ROAD USERS' STRATEGIES AND COMMUNICATION: DRIVER-PEDESTRIAN INTERACTION

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Abstract:

The aim of presented research is to describe pedestrians' road-crossing strategies, drivers' strategies (legal and illegal) applied to situations involving pedestrians crossing the road, and their mutual communication (formal and informal), and to describe their encounters. Risk strategies and risky combinations of different strategies are identified. Risk and protective factors on the part of both pedestrians and drivers are described. Conflict situations (conflicts, "near misses", and accidents) are analysed and the causal nexus of events leading to such traffic conflicts is described. The conclusions are interpreted in the context of the traffic environment. Exploration of pedestrians' and drivers' attitudes and behaviour is summarised using focus group analysis. In this paper the outcomes of the focus groups are presented and discussed.

Keywords:

pedestrians; zebra crossing; road-crossing strategies, pedestrian behaviour; pedestrian safety, driver-pedestrian interaction

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1. Introduction

1. 1. Walking as a mode of transport

Walking, the most traditional mode of transportation, can carry a high risk of injury or death on many roads. Motor vehicles have only been around for about a century but during that short time, they have often made walking hazardous.
Walking as a means of transport is commonly used for rather short trips. This means that it is actually difficult to assess pedestrian mobility at country level, as the national travel surveys often do not register the shorter trips. Additionally, the walking parts of trips made primarily by public transport are usually not taken into account. At present, the importance of walking is therefore underestimated (Wittink, 2011). Walking is particularly important for children below the age of 12 and adults aged 75 and above.
Survey data from a selection of seven European countries show that 12-30% of all trips are made by walking (as the main mode of transport), the highest figures being for the United Kingdom and the Netherlands (ERSO, 2013), the lowest for Finland. The average length of walking trips varies from just under 1 km (United Kingdom) to 2.8 km (Finland).
Walking is a way of travelling used mainly for two purposes: short trips to specific destinations such as shops, when there is probably not too much to carry, and leisure trips where the walking in itself is the main purpose (Hydén, Nilsson, & Risser, 1998). About 15-30% of all person-kilometres walked (on an average day) are for shopping purposes. Home-leisure trips cover about 30-55% of the person-kilometres, with Switzerland at the top and Finland at the bottom (OECD, 2009).

1. 2. Encounters between pedestrians and drivers

Swedish studies (Danielsson et al., 1993, Trafikkontoret, 1994, Hyden et al., 1995) showed that only 30%, 4-6% and 24%, respectively, of drivers gave priority to pedestrians at zebra crossings.
In Israel, in a controlled experiment Katz et al. (1975) found that drivers slowed down or stopped more often for pedestrians who were crossing when:
1) the approach speed of the vehicle was low;
2) the pedestrian did not look at the approaching vehicle;
3) there was a relatively long distance between the vehicle and the pedestrian's point of entry into the road, and
4) a group of pedestrians, rather than an individual, attempted to cross.

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 or was approaching their part of the carriageway.
In Finland, Himanen and Kulmala (1988) found that the most important explanatory variables influencing drivers' behaviour included pedestrians' distance from the kerb, the size of the city, the number of pedestrians crossing simultaneously, vehicle speed, and vehicle platoon size. In encounters, the drivers mostly continued to drive on; 10% of the drivers braked or weaved slightly, and 15% clearly braked/weaved. 16% of the drivers stopped because of the pedestrian.
In a literature review on communication between road users, Persson (1998) found that the likelihood of a driver giving precedence increases if information about the pedestrian's intention is 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 foot on the carriageway, and made a hand sign that he was about to cross.
Situations in which the pedestrian passes first can be divided into three categories (Varhelyi, 1998):
a) crossing before the arrival of the car without influencing its speed;
b) situations when the approaching car is provoked to brake by the pedestrian who does not stop before crossing;
c) ideal situations, when the approaching car brakes on the driver's own initiative in order to give way to the pedestrian.

