SMALL ALTERATION IN STOP SIGN DESIGN: EVALUATIONS COMPARING SWEDISH AND BRAZILIAN SAMPLES.

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ABSTRACT

Some researchers claim that drivers pay very small attention to road signs system and showed that "the road sign system does not fulfill its intended and assumed function in a satisfactory way". And affirm if they could generalize their experiment that "it is not an exception but rather a rule that drivers overlook traffic signs". Based on this statement our problem is showed, traffic signs don´t attract attention of drivers. Some brazilian researchers, however, have pointed out that it is quite important to make more evaluation in the layout (border) and support of traffic signs, because the new traffic signs, which are used in some cities in Brazil, have a greater conspicuity than the standard ones, but their results only means tendencies of choice, because they are based on small samples.

Conspicuity is an important factor in the evaluation of traffic signs. This property can be divided in two different ways: search and attention conspicuity. Search Conspicuity: "property of an object that enables it to be quickly and reliably located by search." Tachistoscope methods could be used in order to test it, because "the observer would have had attention directed specifically to that task of locating the designated object". The visual impact is directly related to the conspicuity of the sign (capacity of the same to get the attention of the users).

The main aim of this research is to evaluate five different layouts for Stop Sign (different borders widths) in order to obtain a new traffic sign with a better visual impact, because this aspect is so important as the legibility and the correct localization in the field.

A Stop Sign analysis will be done in both countries where the same layout is used only with a small difference of its border. 120 subjects will be interviewed in each country in order to provide a data set for our inferences. Tachistoscope presentation of traffic signs will be used in order to discover what of the Stop Sign layouts that attract the greatest attention by the subjects.

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1. INTRODUCTION

Brazil is one of the world leaders in traffic accidents, close to 350,000 injured people, 50,000 seriously injured people and 50,000 killed people. These accidents cost more than US$ 10 billions for the country in hospital expenses, health treatments, material loses, work absences, early retirement, etc.

Gold (1998) points out that studies made in Brazil and other countries indicate that vehicles, traffic signs and road and crosswalk building and maintenance are contributing factors in many accidents. Hence, it is possible to significantly reduce traffic accident rates through traffic engineering.

According to McGee & Taori (1998), traffic signs are one of the most important parts of highway infrastructure. They are the communication way with road users about relevant aspects of it, like regulation, warnings, places location and others that also could be suitable. A better traffic sign system would contribute to an increase in traffic safety and a more efficient transport system. Of course only a better traffic sign system will not solve all safety problems, but it can help a lot to adjust drivers' behavior.

Fisher (1982) said that the function of traffic signs is to provide road users with information about traffic system conditions in order to allow them to anticipate events and, where necessary, to encourage them to adjust their behavior appropriately.

In this context it is of high importance to analyze the traffic signs in all of their ways. Much research is made on traffic signs related to visual perception, it means, studies about colors, shapes, sizes, visibility distance and location of traffic signs on streets.

Ferraz, Pierri & Fortes (1997) stress the existence of the following problems related to traffic signs in many Brazilian cities:

- Some traffic signs in their minimum size present low visual impact. Frequently the drivers do not perceive the existence of signs, even when the requisites of location and position are properly obeyed. This is intensified in the real world because the lack of maintenance;
- Traffic signs fixed in common posts bound for the support of cables get less perception compared to those fixed in its own posts. The visual impact is even better when the posts are colored (a practice adopted in many cities, which is, paradoxily, contrary to the legal rule that the sign posts should be painted in a neutral color);
- Some cities exaggerate in the quantity of traffic signs, thinking that it will solve the traffic problems. Consequence: the proliferation of signs impair the perception of the same and act in a negative way in the urban environment's harmony and beauty;
- There are no preoccupations with the sign-post whole set. In this sense, it is worthy to remember that what is beautiful, in general, gets more attention than what is ugly. And the traffic signs were made to get attention;
- The perception of the traffic signs is highly impaired because of the proliferation of the moveable propaganda signs placed on the sidewalks of urban streets.

Keeping in mind the sign problems cited above, the same authors suggested and begun in Sao Carlos City – SP the implementation of the following actions towards the street signalization improvement:

- Intensification of control in order to comply with the existent laws which prohibits the setting of commercial propaganda in the sidewalks be truly respected;
- Substitution of the traffic signs fixed in common posts and other strange elements by new signs set in its own posts painted in bright colors;
- Introduction of small alterations in some signs in order to improve the perception of some signs and also using sign size of at least 60 cm.

