

Vulnerable road users: Characteristics of pedestrians

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Introduction

Pedestrians are vulnerable road users and comprise the largest single road user group. Walking is a major form of transport in urban areas and crossing a road is a key element in a journey on foot. A pedestrian network is part of the transport system and cannot be separated from it. Road crossing points are the critical links in a connected pedestrian network. Crossing the road is one of the most hazardous activities that a pedestrian can undertake as there is greater potential for conflict with the other road users.

This paper presents some of the findings from a literature review as part of the author's Masters degree research report [1], the goal of which was to discover how pedestrians negotiate the urban walking environment and describe some of the most important characteristics of pedestrian crossing behaviour in urban areas - information that traffic engineering practitioners can use for selecting the correct pedestrian facilities at appropriate locations.

The research project investigated pedestrian movement characteristics and crossing behaviour and compared results with the findings sourced from a literature review. The research involved reviewing the existing literature and conducting empirical research to study microscopic pedestrian flow characteristics.

Keywords

Pedestrian, Pedestrian behaviour, Pedestrian characteristics, Pedestrian crossing point

Characteristics of pedestrians

The qualitative and quantitative design of a pedestrian environment requires a basic understanding of related human characteristics and capabilities. The pedestrian population is not homogeneous. It means there is no such thing as an 'average' pedestrian; size, speed, strength and judgement can vary significantly between individuals depending on age, gender, mobility, level of awareness or aggression [2]. Pedestrians require the following skills in order to interact safely with traffic [3]:

- *Detecting the presence of traffic:* the detection of traffic involves a range of basic processes, including selective attention, visual search, resistance to distraction, co-ordination of visual and auditory information, and the perception of crossings (in terms of the opportunity they afford for detecting approaching traffic).
- *Visual timing judgements:* this requires the pedestrians to determine a vehicle's direction and rate of movement so that accurate time-to-contact judgement can be made. Such judgement provides information about the time available for crossing.

- *Co-ordination of information from different directions:* the pedestrians rarely have to deal with traffic approaching from a single direction, thus timing and other judgement must be made in relation to vehicles approaching from two or more directions. This requires the ability to divide attention, to hold information in memory and to co-ordinate and integrate this information.
- *Co-ordination perception and action:* this involves the ability to relate the time available for crossing to the time required to cross. The latter will vary according to characteristics of the individual's own movement, as well as to other factors such as the width of the road. Such knowledge about movement capability must then be calibrated to visual information about the time available to cross, so that realistic safety margins can be set and other decisions made.

Pedestrian characteristics by age groups

In general, common pedestrian characteristics by age groups are [4]:

Age 0 to 4 years

- learning to walk
- requiring constant parental supervision
- developing peripheral vision, depth perception

Age 5 to 12

- increasing independence, but still requiring supervision
- poor depth perception
- susceptible to darting out or 'intersection dash'

Age 13 to 18

- sense of invulnerability
- susceptible to intersection dash

Age 19 to 40

- active, fully aware of traffic environment

Age 41 to 65

- slowing of reflexes

Age 65+

- street crossing difficulty
- poor vision
- difficulty hearing vehicles approaching from behind
- high fatality rate.

Land Transport New Zealand (LTNZ)¹ [5] noted that pedestrian physical ability is affected by a great range of factors. Table 1 shows the ways in which pedestrians differ and how those differences affect the road/street crossing function.

Table 1. Pedestrian physical abilities [5]

Ways in which pedestrians differ	Affecting	Impacting upon
Height	Ability to see over objects; ability to be seen by others	<ul style="list-style-type: none"> • Sight distance
Speed of reflexes	Inability to quickly avoid dangerous situations	<ul style="list-style-type: none"> • Crossing opportunities
Visual perception	Ability to scan the environment and tolerate glare	<ul style="list-style-type: none"> • Legibility of signs • Detection of kerbs and crossing locations • Crossing hazards • Tactile paving • Judging traffic
Attention span and cognitive abilities	Time required to make decisions; difficulties in unfamiliar environments; inability to read or comprehend warning signs	<ul style="list-style-type: none"> • Positive detections • ‘Legibility’ of streetscape • Consistency of provision • Use of symbols
Balance and stability	Potential for overbalancing	<ul style="list-style-type: none"> • Provision of steps and ramps • Kerb height • Gradients • Crossfall
Manual dexterity and coordination	Ability to operate complex mechanisms	<ul style="list-style-type: none"> • Pedestrian activated traffic signals
Accuracy in judging speed and distance	Audible clues to traffic being missed	<ul style="list-style-type: none"> • Need to reinforce with visual information
Energy expended in movement	Walking speed	<ul style="list-style-type: none"> • Crossing time

Characteristics of children as pedestrians

Child pedestrians (pedestrians aged less than 15 years [6]) display significantly different characteristics to adults, not only in physical build but also in developmental maturity [5]. Quite often adults consider that children are more capable than they actually are [7] but children are still developing their cognitive and social skills and abilities. The ability to cross a street safely develops with age. Children do not reach an adult level of performance in traffic (i.e. do not have the perceptual and cognitive capacity to make sound judgements about traffic safety) until about 12 years of age [8, 3, 9].

A child's capacities to perform the task of crossing the street, particularly in scanning the environment as a whole, are poorer than an adult's. The more complex the traffic environment, the more difficult the crossing task will be for children to perform. Young children have limited ability to process information in their peripheral vision, so they need more time to react once an object in the periphery is seen [7]. Children also tend to believe that others will protect them, and can be overconfident in many circumstances [5].

