ELSEVIER

Accident Analysis and Prevention 39 (2007) 427–432

ACCIDENT ANALYSIS & PREVENTION

www.elsevier.com/locate/aap

Short communication

A strategy to reduce older driver injuries at intersections using more accommodating roundabout design practices

Dominique Lord [a,c,*], Ida van Schalkwyk [b,1], Susan Chrysler [c,2], Loren Staplin [d,3]

[a] *Zachry Department of Civil Engineering, Texas A&M University, TAMU 3136 College Station, TX 77843-3136, United States*
[b] *Department of Civil & Environmental Engineering, Arizona State University, P.O. Box 875306, Tempe, AZ 85287-5306, United States*
[c] *Center for Transportation Safety, Texas Transportation Institute, The Texas A&M University System, 3135 TAMU College Station, TX 77843-3135, United States*
[d] *TransAnalytics, LLC 1722 Sumneytown Pike, Box 328, Kulpsville, PA 19443, United States*

Received 21 March 2006; received in revised form 16 May 2006; accepted 21 September 2006

Abstract

This paper briefly summarizes a laboratory study investigating strategies designed to improve the ability of our most vulnerable drivers, the elderly, to safely negotiate the most dangerous and demanding of all traffic situations – intersections – through increased use of modern roundabouts. Compared to conventional intersections, roundabouts have demonstrated the potential to significantly reduce the most injurious (angle) type of crashes and slow the operating speed of all vehicles, while maintaining a high capacity for moving traffic through an intersection. This research sought to develop and evaluate countermeasures with the potential to improve the perceived comfort, confidence, and/or safety of seniors in using roundabouts. Research methods included focus groups and structured interviews utilizing photographs, which had been edited to include novel traffic control devices. The results suggest that design elements that improve the path guidance for older drivers are necessary to encourage roundabout use by this group. Recommendations for improved practice related to advance warning signs, guide signs, yield treatments, directional signs, and exit treatments are presented.

Keywords: Older driver; Intersection; Roundabout; Safety; Engineering countermeasure

1. Introduction

More crashes occur at intersections, resulting in more injuries and fatalities, than most other driving situations; and this risk is exacerbated for older persons who, with their declining functional abilities but increasing frailty, represent the fastest growing segment of the driving public. It is anticipated that the population of older drivers will increase from 33.5 million in 1995 to more than 50 million in 2020, which will account for about one-fifth of the driving population in the United States (Staplin et al., 2001). Coupled with an overwhelming reliance by seniors on private vehicle travel to meet their personal mobility needs, these trends make it imperative to somehow lessen the risk of older drivers at intersections.

Over recent years, there has been an extensive effort to improve the designs of signalized and unsignalized intersections. An innovative design element that has shown to significantly improve intersection safety is the use of modern roundabouts (Elvik, 1993; Flannery, 2001; Persaud et al., 2001). In many countries, a substantial number of conventional intersections have been replaced with roundabouts in order to provide a safer environment for drivers. In the United States, modern roundabouts are still rarely used but have been implemented steadily over the last few years and are expected to become increasingly popular alternatives for context-sensitive design and/or traffic calming applications within the next few decades.

Older drivers are significantly over-represented in intersection-related crashes. Staplin et al. (2001) reported that between 48% and 55% of all fatal crashes involving a driver 80 years old or older occur at intersections, more than twice the rate for drivers age 50 or less (23%). Frailty is also an important con-

* Corresponding author. Tel.: +1 979 458 3949; fax: +1 979 845 6481.
E-mail addresses: d-lord@tamu.edu (D. Lord), idavan@asu.edu (I. van Schalkwyk), s-chrysler@tamu.edu (S. Chrysler), lstaplin@transanalytics.com (L. Staplin).
[1] Tel.: +1 480 965 3001; fax: +1 480 965 0557.
[2] Tel.: +1 979 862 3928; fax: +1 979 845 4872.
[3] Tel.: +1 215 855 5380; fax: +1 215 855 5381.

