# Investigating the Age Effects on Subjective Assessments of Traffic Signs

**Sri H. Kurniawan and Panayiotis Zaphiris**
**Dept. of Industrial and Manufacturing Engineering and Institute of Gerontology**
**Wayne State University**
**Detroit, MI 48202, U.S.A.**

## Abstract

Traffic signs function as an aid for drivers on the road. Hence, it is important to ensure that traffic signs are effective. The study investigates whether verbal or pictorial signs were less likely to be violated and would catch the driver's attention first. Twenty older and twenty younger drivers participated tested eleven verbal signs and eleven of their pictorial versions. Based on the statistical analysis results, pictorial signs were found to be superior to verbal ones. Using card-sorting technique, driver's underlying perception of what make a traffic sign stand out among other signs were also investigated.

**Keywords:** aging, traffic sign, card sorting, human factors, ergonomics

## 1    Introduction

Traffic signs are an integral part of the road. It has various functions, ranging from regulating, warning, to guiding traffic. Having an 'appropriate' traffic sign in the right place would aid the drivers and pedestrians to use the road efficiently, comfortably, and safely. On the other hand, 'inappropriate' traffic signs might invite problems on the road, which could be as simple as traffic slow down or as bad as fatal accidents. User's perceived appropriateness of traffic sign depends on many factors, such as age, driver's physical and mental conditions, driving skill, environment, road condition, etc. Fisher [4] added that the effectiveness of traffic signs should be assessed in terms of their ability to sensitize the driver to hazards. In summary, the effectiveness of traffic signs depends on whether the road users could perceive and utilize traffic signs properly.

While there are numerous streams of studies on traffic signs or road use in general, studies linking different aspects of road use and age have received more and more attention in recent years. This is not a surprising fact, considering that older people are a growing proportion in the population, with the number of older drivers predicted to exceed 2.5 times the 1996 levels (17.5 millions) within 30 years. The proportion of older drivers on the streets as well as the proportion of total mileage for elderly drivers also increase significantly. In 1990, elderly drivers accounted for 6.7% of all miles driven. By 2030, conservatively estimated, elderly drivers will account for 18.9% of all vehicle miles driven, almost triple the 1990 figure [2].

Because older drivers represent an important segment of road users, traffic sign design as an integral part of the road system definitely needs to accommodate their requirements. In addition, the aging process frequently leads to medical conditions that may impair the driver's ability to operate a motor vehicle safely because it affects the level of perception, judgmental processes, or motor abilities. As the basic function of traffic signs is to aid drivers, it would be necessary to ensure that traffic signs will help older drivers to overcome these age-related limitations.

In a study conducted by the Federal Highway Administration Turner-Fairbanks Highway Research Center in McLean (Virginia) on 22 highway pictorial warning signs currently used in the US, the legibility distance was found to decrease with age [6]. Furthermore, a study found that glare and luminance reduce the legibility distance for the older observers (65-79 years) although it has no deleterious effects upon young (18-25 years) and middle aged (40-55 years) drivers [8]. Another study on the subjective assessments of legibility distance, viewing comfort, lighting uniformity, and color rendition, found that there was no age difference in all measures except for color rendition [9].

Kline, et al [5] found that pictorial/icon signs were recognizable when they were only half the size of their text version and that the difference was magnified at dusk. In other words, with the same size, the icon signs could be seen from a greater distance than the text versions. However, the authors added that text signs will have an advantage over icons if they are large enough to be legible and the literate driver has little doubt about their meaning. Similar result has been observed in Paniati's study [6]: depending on the message, the visibility distance of a symbolic sign would be 1-4 times greater than an alphabetic sign.

A study in a campus surrounding found that the compliance rate varied with the types of signs and the types of vehicles they are driving [3]. That is, the drivers were more reluctant to violate pictorial signs than verbal signs in the campus surrounding.

