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TECHNICAL NOTE

Study of Road Signs in Saudi Arabia

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Abstract. This paper presents the results of a study to evaluate 15 of the most common traffic signs used in Saudi Arabia. These signs are mostly adopted from the North American standards and may or may not be appropriate for this country due to population stereotype effects. This was tested by presenting five selected signs from each of regulatory, warning and guidance categories. These signs were presented through a tachistoscope to a controlled group of 19 King Saud University students with average age of 22 years and average driving experience of 5.68 years. Number of errors and reaction time were recorded for each sign and subject. Based on the results, the signs were analyzed for their communication ability. It was found that the symbolic signs e.g., 'Priority over on-coming traffic' and 'Prohibition of stopping', produced statistically significant errors in detection, whereas, the letter/numeric signs e.g., Parking, Speed Limit and Hospital produced least errors with minimum reaction time. Modifications to certain signs is recommended to incorporate population stereotype effect.

Introduction

Driver behavior can be affected by the roadway conditions and surroundings, specially the traffic signs. If the traffic signs are improved, the accidents can be reduced, the traffic flow can be streamlined and the existing roadway facilities could be effectively used.

Extensive research has been directed toward improving the effectiveness of road signs. The relevant research is described as follows:

Shinar and Drory [1] studied the drivers for recall and recognition of the sign during day and nighttime driving. They stopped drivers at 200 meters after they pass

a warning sign. The results proved the hypothesis that recall was lower in daytime than at nighttime because the roads were clearer during the day and the driver concentrated less on the sign. They also concluded that sign content, roadway environment and subjective levels of fatigue and boredom had no significant effect on sign registration.

Hofstetter [2] reported on the computed distances of legibility of standard traffic control signs. The results showed that, in general the regulatory signs have the shortest distances and shortest duration of legibility and the warning signs the longest.

Johanson and Rumar [3] demonstrated that the road sign system does not function in its intended way and that the drivers are sometimes blamed unnecessarily. Also the signs are generally incompatible with the human input system. Their conclusions were based on a 1000 drivers study indicating that on the average 47% of the drivers recorded a road sign.

Johanson and Backlund [4] completed a study on 5000 Swedish drivers. They reported that the overall probability of a road sign being noticed is under 50%. The major conclusion was that the road sign system does not achieve its intended purpose.

A study by Summala and Hietamaki [5] supports the explanation that the problems of the traffic sign system are mainly due to motivational factors i.e., the more significant the sign the greater the drivers immediate response to it.

Dewar [6] emphasizes that the same information should be received in more than one way by the driver to help process the information more effectively. He also concluded that on prohibitive turn control signs e.g., 'no U-turn', the red slash should not be used, as it tends to obscure the legibility of the symbol. It was concluded to use a partial slash.

Morris *et al.* [7] studied the visual performance of drivers during rainfall and concluded that the film of water on the windshield itself was the primary factor in reduced visual acuity.

Dewar *et al.* [8] compared original signs and their modifications in terms of percentage correct and in terms of reaction time in milliseconds. They found correlations between 0.55 and 0.69 between reaction time and glance legibility, which is associated with the correct interpretation at a brief exposure time.

Roberts *et al.* [9] studied the freeway diagrammatic signs in the state of New Jersey, U.S.A. They concluded that more consistent driver behavior and fewer accidents were reported when diagrammatic signs on a beltway exit were used. The main reason for that was decreased driver interpretation or decreased reaction time.

Whitaker and Sommer [10] studied the perception of traffic guidance signs containing conflicting symbols and direction information. They concluded that agreement between symbol and arrow direction is an important element in decreasing perceptual conflict within a sign.

In light of the above studies, an experiment was designed and conducted at King Saud University in 1992. It is described as follows:

Methods and Procedure

A controlled group of 19 King Saud University students in their early twenties (avg. age 22 years), average driving experience of 5.68 years and average 6.74 hrs of driving per week participated in the study.

