# ROAD ACCIDENTS TO CHILDREN AS PEDESTRIANS:

The relationship between behaviour and accident risk.

by

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Work of this nature necessarily relies on the group approach. Where others have primarily been responsible for the work they have been acknowledged in the text. For example, C.I. Howarth was largely responsible for the conceptual framework for analysing accident risk, reported in Chapter 2. This work owes much to the advice, assistance and encouragement of Dr. D.A. Routledge, who became a joint-director of the research contract and Angela Lightburn, who was a member of the research team.

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ABSTRACT

This thesis will argue that there is a mismatch between the information children are receiving about crossing roads from parents, schools and safety programs and the information they gain from their own experiences and from their observations of adult pedestrians.

Initial observations suggested that two features of children's behaviour on the roads lead to their greater liability to have accidents as pedestrians. Children can often be seen to enter the carriageway without paying attention to the traffic - this behaviour, popularly called "heedlessness", appears frequently in accident report forms as an explanation of the accident. Secondly, children can often be seen to behave inefficiently, hesitating, making false starts and running dangerously close to cars, when they are apparently fully aware of the traffic. This behaviour is best described as lacking in skill.

The studies, to be reported, relate measures of children's road crossing behaviour to measures of their accident risk. They reveal basic differences in the way children behave on busy, major roads and on quiet, minor roads. There is little evidence of "heedless" behaviour on major roads, where children generally are fully aware of what they are doing, but the children use different crossing strategies to adults. There is a contradiction between the way children are instructed to cross these roads and the way in which experienced pedestrians cross. Whereas, for example, children are instructed to stop at the kerb before starting to look for traffic, adults seldom arrive at the kerb without previously having assessed the crossing situation. Children do however develop these more efficient, adult crossing strategies in spite of the training programs. Children behave quite differently on quiet, minor roads. Here, there is more evidence of "heedless" type behaviour, and since quite frequently these roads are being used by the children as an extension of the pavement, it is unrealistic to expect them to behave

otherwise. Conventional road safety instruction in this situation seems inappropriate.

An approach for reducing accidents is proposed, the effectiveness of which could be assessed by the behavioural and risk measures developed in the study. A greater awareness of the different problems associated with crossing major and minor roads is required. On major roads we should aim for a greater segregation of children and traffic, they should be easily identifiable, and instructions for crossing them made more relevant. On minor roads it must be accepted that conventional safety instruction is inappropriate, and an alternative approach must be found. It is suggested that the role of the driver is a greatly neglected factor here, and that drivers should be encouraged or forced to drive more responsibly in areas with high densities of children.

# CONTENTS

# CHAPTER 1

## INTRODUCTION

The Problem.

Of the 800,000 children born in Great Britain during 1970, 2,200 have either been killed or seriously injured while crossing or playing on roads before reaching their fifth birthday. Before they reach their fifteenth birthday another 6,600 will have been killed or seriously injured. 30,000 of these children will have been involved in some type of injury accident as a pedestrian by the time they are 15 years old, a chance of 1 in 27 (based on 1975 accident rates). To put it another way, 30,000 children are killed or injured each year as pedestrians.

Since the beginning of the century steady progress in the field of medicine has reduced, and is continuing to reduce, the numbers of deaths from disease. Accidental death is now the leading cause of death in the 5 - 14 years age group in every European Country. (Council of Europe 1972). Road traffic accidents are now the most important cause of childhood accidents and children are most likely to be killed as pedestrians (Watson 1971). While we have suceeded in dramatically reducing the number of children dying from disease, the number of children killed as pedestrians in this country has been rising steadily and it is only in the past few years that the numbers of these accidents have stopped increasing. Children are far more likely to be killed or disabled by a road traffic accident as a pedestrian than by any other cause. The cost to society of these accidents lies not only in the loss of life but in the long term economic consequences of permanent disability. The argument for more investment in research into childhood accidents is sound from both a humane and a cost-effective viewpoint.

