are required to perform the various driving tasks. However, statistical relationships between visual parameters and driving performance measures such as accident rates and traffic violation rates have been weak. This is most likely because accidents and violations that occur are usually resulted from a combination of factors. Yet, it is important to impose vision standards on drivers. The purpose of establishing vision standards is to improve driving safety and efficiency. Therefore, the objective of this study was to look at the ocular status and visual performance of selected public bus drivers in Malaysia.

MATERIALS AND METHODS

Subjects

A total of 52 bus drivers from a randomly chosen public bus operating company in the Klang Valley were examined.

Tests

The optometric examinations carried out were measurement of visual acuity for distance, using the Snellan chart, measurement of near acuity using a reading chart, measurement of near point of accommodation and convergence using the RAF rule, measurement of distance phoria using the Maddox cross, measurement of near phoria using the Maddox wing, measurement of stereopsis using the TNO and assessment of colour vision using the Ishihara plates, SPP2 plates, D15 panel and FM100 Hue test. All examinations were done in a room provided by the bus company at the bus terminal.

RESULTS

Demography of subjects

A total of 50% of the drivers were Malays (n= 26), 35.5% Indians (n=20) and 11.5% Chinese (n=6). All drivers were males with age ranging from 33 years to 56 years old (mean age of 44.5 ± 6.2 years). This is shown in Figure 1.

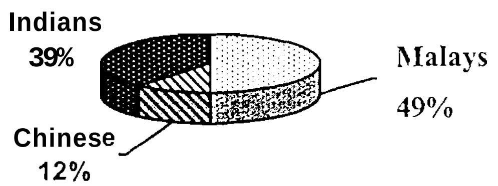


Figure 1: Subject distribution according to race

Vision

Habitual vision was taken for all drivers. Figure 2 shows that 32 drivers (61.5%) had 616 vision, 18 drivers (34.6%) had 619 vision and only two drivers (3.9%) had vision of 6/12. The distance vision of all bus drivers was within the recommended vision standards.

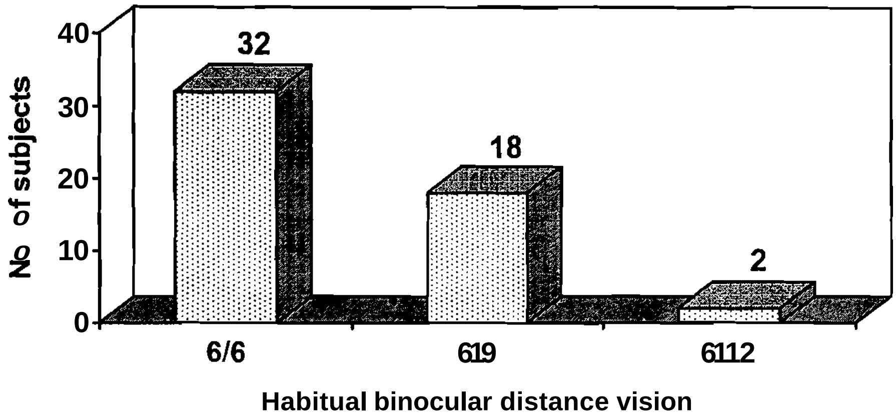


Figure 2: Binocular habitual distance vision of all bus drivers tested.

Figure 3 shows near vision of the bus drivers. It can be seen that 8 drivers (15.4%) had N5 vision, 22 drivers (42.3%) had N6 vision, 14 drivers (26.9%) had N10 vision whereas 8 drivers (15.4%) had N12 vision.

