

PERCEPTION AND RECOGNITION OF TRAFFIC SIGNS IN RELATION TO DRIVERS CHARACTERISTICS AND SAFETY – A CASE STUDY IN POLAND

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ABSTRACT:

Driver communications systems are an important aspect of highway safety, and traffic control devices (TCDs), are an important part of the driver communications systems. The most prevalent of all TCDs are highway signs, and for effective traffic control it is essential that all drivers comprehend their meaning. As our world shrinks towards a global village, and as more and more of us cross-cross this 'village', variations in signing among countries, poor sign design, and different levels of familiarity with signs used in different countries may all impair communications with drivers. The purpose of this study was to evaluate the scope of the problem by comparing sign comprehension of different driver groups in Poland, using signs from four countries from four continents. The Sign comprehension test consisted of a set of 31 colour pictures of highway signs. The results of this study demonstrate the urgent need for greater uniformity in highway sign design among countries, and greater emphasis on ergonomic principles in the design of new signs and redesign of existing signs.

INTRODUCTION

Driver communications systems are an important aspect of highway safety, and traffic control devices (TCDs) are an important part of the driver communications systems. The most prevalent of all TCDs are highway signs, and for effective traffic control it is essential that all drivers comprehend their meaning.

Previous studies indicate individual differences in sign comprehension – especially driver age and culture, showing that older drivers had generally lower levels of comprehension than younger drivers.

The last decade findings suggest that communications through symbolic signing may be a problem. As our world shrinks towards a global village, variations in signing among countries, poor sign design, and different levels of familiarity with signs used in different countries may all impair communications with drivers. This problem is of course exacerbated in a world where people are licensed in one country, where they are required to learn one "standard" set of signs, and then are expected to obey the signs in other countries with a different sets of "standard" signs.

The purpose of this study was to evaluate the scope of the problem by comparing sign comprehension from different countries by different driver groups.

THE RESEARCH PROJECT

Subjects:

250 unpaid volunteers participated in the study. The sample consisted of 50 drivers (25 males and 25 females) from each of the following groups G1-G5:

- G1. Novice drivers. License applicants who have just passed the 'theoretical test' that consists knowledge of rules of the road and sign comprehension, or inexperienced drivers who have just received their license.
- G2. Tourists. Drivers who are licensed in another country.
- G3. Older drivers. Licensed drivers who are at least 62 years old, and who have not taken a driving test in at least ten years.
- G4. Problem drivers. Drivers with repeated violations, with essentially enough points to warrant a 'remedial training course'.
- G5. Regular experienced drivers, selected from university students.

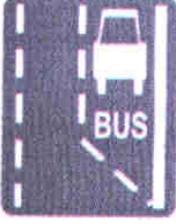
Materials:

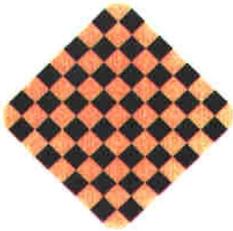
The materials consisted of an individually administered short questionnaire and a sign comprehension test. The questionnaire contained items on the driver's age, sex, and driving experience. The sign comprehension test consisted of a set of 31 colour pictures of highway signs, each printed on a separate cardboard card. Diamond-shaped and square-shaped signs were 7-10 cm across, triangular signs were approximately 10 cm high, and circular signs were approximately 10 cm in diameter.

Table 1 contains images of the 31 signs along with a listing of the specific countries that use them, and lists the meaning of the signs. In general there were 15 signs common to four continents, namely Europe, North America, Asia and Australia (Nos. 8, 9, 10, 11, 13, 14, 16, 17, 18, 19, 25, 27, 28, 29 and 30, in Figure 1). The remaining 16 signs were unique to specific countries: 3 signs unique to Canada (Nos. 20, 21, and 31), 3 signs unique to Finland (Nos. 15, 23, 24), 2 signs unique to Poland (Nos. 3, and 4), 2 signs unique to Israel (Nos. 5 and 22), and 3 signs unique to Australia (Nos. 1, 2, and 6). Finally one sign was common to Finland and Poland (26), one sign was common to Finland, Poland, and Israel (7), and one sign was common to Canada and Australia (12).

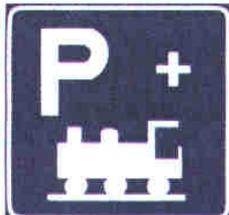
Table 1. Traffic signs tested during an experiment.