Figure 1. shows the pedestrian casualty rates for different age groups from 1965 to 1975. Until 1968 casualty rates for all groups of young pedestrians has increased steadily. Since then, partly because of an increased awareness of the problem (and interest in road safety in general),

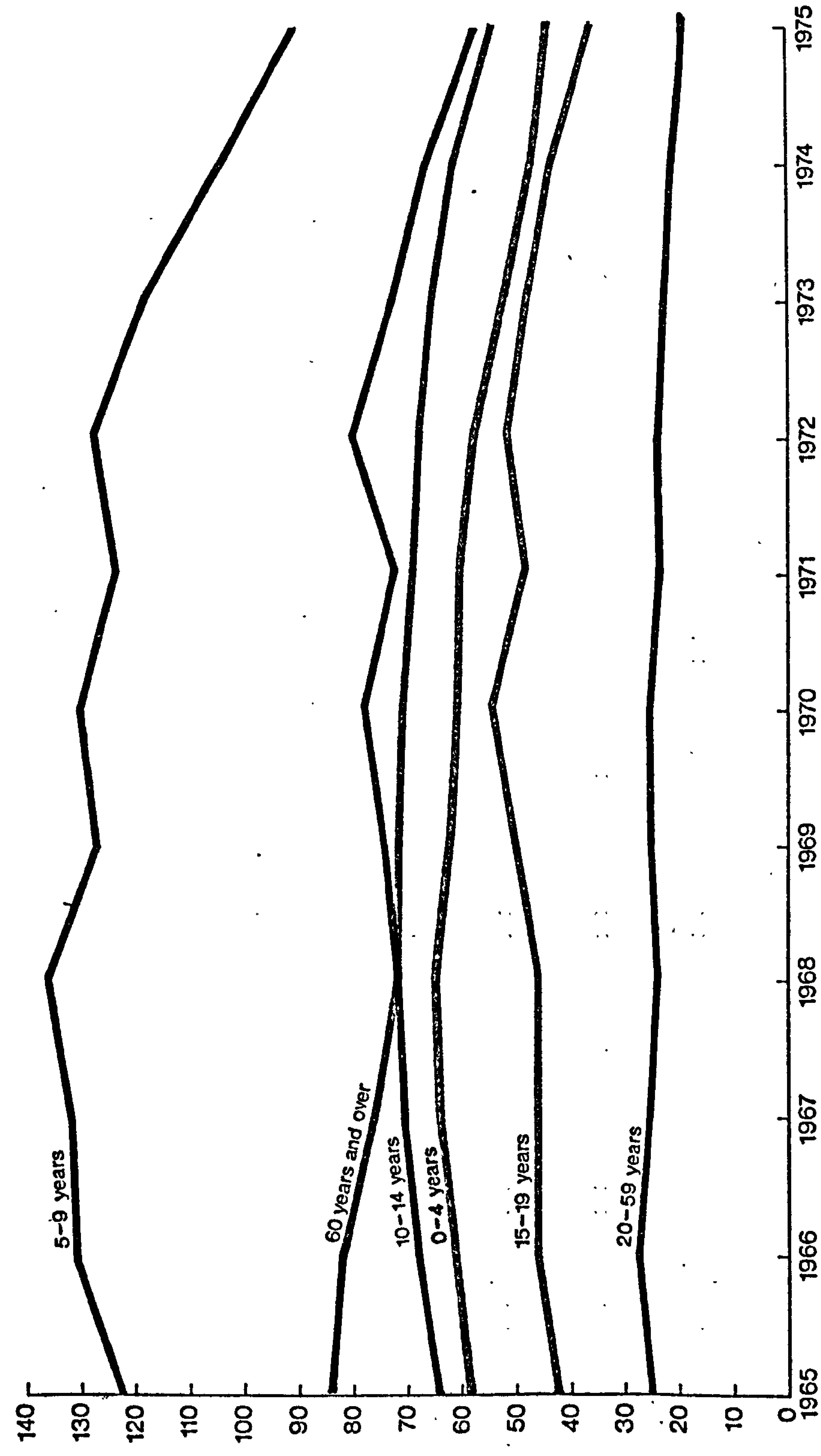
FIGURE 1

Pedestrian casualty rates 1965-1975.