## 2    The Objectives of the Study and the Hypothesis

This study investigates older and younger drivers' perceptions of traffic signs. Eleven pictorial signs and their verbal versions (see Figure 1) were compared to investigate which version is less likely to be violated and which one is more eye-catching. Using the card-sorting technique, the drivers were asked to group the cards based on what they view as differentiating factors. By extracting the differentiating factors, it is possible to understand what will make a traffic sign stand out when placed among other signs.
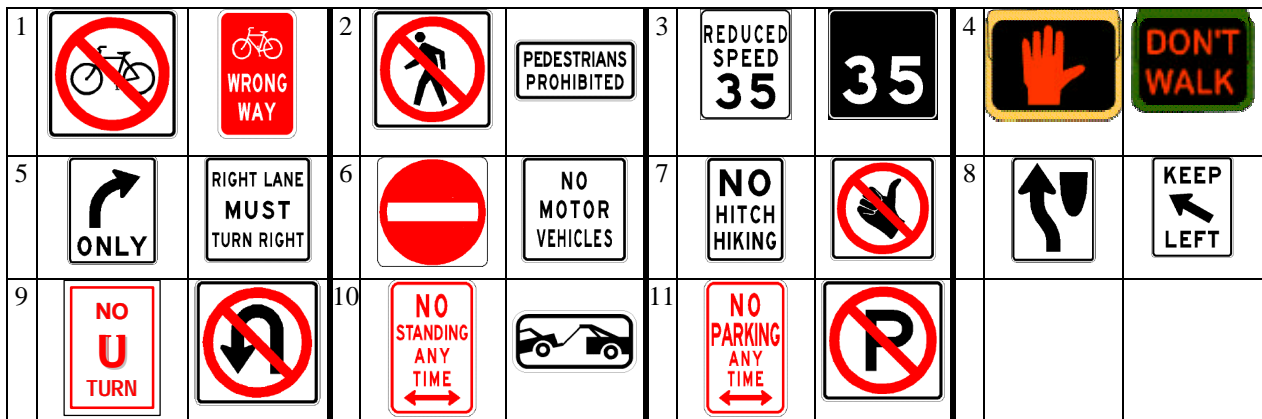


Figure 1. The traffic signs used in the study

Three hypothesis are tested in the present study:
H-1: Pictorial signs are less likely to be violated and are more eye-catching than verbal signs.
H-2: Older drivers consider the physical aspects of sign (e.g. color, shape) as the grouping factor.
H-3: Younger drivers consider the perceptual aspects of sign (e.g. meaning) as the grouping factor.

## 3    Methodology

Twenty older drivers or ex-drivers (had driven in their younger years) and twenty younger drivers participated in the study. In the older group, the mean age is 71.3 years (S.D. = 6.6 years), five are males and fifteen are females. In the younger group, the mean age is 36.2 years (S.D. = 12.1 years), eleven are males and nine are females. On average, the participants in this experiment had at least high school formal education, are daily drivers and have been involved in traffic accident either as the one at fault or being hit by other driver.

The first part of the study was the card-sorting task [10]. In this study, each of the eleven pictorial signs and eleven of their equivalent verbal version was printed on an index card. Then, each participant was given twenty two cards and was asked to group the cards into two piles. The participants were tested in an individual session to make sure that the grouping was based on individual observation rather than group observation. When they were comfortable with their final sorting arrangement, they were asked to write down why they grouped the cards that way. Each participant was then asked to regroup the cards into three piles by using a different grouping strategy to obtain more diverse dimensions. The task was not time-limited.

The next part of the study was a questionnaire with the pictorial and verbal versions of signs displayed side by side. Participants were asked which versions ('pictorial', 'verbal' or 'equal') they would feel more reluctant to violate and which would attract their attention first. The participants were then asked to state the reasons behind their choices. When the participants chose 'equal', they did not have to state the reason.

## 4    Results and Analysis

### 4.1    Differentiating Factors in a Group of Traffic Signs

The first part of the study was the card-sorting task. The results of the experiment were two and three piles of cards for each participants and the reasons behind his/her grouping strategies (called the differentiating factors). The differentiating factors mentioned by the older and younger driver groups are listed in Table 1.