Concerning the introduced alterations of the traffic signs: kind of posts (supports) and the design of the vertical signs, the authors made clear that the propositions elaborated by them and implemented were based only on their personal experiences, in other words, without scientific ground.

Analyzing the alterations made by Ferraz *et al* (1997) in the traffic signs of the city of São Carlos – SP, Mise (2000) compared the new traffic signs with the standard ones, having attained results which points at improvements in the user's perception between 12 and 51% when using the news signs, depending of the kind of sign. In this research, when pairs of traffic signs were showed, the new and the standard one, the following question was presented for the subjects: "Which of these traffic signs attract your attention most?"

Fontana (2001) adopted the judgment criteria for interview subjects about the visual impact of traffic signs, which of those that attract more of your attention? The obtained results that showed the best perception of the set traffic sign post. For the evaluation of changes, she used Rank Order method in order to choose the best alternatives. This method was chosen because it permits the use of a great number of stimulus that will be judged in relation to each other and the results are expressed as scales. To obtain data, the subjects must set the stimulus in categories according to criteria previously specified, and in this case it was "what of these traffic signs get more of your attention?" The traffic signs were analysed in separate groups in order to obtain the results by border, width, post colour, shape and width. The principal results of this experience are presented below by traffic sign analyzed:

- **Stop Sign** - In relation to the sign dimension, the results points at the values which get the largest preference to the width of 70 and 80 cm (standard sign is 60 cm). The standard sign of Stop Sign, which presents an internal border of 2 cm in the white color and an external border of 1 cm in the red color showed to be less attractive in relation to the sign with only a white border. This fact was verified in the initial experiences concerning to the analysis of the sign layout. In relation to the white border dimension, the results show a preference to widths ranging from 10 to 12,5 % of the value of the sign width. In relation to the posts dimension, the results show that the choices go to those which present a width or a diameter ranging from 10 to 15 cm. In relation to the post colors, the preference goes to the primary colors yellow and red (the Brazilian Traffic Code says that post colors must be neutral). In relation to the format of the posts, there is a small preference for the square format.
- **One Way Sign** - About the sign dimension, the results points at the values which gather the largest preference to the width of 60 and 70 cm (standard sign is 40 cm). In what refers to the

red border dimension, the results show a preference by a width of 10 and 12,5 % of the value of the sign diameter (standard sign is 10%). In what refers to the dimension of the posts, the results show that the choice goes to those which present a width of 10 and 15 cm. In relation to the post colors, which has the major preference are the primary colors yellow and red (the Brazilian Traffic Code says that post colors must be neutral). About the format of the posts, there are small preferences for the square format.

Dewar, Kline & Swason (1997) studied the symbols contained in the signs and those which were considered "problematic" had their "layout" modified, passing by various tests to verify their understandability. So it was possible to determine some rules to the symbols contained in the signs. They made a two phases study. In the first one, the comprehension level of 85 symbols in daytime legibility was evaluated. Based on these results, other studies were made to evaluate the legibility distance under night and night with glare conditions, glance legibility, reaction time and conspicuity. In the second phase, 13 of these symbols were modified/redesigned in order to improve their legibility or understandability. The obtained results in these studies served as background to develope some guidelines for symbol sign design, and the authors agree that the key design guidelines are *to minimize symbols complexity by using as few details as possible, and maximize the distance between sign elements.* They also stress that other scientific evaluation for new symbols developed should be done. The authors had made some other evaluations before this, as can be read in Dewar (1976), Kline & Fuchs (1993), Ells & Dewar (1979) and Dewar (1998).

Murray, Magurno, Glover and Wogalter (1998) made similar research as Dewar (1976), but using a different presentation. The difference in slash was the replacement of no slash for a translucent slash. They analyzed 16 symbols and also included an evaluation about the symbols orientation. Their presentation was made using a set of laminated cards with the symbols – 8 cards per symbols (2 orientation X 4 different slashes). Subjects must lay them out on a table in an order based on how effectively each conveyed the intended message. They had to arrange the cards from the worst to the best. Results from this research pointed to over and under symbols slash. Authors said that this choice is a function of Gestalt principles, because both of the chosen slashes present a complete form.

