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Cyclists' perception of risk in roundabouts

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Abstract

Converting an intersection into a roundabout improves motor vehicle safety, but a similar safety effect is not found for car–bicycle collisions. Very little is known about the reasons behind these collisions. In this study a first step towards an understanding of the reasons behind these collisions is taken. The study focuses on cyclists' perceived risk in specific situations, factors influencing the perception of risk and cyclists' knowledge about traffic rules regulating the interaction between road users in roundabouts.

One thousand and nineteen cyclists aged 18–85 participated in the study. Data were collected using structured interviews conducted in five Danish roundabouts.

Underestimation of risk and lack of knowledge about relevant traffic rules may contribute to car–bicycle collisions in roundabouts. Cyclists prefer road designs with a clear regulation of road user behaviour. A need to increase knowledge about traffic rules regulating road user behaviour in roundabouts is identified.

Keywords: Roundabout; Risk perception; Bicycle

1. Introduction

In Denmark, after single-vehicle accidents, the second most common type of accident is an accident involving a left turning vehicle (Danmarks Statistik, 2006). When an intersection is converted to a roundabout left turns no longer occur and the traffic flow is slowed down. Consequently, the number of motor vehicle accidents decline. A safety effect of converting an intersection to a roundabout has been found in Denmark as well as in other countries. In a review study Elvik and Vaa (2004) found a mean reduction in serious injury accidents of 10–40%. The studies included were from Northern Europe, Australia and the US. In a Danish study it was found that the average number of injured per accident in roundabouts was 1.06 whereas it was 1.35 in intersections (Jørgensen and Jørgensen, 2002). Due to the fact that there is a high degree of underreporting of Danish bicycle accidents (Bach, 2004) it is difficult to estimate the size of the problem. According to the official Danish accident statistics 50–60 cyclists are killed and 1,500 cyclists are injured every year (Hemdorff and Lund, 2005). Approximately 110 of these accidents took place in a roundabout. However, a new Danish study found that the degree of underreporting of bicycle accidents in roundabouts is 75% (Hels and Orozova-Bekkevold, 2007). Thus, bicycle accidents in roundabouts appear to be a much larger problem than hitherto believed.

In accordance with this, safety effects of converting an intersection to a roundabout are primarily found in relation to car–car collisions and do not apply to car–bicycle collisions to the same extent (Herslund and Jørgensen, 2003). Consequently, in Denmark 81% of killed or injured road-users in roundabouts are cyclists or moped riders (Jørgensen and Jørgensen, 2002).

The most frequent types of police registered bicycle accidents in roundabouts are accidents involving a cyclist circulating in the roundabout and a car that either enters or exits the roundabout. Only little is known about the reasons behind these accidents, although results from a few studies focusing on the behaviour of the driver indicate, that the phenomenon 'looked-but-failed-to-see' is involved (Rääsänen and Summala, 1998; Herslund and Jørgensen, 2003). Looked-but-failed-to-see regards the behaviour of the driver just before the accident and refers to situations where the driver, although looking in the direction of the cyclist, fails to perceive it. Even less is known about the behaviour of the cyclist in these situations although it has been suggested that misinterpretation of the intention of the driver possibly is a contributing factor (Rääsänen and Summala, 1998). Misinterpretation of the intention of the driver may cause

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the cyclist to expect the driver to yield. However, not having seen the cyclist, the driver has no intention to yield. Consequently, both parties continue and thus increase the risk of collision. In order to verify this suggestion as well as being able to reduce the number of bicycle accidents in roundabouts, studies focusing specifically on the cyclists are necessary.

Perception of risk has been shown to influence decision making as well as actual behaviour in different situations (see for instance Deery, 1999; Lam, 2001; Chaudhary et al., 2004; Lam, 2005). Since the 1960s a number of different theories and models of driving behaviour that include perceived risk as a central motivational factor have been suggested (for an overview, see Ranney, 1994). Thus, although the authors of the different theories and models disagree with regard to the specific influence of perceived risk, perceived risk is generally recognised as an important influential factor in relation to driving behaviour. However, within the field of traffic safety research, studies on perceived risk have primarily focused on drivers. Therefore, the influence of risk perception on the behaviour and accident involvement of cyclists is less well documented. In particular, knowledge about risk perception in specific situations is sparse.

