IETI Transactions on Ergonomics and Safety
http://ieti.net/TES/

2019, Volume 3, Issue 1, 32-37, DOI: 10.6722/TES.201907_3(1).0004

EXPERIMENTAL STUDY: HOW FAST IS THE CHILDREN'S REACTION TIMES FOR DIFFERENT HEIGHTS OF TRAFFIC SIGNS - ERGONOMIC PRINCIPLES AND TRAFFIC SAFETY ASPECT

Aleksandar Trifunović[1a], Svetlana Čičević[1b], Magdalena Dragović[2,c]
[1]University of Belgrade, Faculty of Transport and Traffic Engineering, Belgrade, Serbia
[2]University of Belgrade, Faculty of Civil Engineering, Belgrade, Serbia
[a]a.trifunovic@sf.bg.ac.rs, [b]s.cicevic@sf.bg.ac.rs, [c]dim@grf.bg.ac.rs,

Abstract A modern traffic setting poses complex and high requirements for all its participants, and among them, especially for children. At the age when they act as independent road users, they participate in traffic, mainly as pedestrians or cyclists. Without a doubt, the journey of children to and from school is a complex and sensitive issue. Children represent a vulnerable population from the standpoint of traffic safety. How do children view the world? What helps them link with their environment? How do children imagining traffic signs? To address this and other questions, this research examines how children react to different heights of traffic signs. This study highlights the importance of ergonomic principles in choosing the height of traffic signs for children. The main conclusion of this study is that children best perceive a traffic sign at the higher of 1.9 m and for him have the shortest reaction time.

Keywords: Ergonomics; traffic safety; traffic signs; children.

1. INTRODUCTION

A modern traffic poses complex and high requirements of all its participants, and among them, particularly to young children. Children have a higher risk of pedestrian injuries. Children are experiencing traffic differently from adults. 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 [1]. They did not always exist because traffic was not like it is today. 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 for the assistance of drivers and pedestrians [2]. Despite their importance, they are not always understood correctly [2] and do not perceive in the same way and at the same reaction times. Many studies have also shown that signs are often wrongly perceived by drivers and pedestrians [2-3]. Some research has shown that the comprehension level of some traffic signs is very low, and some are misinterpreted [2]. Ben-Bassat and Shinar [4] tested if these differences in comprehension of signs could be explained by the signs' compliance with ergonomic design principles. 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 [2]. Symbols and colors on traffic signs significantly affected both correctness of the answers and reaction time [5-6].

IETI Transactions on Ergonomics and Safety
http://ieti.net/TES/

2019, Volume 3, Issue 1, 32-37, DOI: 10.6722/TES.201907_3(1).0004

Many studies have proposed various changes to the traffic signs [7-8]. 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 Experimental Procedure

In the experiment, 60 respondents participated. Of the total number of respondents, 29 were females and 31 males (Figure 1). We chose educational institutions from rural or urban environments providing state-funded preschool education programs as venues for this experiment. Our experiment presented a test to children (6-10 years old), designed to examine their reaction times (RT) for different heights of traffic signs (TS). Traffic signs are placed at a height of 1.6m, 1.9m and 2.2m (2.2m is lawfully defined height of traffic signs in the populated place). All subjects were doing an experiment for three different conditions.

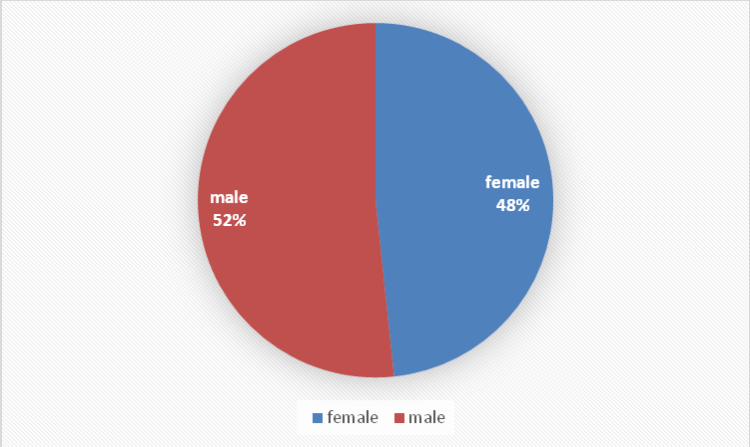

Figure 1. Percentage of respondents by gender.

2.2. Data Analyses

Statistical analysis was performed by the statistical software package IBM SPSS Statistics v. 22. Based on the results of descriptive statistics and cross tabulation it was presented the basic statistical analysis of data obtained in the experiment. 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 used for additional comparison. All tests were carried out on the basis of the recommendations of the textbook "SPSS Survival Manual" [9]. The threshold of statistical significance (α) is set at 5%.

