2012 International Conference on Humanity, History and Society
IPEDR vol.34 (2012) © (2012) IACSIT Press, Singapore

Evaluation Based On Stereoscopic Vision Test within Driving Schools Assessment Center

Mihaela Chraif [1], Mihai Aniței [2]

Bucharest University, "Titu Maiorescu"Bucharest, Romania

Abstract. The current study focuses on highlighting the importance of using psychological tests which have high predictive value in the evaluation and selection of drivers from amateur driving schools. The participants were a group of 284 individuals, aged between 18 and 55 years old mean = 37.2, standard deviation = 12.37, both genders, coming from urban and rural background, first-timers in driving school. The results have emphasized the fact that after applying a multiple linear regression model, the predictors with statistically significant value were: the stereoscopic vision test, the peripheral perception test, speed and distance estimation test and the reaction time test. Therefore, it is advisable to design the psychological testing batteries according to the psychological criteria which must be achieved.

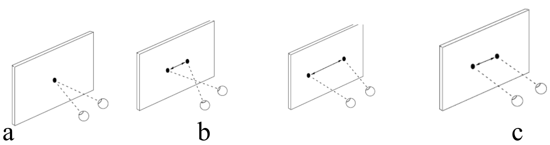
Keywords: stereoscopic vision, driving criteria, reaction time.

1. Introduction

Sensory acuity plays an important role which means the aptitude of perceiving light, the contrast between light and darkness, of recognizing a target, of having adequate visual fields [1]. The receptors for shape highlight the round or squared frames as well as the directions of lines. Textures and colors are processed by other visual primary areas. In forming the visual perceptions, some processes operate sequentially, whereas others operate in parallel. Although we talk about visual processing as a bottom up process of rudimentary analysis or as local unities of information which are designed in coherent percepts, [2].

The stereoscopic vision can be practiced and therefore it involves practicing the eyes to always watch stereoscopic images. Previous studies and researches have proved that visual interpretation, stimuli processing and especially face processing are acquired during childhood. The basic mechanism of image and object processing has existed since childhood in the visual cortex and only one experience will lead to binocular interpretations. Moreover, 3D vision depends on the eyes' muscles. If the muscles of an eye are more undeveloped during childhood and they are not put to practice, the eye is partially suppressed as function in the neocortex; the neocortex is functioning only with impulses which come from one single eye.

The components of the stereoscopic vision: 1) the convergence of eyes given by the eyes muscles until the moment when the double vision is recovered; 2) the focus of crystalline lens; 3) corrections after stereoscopic vision (physiological diplopia).



a b c d

Fig 1: Normal vision with focus on an object (a) parallel processing (b) cross processing (c) and (d) divergent processing.

Figure 1 shows how the way in which ocular globes focus on an object within the central filed in order to process information. At this stage, it cannot process the information in 3D and it cannot observe stereograms.

[1] Mihaela Chraif: mihaelapopa14@yahoo.com; fax: +40314253445
Tel: +40768811012

Other methods for visual procesing of stereograms and 3D visualization of hidden objects are the methods of parallel processing, cross processing, and divergent processing. The person who watches the stereogram will focus, as it is the case, his/her ocular globes before or after the vertical line where the image with the stereogram is. Therefore, from the stereogram the hidden object is going to be detached from the stereogram in a 3D composition [3].

[4] published a paper where there are described numerous studies are described which will be presented in the following paragraphs. These studies represented the starting point for the experimental investigations and the validation studies done within the current study.

Despite all these, systematic investigation have begun only after the studies of Nakayama and Shimojo, who clearly showed that semi-coverings are significant in the profound localizing of monocular objects, in illusory surface forming and the binocular rivalry [5], [6], [7].

The research paradigm has produced within the last years results which indicate the fact that the Da Vinci stereopsis is significant, for example, in determining the fusion latency of stereograms, in solving problems of correspondence, in the perceptions of the illusory surface, in determining the properties of the surface, in integrating the surface from behind the hidden figures, in the visual processing of monocular objects direction and in producing the perception of volume in 3D vision.

Taking in consideration the stereoscopic capture[5] cited by [4] have described a phenomenon where monocular objects are localized adjacent to a group of binocular objects and this creates the perception of an illusory outline. This effect is shown in figure 2 where a part of the white rectangles are visible only with the help of one eye.