Table 1. The differentiating factors of the card grouping

| Differentiating Factors | Young | Old |
|---|---|---|
| Color | 19.57% | 9.30% |
| Type (symbol vs. text) | 15.22% | 9.30% |
| Component (red slash, the word 'no', etc) | 8.70% | 4.65% |
| Target users (pedestrians, motorized vehicle, non motorized vehicle) | 23.91% | 32.56% |
| Force (helping, threatening, instructional) | 19.57% | 16.28% |
| Shape (rectangular, round, etc) | 2.17% | 0% |
| Actions (parking, moving, directions, etc) | 8.70% | 20.93% |
| Obedience (most likely obeyed/violated) | 2.17% | 0% |
| Consequence (with/out descriptions of consequence of violation) | 0% | 6.98% |

### 4.2    The Sign's Version that Caught the Drivers' Attention First

Table 2 lists the percentage of participants who stated that pictorial or verbal icons would attract their attention first as well as the percentage who said that both versions would equally attract their attention in the first sight. Across all ages, the results were in line with previous findings: pictorial signs are more effective in attracting driver's attention than verbal signs.

Table 2. Percentage of drivers choosing a certain version of traffic signs in terms of their eye-catching feature

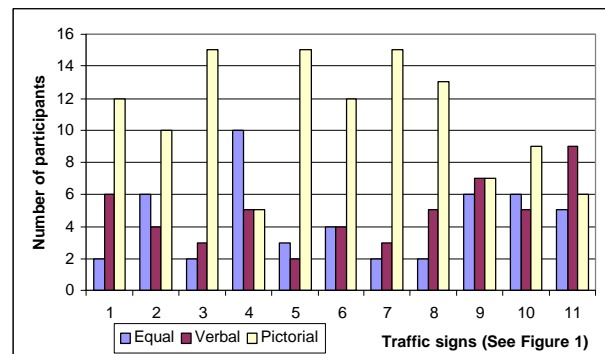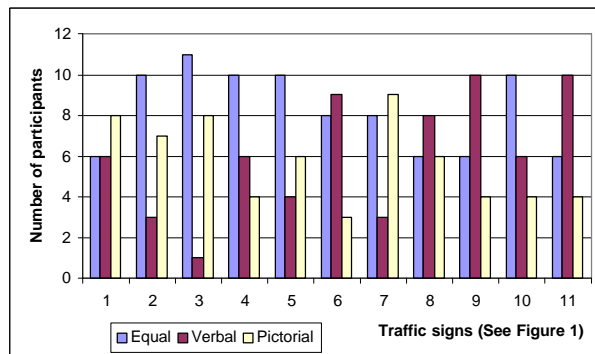| Age Group | Sign Versions | | |
|---|---|---|---|
| | Pictorial | Verbal | Equal |
| Young | 59.5% | 20% | 20.5% |
| Old | 28.2% | 30.4% | 41.4% |
| Across all ages | 43.1% | 25.5% | 31.4% |



Figure 2. The signs' versions that attract older drivers' attention (left) and younger drivers' attention (right)

Figure 2 described in details the number of participants choosing a certain version for each sign (See Figure 1 for reference). In both age groups, the analysis of variance shows a significant difference ($p \leq 0.05$) between the mean of the numbers of participants choosing verbal, pictorial or equal. The Bonferroni post-hoc analysis showed that for older drivers there is a significant difference ($p \leq 0.05$) between the mean of the numbers of participants choosing equal and pictorial and the mean of the numbers of participants choosing equal and verbal signs. There is no significant difference between the mean of the numbers of participants choosing verbal and pictorial signs. On the other hand, the Bonferroni post-hoc analysis showed that for younger drivers there is a significant difference ($p \leq 0.05$) between the mean of the numbers of participants choosing equal and pictorial and the mean of the numbers of participants choosing pictorial and verbal signs. There is no significant difference between the mean of the numbers of participants choosing equal and verbal signs.

Table 3 lists the reasons why participants prefer either pictorial or verbal.