(Reproduced from Road Accidents 1975. HMSO)

Fig.1

PEDESTRIANS KILLED OR SERIOUSLY INJURED PER 100,000 POPULATION: 1965–1975



the casualty rates for pedestrians and for all other road users, has been declining. Environmental changes and new traffic engineering and management techniques have also played their part. Children, however, are still far too vulnerable, a 5-9 year old child is 4½ times more likely to be killed or injured as a pedestrian, than an adult. Figure 2. shows the average number of child pedestrian casualties per annum. Boys have more accidents than girls, twice as many between the ages of 5 and 9.

### Approaches to the problem.

There are several comprehensive reviews relating to child pedestrian accidents. Haddon, Suchman and Klein (1964) in an excellent book covering all aspects of accident research sum up the small number of early studies. More recent and comprehensive reviews can be found in Colbourne (M.Sc. thesis 1972) and Routledge (Ph.D. thesis 1975). Only the more important studies will therefore be considered here.

The bulk of research to date has approached the problem of accidents from an epidemiological standpoint. The now classic paper by Gordon, in 1948, proposed that accidents could be studied epidemiologically, drawing attention to the similarities between various distributions of diseases and distributions of accidents. The rapid progress in the control of the major infectious diseases, and the discovery of important new drugs at this time had rapidly increased the relative importance of accidents, and public health workers were quick to adopt this new analytical technique.

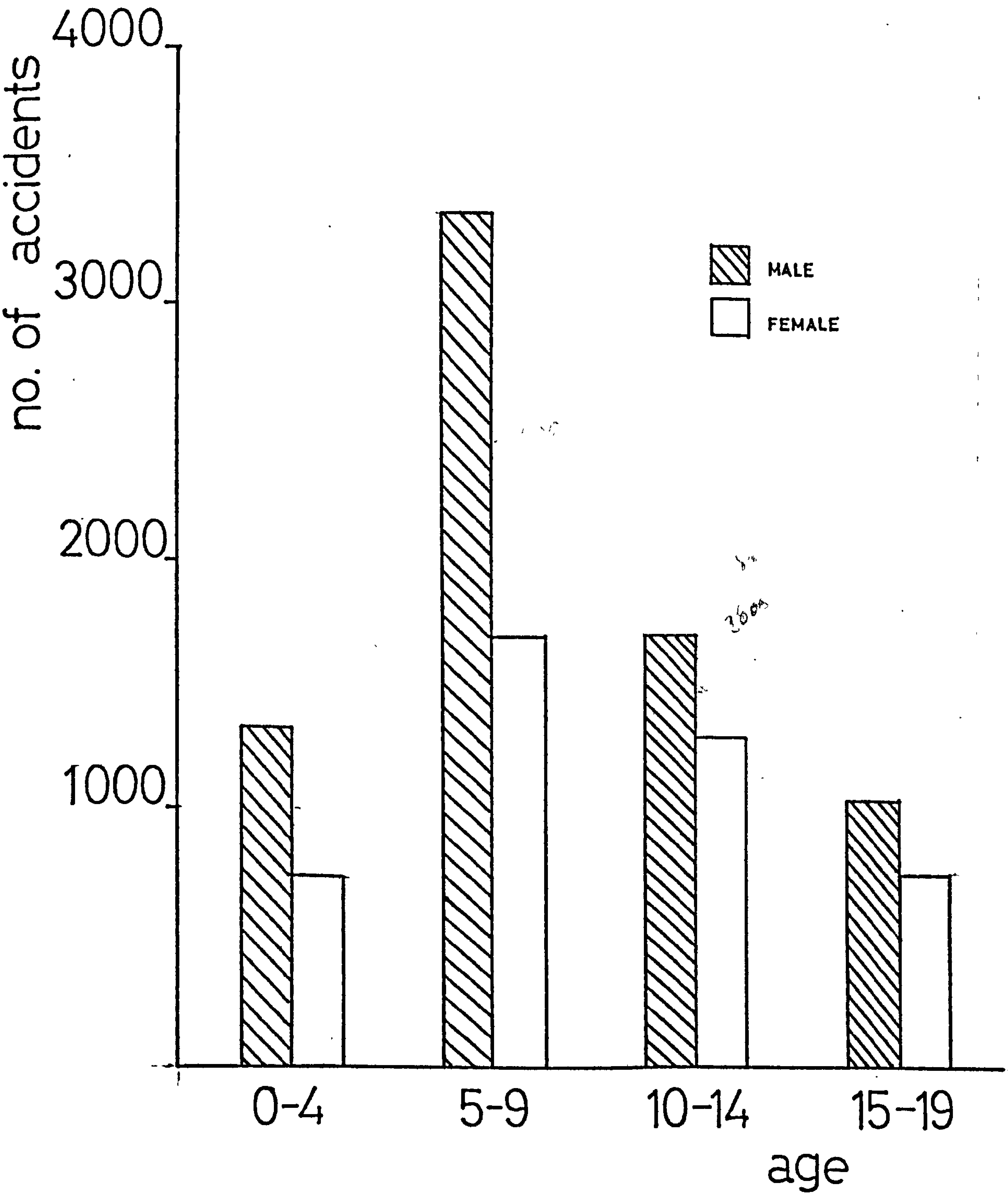
Comprehensive accident data are now collected in most developed countries and epidemiological studies have been used to describe the frequency and distribution of accidents in an attempt to identify common factors in accidents. In this country accident data are gathered by the police authorities and is processed centrally by the Transport and Road Research Laboratory (TRRL), from whom most of the epidemiological studies originate, in the form of an annual review of road accidents entitled