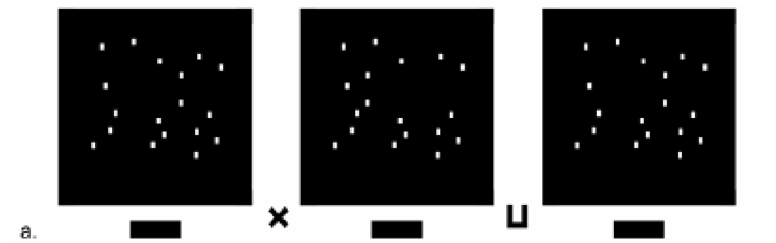


Fig 2: Monocular objects localized adjacent to a group of binocular objects create the perception of an illusory outline. Source: [4]

Figure 3 illustrates a schematic version of figure 2 and it emphasizes that when two rectangles visible only to the left eye and two rectangles visible only to the right eye are correspondingly localized between the binocular rectangles, two illusory outlines are perceived and an illusory surface is formed between them.

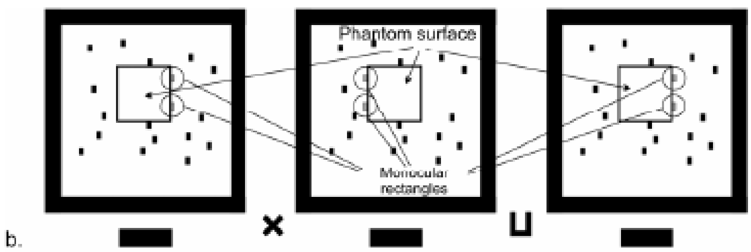


Fig 3: Illustration of the schematic version of figure 2. Source: [4]

The experimental demonstration shows the fact that the visual system can use information about the semi-coverings for surface forming.

In the 3rd experimental study done by [4] it was shown that a ghost surface has surface properties similar to a usual illusory figure investigating a series of basic aspects of the stereo capture focused on the stereoscopic capture. Starting from the schematic illustration of the stereoscopic capture, the stereograms are being built on the basis of this principle and it can be exemplified with the stereogram from figure 4 and it was used in the first two experimental studies together with the subtest of stereoscopy of the vizioest in order to differentiate the group of participants who have stereoscopic vision together with the subtest of stereoscopy mentioned previously.

Fig 4: Orchid stereogram

According to [5] cited by [4] people who have stereoscopic vision will detach based on the texture gradient especially traced that form “stereoscopic texture” which the individuals will detach from the background and they will watch the image in 3D based on the texture gradient.

Therefore, starting from the stereoscopic vision and the stereo image detachment from the background, researchers have also created mathematical models which are the base of designing the software programs aimed at showing on the screen the 3D images.

2. The research objectives and hypotheses

2.1. The objectives

1) The first objective was to build a psychological battery to assess drivers’ behavior with predictive value for the driving performance.

2) The second objective focused on highlighting the stereoscopic perception test as a predictor of driving performance.

2.2. The hypotheses

The stereoscopic perception test has predictive value for the driving performances.

The tests selected in the psychological battery for the assessment of drivers have predictive value for the driving performance.

3. The method

3.1. The participants

For this research the participants were real-life driving school students who attended driving schools in Bucharest, Romania, between May and September 2011. There have been 284 participants, aged between 18 to and 55, mean = 37.2, standard deviation = 12.37, both genders, coming from urban and rural background, first-timers in driving school.

3.2. The instruments

1) The Visiotest-Campitest Apparatus [8] is an instrument designed for the complex determination of the vision (the evaluation of the visual, function) and of the visual field. The visual indicators were presented on page 101 in the first study.

2) The peripheral visual test [9] aims to assess the abilities to perceive and to process peripheral visual information, highlighting the rapid perception of stimuli in the lateral sides of the visual field.

3) The DEST test for the estimation of speed and distances [10], makes possible an examination of three aspects of performance: the precision of speed estimations, the harmonious correlation between senses and motor reaction. It examines the participant's ability to estimate the speed - distance and it shows on the screen a small test rectangle which moves on a horizontal direction with constant speed from left to right.