A tachistoscope is a device used to present a stimulus, which in this case was a traffic sign, to an individual or a group at varying exposure and shutter speeds. This device was used to present 15 different road signs used in the Kingdom's traffic system to each subject. The signs are placed in Fig. 1, five signs were selected from each of the 3 categories, namely regulatory, warning and guidance. Reaction time and the number of errors for each sign were recorded. The reaction time is basically the time it takes a person to perceive, decide and conclude or move to a certain stimulus, which in this case was a sign. On the other hand, an error is the mistake committed in interpreting the sign. The reaction time can be measured through a reaction timer or a stop watch and error can be recorded by comparing the subjects response with the correct response. The signs were presented in a random order. Subjects were asked to press a button as soon as they recognize the sign, the viewing distance and exposure time was kept constant for all signs in order to obtain the ranking of the signs with respect to their communicativeness. One way ANOVA was used to test the hypothesis for equality of means, two models were analyzed (one each for reaction time and number of errors). Duncan's multiple range test was used to find the significant differences and to obtain the ranking for both number of error model and reaction time model. The results are presented in Tables 1 and 2.

Conclusions and Discussion

Due to the fact that the traffic sign system was developed mainly on North American standards and is being used in a middle eastern country like Saudi Arabia, it was expected that the communicativeness of the signs would be different, where, some signs would be more comprehensible than others.

The collected data on 19 subjects was analyzed separately for reaction time and number of errors using analysis of variance. It was found the means of both reaction time and error were significantly different at .01 and .05 levels, resulting in the rejec-

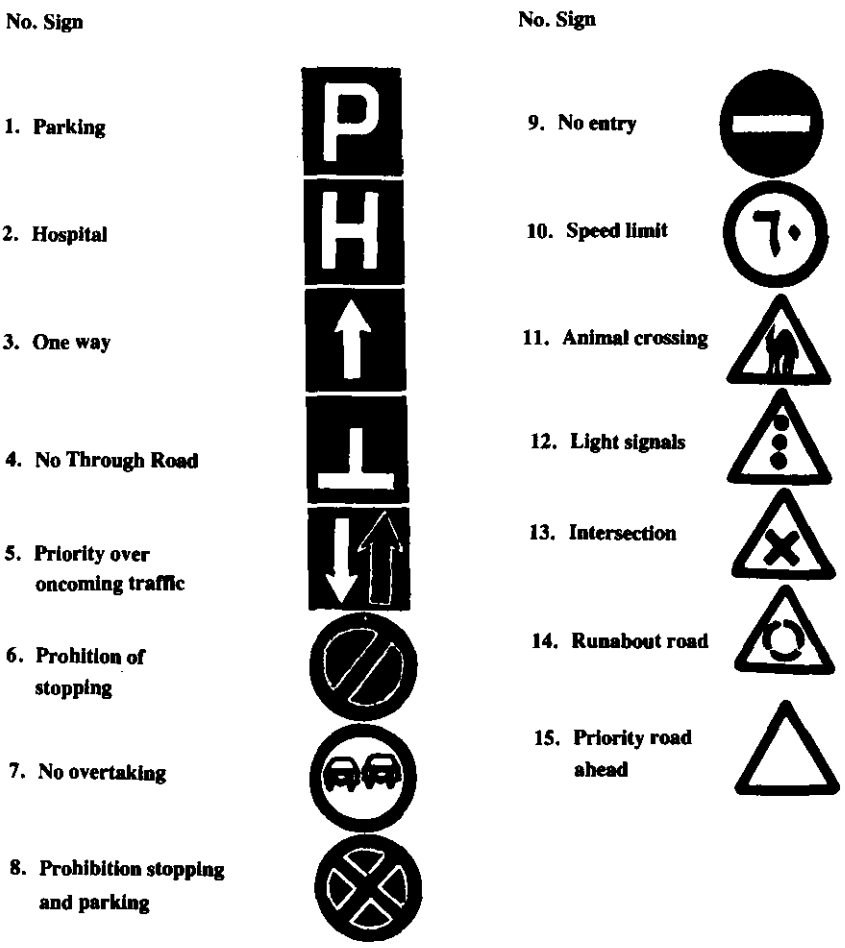

Fig. 1. Traffic signs used in the study

tion of the null hypothesis (see Tables 3 and 4). Therefore, for further analysis, the Duncan multiple range test was used to find the statistically significant differences and also to get the ranking of different sign types with respect to the lowest reaction time and least errors.