## FIGURE 2

Number of accidents to young pedestrians by sex and age.

Fatal and serious casualties 1975.

Fig. 2



no. of accidents
4000
3000
2000
1000
MALE
FEMALE
0-4
5-9
10-14
15-19
age

Road Accidents in Great Britain (HMSO). The Metropolitan Police, the Royal Society for the Prevention of Accidents and more recently Local Authorities are also active in this area. Havard (1974) summarises the importance of this work: "Until the adverse human and environmental factors have been identified and fully researched there is little chance of introducing the most effective counter measures".

So far just about all that we know about child pedestrian accidents can be summarised as follows:

Long Term Trends. Figure 1, shows that the child pedestrian accident rate for the youngest age group, after reaching a peak in 1967 has been declining steadily since then. The rates for the two older age groups continued to increase until 1970, but are now beginning to decline. (Road Accidents 1975).

Age and Sex. Figure 2 shows the distribution of child pedestrian accidents by age and sex. The number of accidents rise to a peak for both sex groups at around 5 years old, then steadily declines, levelling off at 15 years old. At the critical age (between 4 and 7 years), boys have twice as many accidents as girls but by the time children are 15 years old this difference has disappeared completely. In other developed western countries the picture is much the same. The Swedish Scandia survey (1971) showed that in Sweden the accident rate is greatest in the 3 - 8 year old age group. Yaksich (1960) showed that in the United States the risk is greatest in the 5 - 9 age group. It is probable that the age at which schooling commences, which varies in different countries, may have an important influence on the incidence and distribution of these accidents.

When the accidents occur. The peak time for these accidents is between 4 and 5 p.m. when approximately 20% of them occur. There are smaller peaks between 8 a.m. and 9 a.m. and between 12 noon and 2 p.m., at the times when children would be travelling to and from school, and traffic is most dense. Most accidents occur on Fridays and Saturdays, Sundays have the fewest accidents. There are more accidents during the summer than during the winter, most probably because of the increased time children spend out of doors during these months.

Where the accidents occur. Child pedestrian accidents are predominantly an urban phenomenon. Whereas the majority of adult pedestrian accidents occur on the busy main roads (classified roads) well over half the accidents in the 5 - 14 year age group occur on the less busy residential roads (unclassified roads). Similarly while the majority of adult pedestrian accidents occur in the more complex traffic environments eg. at junctions, children have equal numbers of accidents at and away from junctions. The diffuse nature of these child pedestrian accidents increases the problems of prevention.

