LETTER HEIGHT FOR STREET NAME SIGNS: AN ON-ROAD STUDY

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Abstract
Required letter height for street name signs was investigated in downtown Toronto. A set of 16 subjects, aged 50 or older, drove along a specific route making turns, as directed by an accompanying experimenter. The study was carried out during non-rush hour periods in the daytime and after dark. New street name signs with 10, 15 and 20 cm (4, 6, and 8-inch) letter heights, using upper and lower case Clearview font, were tested at signalized intersections. Signs were located on the traffic signal arm. Performance of signs was assessed in relation to driver detection, recognition distance, speeds, and subject ratings. Based on the results, 20 cm letter height signs were recommended. Reflective material provided equal legibility at night as during the day in well-lit areas downtown. Placement of signs was found to be critical. A sign placed on the left signal arm, due to implementation problems, was missed more frequently than signs with the same letter height placed nearer where drivers were looking, at the right side signal light.
Keywords : Signs, Driver Behaviour

HAUTEUR DES LETTRES POUR LES PANNEAUX DE NOM DE RUE : UNE ÉTUDE SUR ROUTE

Résumé
La hauteur de lettre requise pour les panneaux de nom de rue a fait l'objet d'une enquête dans le centre-ville de Toronto. Un groupe de 16 personnes, de 50 ans ou plus, a conduit sur un parcours spécifique, en effectuant série des virages, selon les instructions d'un expérimentateur qui les accompagnait. L'étude a été réalisée en dehors des heures de pointe de jour et de nuit. De nouveaux panneaux de nom de rue avec des hauteurs de lettre de 10, 15 et 20 cm (4, 6 et 8 pouces), utilisant une police de majuscules et de minuscules Clearview^{MC}, ont été testés aux intersections où se trouvait cette signalisation. Les panneaux étaient situés sur le bras des feux de circulation.
L'efficacité des panneaux a été évaluée en fonction de la détection par le conducteur, de la distance à laquelle ils sont identifiés, de la vitesse de conduite et des cotes attribuées par les personnes passant le test. En se basant sur les résultats, les panneaux avec une hauteur de lettre de 20 cm ont été recommandés. Les matériaux réfléchissants offrent une lisibilité identique de nuit et de jour dans les zones bien éclairées du centre-ville. Il a été déterminé que l'emplacement des panneaux est crucial. Un panneau placé sur le bras du feu de circulation gauche en raison de difficultés de mise en place, a été raté plus souvent que les panneaux avec les mêmes hauteurs de lettre placés plus près du champ de vision des conducteurs, sur le feu de circulation du côté droit de la chaussée.
Mots clés : Panneaux, Comportement des conducteurs

INTRODUCTION

The goal of this study was to investigate the required letter height for street name signs in downtown Toronto. To be effective, a street name sign must meet two important driver needs. First, it must be conspicuous, and therefore easily detected, especially in visually cluttered urban backgrounds. Second, it must have sufficient letter height to allow drivers the time and distance needed to read the sign, make a lane change and reduce speed prior to making turns. Current standards determine letter height based on the importance of the road within the road hierarchy rather than on an explicit consideration of driver needs. This report describes an on-road study of driver needs.

EXPERIMENTAL DESIGN

Three letter heights were tested: 10, 15 and 20 cm (4, 6 and 8 inches) on new signs, fabricated for the study. These had white letters on a blue background and used the Clearview font, which has been specifically developed for improved traffic sign legibility *(1)*. The signs were reflectorized, using diamond grade sheeting to improve visibility at night.

The road from which drivers made their turns was a busy, one-way, 3 lane, downtown arterial with frequent intersections, posted at 50 km/h. Streetlighting was present on both sides of the street. Four test signs of each letter height were erected along the test route. Subjects were given the names of streets at which they were to turn one at a time. Turns were only requested when the traffic signal was green and drivers would not be slowing as they approached the target sign. Measures were based on an average of 40 approaches for each sign size. We also took the opportunity to measure responses to an old blue and white 10 cm sign which was in place prior to the study, based on a total of 16 approaches.

SUBJECTS

In order to ensure that the majority of drivers would be accommodated by the letter heights recommended we recruited 16 drivers, half male and half female, aged 50 or above. The average age of the subjects recruited was 61.8 years (range 51 to 78 years). Subjects were recruited through newspaper and community centre advertising and were screened beforehand to ensure they were unfamiliar with the test area, and so would be relying on the street signs. Subjects performed the experiment in their own vehicles.