*4) The reaction time at the yelow light***.**

5) The questionnaire of the driving performance assessment (CEPCA 2008)

The questionnaire is designed after a performance evaluation form of the driver in the traffic. It has 11 items, assessed on a Likert scale from 1 (totally disagree) to 5 (strongly agree). Applied as a pilot questionnaire, we obtained an Alpha Cronbach = 0.736 for 10 items (the 11th item is overall performance in traffic) and a coefficient correlation of 0,637 (p> 0.01) obtained for each person examined with both questionnaires.

3.3. Experimental design

2.1.1. Independent variables

- For the DEST test for the estimation of speed and distances, the independent variable in the regression model is: Number of correct estimations, Underestimations, Omitted, the estimation tendency, and the estimation mean error.
- For the peripheral perception test the independent variables considered predictors in the regression model are: VMT (ARO) (the average of the overall reaction time for stimuli from left and from right), VMD (ARR) (the average of the overall reactions time reaction times from right), and VMS (ARS) (the average of the overall reactions time reaction times from left).
- For the composed reaction time (the Donders model) with response at the yellow light, the independent variables are: overall reaction time (motor time + decision time), motor time, and decision time.

2.1.2. Dependent variables

As dependent variables, we operationalized two criteria of a questionnaire which was were pt plural submitted to the process of convergent validity [11], at the driving school Ilioara, with a questionnaire used by driving school instructors in assessing students' performance while driving in traffic.

Dependent variables (criteria): maintaining the vehicle on a straight line and the overall assessment of performances while driving in traffic.

4. The results

The results obtained after data collection and multiple regression analysis in order to create a test battery for amateur drivers' aptitude testing were interpreted as follows:

The descriptive statistics on means and standard deviations of the participants raw scores can be observed in Table 1. The criterion for the linear regression model was represented by "maintaining the straight direction on the road". The values of the correlation coefficients between the independent variables (predictors) and the "straight direction" criterion were presented in the table highlighting the correlation matrix between the predictors and criterion.

On this matrix the positive and negative significant correlations between variables are highlighted. Thereby one can conclude that independent variables "correct estimates number" ($r=0.37$; $p<0.05$) and "estimation trend" ($r=0.25$ $p<0.05$) are significantly positive correlated with criterion. The variables: "mean estimation error" ($r=-0.43$ $p<0.05$), "visual test stereoscopy" ($r=-0.41$ $p<0.05$), Left Mean Speed ($r=0.38$ $p<0.05$), Right Mean Speed ($r=-0.27$ $p<0.05$) and Total Mean Speed ($r=-0.45$) are significantly correlated with the criterion.

Table 1. Model Summary (b), N=284

Model	Model Summary		
	R	***R Square***	***R Square Adjusted***
1	0.689(a)	0.474	0.466

a). Predictors: (constant), omitted, mean estimation errors, correct estimations, estimation trend, Visiotest-stereoscopy, LMS, RMS, TMS, Decision time, Reaction time, Motor time..

b). Dependent Variable: criterion (total performance in auto vehicle driving)

Table I indicates that this regression model's predictors are accountable for 47.4% reduction of the estimation error variance.

Following the presentation and analysis of the β coefficients and their significance, the multiple regression equation is:

Y= 73.84 + 0.23*CORRECT + -0.31*Visual test/Stereo grams - 0.37*LMS

Y= 73.84 + 0.23*X1 - 0.31*X7 - 0.37*X8

Y = criterion: straight direction

Therefore, the multiple regression models that explicates the “straight direction” criterion has the following predictors: correct estimations number (Correct), stereoscopy test (Visual test) and LMS (mean reaction time for stimuli on the left side)

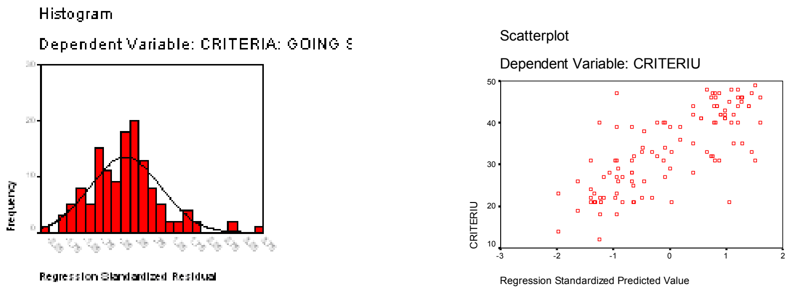


Figure 5: a) the histogram Figure b) Theoretical regression model „Straight direction” criterion expected and observed values

As noticed in figures 5 a and b, there is a strong and positive correlation between observed and expected variables (based on the predictor collected data). The outcome regression model has predictive value for the “maintaining the straight direction on the road” criterion.