Sign No.	Sign picture	Sign meaning	Countries which use this sign
1		Railroad Crossing with Lights.	Australia

2		Truck Crossing	Australia
3		Bus Lane Begins	Poland
4		No Entry for Vehicles Carrying Explosives	Poland
5		No Entry for Motorcycles/Mopeds	Israel
6		Reverse Turn (Left then Right)	Australia
7		Priority for Oncoming Traffic	Finland Israel Poland

8		Bicycle Path	Australia Canada Finland Israel Poland
9		Railroad Works	Australia Canada Finland Israel Poland
10		Bumps on Road	Australia Canada Finland Israel Poland
11		Right Curve	Australia Canada Finland Israel Poland
12		Termination of Road	Australia Canada
13		Railroad Crossing Ahead	Australia Canada Finland Israel Poland

14		Slippery Road	Australia Canada Finland Israel Poland
15		Congestion	Finland
16		Road Narrows	Australia Canada Finland Israel Poland
17		Pedestrian Crossing Ahead	Australia Canada Finland Israel Poland
18		Children Crossing Ahead	Australia Canada Finland Israel Poland
19		Steep Hill Ahead	Australia Canada Finland Israel Poland

20		Diagonal Railroad Crossing Ahead	Canada
21		Truck Entrance	Canada
22		End Speed Limit (for trucks 30 kph, for cars 50 kph)	Israel
23		End Built Up Area	Finland
24		Parking for Public Transport	Finland
25		No U Turn	Australia Canada Finland Israel Poland

26		End Priority Road	Finland Poland
27		No Left Turn	Australia Canada Finland Israel Poland
28		No Entry	Australia Canada Finland Israel Poland
29		No Entry for Pedestrians	Australia Canada Finland Israel Poland
30		No Parking	Australia Canada Finland Israel Poland
31		Pavement Ends	Canada

Procedure:

All participants first answered the few biographical questions and were then presented with the sign cards, one at a time. All participants were shown all 31 signs: both those in use in their country and those that are not in use in their country. Prior to each presentation the cards were shuffled, so each participant saw the signs in a different random order. The instructions pertaining to the sign comprehension were: "you are driving down a road when you see this sign ahead of you on the side of the highway. Tell me in as much detail as you can what you think is the meaning of this sign". The experimenter then wrote the participant's response verbatim. If the answer was incomplete, the participant was asked to elaborate if he/she can.

The participants' responses to each sign were coded into one of the following four categories:

- correct and complete (coded as +2),
- partially correct (e.g. no turn, instead of no left turn – coded as 1),
- incorrect (0),
- opposite of the true sign meaning (e.g. priority to traffic in my direction instead of priority to on-coming traffic – coded as -2).

In the rare cases where the appropriate code was not immediately obvious, the experimenters made a group decision, and that decision then served as a guideline for the coding in all other participating countries. In general the coding was quite straightforward.

ANALYSIS OF RESULTS

The first stage of analysis was conducted in order to identify the most significant variables that responsible for the proper comprehension of signs. Descriptive analysis and Analyses of Variance of all tested signs (without groups) were useful in classification of signs under their picture perceptual correctness. Based on this analysis all signs were grouped into five categories, namely: very good sign, good sign, satisfactory sign, poor sign and unsatisfactory sign, as shown in Table 2.

The second type of analyses sought to identify the level of comprehension and variations among drivers of different groups in the comprehension of the specific signs studied here.

From table 2 it is obvious that aside from the expected and large overall difference in performance on local vs. non-local signs, a simple pattern is not the rule. To understand these results, performance on the individual signs was assessed, and is discussed below.

Comprehension of "very good" signs

Seven signs (No. 9, 10, 14, 16, 19 and 28) has been recognised as very good and recognised by nearly all drivers. All those signs belong to the group of widely used standard signs at all five countries from four different continents. Six of them are warning signs and one is a prohibitions sign. An example of sign from this group, perceptually correct, is a warning sign (No. 9) "road works". Nearly all 250 subjects understand precisely the meaning of the sign, and none gave the opposite meaning, which is shown at histogram in fig. 1.

Comprehension of "good" signs

Eleven signs (No. 5, 7, 8, 11, 13, 18, 25, 26, 27, 29 and 30) got correct or partially correct assessments from at least 85% of all 250 subjects, and received none opposite ones. Eight of signs from this group belong to the standard signs used in all countries, one sign is used in three countries (Poland, Finland, Israel), one sign is used in two countries (Poland, Finland), and only one sign in this group is not used in Poland being unique to Israel. Signs recognised as "good" has graphical symbols with physical representation, and also conceptual compatibility with the message of the sign.