A recent report from TRRL, based on a special study of child pedestrian accidents carried out in conjunction with the Hampshire Constabulary, has provided some new and previously unavailable information and it is worth summarising the main findings from this accident sample (Grayson 1975).

Where the children were going. Nearly a third of school aged children were either on their way to or coming from school at the time of the accident. There are no marked age or sex differences as far as specific journeys are concerned. However when the child was reported as having been playing in the street at the time of the accident these differences are pronounced. Nearly twice as many boys as girls were involved in an accident while out playing, and there is a marked decrease in playing accidents with age. Nearly 40% of the pre-school children have accidents while playing and only 7% of the 10 - 14 year olds.

Who they were with. Less than half the children were alone at the time of the accident. A third of them were accompanied either by an adult or by an older child. No sex differences were found.

What they were doing. Only 40% of children claimed they had stopped at the kerb before crossing and 80% were running at the time of the accident. Boys stopped less and ran more frequently.

Type and action of vehicle. In the great majority of cases pedestrians were struck by vehicles which were recorded as "going ahead" at the time of the accident. Few accidents involved turning vehicles.

Side of the road. Two thirds of the accidents occurred on the nearside of the road, the proportion of farside accidents decreased with age.

Drivers of vehicles involved in pedestrian accidents. Little is known about the drivers who collide with pedestrians. On the basis of a statistical analysis of drivers who were involved in accidents with child pedestrians, Howarth, Routledge, Repetto-Wright (1972) suggested that drivers of different ages and sexes may react differently in the accident situation that involves the child pedestrian. A preliminary analysis from an 'on-the-spot' accident follow up study (Storie 1977) has shown that in 86% of all pedestrian accidents the driver is male. A full analysis of the data is to be published shortly.

Considerable research effort has been directed towards studies of social and personality factors of children involved in accidents. The idea that some people are fundamentally worse accident risks than others, forms the basis of many insurance schemes, licensing restrictions and enforcement programs. Ever since Greenwood, Woods and Yule (1919,1920) investigated injury accidents sustained by women workers in munition factories, the concept of "accident proneness" has been widely researched, and arguments as to its existance or to its usefulness as a methodologic approach are unresolved. (Haddon et al 1964, Arbous and Kerrich 1953, Shaw and Sichel 1971). Several studies have been carried out with child "accident repeaters", the most comprehensive clinical study is that of Marcus et al (1960), who concluded that the accident pattern of a group of 23 children who had had 3 or more major accidents, though related to emotional problems, was not related to a specific diagnostic catagory.

Burton (1968) compared the personality characteristics of 20 children aged between 5 and 15 years who had been admitted to hospital following a road accident, with an accident free control group. She concluded , on the basis of a somewhat small sample, that "road accident involvement on the part of the child is rarely a chance occurrence, almost inevitably there is a long previous history of environmental stress and frustration".

Several studies of the social background of accident involved children (Langford et al 1953, Douglas and Bloomfield 1958, Backett and Johnson 1959, Read et al 1963, Ekstrom et al 1966, Burton 1968), suggest that the family environment exerts an important influence upon accidents and that a disturbed home environment may render an individual more susceptible to accidents. The level of intelligence of the child was not found to be a significant factor. However, these studies of personality and social characteristics of accident involved children, tend to be difficult to interpret since the criteria for "accident involvement" and for matching of controls are different in each study, and are best summarised by Routledge (1975). "Invariably these studies have been retrospective, so that any differences found between the accident involved and comparison groups may be a consequence of the children's involvement in accidents. The children's activities, abilities or even personalities may have been altered by their accident involvement, and the assessments of parents and teachers, from which much of the data on which these studies are based, has been obtained, may well be influenced by knowledge of the accident. Finally, very few of the investigators make clear whether the personality and social factors found to be associated with accident involvement are the direct cause of the accident, or simply increase the child's exposure to accident risk".