In encounters, three out of four drivers maintain the same speed or accelerate and only one out of four slows down or brakes (Varhelyi, 1998). The profile of mean speeds reaches its highest value at a distance of 40-50 metres before the zebra crossing, where it is statistically significantly higher than in non-encounters. This may be an indication of “competitive behaviour” in the form of “signalling by speed” that the driver does not intend to give way to the pedestrian. The driver’s decision on the approach strategy is made approximately at this distance from the zebra crossing. In most cases, drivers expect pedestrians to stop and they place the responsibility for avoiding a collision on the pedestrian and thereby influence both the safety and access of the pedestrian. Drivers do not lower their speeds sufficiently in order to be prepared to stop in an unexpected dangerous situation.
It might be argued that it is better for pedestrians to cross the street with extra-large margins (when there are no cars nearby) instead of finding strategies that make drivers lower their speed. But pedestrians can also make mistakes; they may be unaware of an approaching car and they can step in front of it by mistake. For such a mistake they should not be sentenced to death (Varhelyi, 1998).
Pasanen (1993) found that the speed of colliding vehicles was higher that the average speed of free 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, Westra and Rothengatten (1993) found that the probability of a conflict was greater if the speed of the approaching vehicle was higher.
The main findings from earlier studies on driver behaviour at zebra crossings can be summarised as follows:
1) the willingness of drivers to give way to pedestrians at zebra crossings is low (4-40%). However, what drivers claim to do is one thing and what they actually do is another. In a questionnaire (Dahlstedt, 1994) Swedish drivers were asked “How often do you give way to a pedestrian at pedestrian crossings?” 67% answered “very often” or “always”;
2) the presence of pedestrians at a zebra crossing has little or no speed-reducing influence on approaching vehicles;
3) drivers do not lower their speeds sufficiently to maintain a readiness to be able to handle a possible unexpected dangerous situation;
4) drivers are more willing to slow down or stop for crossing pedestrians when the speed of their vehicle is low;
5) explanatory variables with significant effects: the distance of the pedestrian from the kerb, the number of pedestrians crossing simultaneously, vehicle speed, and vehicle platoon size, but also the size of the city;
6) explanatory variables with no significant effects: street width, the presence of a refuge, the pedestrians’ age or sex, and whether they are pushing a baby carriage or a bicycle;
7) the so-called free vehicles have a central significance.

Encounters between cars and pedestrians at zebra crossings are critical situations in which there is a need for better speed adaptation. In an encounter with a pedestrian, the driver has to be influenced before he or she reaches the “decision zone” 50 to 40 metres before the zebra crossing in order to prevent the “signalling by speed” behaviour. Empirical research with humps and mini-roundabouts shows that when vehicular speeds at zebra crossings are brought down to 30 km/h and below, the interaction between vehicles and pedestrians becomes more equitable and drivers are more willing to give way to pedestrians (Hyden et al., 1995).

1. 3. Social aspect

In traffic, in contrast to most other situations where people have to interact, the participants are relatively anonymous, the interactions are short, and the opportunities to communicate are more restricted. Because of the limited possibility of communication in traffic misunderstandings and

misinterpretations often occur, which may result in irritation among road users. Besides the fact that irritation as such turns drivers into “bad” drivers, irritated drivers are also disposed to act aggressively (Bjornskau, 1996). It seems that anger or irritation arises in interaction between road users (e.g. when another road user is obstructive). However, the degree of irritation evoked might be dependent on how the negative behaviour of other road users is interpreted, that is, how behaviour is attributed.

Attribution refers to the process by which individuals arrive at causal explanations for their own and others` behaviour (Ross, 1977). Several studies have shown that drivers are subject to attributional biases when judging the behaviour of other road users. One such bias is false consensus, which refers to a tendency of persons “to see their own behavior choices and judgements as relatively common and appropriate to existing circumstances while viewing alternative responses as uncommon, deviant, or inappropriate” (Ross, Greene, & House, 1977, 280).

Zaidel (1992) argues that every individual driver is influenced by the social environment, which consists of other road users, general social norms, and formal traffic rules. At the same time, every road user is a part of other road users’ social environment. There are four important ways the social environment can influence a driver:

a) others’ behaviour can be used as a source of information;
b) communication with others;
c) others as a reference group;
d) imitation of others.

Rothengatter (1991) claims that normative behaviour becomes attractive to road users if they perceive that most other road users comply with it and those who do not are getting punished. One can expect that it is not only punishment from the road authorities, but also punishment from fellow road users that has this effect.

