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Pedestrian-driver communication and decision strategies at marked crossings

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ABSTRACT

The aim of this work is to describe pedestrian-driver encounters, communication, and decision strategies at marked but unsignalised crossings in urban areas in the Czech Republic and the ways in which the parties involved experience and handle these encounters. A mixed-methods design was used, consisting of focus groups with pedestrians and drivers regarding their subjective views of the situations, on-site observations, camera recordings, speed measurements, the measurement of car and pedestrian densities, and brief on-site interviews with pedestrians. In close correspondence with the literature, our study revealed that the most relevant predictors of pedestrians' and drivers' behaviour at crossings were the densities of car traffic and pedestrian flows and car speed. The factors which influenced pedestrians' wait/go behaviour were: car speed, the distance of the car from the crossing, traffic density, whether there were cars approaching from both directions, various signs given by the driver (eye contact, waving a hand, flashing their lights), and the presence of other pedestrians. The factors influencing drivers' yield/go behaviour were: speed, traffic density, the number of pedestrians waiting to cross, and pedestrians being distracted. A great proportion of drivers (36%) failed to yield to pedestrians at marked crossings. The probability of conflict situations increased with cars travelling at a higher speed, higher traffic density, and pedestrians being distracted by a different activity while crossing. The findings of this study can add to the existing literature by helping to provide an understanding of the perception of encounter situations by the parties involved and the motives lying behind certain aspects of behaviour associated with these encounters. This seems necessary in order to develop suggestions for improvements. For instance, the infrastructure near pedestrian crossings should be designed in such a way as to take proper account of pedestrians' needs to feel safe and comfortable, as well as ensuring their objective safety. Thus, improvements should include measures aimed at reducing the speed of approaching vehicles (e.g. humps, speed cushions, elevated crossings, early yield bars, and narrow lanes), as this would enhance yielding by motor vehicles. Other measures that specifically rely on the subjective perception of different situations by the parties involved include the education and training of drivers, the aim of which is to promote their understanding and appreciation of pedestrians' needs and motives.

1. Introduction

1.1. Walking and the interaction of pedestrians with motor vehicles

Walking is the most traditional mode of transport and it plays an important role even today. Survey data from a selection of seven European countries (Denmark, Finland, the United Kingdom, the Netherlands, Sweden, Switzerland, and France) shows that 12–30% of all trips are made by walking (as the main mode of transport), the highest figure being for the United Kingdom (OECD, 1998). For short trips under 5 km, the share of walking is higher, with a maximum of 45% in the United Kingdom. The average length of walking trips varies from just under 1 km (UK)–2.8 km (Finland).

While walking can carry a high risk of injury or death on many roads, the number of fatalities among pedestrians in Europe has decreased by about 65% since 1980. However, pedestrian fatalities still account for about 17% of all traffic fatalities, although major differences between countries exist in this respect. The proportion of pedestrian fatalities ranges from 10% in Belgium and the Netherlands to 35% in Poland (SafetyNet, 2009; WHO, 2013, 2015). Pedestrians' safety depends, to a large extent, on vehicular speeds. At a collision speed of 50 km/h the risk of fatal injury for a pedes-

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trian is almost eight times higher compared to a speed of 30 km/h (Leaf and Preusser, 1999).

At the same time, lower speed also improves drivers' preparedness to yield (Varhelyi, 1998a,b). This is relevant because Swedish studies (Danielsson et al., 1993; Hyden et al., 1995; Trafikkontoret, 1994) showed that only 30%, 4–6%, and 24%, respectively, of drivers gave priority to pedestrians at zebra crossings. Data from the Czech Republic (Lehka, 2015), describing drivers' yielding behaviour at 10 marked unsignalised crossings in Prague, shows that only 45% of drivers gave priority to pedestrians in situations where they were obliged to.

Pasanen (1993) found that the speed of colliding vehicles was higher than the average speed of non-platoon vehicles in the reference traffic and the probability of a driver being involved in a pedestrian accident at a speed over 50 km/h was more than double when compared to a speed less than 50 km/h. On the basis of observations of car-pedestrian encounters at pedestrian crossings at non-signalised intersections in four European countries (the United Kingdom, Portugal, Greece, and France), Rothengatter (1993) found that the probability of a conflict was greater if the speed of the approaching vehicle was higher.

In addition to speed, there are other factors that influence drivers' yielding behaviour. In Israel, Katz et al. (1975) found in their controlled experiment that drivers slowed down or stopped more often for pedestrians when the pedestrian did not look at the approaching vehicle, when there was a relatively long distance between the vehicle and the pedestrian's point of entry onto the road, or when a group of pedestrians rather than an individual was attempting to cross.