PROCEDURE

A research assistant accompanied the drivers in their vehicles and directed them along the selected corridor giving instructions about where to turn, one at a time. Subjects were instructed to drive in the lane adjacent to the lane from which they were required to make the turn, and to activate their turn signal as soon as they could read the sign for their turn. The drivers then made the appropriate lane change and completed the requested turn. The research assistant recorded distance from turn signal activation to reaching the stop bar as well as speed on the approach and at the stop bar. After each turn subjects were asked if the average driver would have (a) lots of time, (b) enough time, or (c) not enough time to make a comfortable turn. One practice turn was made before data collection started. The study was carried out during non-rush hour periods in free-flowing traffic.

ANALYSIS

Recognition distance refers to the distance from the stop bar at which the driver activated his or her turn signal. Results are presented based on this distance because this is the distance that is important to the driver. Turns are made from the stop bar and not from the actual sign location. Sign legibility distance refers to the distance from the sign at which the driver activated the turn signal. To obtain this distance, the width of the intersection needs to be added to the recognition distance.

Recognition distance was determined from the number of lane marks counted by the research assistant from the time the subject made a turn indication to the time they reached the stop bar. A lane mark (stripe and gap) averaged 8.5 m. Depending on the placement of the stop bar, the final lane mark could be very short. Therefore the last two lane marks were measured at each turn point and this specific value was used for the measure of the last 2 lane marks for each intersection. Given the measuring scale, the error in the distance measurement would be one-half a lane mark length or within 4.25 m.

Approximate measurements were made for speed by means of observations of the speedometer, accurate within approximately 5 km/h. T-tests were used to determine whether differences in recognition distance between signs were statistically significant at a 0.05 level.

RESULTS

Recognition and Sign Legibility Distances

A t-test showed no statistically significant difference (considered as $p < 0.05$) in recognition distance between the old and new 10 cm sign. As would be expected, recognition distances from the stop bar for the 15 and 20 cm signs were significantly longer than for either the old or new 10 cm signs ($p < 0.01$). (See figure 1)

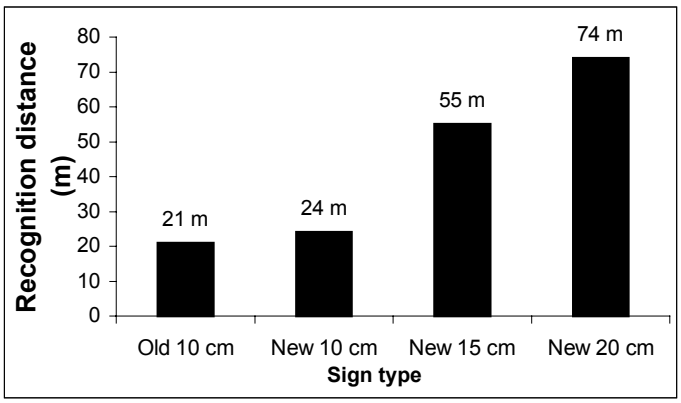

Figure 1: Recognition-to-stop bar distance for downtown location

When intersection width was added to recognition distance, the resulting sign legibility distance showed that the impact of increasing the letter height is approximately linear, ranging from 45 m. to 76 m. to 95 m., for 10, 15 and 20 cm signs, averaging 4.7 m/cm. There was no significant difference in legibility between these signs.

Misses
Misses were recorded when subjects did not see the street name sign at all or in time to make a safe turn. The number of signs missed area was as follows: 44% for the old 10 cm sign, 22% for the new 10 cm signs, 7% for the new 15 cm signs, and 0% for the new 20 cm signs. The new 20 cm sign was found to have significantly fewer misses than the new and old 10 cm signs ($p < 0.01$). There was also a trend towards fewer misses than for the new 15 cm sign ($p < 0.1$). The poor performance of the old signs is likely associated with their poor conspicuity. They are not consistently located on any one corner, and the driver must search for them. In contrast, the new signs, which were only at selected intersections along the test route, were all located on the traffic signal arms. Misses for the new 15 cm sign occurred at only one of the four 15 cm sign locations. In this location, because of hydro wires, it had not been possible to mount the sign on the right traffic signal arm, and so it was mounted on the left one. This unexpected placement seemed sufficient to produce misses, even though the sign recognition distance was the same as at other 15 cm sign locations where no misses occurred.

Speeds
Approach speed refers to the subject's speed on approach to the intersection at which the turn was made, before the sign could be read. The faster the approach speed, the less time a driver has to read a sign with a given letter height, and the less time to carry out a lane change manoeuvre. The speed limit was 50 km/h. The average approach speed for all signs was 38 km/h and the average speed at the stop bar was 22 km/h.