As a part of a long-term investigation of child upbringing, Newson and Newson (1976) constructed an index of chaperonage from interviews with 700 mothers of 7 year old children. The index was constructed to determine the extent to which children in their everyday experience came under the supervision of their parents. They found significant sex and social class differences and concluded that "....by the age of seven, and in a whole variety of ways, the daily experience of little boys in terms of where they are allowed to go, how they spend their time, and to what extent they are kept under adult surveillance is already markedly different from that of little girls". And "....it is clear that the chaperonage factor discriminates between the different social class groups, so that a descent of the scale involves a falling off of adult supervision". Our own studies of children's exposure to traffic and supervision, (Howarth, Routledge and Repetto-Wright 1974 (b) ) based on comparisons of accounts by both children and parents of the children's movements in the previous 24 hrs., found that parents tend to underestimate the children's exposure. No differences were found between the sexes at this age. The index of chaperonage most probably reflects parents attitudes towards supervision rather than the actual degree of supervision itself.

A road safety survey amongst mothers of children between the ages of 2 and 8 concluded that age was the most important determinant of children's exposure. (Sadler 1972). "The factor which above all affects the chances that a child will play in the street, go on errands and messages, ride a bicycle on the road, walk to school on his own etc. is his age. When he is just two years old he is unlikely to be allowed to do most of these things but by his ninth birthday he will be allowed to do most or all of them". Other factors such as social class, position in the family, the area in which the child lived and sex were found to have little or no influence on the child being allowed on the road for whatever purpose. The incidence of street-playing however, was found to be higher amongst boys than girls.

Road Safety Education.

A new crossing code, the "Green Cross Code", was introduced in 1971. For sometime it had been felt that the "Kerb Drill", which was introduced in 1942, was no longer appropriate due to increases in the volume and speed of vehicles. Pease and Preston (1967) had also found, on the basis of interviews and asking children to act out the kerb drill on an imaginary road, that the children appeared to learn the "Kerb Drill" by rote and tended to misinterpret it. The new crossing code was developed and evaluated by use of a questionnaire and tests of children's ability to follow the code. (Sargent and Sheppard 1974).

The aim of road safety education is to teach children to cross roads safely and so reduce the number of accidents to children as pedestrians. The usual method of designing and evaluating the potential effectiveness of safety campaigns or teaching programs is, in the first instance, to test the children's understanding and recollection of the material presented. After a program has been running for some time , its' effectiveness is assessed by looking at changes in the accident rates. - Or, to put it another way, "using dead or injured children as the dependant variable" (Howarth circa 1972). Apart from some obvious disadvantages, it is notoriously difficult to interpret this type of statistic. Changes in accidents rates are influenced by many factors which are difficult to control for. At the national level, strikes by transport workers or increases in fuel prices can cause fluctuations in overall accident rates. At more local levels fluctuations or downward trends in accident rates may be attributable to a multiplicity of factors, eg. traffic engineering projects, redevelopment schemes or other road safety campaigns. In addition, continual improvements are being made in vehicle design.

It is tempting to attribute the downward trend in accident rates for the younger child pedestrians (Fig 1) to the introduction of the Green Cross Code in 1971, and indeed statistics have been produced to support this (HMSO 1974). However, apart from the limitations of this method of evaluation mentioned earlier, one cannot be certain whether it was the increased publicity and interest generated by the introduction of the code that produced a decrease in accident rates, rather than the content of the code itself. The Green Cross Code is shown in Appendix 1.

Colbourne (1973) has extensively reviewed the earlier studies of road safety education. As she pointed out, few of the studies attempted to show whether road safety teaching had any effect on changing behaviour in a real road situation, or in reducing accidents. There have been some exceptions. Johnson and Munden (1957) assessed the effect of route instruction on junior school children by observing the children outside the school before and after instruction, and found some small positive effects. Ongoing research at the Transport and Road Research Laboratory is designed to assess children's performance on a simulated road network within the grounds of the Laboratory. No results have yet been published.

An alternative approach to the study of Child Pedestrian Accidents.

The studies described here are part of a research project on child pedestrian accidents, directed by C.I. Howarth and funded by the Transport and Road Research Laboratory. From the broad brief "To study factors involved in accidents to young children as pedestrians" two main aims became apparent.

1. Firstly by establishing the causes of pedestrian accidents to young children, preventative measures might be more soundly based.