The predictors-criterion relationship for the auto vehicle driving performance evaluation questionnaire based on the “total performance appraisal” criterion

According to the table presenting the descriptive statistics, the data generated following the multiple linear regression with the criterion “total performance in driving the auto vehicle on the road”.

The table presenting the correlation matrix between the independent variables and the corresponding criterion highlights the correlations between the dependent and independent variables. Thereby the dependent variable (criterion) “total performance in auto vehicle driving” correlates significantly with the following independent variables: “correct estimation number” (0.43; $p<0.05$), “mean estimation error” ($r=-0.41$; $p<0.05$), visual test-stereoscopy ($r=-0.48$; $p<0.05$), LMS ($r=0.36$; $p<0.05$), RMS ($r=0.35$; $p<0.05$) and TMS ($r=0.37$; $p<0.05$) are positive and significant correlations with the criterion.

Following the data analysis one can ascertain that the stereoscopy level of the participants strongly and negatively correlates ($p<0.01$) with traffic performance (total performance appraisal). Moreover, reaction time strongly and negatively correlates with the stereoscopy level of the vehicle driver. Thereby, the decision time ($r=0.27$; $p<0.05$) for the yellow stimuli gets lower as the stereoscopy level gets higher. This feature may put traffic participants in unforeseeable and uncontrolled reactivity situations towards different stimuli that may appear in the visual field.

Table 2 Model Summary (B) N=284

Model	Table Column Head		
	R	***R Square***	***R Square Adjusted***
1	0.706(a)	0.498	0.479

a). Predictors: (constant), omitted, mean estimation errors, correct estimations, estimation trend, Visiotest-stereoscopy, LMS, RMS, TMS, Decision time, Reaction time, Motor time..

b). Dependent Variable: criterion (total performance in auto vehicle driving)

As shown in table 3 the resulted multiple regression model accounts for a 49.8% reduction of the estimation error.

Following the presentation and the analysis of the β coefficients and their significance, the multiple regression equation is:

Y= 69.53 + 0.16*Correct + 0.25*Mean estimation error - 0.27*Visual test/Stereo grams + 0.35*LMS + 0.38*RMS + 0.31*TMS + 0.22*Decision time + 0.31*Reaction time + 0.29*Motor time

Y= 69.53 + 0.16*X1 + 0.25*X5 - 0.27*X6 + 0.35*X7 + 0.38*X8 + 0.31*X9 + 0.22*X10 + 0.31*X11 + 0.29*X12

y= criterion “total performance in auto vehicle driving”

According to the obtained data, the multiple regression models that explain the “total performance on the road” criterion has the following predictors: no. of correct estimations (correct), mean estimation error, stereoscopy test (Visual test), LMS (mean reaction time to the stimuli on the left side), RMS, TMS, Reaction time, Motor time and Decision time.

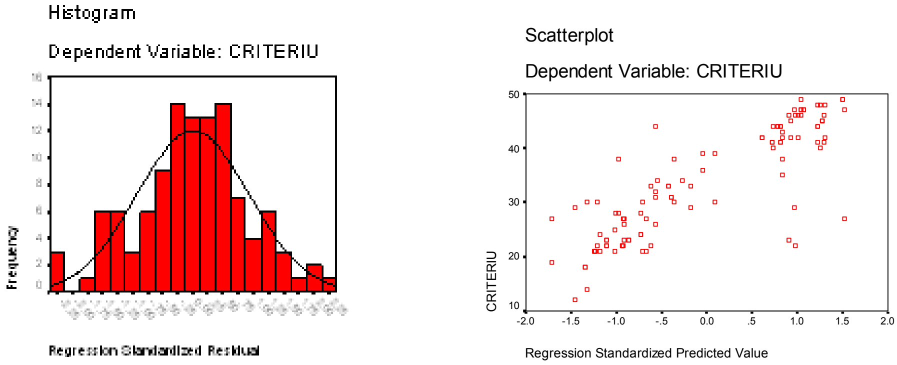


Figure 6 a) Histogram for criterion; b) Scatter-plot Graph: correlation between predictors and total performance criterion

As it can be observed in figure 6 a and b there is a strong and positive correlation between the observed and the expected variables (based on the predictor collected data for predictors). The resulted regression model has predictive value for the criterion “maintaining straight direction in trafic” and accounts for a 49.8% reduction of the estimation error.