Table 3. Participants' reasons of why the signs caught their attention first

| Pictorial Signs | Verbal Signs |
|---|---|
| Red slash and circle | Solid red color of the sign |
| Less reading/No text | Direct order (tells you what to do) |
| Bigger/bold object(s) in the sign | Familiarity (never saw the other) |
| Familiarity (used to it/more common) | The word "DON'T" in the sign |
| Faster to interpret (while moving) | The word "NO" in the sign |
| More descriptive/visual | Universality of message (can't be misinterpreted/clearer meaning) |
| High contrast (White on black) | |
| Showing consequence of violation | |
| Redundant symbols | |

### 4.3    The Sign's Version Drivers are More Reluctant to Violate
Table 4 lists the percentage of participants who chose the version they were more reluctant to violate as well as the percentage of drivers who said that both versions felt equally forceful.

Table 4. Percentage of drivers choosing the version they are more reluctant to violate

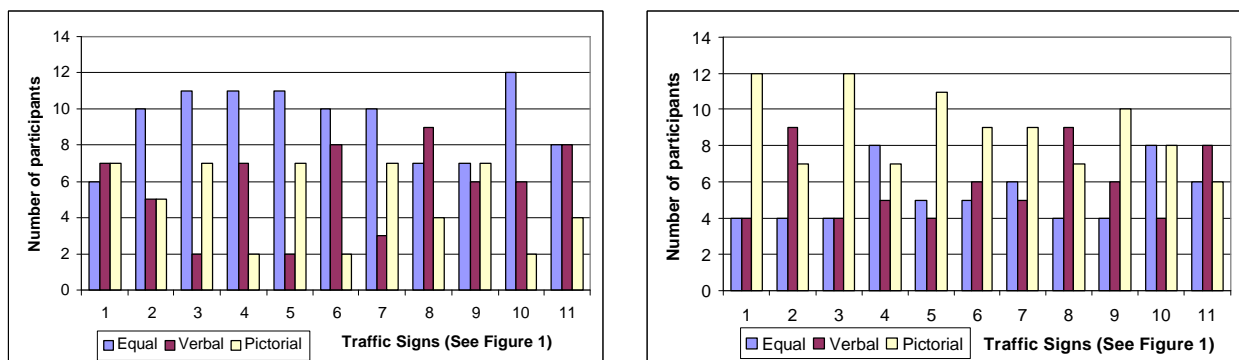| Age Group | Sign Versions | | |
|---|---|---|---|
| | Pictorial | Verbal | Equal |
| Young | 44.4% | 33.3% | 22.2% |
| Old | 24.1% | 29.1% | 46.8% |
| Across all ages | 34% | 27% | 39% |



Figure 3. The signs' versions that older drivers (left) and younger drivers (right) are more reluctant to violate

Figure 3 described in details the number of participants choosing a certain version for each sign (See Figure 1 for reference). In both age groups, the analysis of variance shows a significant difference ($p \leq 0.05$) between the mean

of the numbers of participants choosing verbal, pictorial or equal. The Bonferroni post-hoc analysis showed that for older drivers there is a significant difference ($p \leq 0.05$) between the mean of the numbers of participants choosing equal and pictorial and the mean of the numbers of participants choosing equal and verbal signs. There is no significant difference between the mean of the numbers of participants choosing verbal and pictorial. However, the Bonferroni post-hoc analysis showed that for younger drivers there is a significant difference ($p \leq 0.05$) between the mean of the numbers of participants choosing equal and pictorial and the mean of the numbers of participants choosing pictorial and verbal signs. There is no significant difference between the mean of the numbers of participants choosing equal and verbal.

Table 5 lists the reasons why participants prefer either pictorial or verbal.