2. Secondly, to try to identify critera by which to assess the effectiveness of such preventative measures.

It was thought that by studying the normal road crossing behaviour of children interacting with traffic, behavioural factors that could lead to accidents might be identified.

At first sight, perhaps the most obvious approach to the problem of child pedestrian accidents is to study them retrospectively, by carefully examining events leading up to, and surrounding accidents after they occur.

"Accident follow-up" studies, as they are commonly known, have been used successfully for investigating motor vehicle accidents, (Kolbuzewski et al 1969) where considerable information can be inferred from both physical evidence and witnesses reports. This approach is not so useful in relation to child pedestrian accidents since it is difficult to find out about the events leading up to the accident in any detail from witnesses reports alone. Information from the two main witnesses, the child and the driver, will probably be the most unreliable. The driver may not give an accurate testimony due to the possibility of prosecution or he may not even have seen the child before the collision. A child interviewed after being involved in an accident may only have the faintest recollection of the events leading up to the accident.

There have been few studies of children interacting with traffic in normal road crossing. The first reported work was by Sandels (1968) in Sweeden who observed young children going to and from school. On the basis of this study and other related studies she concludes that "It is not possible to fully adapt small children to the traffic environment of the seventies. Therefore the 1970's traffic environment must be adapted to the children. The responsibility lies with our authorities". (Sandels 1972). This may be so, but children will have to cope with traffic from an early age for many years yet to come. Children are now more independent and are allowed greater freedom of movement, it is therefore important that they are able to cope with traffic from an early age.

A systematic methodology for analysing child pedestrian behaviour has been presented by Heimstra, Nichols and Martin (1969). The main emphasis of the study was on developing an analytical system and Heimstra (1971 - personal communication) reported that analysis of 15,000 observations was being carried out. However, our recent attempts to find out about this work have been unsuccessful, which suggests that the study may have been abandoned. Finlayson (1972) filmed children crossing roads outside their schools. She identified children who exhibited dangerous behaviour, and gave them personality tests. Some personality characteristics of these children are consistent with findings reported in studies of accident repeaters. Grayson (1975), extended our method (Routledge, Repetto-Wright and Howarth 1976) of collecting and analysing pedestrians behaviour. By using lampost mounted 16 mm. cameras he observed large numbers of pedestrians and found evidence indicating the use of different crossing strategies by children and adults.

Observation studies of child pedestrians present considerable methodological difficulties, but perhaps the most serious weakness of the technique lies in demonstrating that behaviour, observed and described as unsafe in normal road crossing, is causally related to accidents. None of the studies mentioned have attempted to do this. We do not know, for example, whether "stopping at the kerb", as emphasised by both the old "Kerb Drill" and the "Green Cross Code" and used as a criterion of safe behaviour in the studies described above, is in any way related to accidents. Although "stopping at the kerb", in itself, is clearly not dangerous, this and other studies (Howarth and Routledge 1970, Harrington 1968) have shown that adults stop less frequently than children before crossing a road, yet they have fewer accidents. Before such descriptions of behaviour are used as criteria of safe road crossing behaviour or as instructions in safety education programs, their importance and role as causal factors in accidents needs to be understood.

A partial solution to this problem, and the only practical one, is to relate behaviour criteria to accident risk. This can only be done by attempting to relate measures of children's road crossing behaviour to measures of their accident risk. In order to obtain estimates of accident risk for different groups of child pedestrians, their exposure to potential accident situations must first be known.

It has long been apparent that analytical studies of accident statistics are of little value in evaluating accident risk unless related to adequate measures of exposure to the conditions in which the accident occurred. Jacobs (1961) draws attention to this in an excellent paper on the conceptual and methodological problems of accident research:- "Failure to recognize and deal with this problem (exposure) has resulted in an unfortunate research situation. Analytical results which possess no more than speculative value are being constantly generated". For example it is impossible to know whether young boys have twice as many accidents as young girls because they behave more dangerously when crossing roads or whether they simply cross twice as many roads as young girls. Nor can we determine whether the very much greater number of accidents to pedestrians which occur at road junctions compared to other locations is because crossing at junctions is more dangerous than elsewhere, or simply because pedestrians cross more frequently at junctions. Typically, official accident reports record many details surrounding an accident, yet few of these can provide helpful information for prevention, either as propaganda or planning, unless appropriate measures of exposure are available.