Table 1.

p.<0.05

<i>Sign No</i>	<i>Numerato r</i>	<i>Sum</i>	<i>Mean</i>	<i>Variance</i>	<i>Introductory classification</i>
Sign 1	250	273	1,092	0,421221	poor sign
Sign 2	250	134	0,536	0,868177	unsatisfactory sign
Sign 3	250	369	1,476	0,555647	satisfactory sign
Sign 4	250	262	1,048	1,073992	poor sign
Sign 5	250	415	1,66	0,924096	good sign
Sign 6	250	222	0,888	0,927165	unsatisfactory sign
Sign 7	250	392	1,568	0,672064	good sign
Sign 8	250	442	1,768	0,403791	good sign
Sign 9	250	488	1,952	0,078008	very good sign
Sign 10	250	478	1,912	0,136803	very good sign
Sign 11	250	446	1,784	0,234281	good sign
Sign 12	250	19	0,076	0,383759	unsatisfactory sign
Sign 13	250	396	1,584	0,348337	good sign
Sign 14	250	480	1,92	0,138153	very good sign
Sign 15	250	250	1	1,228916	poor sign
Sign 16	250	463	1,852	0,158731	very good sign
Sign 17	250	479	1,916	0,197735	very good sign
Sign 18	250	442	1,768	0,291341	good sign
Sign 19	250	480	1,92	0,114056	very good sign
Sign 20	250	214	0,856	0,69404	unsatisfactory sign
Sign 21	250	191	0,764	0,992273	unsatisfactory sign
Sign 22	250	292	1,168	1,401382	poor sign
Sign 23	250	357	1,428	1,097205	satisfactory sign
Sign 24	250	237	0,948	0,708129	poor sign
Sign 25	250	444	1,776	0,760867	good sign
Sign 26	250	436	1,744	0,504482	good sign
Sign 27	250	456	1,824	0,555245	good sign
Sign 28	250	489	1,956	0,066329	very good sign
Sign 29	250	420	1,68	0,901205	good sign
Sign 30	250	403	1,612	0,479373	good sign
Sign 31	250	268	1,072	0,814072	poor sign

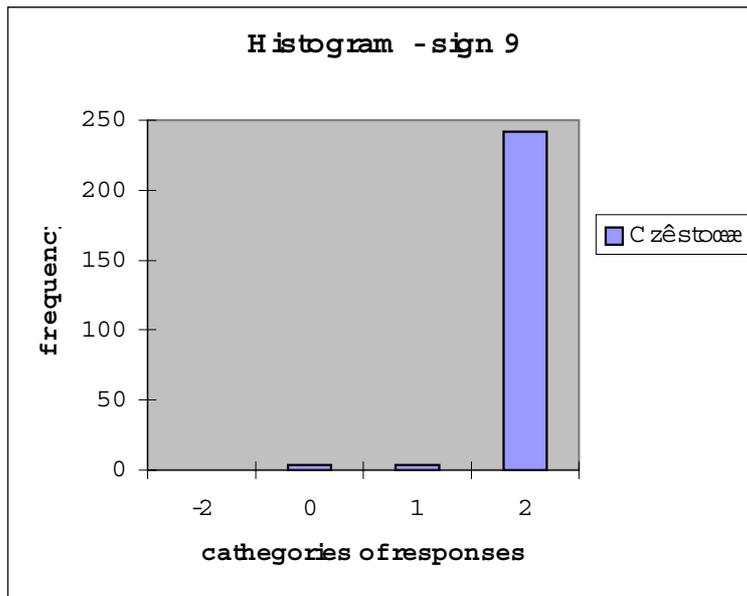


Fig.1. Histogram of evaluation of meaning of international (Canadian, Israeli, Polish, Finnish and Australian) sign No. 9 "road works" by Polish respondents.

Unsatisfactory signs

Five signs were not recognised by majority of 250 subjects, and also misunderstood by some of them. An example of such an unsatisfactory sign, which was not understood by most drivers is Australian and Canadian information sign (No.12). Only 6% of 250 drivers understood the meaning of this sign, while 89% of subjects answered "I do not know", or gave a wrong opposite meaning, which is shown in fig.2. There are no perceptual properties in design of this sign, neither uniformity and spatial compatibility, familiarity, or standardisation.