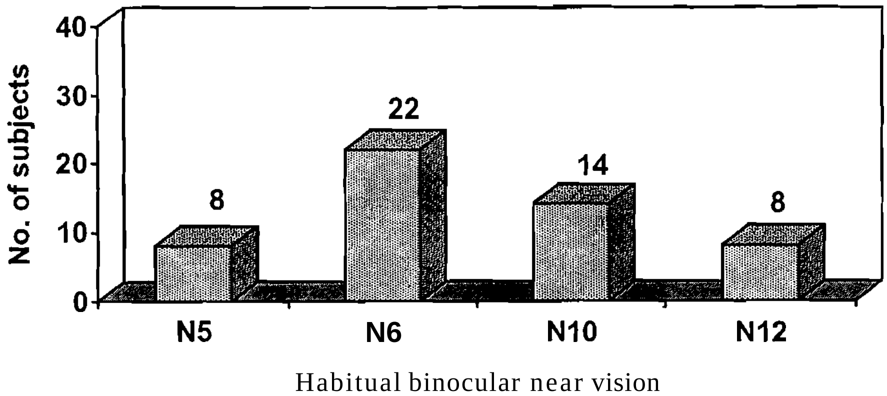


Figure 3: Binocular habitual near vision of all bus drivers tested.

Phoria

The types of phorias and mean phoria are shown in Table 1.

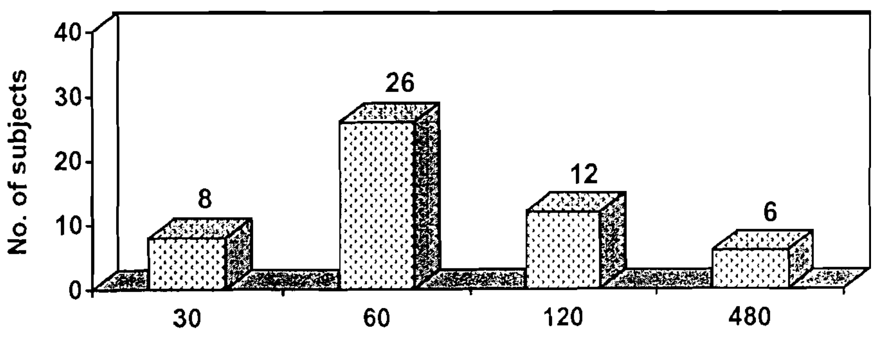
Table 1: Types of phoria, mean phoria and the standard deviations **for** distance and near of all subjects.

Phoria (prism diopters)	No. of sub	Minimum	Maximum	Mean	Standard deviation
Distance horizontal phoria	52	-4.00 (exophoria)	3.00 (exophoria)	-0.327 (exophoria)	1.766
Distance vertical phoria	52	-0.50 (Rhyphophoria)	0.50 (Rhyperphoria)	0.058 (Rhyperphoria)	0.216
Near horizontal phoria	52	-6.00 (exophoria)	4.00 (exophoria)	-0.692 (exophoria)	2.593
Near vertical phoria	52	-0.50 (Rhypophoria)	0.50 (Rhyperphoria)	0.038 (Rhyperphoria)	0.196

The mean distance horizontal phoria for all subjects was –0.33 ± 0.18 prism diopters (that is exophoria) whereas the mean distance vertical phoria was –0.06 ± 0.22 prism diopters (that is right eye hypophoria). For near, the mean horizontal phoria for all subjects was –0.69 ± 2.59 prism diopters (that is exophoria) whereas the mean vertical phoria was 0.04 ± 0.20 prism diopters (that is right hyperphoria). All the mean phorias were within normal limits.

Stereopsis

Figure 4 shows the level of stereopsis of all the bus drivers tested. It can be seen that 34 drivers (65.4%) had good stereopsis, which is between 30 and 60 seconds of arc, and only 18 drivers (34.6%) had stereopsis outside the normal range.



Stereopsis (sec. of arc)

Figure 4: Stereopsis of all bus drivers tested.

Near point of convergence (NPC) and near point of accommodation (NPA)

The mean NPC for all the drivers tested was found to be 13.0 ± 7.3 cm and the mean NPA of all the drivers tested was 19.0 ± 8.26 cm. This is shown in Figure 5.