To facilitate social interaction in traffic formal rules regulate road users’ behaviour. However, sometimes road users do not comply with the formal rules. Reasons for failures to follow traffic laws could be a lack of motivation or a lack of knowledge about the formal rules in specific situations. Sometimes traffic rules are vague or ambiguous and are understood differently by different persons. Furthermore, some traffic rules are not congruent with the road design, or the rules are not adjusted to human requirements or natural behaviour patterns (Helmers & Aberg, 1978).

Informal rules are composed of expectations. When some expectations are regularly provoked in a specific situation, it indicates that an informal rule is in effect (Hjorthol, Assum, & Solheim, 1984). A driver’s behaviour is largely determined by what he or she expects another road user to do. Expectations of other drivers’ 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. However, sometimes drivers’ expectations can be wrong. An important error in traffic 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 (1968) was one of the first to claim that there are two kinds of rules in traffic – formal and informal. He studied traffic from a game theory perspective and argued that rules do not tell us what is morally right or wrong; rather, they merely tell us whether what we are doing is part of the game. In some situations it is useful to use a formal rule, while in other situations an informal rule is more appropriate. Conflicts between road users might arise when different participants in a specific situation act according to discrepant formal or informal traffic rules. This is because a road user’s ability to correctly predict another road user’s behaviour is reduced if the other road user complies with a different rule system (Wilde, 1976). Helmers and Aberg argued that when formal traffic rules do not correspond with the road design, informal traffic rules, based on expectations about other road users’ behaviour, are developed through interaction between road users.

1. 4. Accident involvement

Walking is a mode of transport in which relatively unprotected road users interact with traffic of high speed and mass. This makes pedestrians vulnerable. They suffer the most severe consequences in collisions with other road users because they cannot protect themselves against the speed and mass of the other party.
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 pedestrian is almost eight times higher compared to a speed of 30 km/h (Pasanen, 1992).
Of all traffic fatalities, the proportion of pedestrian fatalities is about 17% (OECD, 2009). However, the differences between countries are large. The proportion of pedestrian fatalities varies from 10% in Belgium and the Netherlands to 35% in Poland. The age groups that have the highest percentage of pedestrian fatalities are children younger than 10 years of age and adults aged 65 years or older. Most fatalities and severe and slight injuries to pedestrians and cyclists occur in urban areas. Motor vehicles (cars, lorries, and buses) account for over 80% of vehicles striking pedestrians. Crashes involving pedestrians occur frequently at facilities designed for pedestrians, such as pedestrian crossings. This means that these facilities are not necessarily good enough to prevent crashes. However, pedestrian crossings might also be the location at which roads are most often crossed. Factors that have been identified as contributory factors in the causation of pedestrian crashes and injuries are the speed of motorised vehicles, the weight and design of motor vehicles, the lack of protection of pedestrians and cyclists, their visibility and vehicle control, and alcohol consumption (ERSO, 2013).
The trends for the number of fatalities among pedestrians in Europe show that since 1980 numbers have decreased by about 65%. However, of all traffic fatalities, the proportion of pedestrian fatalities is still about 17% (OECD, 2009).
Accident statistics in Sweden show that 36% of all accidents involving injury between pedestrians and motor vehicles (and are reported to the police) occur at pedestrian crossings (OECD, 2009). In Finland, Pasanen (1992) found that pedestrians were regarded as being legally guilty of causing accidents in 84% of the cases that were studied in Helsinki. However, for various reasons, the pedestrian may often be in such a state that he or she is totally unaware of the approaching car. According to Pasanen, in such situations both the consequences and the probability of an accident are dependent on vehicular speed.

At-risk groups and risky situations were identified as follows:
a) children and elderly pedestrians;
b) in cities (inhabited areas) – 9/10 of all injuries, but in rural areas more severe and more deaths;
c) half of all deaths occur at night (and in twilight) and during bad weather conditions (rain mostly);
d) the likelihood of an accident rises in proportion to the socio-economic activity in the area;
e) the likelihood of an accident rises in proportion to the number of cars registered in the area;
f) most pedestrian collisions happen when a pedestrian is crossing the road.