Drivers are more likely to yield to assertive pedestrians who walk briskly in their approach to the crossing, while on the other hand the probability of yielding is reduced if vehicles are travelling in platoons (Schroeder and Rouphail, 2011).

Griffiths and Marlow (1984) found in the UK that most drivers were only prepared to stop at a zebra crossing when a pedestrian still occupied their part of the carriageway or was approaching it. Earlier, but almost like a summary of the studies that followed later (see above), Himanen and Kulmala (1988) found that the most important explanatory variables influencing drivers' behaviour (increasing willingness to yield to a pedestrian) included: pedestrians' distance from the kerb (short distances), the size of the city (bigger cities), the number of pedestrians crossing simultaneously (more pedestrians), and vehicle speed (lower speed).

In a literature review on communication between road users, Persson (1988) found that the likelihood of a driver yielding to pedestrians increased if information on the pedestrian's intention was increased by way of the combination of various forms of signs. While almost none of the drivers gave precedence at a zebra crossing when the pedestrian just stopped at the kerb and looked at the approaching drivers, 31% stopped or slowed down when the pedestrian looked at the driver, put his or her foot on the carriageway, and made a hand sign that he or she was about to cross. Considering signs coming from the drivers, Varhelyi (1998a,b) found that three out of four drivers maintained the same speed or accelerated before pedestrian crossings with pedestrians present, and only one out of four slowed down or braked. Maintaining speed or even accelerating may be interpreted as a statement by the driver that he/she does not intend to give way to the pedestrian.

Findings from earlier studies on driver behaviour at zebra crossings suggest that the willingness of drivers to give way to pedestrians at zebra crossings is low (4–40%). However, drivers obviously see that differently. For instance, Swedish drivers claim that they yield "very often" or "always". Thus, it is obviously necessary to understand the subjective view of the involved parties better, in order to shed some light on these contradictions between the perception of the road users and research results. Much of this has to do with communication between road users.

1.2. When communication can go wrong (and lead to an accident)

A road user's behaviour is largely determined by what he or she expects other road users to do. Expectations of other road users' future behaviour might be based on formal traffic rules, informal traffic rules, road design (which is often the reason for the development of informal traffic rules), and/or the other drivers' current behaviour (Hjorthol et al., 1984). However, sometimes expectations concerning the behaviour of others can be wrong. An important error in traffic, according to Rumar, is a lapse of cognitive expectation, illustrated by a failure to look for a specific type of road user, or a failure to look in the direction of the road user in question (Rumar, 1990). Lurie (1987) was one of the first to claim that there are two kinds of rules in traffic, formal and informal. In some situations it is useful to use a formal rule, while in other situations an informal rule is more appropriate. Problems between road users might arise when different participants in a specific situation act according to discrepant formal or informal traffic rules. And of course, a road user's ability to predict another road user's behaviour correctly is reduced if the other road user applies a different rule system. For instance, car drivers may, as a rule, expect that pedestrians will stop and let them continue in order to be safe, and thus not look at their own behaviour as an infringement of yielding rules, while the pedestrians (and the researchers?) look at this in a different way.

Vehicle speeds play an important role in this area of discretion, which needs communication in order to come to a common conclusion and to coordinate mutual moves appropriately. What one may expect others to do as a next move is never fully clear, and quick and appropriate reactions to unexpected moves by the other party may be necessary. Such appropriate reactions are, of course, easier when vehicle speeds are low.

1.3. Study aim and research questions

The aim of this work was to describe pedestrian-driver encounters, communication, and decision strategies at marked crossings in an exploratory way. Papers dealing with car-pedestrian interaction do not usually attempt to shed light on the communication process as a whole. It is important to know whether or not drivers yield under certain conditions, such as the distance to the intersection and speed. However, it is equally important to understand how the parties involved – both pedestrians and drivers – experience such situations. When do drivers feel that it is necessary to stop or not to do so, when do pedestrians feel that it is safe to cross, and what strategies do they choose to cross the road safely and without too much waiting time? These things are important to know when one wants to take measures later on. Of course, research that shows that reducing the speeds of cars before pedestrian crossings reduces the yielding infringements of drivers is important (e.g. Leden et al., 2006). But there is even more room for improvement, e.g. through awareness-raising measures, where, among other things, arguments are used to motivate people to behave differently, for instance to yield more properly. Moreover, there could be other things that pedestrians find disturbing when they have the right of way. This could be how cars decelerate when they yield, for instance in such a way that pedestrians are not sure whether they will stop, or when cars do not come to a complete halt when yielding but move forward very slowly into the pedestrians' "halo", which could be experienced as disturbing by pedestrians. Consequently, the goal is to discover different types of interactions and to try to understand how these interactions are perceived by the actors involved. To this end it seems appropriate to apply the