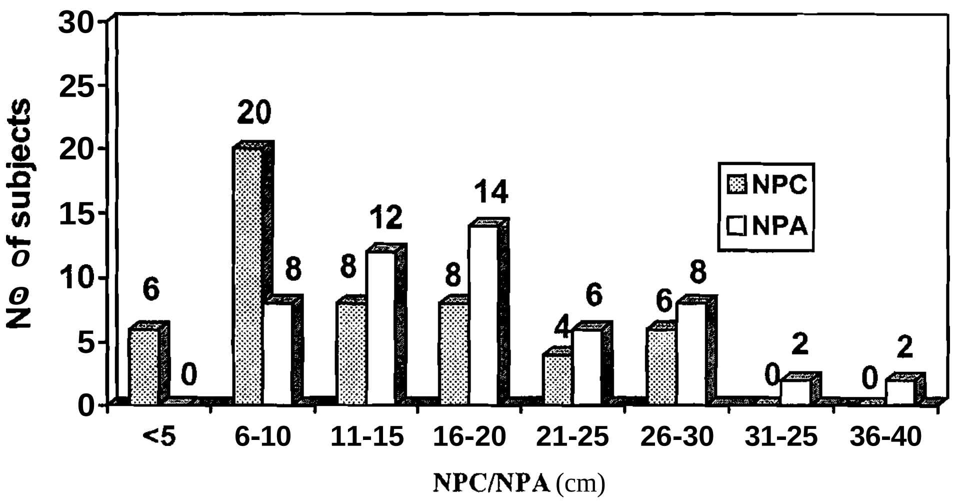


Figure 5: Distribution of near point of convergence (NPC) and near point of accommodation (NPA) of bus drivers tested.

COLOUR VISION

Four different colour vision tests were done; they are Ishihara plates, SPP2 plates, D15 test and FM 100Hue test.

Ishihara Plates

A total of 48 drivers (92.3%) passed this test. This showed that only 4 drivers (7.7%) had a red-green type of colour vision defect. This is shown in Figure 6.

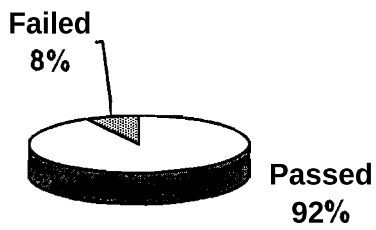


Figure 6: Results of Ishihara Plates test.

SPPZ Plates

Testing with these plates showed that 20 bus drivers (38.5%) had colour vision defects and 61.5% (32 bus drivers) had normal colour vision. Out of the bus driver 20 with colour vision defects, 16 bus drivers (30.8%) had a blue-yellow (tritan type of defect) and the other 4 bus drivers (7.7%) had a mixed type of defect. This is shown in Table 2.

Table 2: SPPZ Plates test results

Type of defects	Frequency	Percentage %
Normal	32	61.5
Tritan	16	30.8
Mixed	4	7.7

D-15 Test

D-15 testing revealed that 28 bus drivers (53.8%) had normal colour vision whereas 24 bus drivers (46.2%) had defective colour vision. Those with defective colour vision had blue-yellow or tritan type of defects (10 drivers, 19.2%), red or protan type of defects (4 drivers, 7.7%), green or deutan defects (2 drivers, 3.8%) and non-polar type of defects (8 drivers, 15.4%). The results are shown in Table 3.

Table *3:* D15 test results

Type of defects	Frequency	%
Normal	28	53.8
Protan	4	7.7
Deutan	2	3.8
Tritan	10	19.2
Non-polar arrangement	8	15.4

Fhl 100Hue Test

Testing with FM 100Hue test showed that 28 bus drivers (53.8%) had normal colour vision whereas 24 bus drivers (46.2%) had defective colour vision. There were 10 drivers (19.2%) with blue-yellow or tritan type of defects, 2 drivers (3.8%) with red or protan type of defects and 12 drivers (23.1%) with non-polar type of defects. These results are shown in Table 4.

Table 4: FM 100Hue test results

Type of defects	Frequency	%
Normal	28	53.8
Protan	2	3.8
Tritan	10	19.2
Non-polar arrangement	12	23.1

Total error scores (TES) were also calculated. The mean √TES was found to be 9.47 ± 4.68. This value was close to the value that was found by Verriest et al. (1952). Had obtained a mean √TES of 8.23 ± 2.44 for the age group of 40 to 49 years.