A brief examination of the limitations and characteristics of children as road users helps to illuminate the problems which may occur during their street crossing activities [10]:

- *Up to age 2* children are not fit to cope with traffic in any way.

- *Between 2 and 7 years*, children are thinking but of the immediate task in hand (one matter at a time). Vision is not fully developed.
- *Between 7 and 11 years* children are capable of abstract thought. They reason about events not actually present but need experience to relate to the task in hand.
- *Children 12 years and over* have reached the stage of formal operations and have an adult grasp of the particulars of logical thought. They are ready to participate at adult level. Vision is not fully developed until around age 16.

The major characteristics which could affect a child's crossing behaviour are presented in Table 2.

Characteristics of older pedestrians

Older pedestrians (aged over 65 years [6]) face reducing capabilities with increasing age [11]. The ageing process generally causes deterioration in physical, cognitive and sensory abilities. More than 50% of the over-65s in New Zealand, for instance, consider themselves to have some form of impairment [5, 6].

Some characteristics of older pedestrians that can affect their walking and crossing ability are [11, 12]:

- impaired vision
 - difficulty seeing pedestrian signals on opposite side of the street

- often find it necessary to look at the ground while walking
- difficulty seeing curbs, cars, other pedestrians and other obstacles
- impaired hearing
- decreased agility, balance and stability
- slow gait, shorter stride
- lack of confidence
- inability to determine boundary between curb and street
- slower reflexes
- exaggerated start-up time.

Table 3 lists the characteristics of older pedestrians which affect their road crossing activities.

Table 2. Characteristics of child pedestrians which affect their crossing activities [5]

Characteristic	Resulting in	Impacting upon
Shorter height	Reduced ability to see over the top of object	<ul style="list-style-type: none"> • Sight lines and visibility
Reduced peripheral vision	Reduced ability to scan the environment	<ul style="list-style-type: none"> • Legibility of signs • Detection of kerb • Crossing locations • Crossing hazards
Limited attention span and cognitive abilities	Inability to read or comprehend warning signs and traffic signals	<ul style="list-style-type: none"> • Positive directions • 'Legibility' of streetscape • Use of symbols
Difficulty localizing the direction of sounds	Audible clues to traffic being missed	<ul style="list-style-type: none"> • Need to reinforce visual information
Unpredictable or impulsive actions	Poor selection of routes and crossings	<ul style="list-style-type: none"> • Lateral separation from cars • Traffic speed and density • Barriers
Lack of familiarity with traffic patterns and expectations	Lack of understanding of what is expected of them	<ul style="list-style-type: none"> • Complexity of possible schemes

Table 3. Characteristics of older pedestrians which affect their crossing activities [5]

Characteristic	Resulting in	Impacting upon
Reduced range of joint motion	Slower walking speed	<ul style="list-style-type: none"> • Crossing time
Vision problems such as degraded acuity and poor central vision	Reduced ability to scan the environment	<ul style="list-style-type: none"> • Legibility of signs • Detection of kerbs • Crossing locations
Limited attention span, memory and cognitive abilities	Require more time to make decision, difficulties in unfamiliar environments, lack of understanding of traffic signals	<ul style="list-style-type: none"> • Positive directions • 'Legibility' of streetscape • Consistency of provision
Decreasing agility, balance and stability	Difficulties in changing level	<ul style="list-style-type: none"> • Provision of steps / ramps • Kerb height
Slower reflexes	Inability to quickly avoid dangerous situations	<ul style="list-style-type: none"> • Crossing opportunities
Reduced manual dexterity and coordination	Reduced ability to operate complex mechanisms	<ul style="list-style-type: none"> • Pedestrian activated traffic signals

Table 4. Characteristics of mobility impaired pedestrians and their effect on crossing [5]

Characteristic	Resulting in	Impacting upon
Extra energy expended in movement	Slower walking speed	<ul style="list-style-type: none"> • Crossing time
Use of mobility aids	Increased physical space needed and good surface quality	<ul style="list-style-type: none"> • Footpath width • Obstruction
Decreasing agility, balance and stability	Difficulty in changing level	<ul style="list-style-type: none"> • Provision of steps/ramps • Kerb height
Reduced manual dexterity and coordination	Reduced ability to operate complex mechanisms	<ul style="list-style-type: none"> • Pedestrian- activated traffic signals

Pedestrians with disabilities

Assuming that the typical pedestrian is fit and healthy, has satisfactory eyesight and hearing, is paying attention and is not physically hindered, will misrepresent a significant proportion of the population [13]. Table 4 shows some characteristics of mobility impaired pedestrians and their effect on street crossing.

Conclusions

The main findings of the literature review were that:

- The pedestrian population is not homogenous. There is no such thing as an ‘average’ pedestrian because size, speed, strength and judgement can vary significantly between individuals depending on age, gender, mobility, level of awareness and aggression.
- Children and older pedestrians face particular challenges when crossing the street. Children do not reach an adult level of performance in traffic until about 12 years of age, and older pedestrians are affected by age-related decline in the function of their visual, perceptual, cognitive and motor systems. However, in contrast to younger pedestrians, elderly people are aware of their limitations.
- Many people have some kind of disability affecting their crossing action and behaviour. Assuming that the typical pedestrian is a person who is fit and healthy with satisfactory eyesight and hearing, who pays attention and is not physically hindered, will misrepresent a significant proportion of the population.

Notes

¹ The organisation formerly known as Land Transport New Zealand (LTNZ) has been amalgamated into the New Zealand Transport Agency (NZTA) since this research was conducted.

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