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Impact on Driver's Visual in low luminance and lack of variation of highway tunnels

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Abstract

There is a strong probability that drivers will suffer a visual illusion due to the dim lighting and monotony of highway tunnels. The danger of a serious car crash is increased because drivers frequently under-estimate their actual speed. Current highway tunnel operations have the problem of finding a low-cost technique to mitigate this optical illusion and enhance driver protection. A driver's perception of speed might be skewed either way depending on the frequency of the visual information they're taking in. However, there has been an absence of rigorous studies examining the effect of different frequencies and intensities of visual information on drivers' perception of speed. This study, present the development and testing of a driving simulation model in simulators and the E-Prime analysis programme. The model was constructed in Autodesk's 3D's Max modelling software. Varying brightness level was explored to account for its influence on the processes of rapid perception and reaction time. The results demonstrated that high-frequency visual information was the primary culprit in the erroneous assessment of velocity. Using a mixture of high- and low-frequency visual information may help mitigate this overestimation.

Keywords: *Speed regulation; highway tunnel; E-Prime research software; visual illusion*

Introduction

Statistics gathered by the Indian Highway Road Police Department link almost a thirty-eight percent of traffic accidents to drivers' erroneous perceptions of their own speeds **(Zhang,et al 2014).** If drivers' misconceptions about their speeds can be dispelled, speeding can be drastically reduced, which in turn improves road safety. There is a greater danger of speeding and rear-end collisions in the central portion of highway tunnels because of the poor lighting, monotony, and semi-enclosed environment that disrupts drivers' visual reference systems. Reasons for this are primarily the tunnel's low temporal frequency and decreased contrast. According to the results of surveys, speed is a factor in up to 40% of tunnel-related traffic accidents **(Chen et al 2011).** The two most common techniques used today to make driving feel faster are the provision of adequate tunnel illumination and traffic engineering infrastructure.

Standard lights are typically used in lower-traffic locations, but their high energy costs make this option unfeasible. Due to this, some of the lights may not work at all. This is also one of the leading causes of car crashes **(Du,et al 2014a).** It was found that transverse and vertical marks with both narrowing and expanding spacing had the same effect on vehicle velocity. The impact of slowing down was aided by transverse marks more than vertical ones. The temporal frequencies between 4 Hz and 16 Hz were the most likely to result in an exaggerated perception of velocity. Highway drivers can constantly use the landscape's varying frequencies as an external source of information about their current speed.

The majority of the recent literature on the topic of how fast can process visual information concentrates on a particular frequency. There is a paucity of quantitative research on how drivers perceive speed when visual information is mixed with different frequencies. There is a general lack of illumination in all of India's highway tunnels. It's easy for low lighting to cause serious optical illusions in drivers **(Du,et al 2014b).**

In this article, we use a driving simulator to quantitatively examine how much drivers experience visual illusion when driving through tunnels. Multiple-frequency traffic patterns were proposed for implementation using retroreflection. To evaluate the efficacy of a suggested modification, experiments were conducted to compare the average amount of visual illusion experienced by drivers before and after the change was implemented.

Objective of the study

To determine the link between drivers' speed illusions and brightness and visual information.

Methodology

In this research 3ds Max modelling software used to establish the model of driving and to find the drivers' speed illusions and brightness and visual information to avoid conducting potentially risky and

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time-consuming field experiments in highway tunnels, where flow, cost, and management traffic are all dependent on tunnel illumination modification and traffic-marking installations E-prime software used. Origin 8.5 and SPSS 20.0 were used to analyse the evaluation data. A simulator with a constantly shifting basis was used for this test. A substantial linear motion can be generated when accelerating and decelerating around a curve or while driving along a straight stretch of road, and a vibration table can simulate surface roughness. Five frontal digital projectors cover 180 degrees of viewing, while five rear liquid crystal displays act as mirrors. To represent the 7:3 male-to-female ratio of Indian drivers, the sample size was 20 participants, 14 of whom were men and 6 of whom were women. Between the ages of 18 and 45, participants were included. The group consisted entirely of experienced drivers with 20/20 eyesight. One straightforward approach to determining a threshold is the technique of limits, commonly known as the method of minimal change **(Shen,et al 2005).**The transition point between the two reactions may be calculated by systematically varying the stimulus. Tests were performed to see how close the simulation came to the actual thing (both involve a common section of highway). Both the field and the simulation settings are shown in Figure 1.1. During the field test, we averaged 74 km/h (as shown by the flash frequency of the lane-edge line) and during the simulation test, we averaged 20 km/h (with a minimum interval of 2.5 km). Through limiting analysis, we arrived at a value of 76.5 km/h for the SSES. The difference of 3.4% is within the allowable range of +/- 5%. It was shown that the suggested simulation model is effective. The SSES experiment findings were normalised to a reference stimulus by using video of the simulated model.