IETI Transactions on Ergonomics and Safety
http://ieti.net/TES/

2019, Volume 3, Issue 1, 32-37, DOI: 10.6722/TES.201907_3(1).0004

3. RESULTS AND DISCUSSION

The rest of this paper will present the results of the children's reaction times for different heights of traffic signs. Figure 2 shows descriptive statistics (mean value) of the children's reaction times for different heights of traffic signs. Children have the shortest reaction time for Middle TS (0.259 s), then Lower TS (0.268), and the longest reaction time for Upper TS (0.336). The results of Student's T-test 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 ($t=2.068$; $p=0.043$).

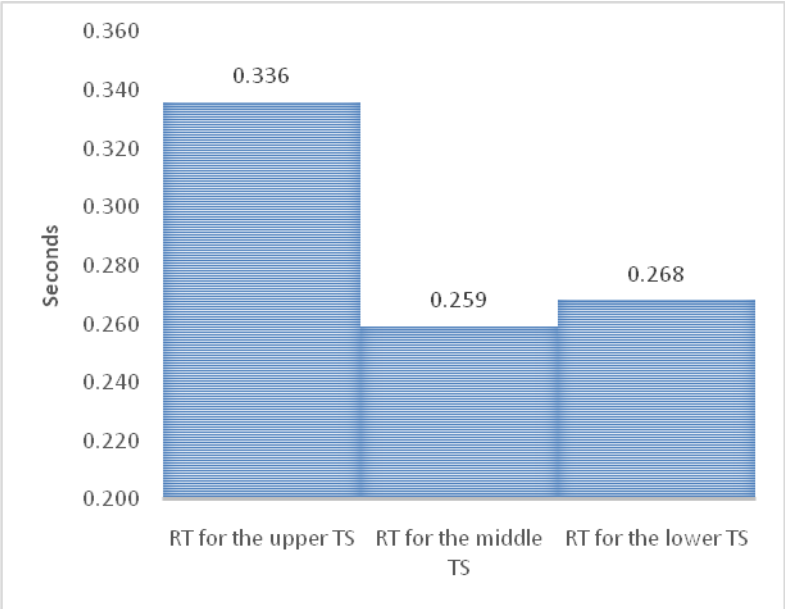

Figure 2. Reaction times for different heights of traffic signs.

3.1. Gender Differences

Based on the results of the T-Test test can be concluded that there are statistically significant gender differences for the children's reaction time: Lower TS ($t = 8.523$; $p = 0.006$), Middle TS ($t = 6.857$; $p = 0.011$) and Upper TS ($t = 10.254$; $p = 0.002$). Boys show a shorter reaction time, compared to girls, for all three height of the traffic signal (Figure 3).

IETI Transactions on Ergonomics and Safety
http://ieti.net/TES/

2019, Volume 3, Issue 1, 32-37, DOI: 10.6722/TES.201907_3(1).0004

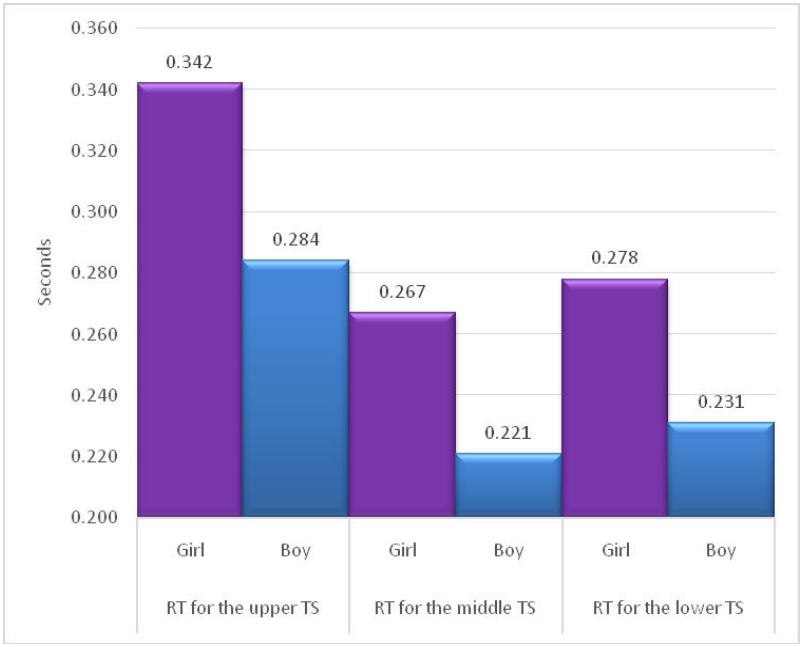

Figure 3. Reaction times for different heights of traffic signs – gender differences.