In terms of marked vs. unmarked crossings at uncontrolled intersections on a two-lane road, the presence of a marked crossing alone is associated with no difference in the pedestrian crash rate compared to an unmarked crossing. On multilane roads with traffic volumes above 12,000 vehicles per day, having a marked crossing alone (without other substantial improvements) is associated with a higher pedestrian crash rate (after controlling for other site factors) compared to an unmarked crossing (TRB, 2000).

2. Methods

The aims of this work are to describe pedestrians' and drivers' behaviour, common strategies, and communication in the situations of their encounters while pedestrians are crossing the road at a marked crossing and, furthermore, to identify factors (relating to pedestrians, drivers, and the design of the road system), which can predict accidents. The research design was built to reflect this aim.
The research design comprises both qualitative and quantitative approaches: the methods of direct

observation and interviews were used. Direct observation was carried out using camera recordings. The cameras were installed in different places (2-4) within urban areas where pedestrian and motorised traffic interact (including both designated and undesignated pedestrian crossings and areas that are not intended for crossing the road). In addition, on-site observation (20 two-hour observation sessions) with a focus on the description of communication strategies (eye contact, gestures, verbal expressions, (vehicle) movements, and signals, such as the flashing of lights) was performed. The characteristics of the wider context were also described (upon observation): an individual pedestrian, a group of pedestrians, the passengers in the car, and situational variables on the part of the pedestrian, such as their psychological condition, motives, and emotional condition. Focus groups with pedestrians were conducted (not on road site). The main goal was to define what pedestrians consider a problem, what their strategies are, and what the main issues are. Short on-site interviews with 200 pedestrians were conducted immediately after they had crossed the road. These interviews were subsequently subjected to text analysis. Pedestrians were selected for interviews according to the strategies they chose to cross the road.

2.1. Methods focused on needs and opinions

For this purpose the focus group method was selected. Focus groups with pedestrians and drivers were conducted. The focus groups with pedestrians concentrated on the following aims:

1. identify pedestrians' needs according to crossings;
2. identify their strategies while crossing (wait/go/communication/signs) and the factors that influence their decision to cross or not;
3. identify what they consider as dangerous (road design, drivers' behaviour) and what they would change.

The focus groups with drivers concentrated on the following aims:

1. identify their strategies when approaching a crossing (wait/go/communication/signs) and the factors that influence their decision to yield or not;
2. identify what they consider as dangerous in pedestrians' behaviour or misunderstanding in communication (what the pedestrian is trying to tell them and the other way around) or to describe conflict situations;
3. identification of research spots (crossings for cameras);
4. what they consider a problem/safety issue.

2. 2. Methods focused on direct observation

For direct observation three methods were used: camera recording, on-site observation (pedestrians and drivers), and speed measurement.
With camera recording we identified near-misses and conflict situations and provided detailed descriptions of these events. The aim was to identify factors which lead to conflicts.
On-site observation focused on pedestrians' behaviour in connection to crossing the road (before crossing, while crossing), pedestrians' communication with drivers and vice versa, and drivers' behaviour (mostly focused on the decison on whether to yield or go).
Speed measurements were conducted with a radar pistol and the aim was to measure the real approach speed of vehicles at different research spots at different times and from different directions.

2. 3. Methods focused on exploration and generalisation

We used on-site interviews with pedestrians as a method for exploration. The aims were to identify pedestrians' decision factors about starting to cross the road, to understand how pedestrians understand drivers' signs or other communication, and to learn what pedestrians do to let drivers know their intention to cross or force drivers to yield.
The last stage of data exploration was an expert workshop, where all the information from the

research was presented and discussed. The workshop proposed interpretations of the results and further steps in the research.

3. Results

In this paper the results from the focus groups with pedestrians and drivers are presented. Four focus groups (two with pedestrians and two with drivers) were conducted and subsequently the records were subjected to text analysis.