The correlation analysis between reaction time and number of errors indicated a negative correlation of – 0.365 showing that the increase in reaction time resulted in decrease in number of errors and vice-versa. It also shows that the drivers should

Table 1. Number of errors

Sub #	Age yrs.	Drvg. exp. yrs.	Drvg per week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	19	2	7	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
2	22	6	7	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1
3	22	4	7	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
4	22	5	7	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0
5	22	5	7	0	0	0	0	1	1	1	0	0	0	0	0	0	0	1
6	20	3	5	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0
7	23	7	7	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0
8	24	7	7	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1
9	24	7	7	0	0	1	0	1	1	0	0	0	0	0	0	0	0	1
10	21	6	7	0	1	0	0	1	1	1	0	1	0	0	0	1	0	1
11	21	7	7	0	0	1	0	1	1	0	0	0	0	0	0	0	0	1
12	21	6	7	0	0	1	0	1	1	1	0	0	0	0	0	1	0	0
13	24	8	6	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0
14	22	4	5	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
15	25	8	7	0	0	1	0	1	1	0	0	1	0	0	0	1	1	1
16	22	4	7	0	0	1	0	1	0	0	0	1	0	0	0	1	1	0
17	22	5	7	0	0	1	0	1	1	1	0	1	0	0	0	0	0	0
18	21	7	7	0	0	1	0	1	0	0	0	0	0	0	0	1	0	0
19	23	7	7	0	0	1	0	1	0	0	1	0	0	0	0	1	0	1
Total				0	1	9	0	19	12	5	2	4	0	0	0	9	2	8
Avg.	22.11	5.68	6.74	0.00	0.05	0.47	0.00	1.00	0.63	0.26	0.11	0.21	0.00	0.00	0.00	0.47	0.11	0.42
Std. Dev.	1.45	1.66	0.64	0.00	0.22	0.50	0.00	0.00	0.48	0.44	0.31	0.41	0.00	0.00	0.00	0.50	0.31	0.49

Table 2. Reaction time table

Sub #	Age yrs.	Drvg. exp. yrs.	Drvg per week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	19	2	7	2.59	2.07	2.69	3.11	2.95	3.03	2.9	1.8	4.12	2.01	2.69	1.92	2.6	2.11	3.27
2	22	6	7	1.45	1.53	2.74	2.29	1.88	2.95	2.85	2.49	2.04	1.59	1.89	2.04	5.32	2.05	6.88
3	22	4	7	1.5	1.71	1.86	2.4	3.15	2.02	2.07	1.63	2.69	2.15	2.08	2.04	2.08	1.79	2.62
4	22	5	7	2.31	1.58	2.09	1.86	2.7	2.34	2.25	1.55	2.22	1.66	2.15	2.71	4.7	1.94	5.79
5	22	5	7	1.97	1.66	2.01	2.27	2.19	1.6	3.48	2.95	2.33	1.99	2.28	1.84	3.98	1.85	5.59
6	20	3	5	1.91	1.88	2.19	1.97	2.69	2.14	4.59	2.24	2.32	1.56	2.21	2.16	3.98	2.06	3.92
7	23	7	7	2.69	2.12	2.32	2.01	2.91	2.25	3.95	3.04	2.48	2.12	3.16	2.21	5.05	2.49	4.13
8	24	7	7	1.92	2.14	1.95	2.45	6.53	2.18	3.07	2.26	1.84	2.23	1.81	2.45	2.51	1.83	5.06
9	24	7	7	2.01	1.89	2.44	2.68	2.81	4.65	4.64	2.21	2.29	2.08	2.06	4.21	2.28	3.45	2.18
10	21	6	7	1.32	5.04	1.78	3.83	1.75	3.02	5.01	6.92	9.01	2.08	2.27	2.31	2.39	3.81	14.01
11	21	7	7	1.84	1.23	2.19	2.45	3.21	2.69	3.11	1.83	2.14	2.09	1.89	1.94	2.15	1.79	6.12
12	21	6	7	2.21	1.35	1.31	3.25	4.17	4.29	4.85	3.41	3.26	2.11	2.95	2.46	4.37	3.81	3.66
13	24	8	6	3.12	2.52	5.09	3.16	3.24	2.26	2.39	2.31	2.11	2.48	2.31	2.61	7.89	4.17	15.16
14	22	4	5	1.36	3.19	3.61	4.32	4.44	3.18	2.06	3.21	2.17	3.62	3.88	4.14	3.66	3.92	2.85
15	25	8	7	1.19	4.21	5.04	4.48	5.91	3.41	2.17	2.34	8.15	2.22	2.69	3.15	7.61	2.18	6.45
16	22	4	7	2.31	2.29	3.15	2.26	5.11	3.56	3.12	3.45	2.11	2.18	3.77	2.42	5.36	1.41	5.19
17	22	5	7	1.64	1.36	1.43	2.18	1.44	2.15	2.1	1.62	2.87	1.69	1.38	1.7	2.72	1.4	2.05
18	21	7	7	1.79	2.07	4.37	2.76	3.24	3.31	4.21	2.45	2.19	2.45	2.7	2.04	5.98	2.19	3.6
19	23	7	7	1.46	1.96	6	1.88	3.67	2.02	2.16	2.72	2.17	1.94	2.87	2.84	3.9	2.46	3.57
Total				36.59	41.8	54.26	51.61	63.99	53.05	60.98	50.43	58.5	40.25	47.04	47.19	77.93	46.71	102.1
Avg.	20.00	5.14	6.10	1.83	2.09	2.71	2.58	3.20	2.65	3.05	2.52	2.93	2.01	2.35	2.36	3.90	2.34	5.11
Std. Dev.	6.63	2.29	2.07	0.64	1.04	1.42	0.95	1.48	0.98	1.21	1.27	2.02	0.63	0.82	0.86	1.84	1.00	3.57