When dealing with traffic signs, one always thinks that the legibility and the correct position of the sign are the most important points. However, as important as these aspects is the conspicuity of the sign (capacity of the same to get the attention of the users) and what is connected to the visual impact of the sign. Cárdenas & Mayor (1995), MUTCD (1988), Ferraz *et al* (1999), Al Madani (2000), Fontana (2001) and Fontana & Ferraz (2001).

Thieman & Avant (1993) said that "*Effective traffic signing is critical to highway safety. According to a recent report (FHWA, 1989), $21 in accident costs is saved for every dollar spent on roadway signing. Thus, determining sign characteristics that produce faster and more accurate driver information processing should be of high priority. Many factors contribute to sign detection, recognition, and response selection*".

Conspicuity is an important factor in evaluation of traffic signs. This property is defined by Cole and Hughes (1984) in two different ways: search conspicuity and attention conspicuity. They also defined these and discuss about methods to measure them:

- Search Conspicuity: *"property of an object that enables it to be quickly and reliably located by search."* Search time and tachistoscopic methods could be used in order to perform this evaluation, because *"the observer would have had attention directed specifically to that task of locating the designated object"*.
- Attention Conspicuity: *"the capacity of an object to attract attention". "The probability of the object being notice when the observer has not had his or her attention directed to its likely occurrence.* The Roadblock paradigm used by Johansson & Rumar (1966), Johansson & Backlund (1970), Shinar & Drory (1983) and Milosevic & Gajic (1986) can provide a data that regards a measure of attention conspicuity.

2. PROBLEMS, AIMS AND HYPOTHESIS

Mori (1978) apud Mori & Abdel-Halin (1981) said that drivers pay very small attention to road sign system and Johansson & Rumar (1966) showed that *"the road sign system does not fulfil its intended and assumed function in a satisfactory way"*. And affirm if they could generalized their experiment that *" it is not a exception but rather a rule that drivers overlook traffic signs"*. Based on this statement our problem is showed, traffic signs don't attract attention of drivers.

Mise (2000), Fontana (2001) and Moraes (2002) pointed out that it is quite important to make more evaluation of these aspects, the layout and post of traffic signs, because the new traffic signs, which are used in some cities in Brazil, have a greater conspicuity than the standards ones, but their results only means tendencies of choice.

The main aim of this research is to evaluate the conspicuity of the stop sign and its modified layouts, in order to obtain a new traffic sign with a better visual impact, because this aspect is so important as the legibility and the correctness location. The visual impact is directly related to the conspicuity of the sign (capacity of the same to get attention from the users).

It's possible to present the null hypothesis of this research: The standard traffic sign has a best visual impact if compared to the modified ones.

3. METHODOLOGY

Design of the research

The first step is to choose important and most used traffic signs in cities, it was decided to evaluate one traffic sign, modifying its layout: Stop Sign showed in figures 1.

Figure 1: R1 Stop Sign

For this traffic sign, some small alterations in its border are proposed as can be seen in figure 2:

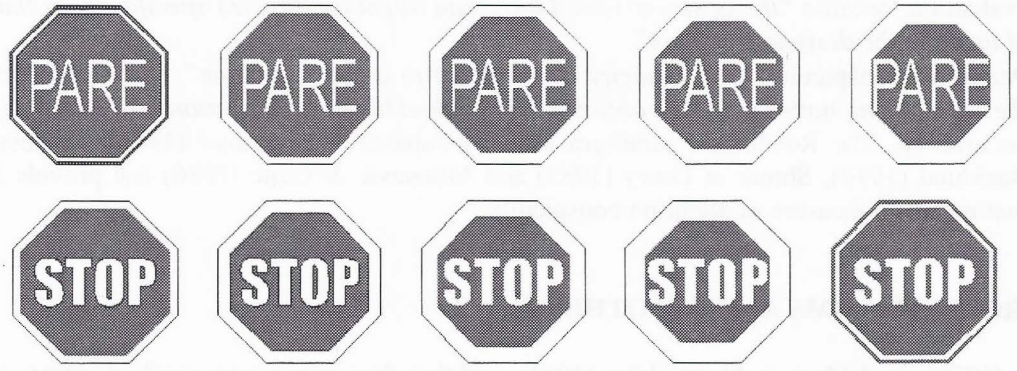

Figure 2: Different Versions (width of the borders).