Increased knowledge about perceived risk in specific situations would be useful in at least two respects. Firstly, such knowledge enables a comparison of perceived and actual risk. This is valuable knowledge in the process of clarifying whether or not the cyclists' perception of risk is a contributing factor in car–bicycle collisions in roundabouts. Low levels of perceived risk could discourage the use of caution in specific situations. Secondly, knowledge about perceived risk in specific situations would be useful for the development of road designs leading to lower levels of perceived risk. Studies have found that high levels of perceived risk influence travel mode in cases where persons have the possibility to choose (Noland, 1995). Thus, when bicycling seems too dangerous road users choose different modes of transportation or even refrain from taking a trip. This may lead to a decline in car–bicycle collisions but using a more integrated approach as suggested by Racioppi et al. (2004) it becomes clear that a negative outcome in terms of lower level of public health outweighs the apparent positive effect caused by a decrease in car–bicycle collisions. This is particularly relevant in relation to elderly bicyclists because independent outdoor mobility is an essential part of the quality of life of older persons (Farquhar, 1995; Siren and Hakamies-Blomqvist, 2006). However, health issues are relevant for the general population. In Denmark physical inactivity is estimated to cause 7–8% of all fatalities (Juel et al., 2006). Thus, from a public health perspective, as well as from a traffic safety perspective, increased knowledge about cyclists' perception of risk in specific situations is highly relevant.

As a first step towards a better understanding of the reasons behind car–bicycle collisions in roundabouts this study focuses on cyclists' perception of risk in a number of selected situations in roundabouts. In addition cyclists' knowledge about traffic rules regulating the interaction between different road users is clarified. The results contribute to an understanding of factors influencing car–bicycle collisions in roundabouts. Implications of the results are discussed.

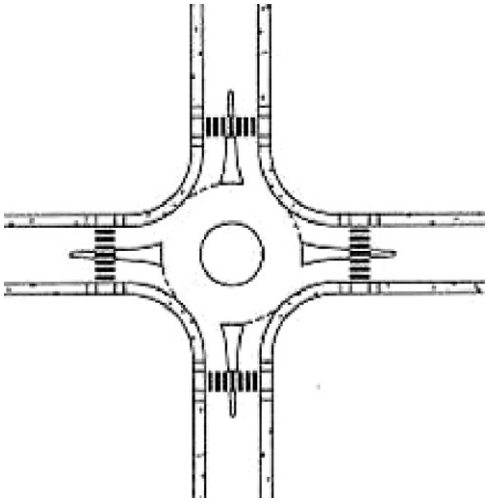

Fig. 1. A diagram identifying very general components of the roundabouts included in the study.

2. Objectives

The aim of this study was to describe cyclists' perception of risk in different situations. A second aim was to identify factors influencing the perception of risk with a particular focus on the influence of the existence of a cycle facility. A third aim was to clarify whether or not cyclists know the traffic rules regulating the interaction between road users in roundabouts.

3. Methods

3.1. Data

Data were collected in five Danish roundabouts. The roundabouts were selected based on the following three criteria: (1) design feature, (2) traffic volume and (3) location. The roundabouts should be located centrally in towns to ensure a certain number of passing bicyclists per day. Very general components of the roundabouts included in the study can be seen in Fig. 1.

All roundabouts had sidewalks along the roundabout as depicted in Fig. 1, but only three roundabouts had zebra crossings as depicted. Two roundabouts had a cycle facility in the roundabout as well as along the sidewalks. This is not shown in Fig. 1. The goal was to select roundabouts with and without cycle facilities and roundabouts that were as similar as possible when considering the three selection criteria. Details of the roundabouts included in the study are shown in Table 1.

Table 1
Roundabouts included in the study

Roundabout	Number of legs	Cycle facility	Entering cyclists per day	Entering cars per day	Number of respondents
1	3	Yes	2525	13611	225
2	5	Yes	3621	9360	236
3	4	No	3037	9586	317
4	3	No	480	9588	41
5	3	No	2598	13855	200