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INDUSTRIAL ENGINEERING DEPARTMENT, FACULTY OF MECHANICAL ENGINEERING, UNIVERSITY OF BELGRADE, SERBIA

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Mirjana Misita
Dragan D. Milanović

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THE IMPORTANCE OF ERGONOMIC PRINCIPLES IN DESIGN OF THE TRAFFIC SIGNS FOR CHILDREN

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Abstract. *Children represent a vulnerable population from the standpoint of traffic safety. A modern traffic poses complex and high requirements to all its participants, and among them, particularly to young children. Children have a higher risk of pedestrian injuries. Children experience traffic differently from adults. How do children view the world? What helps them to link with their environment? How do children imagine traffic signs? To address these questions, this study examines how fast the children (between 6 and 10 years of age) react to traffic signs mounted at different heights. The analysis of the results indicated that there were differences in mean reaction time for traffic signs of different heights. Children best perceive a traffic sign when it is mounted at 1.9 m. The research highlights the importance of ergonomic principles in choosing the appropriate height of traffic signs for children.*

Key words: *Ergonomic design, Traffic signs, Children.*

1.INTRODUCTION

In modern times, it's hard to imagine a world without traffic signs, and it's even more difficult to imagine the world before there was a need for them. They did not always exist because traffic was not like as it is nowadays. In one form or another, traffic signs have been in use since the time of the Roman Empire. Traffic signs provide important information, guidelines, and warnings on the road; they are designed and placed to assist drivers and pedestrians [6]. Despite their importance, they are not always understood correctly [7] and they are not perceived in the same way nor equally fast. Many studies have also shown that signs are often wrongly perceived by drivers and pedestrians [1, 6]. Some findings indicate that the comprehension level of some traffic signs is very low, and some are misinterpreted [6]. Ben-Bassat and Shinar (2006) tested if these differences in comprehension of signs could be explained by the signs' compliance with ergonomic design principles [3]. They found that signs that comply with three basic ergonomic principles – physical and conceptual compatibility, standardization, and familiarity – are generally better understood than signs that do not comply with these principles [6]. Symbols and colors on traffic signs significantly affected both the correctness of the answers and reaction time [8, 4]. Many studies have proposed various changes to the traffic signs [2, 9, 10, 11]. Besides, the speed of the response plays an important role in the perceptual judgments made by all participants in traffic situations and thus it is one of the critical components in the design of traffic signs of highways and streets. Age-related differences in the processing speed have been observed in a great variety of tasks involving visual search and response selection. In spite of the great number of researches in this area, these differences are still rarely reported although they are an indicator of the neural maturity of children's information processing system.

For the above reasons, the aim of this paper is to examine how children react to different heights of traffic signs.

2. METHODOLOGY

2.1. Participants and Experiment Procedure

Educational institutions from rural and urban environments providing state-funded preschool education programs were chosen as venues for this experiment. Of the total number of 60 respondents, 29 (48.3%) were females and 31 males (51.7%). In this study, simple RTs to presented targets - traffic signs (TS) of different heights were measured. Traffic signs were placed at 3 heights - 1.6m, 1.9m and 2.2m (2.2m is lawfully defined height of traffic signs in the populated place). For the sake of simplicity, these three TS heights will, in the rest of the manuscript be denoted as lower, middle and upper TS, respectively. The subjects (children aged between 6-10 years) were instructed to depress the response button immediately he/she recognized the stimulus - certain traffic sign, the response button terminated the clock counter. All subjects were tested under all three different conditions.

2.2. Data Analyses

Statistical analysis was performed using the statistical software package IBM SPSS Statistics v. 22. Normality distribution was tested by inspection of histograms and the Kolmogorov-Smirnov test. As the Kolmogorov-Smirnov test has determined that results do not significantly deviate from a normal distribution, the decision was to use Student's T-test and ANOVA. Dunnett's T3 Post Hoc test has been undertaken for additional comparisons. All tests were carried out on the basis of the recommendations from the textbook "SPSS Survival Manual" [5]. The threshold of statistical significance (α) is set at 5%.

3. RESULTS AND DISCUSSION

The rest of the paper presents the results of the children's reaction times for different heights of traffic signs.

The analysis of the results indicated that there were differences in mean reaction time for traffic signs of different heights (Figure 1). Generally, children showed the shortest reaction time for the Middle TS (0.259 s), then for the Lower TS (0.268), while the slowest reaction time was for the Upper TS (0.336). The series of performed paired Student's T-tests show statistically significant differences between RT for the lower TS and RT for the middle TS ($t=7.291$; $p<0.001$), RT for the lower TS and RT for the upper TS ($t=6.681$; $p<0.001$), as well as between RT for the upper TS and RT for the middle TS ($t=2.068$; $p=0.043$).