Table 3. Errors Analysis

Analysis of variance for ERROR				
Source of variation	**Sum of squares**	**d.f.**	**Mean square**	**F-ratio**
Between groups	23.42	14	1.67	15.11*
Within groups	29.89	270	.11	
Total (corrected)	53.31	284		

* Significant at ° = 0.01, 0.05

Multiple range analysis for ERROR by SIGN

Method: Sign No.	95 percent Count	Duncan average	Homogeneous groups
1	19	.0000000	*
4	19	.0000000	*
10	19	.0000000	*
11	19	.0000000	*
12	19	.0000000	*
2	19	.0526316	**
8	19	.1052632	**
14	19	.1052632	**
9	19	.2105263	***
7	19	.2631579	***
15	19	.4210526	***
3	19	.4736842	**
13	19	.4736842	**
6	19	.6315789	*
5	19	1.0000000	*

* denotes a statistically significant difference.

get more time to view a particular sign to make better decisions about the sign. It was evident that the subjects responded quickest to the Parking sign (# 1), Speed limit (# 10), Hospital (# 2). The average error was either zero or negligible for these signs (Table 3). It is interesting to note that none of these three signs had symbols but were either alphabets or numbers whereas the two signs namely Priority Over Oncoming traffic (# 5) and Prohibition of Stopping (# 6) produced serious errors with none correct responses for the former indicating the lack of communicativeness of those signs. Some of the signs may have been mistaken for others like the One Way Sign (# 3). This sign was ranked third on average errors because it might have been mistaken for direction. The parking sign (# 1) which had the quickest reaction time also had the least error with every subject giving the correct response. Other signs with no error recorded were, No Through Road a (# 4), Speed Limit (# 10), Animal Crossing (# 11) and Light Signals (# 12).

Table 4. Reaction time analysis

Analysis of variance for REACTION TIME				
Source of variation	**Sum of Squares**	**d.f.**	**Mean square**	**F-ratio**
Between groups	201.57	14	14.39	7.18*
Within groups	541.76	270	2.11	
Total (corrected)	743.33	284		

* Significant at ° = 0.01, 0.05

Multiple range analysis for reaction time by SIGN			
Method sign No.	**95 percent count**	**Duncan average**	**Homogeneous groups**
1	19	1.926	*
10	19	2.118	**
2	19	2.200	***
14	19	2.458	****
11	19	2.476	****
12	19	2.483	****
8	19	2.654	****
4	19	2.716	****
6	19	2.792	****
3	19	2.856	****
9	19	3.079	****
7	19	3.209	***
5	19	3.368	**
13	19	4.102	*
15	19	5.374	*

* denotes a statistically significant difference.