As resulted from the data analysis, the statistic hypothesis regarding the predictive value of the selected criteria for the experimental aptitude test battery was confirmed only for the “Correct” variable of the DEST test for speed and distance estimation, for the “LMS” variable of the peripheral perception test and for the stereoscopy test.

The experimental model implies that the conditions to measure performance are controlled by the researcher. The laboratory tasks that simulate an aspect of driving a vehicle allow required control but have limited validity. The tasks that test the reaction time, for example, could have good surface validity, but there is little evidence that reaction time is indeed a valid measure unit for the performance on auto vehicle driving in traffic [12], or that it can bring any clue regarding the possible involvement of a participant in a traffic accident.

The regression models resulted confirm the hypothesys in and explane a 47.4.8% reduction of the variance estimation error for the first model and a 49.8% reduction for the second regression model with the criterion “total performance”.

5. Conclusions

In this research it has been underlined the importance of prediction in psychological evaluation starting from the fact that psychological tests must have predictive value at for the human operator’s workplace and on the other hand, the general aim of investigating the role of peripheral perception, of visual processing of stimuli and of reaction time to the visual stimuli in the activity executed by the individual.

The aspects and the particularities which concern the visual stimuli and their visual processing as well as the superior mechansims which take place (perception, reprezentation, memory and thinking) often have a strong impact on some characteristics of their workplace and some personal features of the human operator in executing the professional activity, of efficiently realizing activities and of achieving high performances in tasks at the workplace.

6. References

[1] E.A. Fleishman, and M.E.Reilly, “*Fleishman Job Analysis Survey (F-JAS*)”, Management Research institute, Inc.

[2] K. Grill-Spector and R. Malach, “The human visual cortex” *Annual Rev Neuroscience,* 27, 2004, p p. 649-677.

[3] W. John, “Investigative Ophthalmology and Visual Science”, *Association for Research in Vision and Ophthalmology,* vol. 19, 1980, pp. 802-809.

[4] J. Häkkinen, “*Half-occlusion Processing in Stereoscopic Vision”*, Doctoral Disertation, 2007.

[5] Department of Psychology,University of Helsinki, Helsinki University Printing House.

[6] K. Nakayama, and S. Shimojo, “Da vinci stereopsis: Depth and subjective occluding contours from unpaired image points”, *Vision Research,* 30, 1990, pp.1811-1825.

[7] S. Shimojo, and K. Nakayama, “Real world occlusion constraints and binocular rivalry”, *Vision Research,* 30, 1990, pp.69-80.

[8] S. Shimojo, and K. Nakayama, “Interocularly unpaired zones escape local binocular matching”. *Vision Research*, 34, 1994, pp.1875-1881.

[9] E.A.P. *Handbook of Viziotest-Campitest*, Editions Scientifiques et Psychologiques, Paris, 1992.

[10] G. Schuhfried, Test de percepție periferică, Viena Test System. Developement and Production of Scientific Equipments A - 2340 Modling, Austria, 1998.

[11] G. Schuhfried, *DEST-Test de apreciere a vitezelor şi distanțelor*, Manualul testului, Viena Test System. Developement and Production of Scientific Equipments A - 2340 Modling Hyrtlstrasse 45 Austria, 1992.

[12] H. Pitariu, and M. Chraif, Converget validity of Behaviourally Rated Anchored Scales [Validarea Convergentă a scalelor cu ancore comportamentale]. *Revista de psihologie a Academiei Române*, 2009, no. 3-4.

[13] M. Anitei, and M. Chraif, “Designing a test battery for predicting the driver behaviour”, Proc. Education and Creativity for a Knowledge Society, Univeristatea "Titu Maiorescu", Ed Universității Titu Maiorescu, 2008, pp.11- 19.