The next step is a tachistoscope presentation of traffic signs to compare the verbal assessments of "what attracts attention most". Some slides will be prepared, each one contained a different "version" of a specific traffic sign with other ones. As Stop sign in Sweden has the same layout as in Brazil, and the only difference is the word Stop and " PARE", a data collection will be developed in Sweden, in order to compare the results. In figure 3 it is possible to see some slides (one used in Brazil another in Sweden) that contain a modified traffic sign.

In the end of this paper all the slides used in the research can be seen, containing stop sign altered for a Swedish and Brazilian evaluation. 120 subjects answered this test in Sweden and 120 in Brazil.

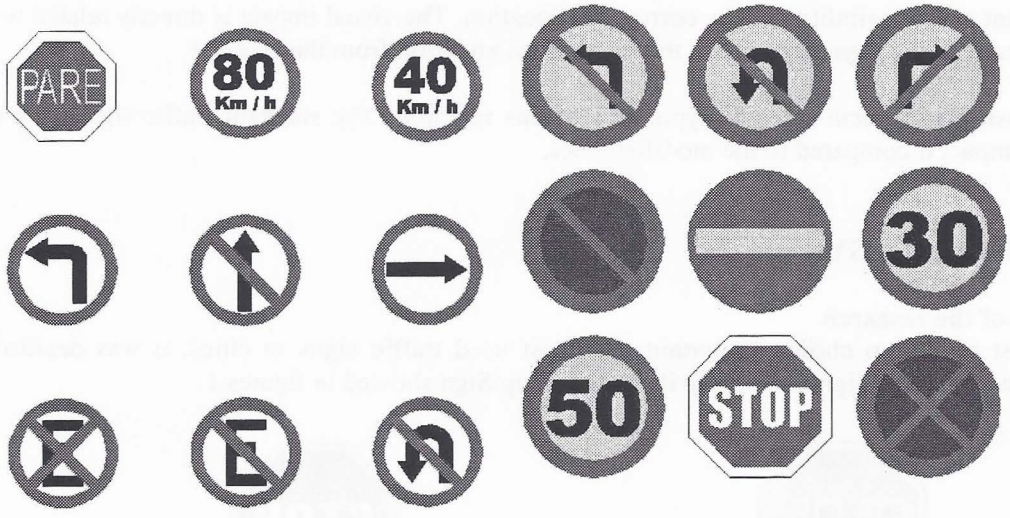

Figure 3: Slides with a modified traffic sign (Brazilian and Swedish versions)

Methods - Tachistoscope test

A Tachistoscope projection consists of a brief exposure of some stimulus for people to evaluate. Based on Cole & Hughes (1984) it's an adequate method to evaluate search conspicuity, because it permits one to know if the stimulus e.g. can be quickly located by search in a projection.

Shoptauggh & Whitaker (1984) were trying to discover the response times to left and right directional traffic signs embedded in street scenes. In order to discover it, they used a brief presentation using a tachistoscope. It was used both permissive and prohibitive traffic signs (words and symbols) in this evaluation. The result was that prohibitive word signs had the lowest response times.

Hoffmann & Macdonald (1980) used tachistoscope presentation in order to evaluate short time retention of information from verbal and symbolic signs and concluded that neither type of sign appeared superior in this property by drivers.

Dewar (1976) also used the same kind of presentation to realize the slash effect in prohibitive traffic signs. He obtained a ranking comparing 4 different layouts for 15 signs – slash over symbol, slash under symbol, partial slash and no slash – that resulted in an analysis of glance legibility. His results suggested that the glance legibility in these traffic signs is better when no slash or partial slash is used to convey the prohibitive message.

4. EXPERIMENTS AND RESULTS

The experiments were performed using 5 prepared pictures, each one containing one of the stop signs (5 versions – figure 2) plus 8 more traffic signs. These pictures were showed to subjects for 1 second, a brief time in a computer monitor. For each picture with 9 traffic signs, subjects should mark in a questionnaire the name of the perceived traffic sign. In this questionnaire, there were 18 traffic sign names, but only 9 names were included in the pictures. The pictures were showed in all possible positions, in order to avoid a learning effect that might happen, because in the group of pictures, the only difference between pictures is the stop sign layout. So, to perform all possible positions we must interview 120 subjects in each city.
The stop sign evaluation was performed in Lund - SE and São Carlos - BR, interviewing 240 subjects.