0001-4575/$ – see front matter © 2006 Elsevier Ltd. All rights reserved.
doi:10.1016/j.aap.2006.09.011

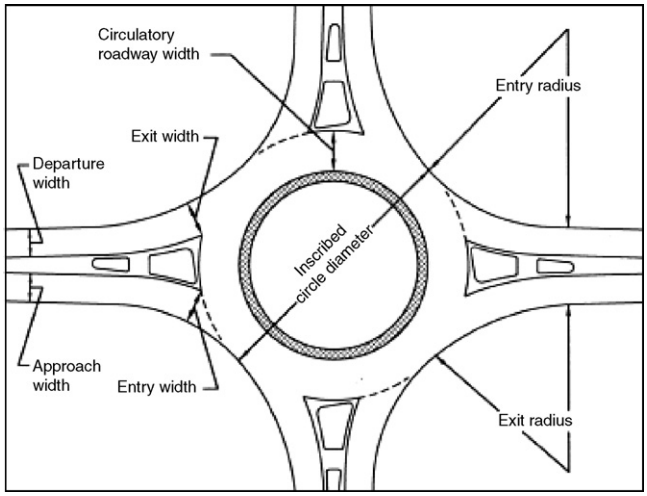

Fig. 1. Basic roundabout geometric design elements (Robinson et al., 2000).

tributing factor; an individual's physical tolerance to the impact forces caused by a crash is significantly reduced from age 40 on (Viano et al., 1990). Because the number of conflict points within a modern roundabout is greatly reduced, and because all traffic moves in the same direction, it is an underlying premise of this research that, by encouraging older drivers to use roundabouts in preference to conventional intersections, both the frequency and severity of crash involvement by this group can be reduced.

Fig. 1 illustrates the main characteristics of a modern roundabout.

This research study was conducted to develop and evaluate countermeasures with the potential to improve the perceived comfort, confidence, and/or safety of seniors in using roundabouts. This was accomplished using structured interviews, together with a simulated approach to and negotiation of a roundabout in which selected characteristics were enhanced, based on input from earlier focus groups. Four groups including a total of 41 drivers age 65 and older viewed videos (from a driver's perspective) and still photos of roundabouts, then discussed particular elements of these facilities with which they had issues or concerns that could affect their willingness to use the roundabout, or their feelings of comfort or safety. Five specific types of signs and related traffic control elements on single lane roundabouts emerged from the focus groups as targets for countermeasure development and evaluation, as described in this report.

2. Method

A series of structured interviews were conducted in College Station, TX, and Tucson, AZ, to evaluate countermeasure alternatives developed by the research team to address issues and concerns raised in older driver focus groups. A total of 31 interviews were held, one at a time, with drivers age 65 and older who did not participate in any other phase of this research. All participants were required to hold a valid driver license and drive at least once a week. The participants, 14 men and 17 women, were recruited from the community through word of mouth and solicitation flyers provided to senior centers. Each person received $40 for participating in the 2 h session. All participants provided informed consent as approved by the Texas A&M University Institutional Review Board.

The countermeasures evaluated in this research focused on five specific roundabout design elements: *advance warning signs*, *lane control signs*, *directional signs*, *yield treatments*, and *exit sign treatments*. For each design element, three alternatives were evaluated—a Base Condition, Countermeasure #1, and Countermeasure #2. The Base Conditions generally represented existing standards of engineering design and practice. The reader is referred to Lord et al. (2005) for a detailed description and a visualization of the different alternatives. A brief description of each alternative is presented in Table 1.

The countermeasure evaluations were performed in response to animated video presentations simulating an approach to and traversal of a roundabout. The animations were constructed by editing (via Photoshop) static images of enhanced features (countermeasure alternatives) into the driver's view of an existing roundabout. The countermeasures were selected with the aim of improving the path guidance of older drivers negotiating a roundabout. The roundabout used as the context for evaluating the countermeasure alternatives was unfamiliar to all subjects participating in this phase of the research. The evaluation process was carried out using paired comparisons between, first, the Base Condition and Countermeasure #1, then between the Base Condition and Countermeasure #2, for each design element, as viewed by a subject using the animation approach noted above. A Latin-square design was used to control for possible effects of presentation order.

Each subject viewed the simulated video presentations for each alternative. Then, the subjects were asked to rate the perceived change in terms of safety, comfort, and confidence between Countermeasure #1 and Base Condition, and between Countermeasure #2 and the Base Condition, respectively. A separate rating was provided for each of the three attributes evaluated. A seven point, Likert-type scale was used for these ratings, where the endpoints ('1' and '7') represented extreme negative and positive perceptions, respectively, and the midpoint ('4') represented 'no change.' Supplemental interviews elicited additional comments about subjects' likes and dislikes relating to each countermeasure tested.

3. Results

An analysis of variance (ANOVA) was applied to the change scores generated by the pairwise comparisons described above to determine whether there were significant differences between the countermeasures and the Base Condition. ANOVAs were also applied to the absolute ratings to determine if reliable differences existed between participants' perceptions of Countermeasure #1 and Countermeasure #2. These results support recommendations for the use of specific treatments to improve the perceived comfort, confidence, and/or safety of older drivers in using modern roundabouts, as reported below.