3. 1. Focus groups with pedestrians

General discourse, which was present can be described as: *"Pedestrians have no rights, always waiting somewhere, annoying drivers".*

Factors, which pedestrians consider when deciding to wait/go:

- speed of the approaching vehicle
- distance of the vehicle (safety gap)
- vehicle deceleration
- eye contact with driver
- familiarity of the place
- view conditions
- traffic density

What pedestrians consider as a risky situation:

- high traffic density
- high vehicle speeds
- crossings without traffic lights
- short pedestrian green phase
- spots without crossings
- crossings including tram
- turning vehicles when green pedestrian light
- crossings near roundabouts
- car passing near pedestrian (just after his/her crossing)
- cyclists on the crossing
- small refugee islands
- bad view conditions
- 2nd vehicle yielding
- drivers distraction

Protective factors/ countermeasures:

- humps
- narrow roads
- enforcement (presence of the police)
- all crossing equipped with traffic lights

Means of communication pedestrians to drivers:

- eye contact (gazing/ staring)
- glimpse of movement to the road
- waving with hand
- saying "Thank you" – waving with hand, smile, wag with the head.

Means of communication drivers to pedestrians:

- flashing with lights

- waving with hand

3. 2. Focus groups with drivers

General discourse, which was present can be described as: *"It`s about toleration and respect. Pedestrians want to feel superior, not wanting to respect driver and wanting to make him stop".* Drivers tend to talk mostly about infrastructure and vehicle equipment (safety systems).
What drivers consider as a risky situation, risky behavior or risky pedestrian`s groups:

- pedestrian running to catch the tram
- jaywalking (red lights, not on the crossing)
- sudden/unexpected pedestrian`s movement (stop/go)
- pedestrian not paying attention to traffic/vehicles
- pedestrians pretending they don`t see car approaching
- pedestrians not prizing their lives
- pedestrian with earphones
- low pedestrians visibility
- bad view conditions (e.g. barriers at tram stops)
- turning right/left when pedestrians have green
- cyclists on the crossings
- risky groups - elderly pedestrians (jaywalking, not paying attention),kids, mothers with prams, runners, rollerbladers, handicapped, drunken pedestrians

Protective factors/ countermeasures:

- crossings with traffic lights
- lights on the crossings
- clearly and well marked crossings
- more crossings
- humps
- refugee islands
- narrow streets
- mutual driver/pedestrian respect

Means of communication:

- flashing with lights
- waving with hand
- eye contact = showing "you can go"

What to do to force pedestrian to stop:

- not to decelerate
- to speed up
- obey eye contact
- driving more in the center of the road (to avoid hitting pedestrian)

Yielding to pedestrians:
Tendency not to give a priority to pedestrian:

- when traffic densities are low *("I consider safety of pedestrian and traffic flow.", "I don`t stop so that I don`t slow down traffic flow")*
- when looking at fuel consumption
- when too close to the crossing (emergency breaking)
- when pedestrian doesn`t start to cross and waits
- when expected that pedestrian will be slowly moving
- when place is familiar

- when pedestrian takes a look and notice driver
- when more crossings in a row
- when other vehicle (in opposite direction) won`t stop
- with growing distance from city center the willingness to yield decline

Tendency to give a priority to pedestrian:

- when disturbed (SMS, phoning etc. – to have more time)
- depends on the pedestrian group (kids, mothers with pram)
- when pedestrian is “on the move” (won`t stop before crossing)

4. Discussion

Each year, more than 270,000 pedestrians lose their lives on the world’s roads (WHO, 2013). Many leave their homes as they would on any given day – to school, work, places of worship, the homes of friends – never to return. Globally, pedestrians constitute 22% of all road deaths, and in some countries this proportion is as high as two thirds.

Most fatalities and severe and slight injuries to pedestrians and cyclists occur in urban areas. Motor vehicles (cars, lorries, and buses) account for over 80% of the vehicles striking pedestrians. Crashes involving pedestrians frequently occur at facilities designed for pedestrians, such as pedestrian crossings. This means that these facilities are not necessarily good enough to prevent crashes.

What can be seen clearly from analysis of focus groups, which focused on the needs, risk perception and mutual communication of drivers and pedestrians, is that discourse of these two groups about their encounters at zebra crossings is very different. On the other hand, there can be seen also some common direction in the risk perception (what is considered as risky situation or risky behaviour). This might suggest, that pedestrians and drivers consider and deal with the same situations, but from the very different perspective.

Our further research will focus on this issue in more detailed manner. The data will be further analysed and interpreted with other data from the research that has been discussed (interviews, on-site observation, and camera recording). We believe that walking as a mode of transport must be continuously supported and promoted – as the main and basic human mode of transport.

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