Sample

All subjects are volunteers, and naive of our goal. There was a short explanation about the test, when it was said then the following suggestion for test time:
1 – The idea of this test is not to discover how many traffic signs you are able to recall, but which of those attracts more your attention in the order you perceived them.
2 – There is no problem if you only remember one traffic sign, please, mark only what you know.

So, they began to see the pictures and mark the names in the questionnaires. Every subject received 5 questionnaires in order to fill in one per picture.

Hypothesis and Results

Our Hypothesis zero was 20% of choice for each traffic sign, and we adopted a $p < 0.05$ in order to accept or not our hypothesis. In Table 1 it is possible to observe all the results of the Swedish test and in table 2 the Brazilian test.

Table 1: Results from Tachitoscope test - Lund Sample

Border	5%	7,5%	10%	12,5%	Brazil Standard
Mean	0.32	0.28	0.34	0.40	0.33
Percentual	31.67	27.50	34.17	40	33.3
P*	0.000	0.000	0.000	0.028	0.000

* Using a Chi square test, $p < 0.05$, and all found values are lower than it.

Table 2: Results from Tachitoscope test - Brazilian Sample

Border	5%	7,5%	10%	12,5%	Brazil Standard
Mean	0.28	0.24	0.21	0.24	0.29
Percentual	28,33	24,17	20,83	24,17	29,17
P*	0.000	0.000	0.000	0.000	0.000

* Using a Chi square test, $p < 0.05$, and all found values are lower than it.

5. CONCLUSION AND DISCUSSION

In Lund, Sweden, it's possible to observe what stop sign is most used, and its layout contained a white border with a width between 5 and 7,5% of its total width (table 01). The results are very interesting (12,5%), because it's so different from the type used here, but it's important to notice that other traffic signs (circular – regulatory ones) have 12,5% of border.

In São Carlos, Brazil, the results are different if compared with the Lund sample. The best layout is Brazilian standard and 5% of white border (table 02). It's important to notice that in São Carlos a modified layout is used (a sign with 60 cm diameter and 5 cm of white border - about 8,33%). In another research study performed 2 years ago, the best results are obtained with a sign with a border of between 10 and 12,5% of white border.

It's clearly a difference between the two analyzed samples. One reason may be different traffic behavior and another one a novelty factor. It's interesting to compare with the results of a previous stimulation based on early results obtained by Fontana (2001). That showed for a São Carlos sample different results, but they were obtained using a different method.

Another aspect that can be discussed is related with the reaction times measured with a short-time presentation – tachistoscope presentation. They can vary between societies, which could also be valid in connection with visual perception.

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Annex: Questionnaires Used

Brazil	Sweden
Nome: Idade: CNH ( ) sim ( ) não se sim, quanto tempo?	Name: Age: Driver license ( ) yes ( ) no if yes, how long?
Por favor, você verá um slide contendo 9 sinais de trânsito, na lista abaixo, você deve assinalar o nome correto dos sinais apresentados. Obrigada!	Please, You'll see a slide containing 9 traffic signs, in the list below, you must mark the right name of the traffic signs showed. Thank you!
( ) passagem obrigatória	( ) förbud mot infart med fordon
( ) siga em frente	( ) förbud mot vändning på väg (U – sväng)
( ) dê a preferência	( ) förbud mot fordonstrafik
( ) sentido proibido	( ) omkörning förbjuden
( ) estacionamento regulamentado	( ) förbud att parkera fordon
( ) parada obrigatória	( ) stopp vid tull
( ) proibido virar a direita	( ) förbud mot vänstersväng
( ) vire a direita	( ) trafiksignal
( ) proibido estacionar	( ) stopp vid vägkorsning eller järnvägskorsning
( ) sentido circular obrigatório	( ) cirkulationstrafik
( ) velocidade máxima permitida de 80 Km/h	( ) begränsad hastighet 30
( ) curva a esquerda	( ) påbjuden gångbana
( ) vire a esquerda	( ) förbud mot ridning
( ) sentido de circulação da via	( ) förbud att stanna fordon
( ) proibido estacionar e parar	( ) förbud mot gångtrafik
( ) velocidade máxima permitida de 60 Km/h	( ) begränsad hastighet 50
( ) velocidade máxima permitida de 40 Km/h	( ) förbud mot trafik med motorcykel
( ) proibido retornar	( ) förbud mot högersväng