3.2. Age Differences

The results of One-way ANOVA showed statistically significant differences between the first and fourth grade for children's RT: lower TS ($F=9.969$; $p<0.001$), middle TS ($F=9.978$; $p<0.001$) and upper TS ($F=4.093$; $p=0.011$). Figure 4 shows the descriptive statistics (mean value) of reaction times for different heights of traffic signs-age differences.

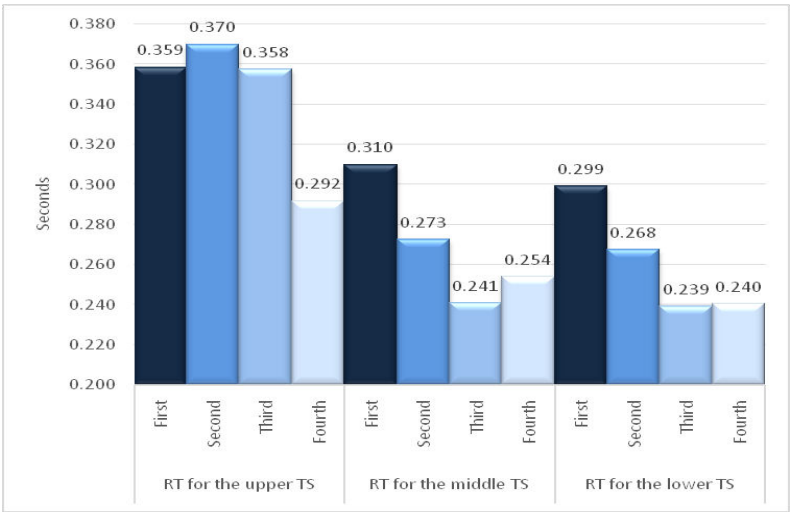

Figure 4. Reaction times for different heights of traffic signs – age differences.

2019, Volume 3, Issue 1, 32-37, DOI: 10.6722/TES.201907_3(1).0004

4. CONCLUSIONS

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

- Boys show a shorter reaction time, compared to girls, for all three height of the traffic signal;

- Respondents have the shortest reaction time for Middle TS (0.259 s), then Lower TS (0.268), and the longest reaction time for Upper TS (0.336);

- There are statistically significant differences between the first and fourth grade for children's RT for all three height of the traffic signal.

Considering the above mentioned, children best perceive a traffic sign at the higher of 1.9 m. Hence follows the conclusion and practical recommendation that children need to place traffic signs at a height of 1.6 m, not at the height of 2.2 m, as defined by the rules. Future research could include the difference between the different traffic signs, as well as different age group respondents (Trifunović et al., 2017b; Trifunović et al., 2018b).

Acknowledgments

This study was supported by The Ministry of Education, Science and Technological Development of Serbia (project 36027, 36022 and 36006).

References

[1] Trifunović A., Pešić D., Čičević S., and Antić B., 2017, The importance of spatial orientation and knowledge of traffic signs for children's traffic safety, *Accident Analysis and Prevention 102,* pp. 81-92.
[2] Shinar D., and Vogelzang M., 2013, Comprehension of traffic signs with symbolic versus text displays. *Transportation research part F: traffic psychology and behaviour 18*, pp. 72-82.
[3] Al-Madani H., and Al-Janahi A. R., 2002, Role of drivers' personal characteristics in understanding traffic sign symbols, *Accident analysis and prevention 34(2)*, pp. 185-196.
[4] Ben-Bassat T., and Shinar D., 2006, Ergonomic guidelines for traffic sign design increase sign comprehension, *Human factors 48(1)*, pp. 182-195.
[5] Braun C. C., and Silver N. C., 1995, Interaction of signal word and colour on warning labels: differences in perceived hazard and behavioural compliance, *Ergonomics 38(11)*, pp. 2207-2220.
[6] Siu K. W. M., Lam M. S., and Wong Y. L., 2017, Children's choice: Color associations in children's safety sign design, *Applied ergonomics 59*, pp. 56-64.

2019, Volume 3, Issue 1, 32-37, DOI: 10.6722/TES.201907_3(1).0004

[7] Appleyard B., 2017, The meaning of livable streets to schoolchildren: An image mapping study of the effects of traffic on children's cognitive development of spatial knowledge, *Journal of Transport and Health 5*, pp. 27-41.
[8] Trifunović A., Čičević S., Zunjic A., Dragović M., 2018, The importance of ergonomic principles in design of the traffic signs for children, proceedings of the 7th International Symposium on Industrial Engineering, pp. 96-98, Univerity of Belgrade - Faculty of Mechanical Engineering, Belgrade.
[9] Pallant J., 2013, *SPSS survival manual*, McGraw-Hill Education, UK.