DISCUSSION

The results of this study showed that all the bus drivers tested had habitual vision of 6/12 or better. This shows that these drivers would have no problems renewing their public services vehicles driving licenses as they fulfill the minimum vision for safe driving criteria as recommended by the Medical Commission on Accident Prevention (1985).

Drivers with a minimum vision of 6/12 should be able to pass the vision tests conducted by Jabatan Pengangkutan Jalan Malaysia because during the test, the drivers are only required to read a number plate from a distance of 67 feet.

Good vision is essential during driving because good clear vision will provide the driver with adequate information to make a certain decisions and take appropriate actions during driving. Allen (1969) has shown in his study that an individual with vision 6/6 takes about 3.9 seconds to read a road sign with words of size 15 cm in height when traveling at a speed of 96 km/hr. But this duration will increase to 1.95 seconds if the vision is 6/12. A driver with poorer vision will need to go closer before he can see the danger and will then not have sufficient time to react and avoid the danger.

Near habitual vision testing in this study showed that 30 drivers (57.7%) had good near vision of N6 or better whereas 22 drivers (42.3%) had near vision of N10 or worse. As there is no minimum near vision requirement for driving, perhaps then this is the reason as to why drivers do not think it is necessary to correct their near vision. The drivers in this study were of the mean age of 44.5 ± 6.2 years and therefore presbyopic. Most of these presbyopic drivers had not been corrected for near vision with near spectacles because they thought it was of no use to them, as during driving, they only needed distance vision to be clear.

Phoria testing showed that mean horizontal and vertical phoria values, both for distance and near, were within normal limits. This shows that none of the bus drivers in this study had serious binocular vision problems.

Stereopsis testing revealed that 65.4% (n=34) of bus drivers had stereopsis within the normal range of 30 to 60 seconds of arc. Only 18 subjects (34.6%) had poor stereopsis. It is possible the poor stereopsis could be due to uncorrected near vision. Poor stereopsis could affect the driver's judgment of distance, especially during parking their vehicles.

The near point of accommodation and convergence of bus drivers in this study is relatively poor, that is 19.0 ± 8.3 cm and 13.0 ± 7.3 cm, respectively. But then again, this is probably because of uncorrected near vision.

Colour vision testing using Ishihara Plates showed that 92.3% (n=48) of bus drivers passed the test and only 4 bus drivers (7.79'0) failed, showing that they had a congenital red-green defect. Testing with SPP2 Plates showed that 32 bus drivers (61.5%) passed the test and only 20 drivers (38.5%) failed the test showing that they had some colour vision problems. D-15 and FM 100Hue tests showed that 28 bus drivers (53.8%) passed these tests and 24 bus drivers (46.2%) failed the test, again showing some colour vision problem. Many bus drivers had a tritan and complex (also known as mixed or non-polar) type of defect. A total of **30.8% had tritan and 7.7% had mixed type of** defects on testing with SPP2 plates; 19.2% had tritan and 15.4% had non-polar type of defects when tested with D15 test; and 19.2% had tritan and 23.1% had non-polar type of defects when tested with FM 100Hue test. The tritan and complex type of defects are acquired types of defects that, in this study, could most probably be due to crystalline lens yellowing. The red-green defects (protan and deutan type) are congenital defects, which were seen in 5 of the drivers.

In conclusion, it can be said that the bus drivers tested in this study had acceptable distance vision as required by the Medical Commission on Accident Prevention (1985). However, the near vision was not very good. Their phorias were within normal limits. Stereopsis, near point of accommodation and convergence, and colour vision were also poor in some bus drivers.

Although good visual status is important for safe driving, one cannot deny that many other factors are equally important. Factors like driving skill, emotions, health, environment also play an important role. Although statistical relationships between visual parameters and driving performance measures such as accident rates and traffic violation rates were weak, yet, it is important to impose vision standards on drivers. The purpose of establishing vision standards is to improve driving safety and efficiency.

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