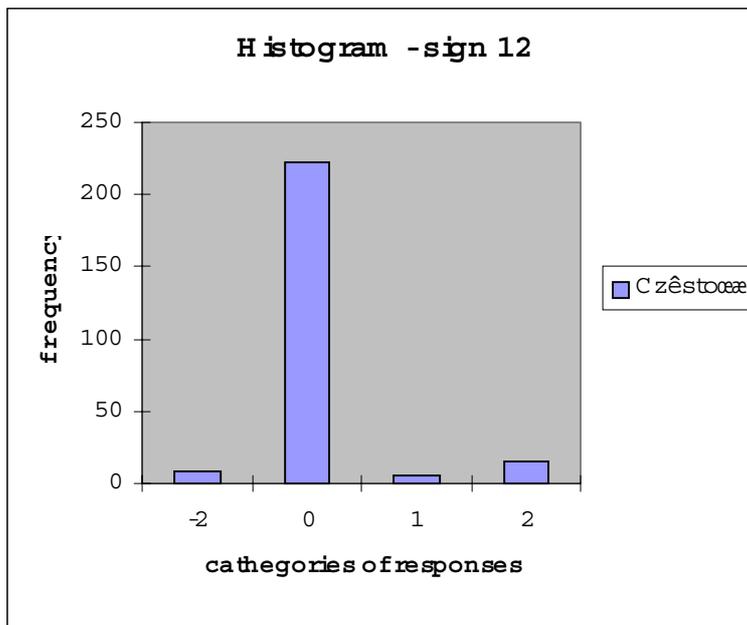


Fig. 2. Histogram of evaluation of meaning of Canadian and Australian sign No. 12 "termination of road" by Polish respondents.

CONCLUSIONS

The results of this study demonstrate the urgent need for greater uniformity in highway sign design among countries, and greater emphasis on ergonomic principles in the design of new signs and redesign of existing signs.

The results showed that signs with good spatial compatibility to the message they represent were all equally and well understood.

The results of this study demonstrate the effects of well understood – but often ignored – ergonomic principles of display design. To enhance comprehension displays should embody as many of the following criteria as possible: spatial compatibility, conceptual compatibility, physical representation, familiarity, and standardisation. One other factor that may account for some of the variation among the sign is relevancy. The desired recognition level should be high for highly relevant signs, and can be lower for less relevant signs. Sign 'registration' studies (e.g. Johansson and Rumar, 1996; Shinar and Drory, 1983) have demonstrated that drivers attend more to signs that are in some sense more relevant to their needs and goals, than to signs that are less relevant. In this study, sign No. 4 (No entry to trucks carrying explosives) is not relevant to drivers of passenger vehicles, and therefore its comprehension level need not be as high as that of signs that are.

Good sign design should incorporate population stereotypes, such as the use of the colour red to indicate danger (as in Stop signs); the use of different sign shapes to distinguish among prohibitive, warning, and guidance signs; and the use of a diagonal line to indicate prohibition of the crossed symbol (such as 'no smoking'). Stereotypes are cultural norms that derive from the ubiquitous use of some symbols, even in contexts other than highway signs and driving. For example, we often use diagonal line over a symbol to indicate prohibition. Consequently, prohibition without such a line can create confusion. An example is the attribution of the opposite meaning to the No Entry to Motorcycles/Mopeds sign (No.5), by a high percentage of the respondents (who believed that the sign indicates that motorcycle/moped entrance is allowed). This is despite the red border of the sign.

Signs with high comprehension values typically contain several of the above criteria. Standardisation alone, for example, is not sufficient unless it is also accompanied by either a good spatial or conceptual representation, or with proper education (as in driver education and driver testing) when the representation is arbitrary. When the sign design is completely arbitrary, then drivers, who have not been exposed to it as a part of their driver education, cannot be expected to comprehend it. This was shown to be the case in signs No.12 (Termination of Road)

Signs that conform to good ergonomic design principles – incorporating high levels of spatial compatibility, conceptual compatibility, physical representation, familiarity, and standardisation – are more likely to be fully comprehended than signs that violate these requirements.

The final conclusions:

1. Signage should be standardised across countries as much as possible
2. All signs should conform as much as possible to good ergonomic design principles that maximise spatial compatibility, conceptual compatibility, physical representation, familiarity.
3. An international committee should be re-established to evaluate current signage in different countries and proposals for new signs, so that as new signs become needed different and potentially incomprehensible versions will not be developed in different countries in parallel.

ACKNOWLEDGEMENT

This report presents results of a study conducted in Poland, which is a part of inter-continental research project of perception and recognition of traffic signs. The whole project covers representation of four continents, namely Asia: Israel (David Shinar, project co-ordinator), North America: Canada (Bob Dewar), Europe: Finland (Heikki Summala) and Poland (Lidia Zakowska) and Australia.

The intercontinental project results will be published soon, showing the inter-cultural comparisons of traffic signs perception. The Polish Committee for Scientific Research, KBN and MOS in Israel supported part of this research. Many thanks to all the people who assisted in the data collection in Poland.

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