The bar graph shown in Fig. 2 shows the average number of error and average reaction time for the 15 signs. However, it could be concluded here that on a highway the reaction time may be the most relevant variable since it is directly related to the communicative ability of a sign. Based upon the findings of this experiment it is concluded that particular signs, for example number 5, 6, 15 should be modified and redesigned to improve the recognition and comprehension and tested further on a comparative basis with the original signs using different groups of subjects if possible. It was expected that a diversified sample including different nationalities, age groups etc. would result in large between subject variability affecting the relative comparison of signs. Even though there are ways of handling those issues statistically, such a problem can be handled in future research on the subject.

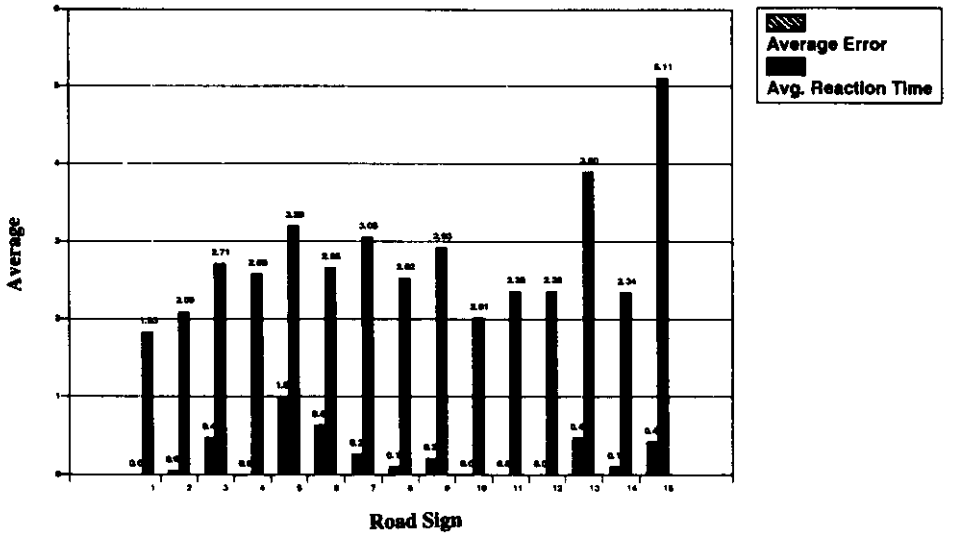

Fig. 2. Average error and reaction time for 15 road signs

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دراسة علامات الطريق في المملكة العربية السعودية

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(استُلم في ١٤/١/١٩٩٢م؛ قُبل للنشر في ٩/٥/١٩٩٢م)

ملخص البحث. تقدم هذه المقالة نتائج الدراسة التحليلية لخمس عشرة لوحة مرورية من أكثر اللوحات استخدامًا في المملكة العربية السعودية. هذه اللوحات مأخوذة عن النموذج الأمريكي الشمالي لعلامات الطرق. ومن الممكن أن تكون مناسبة أو غير مناسبة للمملكة العربية السعودية تبعًا لتأثير السلوك النمطي السائد بين أفراد المجتمع. ولقد تم اختيار ذلك بتقديم خمس لوحات مرورية من التصنيفات الثلاثة التالية: التنظيمية، التحذيرية والإرشادية. وتم عرض هذه اللوحات باستخدام جهاز التأخير المرئي (tachistoscope) على مجموعة ضابطة مكونة من ١٩ طالبًا من جامعة الملك سعود بمتوسط عمر ٢٢ عامًا ومتوسط خبرتهم في قيادة السيارات ٥,٦٨ أعوام.

تم تسجيل الأخطاء وزمن الرجع لكل لوحة من اللوحات ولكل فرد من أفراد العينّة. واستنادا إلى النتائج التي تم الحصول عليها تم تحليل مدى قدرة اللوحات المرورية في توصيل المعلومات المطلوبة وتبين أن اللوحات الرمزية (مثال أفضلية المرور للقادم، وممنوع الوقوف قطعيًا) قد أظهرت أخطاء ذات دلالة إحصائية في التعرف عليها، بينما أظهرت اللوحات المرورية التي تستخدم الأرقام والحروف (مثال موقف (P)، السرعة القصوى (60)، مستشفى (H))، أقل الأخطاء مع انخفاض دالٍ في زمن الرجع، وقد أوصت الدراسة بتعديل اللوحات المرورية بما يتناسب مع السلوك النمطي لأفراد المجتمع.