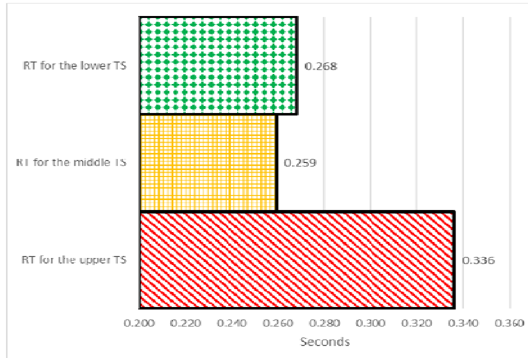

Figure 1. Mean reaction times for different heights of traffic signs

3.1. Age differences

One-way ANOVA indicated significant age group-related differences in RT. The results showed statistically significant differences between the first and fourth-grade children in RT for traffic signs of all three heights: for lower TS ($F=9.969$; $p<0.001$), for middle TS ($F=9.978$; $p<0.001$), as well as for upper TS ($F=4.093$; $p=0.011$). Figure 2 shows age differences in the mean values of reaction times for different heights of traffic signs.

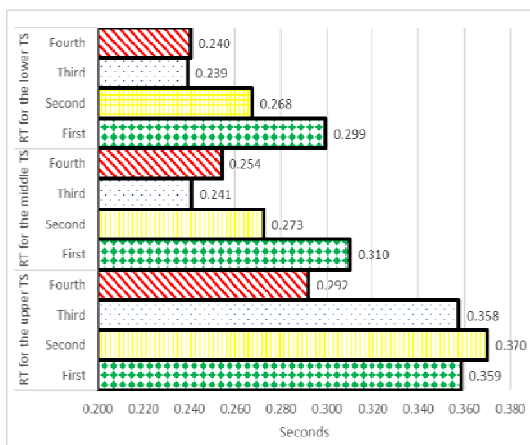

Figure 2. Age differences in mean reaction times for different heights of traffic signs.

3.2. Urban and Rural Areas

Reaction time data was also compared between urban and rural children. Figure 3 shows urban-rural differences in the mean values of the children's reaction times for different heights of traffic signs. The results of T-Test showed statistically significant differences for the children's reaction time according to area: Lower TS ($t = 9.762$; $p = 0.003$), Middle TS ($t = 8.187$; $p = 0.006$) and Upper TS ($t = 12.928$; $p = 0.001$). Children from the urban area react faster than children from the rural area, for all three heights of the traffic signal.

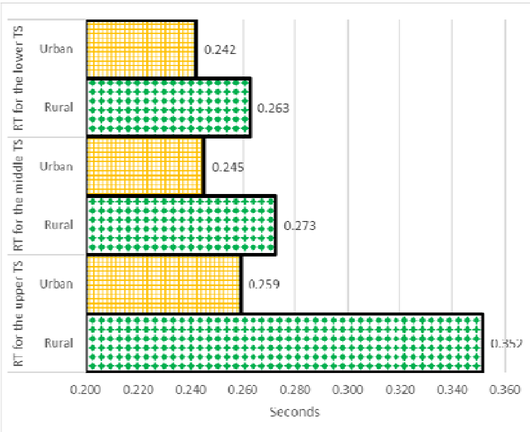

Figure 3. Urban-rural differences in mean reaction times for different heights of traffic signs.

4. CONCLUSIONS

Based on the data collected and analyzed in this research, some general conclusions can be derived:

- Children showed the shortest reaction time for TS mounted at 1.9 m (0.259 s), then for TS at the middle height (0.268), and the slowest reaction was for Upper TS (0.336);
- There are statistically significant age-related differences in children's RT for all three heights of the traffic signs;
- Children from the urban area react faster than children from the rural area, for all three heights of the traffic signs.

Taking into account the above mentioned, children best perceive a traffic sign when it is mounted at 1.9 m. Hence follows the conclusion and practical recommendation that, at least in school areas, traffic signs need to be placed at lower heights than defined by the rules (2.2 m). Ergonomic principles of design should be involved to improve traffic signs recognition and further behavior of traffic participants. It can be concluded that it is important to incorporate ergonomics in the design of road signs to ensure driver and road safety.

Future research should include all types of road signs, as well as more age groups of respondents.

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