Table 5. Participants' reasons of why they are reluctant to violate the signs

| Pictorial Signs | Verbal Signs |
|---|---|
| Red slash and circle | Solid red color of the sign |
| Less reading/No text | The word "MUST" in the sign |
| Bigger/bold object(s) in the sign | The word "ANYTIME" in the sign |
| Familiarity (used to it/more common) | The word "DON'T" in the sign |
| Faster to interpret (while moving) | The word "NO" in the sign |
| Redundant symbol | The word "ONLY" in the sign |
| Less polite | The word "PROHIBITED" in the sign |
| Showing consequence of violation | Direct order (tells you what to do) |
| | Familiarity (never saw the other version) |
| | Universality of message (can't be misinterpreted/clearer meaning) |

## 5 Discussions

### 5.1 Differentiating Factors in a Group of Traffic Signs

The older and younger participants mentioned similar differentiating factors when they grouped the cards. However, the frequency of occurrence of a certain differentiating factor varied by age. More younger drivers mentioned the physical aspects of the signs (e.g. color, type, shape) as the differentiating factors. On the other hand, more older drivers paid attention to the signs' content (e.g. target users, forcefulness, consequence). The older drivers were also concerned with the consequence of the violation, something not mentioned by the younger drivers. Therefore, both the second hypothesis: Older drivers would have underlying perception of physical aspects of sign (e.g. color, shape) as differentiating factors between signs and the third hypothesis: Younger drivers would have underlying perception of perceptual aspects of sign (e.g. meaning) as differentiating factors between signs, are not supported in the study.

Because a traffic sign has to stand out and be easily spotted, recognized and digested by drivers (as [7] suggested), it is important to ensure that two or more traffic signs placed side by side be differentiable in the drivers' perception. From the results of the card sorting experiment, there are several signs that are bad to be put side by side. For example, it might be a bad idea to put two red verbal rectangular traffic signs side by side because the drivers might "miss" one of them, as they are so similar in their perception.

### 5.2 The Sign's Version that Caught the Drivers' Attention First

The results show that for the younger group, the first hypothesis, which stated that the pictorial signs would be considered more attractive than verbal signs, is partially supported. That is, in the older group, although pictorial signs are still considered more attractive than the verbal ones, the difference is not significant. When collapsing across ages, however, the first hypothesis was supported: significantly higher number of participants chose the pictorial signs than the verbal ones.

On the other hand, it was observed that whether the signs are pictorial or verbal, if they have these features, they would be chosen by some participants: containing solid red color, familiar, quickly understandable (more descriptive, faster to interpret while driving, direct order and clearer meaning).

### 5.3 The Sign's Version Drivers are More Reluctant to Violate

The result showed that for the younger group, the first hypothesis stating that the pictorial signs are less likely to be violated than verbal signs is partially supported. That is, in the older group, although pictorial signs are less likely to be violated than the verbal signs, the difference is not significant. When collapsing across ages, however, the first hypothesis was supported. Significantly higher number of participants chose the pictorial signs than the verbal ones. It was also observed that whether the signs were pictorial or verbal, if they have the features described in Section 5.1, they will surely be chosen by some participants.

Paniati's [6] result which revealed that depending on the message, the visibility distance of symbolic sign would be greater than alphabetic sign was also mentioned by the participants in the present study. Some of the reasons for choosing pictorial signs were mentioned to be due to bigger/bolder objects in the signs. Some participants also mentioned that they thought the pictorial signs would be faster to recognize while driving.

## 6 Conclusions

This study investigates which version of traffic signs (i.e. verbal, pictorial or equal) would be less likely to be violated and more eye-catching to older and younger drivers. Three hypothesis were tested in the present study:
H-1: Pictorial signs are less likely to be violated and are more eye-catching than verbal signs.
H-2: Older drivers consider the physical aspects of sign as the grouping factor.
H-3: Younger drivers consider the perceptual aspects of sign as the grouping factor.

The results of the analysis show that the first hypothesis was supported across all ages but the second and third hypothesis was not supported. This study could contribute to the traffic sign designers in several ways. First, it is important to take into consideration what aspects would make a traffic sign stands out among other signs. Second, it is important to remember that different factors matter differently to older and younger drivers. Since traffic sign is a traveling aid for every road user, it is important to accommodate drivers of all ages when designing traffic signs.

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