The approach speed data were combined with the recognition distance data to give a measure of the time available to the subjects, if they continued at the approach speed, before reaching the stop bar. Drivers who did turn, decelerated, and thus the actual time was longer. At the average approach speed of 38 km/h, the 10 cm signs allowed only 2 seconds, the 15 cm signs, 5 seconds, and the 20 cm signs, 7 seconds. A lane change had to be made once the driver signaled. The less time available, the more abrupt the lane change and the more abrupt the deceleration prior to turning. Surprisingly, drivers turning at the 20 cm signs had not slowed any more by the time they reached the stop bar than drivers turning at the 10 cm signs ($p < 0.01$). However, since drivers had less time available, the deceleration rate for the 10 cm signs was double that for the 15 and 20 cm signs (1.1 m/s^2 compared to 0.56 and 0.51 m/s^2).

Subject Ratings
After each turn at which measurements were taken, the subject was asked: "Do you feel the average driver would have lots of time, enough time or not enough time to make a safe and comfortable turn". Almost all subjects found that they did not have enough time to make a safe turn at intersections with new or old 10 cm signs. For intersections with 15 cm signs, subjects felt they had enough time 56% of the time, and not enough time 19% of the time. For intersections with 20 cm signs, subjects said they had lots of time or enough time 97% of the time. T-tests showed that all of these values were significantly different except between the old and new 10 cm signs ($p < 0.01$).

DISCUSSION

The measures of recognition distance and speed used in this study were approximate measures, which could be easily and cost-effectively obtained. Nonetheless the results provide considerable insight into the very fundamental driving task of sign reading in unfamiliar areas. The inadequacy of the current 10 cm letter height on downtown Toronto

signs is made obvious by subjects consistently rating them as providing insufficient time for the average driver. The impact of such signs on safety is suggested by the fact that deceleration rates for subjects approaching turning points with 10 and 15 cm signs were double those in the case of 20 cm signs.

Although one might conclude that it is best to locate signs on the near side of a signalized intersection, for the sake of legibility, it is unlikely that drivers are looking there as they approach. Given the importance of the traffic signal colour, drivers are much more likely to be looking at the signal. A sign placed close to that signal will be more easily detected than one placed in another location, which the driver has to search for, given the lack of standardization of street name sign location in Toronto (and many other cities).

Support for this supposition comes from the results concerning one of the signs with a letter height of 15 cm. There were 4 locations with such signs: 3 of these signs were placed on the right signal arm. Due to implementation problems, the fourth one was placed on the left signal arm. This latter one was the only sign with that letter height where subjects missed the turn. This finding provides even more support for right signal arm placement when one considers that in order to make all the required turns along the test route, the subjects had to locate signs placed at every corner of the intersections they crossed. Therefore, they would not have been expecting to see signs next to the right signal arm at each intersection. However, they easily detected them when they were so placed.

The legibility distances determined from the distance from the sign at which the subject signaled the turn were consistent from sign to sign. The legibility distance was consistent across letter height, equivalent to 4.7 m/cm.

The 10 cm signs were too small given the speeds involved. The old style 10 cm sign was also poorly located and had a higher miss rate (44%) than the new test 10 cm sign located on the traffic signal arm (22%).

RECOMMENDATIONS

Based on the results, recommendations were made with respect to letter height, reflectorization, placement and use of advance signs.

Letter Height

Based on high driver ratings and no misses, letter heights of 20 cm were recommended. At 38 km/h these signs provide the equivalent of 7 seconds at the approach speed for drivers to change lanes. While 15 cm signs were rated "enough time" there are faster approach speeds on some downtown arterials than in the test area.

Reflectorization

Reflectorized signs were recommended. The diamond grade reflective material worked very well given that there were no significant differences between legibility distances during the day as compared to at night.

Placement

Consistent placement of signs was recommended. All 3 misses for the 15 cm sign occurred at only one of the 15 cm sign locations where, due to hydro wires in the way of the right traffic arm, the sign was placed on the left traffic arm. The unpredictable placement for the old 10

cm sign contributed to it being missed 44% of the time. If signs are placed where drivers do not expect to see them, they are far more likely to miss seeing them.

It was recommended that street signs be placed on the right signal arm, or if this arm is not visible on the approach, on the left signal arm. The sign is placed where drivers expect to see signs – on the right of their path. It is also placed near the traffic signal, at which drivers will be looking, making it easier for drivers to detect.

REFERENCES

(1) Garvey, P.M., Pietrucha, M.T. and Meeker, D.T. (1996). *Development and testing of a new guide sign alphabet*. Pennsylvania Transportation Institute Final Report No. PTI-9627. The Pennsylvania State University, University Park, PA.