Figure1.1 field scene and a simulation scenario were used to verify the accuracy of the model.

Results and discussion

After E-Prime calculated the median response times for each velocity range, a normal curve fitting was performed. In the following equation, x is the anticipated value of the driving speed, y is the probability density function of the response time, e and π are constants, and σ is the standard deviation of the driving speed. Figure 1.2 presents a graphical representation of the distribution of response times.

$$y = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-x_c)^2}{2\sigma^2}}$$

The results show that as the physical speed of the comparison stimulus is closer to the Stimulus of subjectively similar speed, it becomes difficult for individuals to discern between the comparison scene and the standard scene in terms of speed, and their reaction times also extend (SSES)

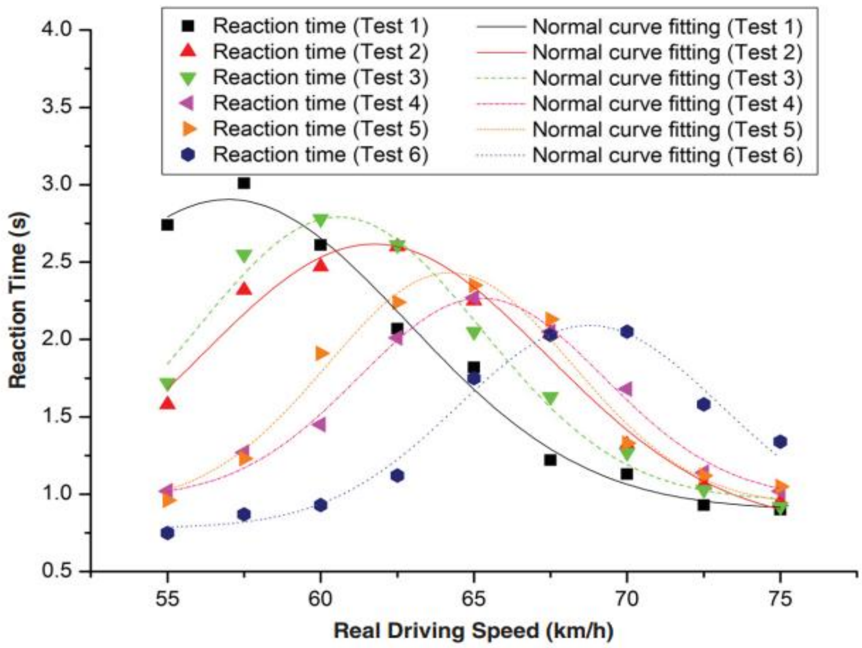

Figure1.2Variation in Reaction Time.

Conclusions

Results from limited-simulation speed perception studies point to high-frequency visual input as the main culprit in drivers' erroneous estimates of actual speeds. The amount of speed overestimation was lowered to a reasonable degree once low-frequency visual information was included. In the same way that speed overestimation grows with decreasing brightness, so does the degree to which the same-frequency visual information is misinterpreted as being faster. Increased lighting in highway tunnels has been shown to lessen drivers' propensity for risky behaviour like racing by making it more difficult for them to perceive their true speed. Experimental results on response times reveal that both luminance and multifrequency visual information have significant effects on how soon an observer acts. Drivers were more alert to speed differences when visibility was improved by increased lighting. Drivers may be protected against their habitual, rapid, unintentional acceleration using these results. The lighting in the centre of highway tunnels has been decreased arbitrarily, making driving there more dangerous. Multifrequency visual information traffic facilities are suggested for installation in tunnels to increase motorist safety.

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