Despite recognition for the need to collect exposure data, studies of pedestrian exposure have been few and far between. Prior to the work of the research group at Nottingham, only two studies had attempted to derive measures of accident risk based on accident rates and exposure. In the first of these, Jacobs and Wilson (1967) compared pedestrian risk in crossing different sections of busy roads in four towns. They found that risk varied with age, children and the elderly being most at risk, but since these comparisons were based on observations and accident statistics for different time periods, they are unlikely to be valid since the distribution of accidents by time of day varies with age. (HMSO 1975).

Levin and Bruce (1968) studied the distribution and location of primary schools in two different contrasting towns. This study makes a considerable contribution to our understanding of the consequences for road safety of different types of road networks. The exposure measures used could not be very precisely compared with the accident statistics and no comparison of accident risk for different age and sex groups were attempted.

Other studies have generated indirect measures of exposure, although none were specifically concerned with child pedestrians. Mellinger and Manheimer (1966) derived exposure measures for children involved in all types of accidents from interviews with parents and hospital records. Their study was concerned specifically with accident repeaters and the measures they developed are not applicable to the study of child pedestrian exposure. The Newson's, in their studies of child rearing practice, have developed an "index of chaperonage" (Newson and Newson 1976) based on interviews with parents and found significant sex differences. However, as mentioned earlier the index is difficult to interpret as a measure of exposure.

Other studies worth mentioning are those of Hole (1966) who looked at play and supervision on estates, and that of Holme and Massie (1970) who compared the location of playgrounds and the journeys made to and from them, by observing and interviewing children. Neither of these studies considered accident risk. Sadler's Survey of road safety among mothers (1972) has already been mentioned. Although providing much useful information on children's journeys and patterns of play, the measures she used cannot be related to accidents to produce useful measures of accident risk.

It was therefore essential to collect data on child pedestrian exposure that can be quantitatively related to relevant accident statistics. In 1972 a statistical model was developed by Professor Howarth to provide a framework for the estimates of risk for different groups of pedestrians crossing at different locations (Howarth, Routledge and Repetto-Wright 1974) and subsequently exposure data was collected in various ways. Children were interviewed at schools and asked what they did during the previous 24 hrs.; maps were drawn from this information showing the children's movements, their accompaniment and the traffic density on the roads they crossed. From this it was possible to estimate the children's exposure for the previous day. The children's parents were interviewed and asked about their children's movements during the previous 24 hrs. Exposure was estimated in a similar way. Parents tended to underestimate the childrens exposure and it was felt that a more accurate estimate of exposure was obtained from the interviews with the children. (Routledge et al, 1974 (b) )

A third method involved directly observing children. Unfortunately data collected by interviews does not provide sufficiently detailed information about where children are crossing and what they were doing. e.g. whether a road is crossed near a parked vehicle or near a junction; the only way to collect this information is to directly observe children crossing roads. Observers were trained to follow a sample of children home from school, recording details of each road crossing on a tape recorder while the children were crossing roads - the children were unaware they were being followed. These early studies of exposure and the development of the conceptual model are discussed fully in the next chapter.

Some early ooservations of children crossing at sites on busy main roads made by Howarth and Routledge (1970) led to studies of gap - acceptance by pedestrians in an attempt to identify easily quantifiable behavioural measures.

"Our very first recording was of about one hundred secondary school children coming out of school across a very busy main road. At first sight their behaviour was horrifying, since they seemed to weave in and out of the traffic in a most dangerous way. They frequently did not pause at the edge of the pavement. When running, they would some times not even slow down at the kerb. We saw fights and games of 'tag' in the middle of the road. We saw children go back into this very busy road to pick up things they had dropped. The first impression was quite terrifying. But on repeated viewing we discovered that in no single instance was a child actually in danger despite the high density of the traffic and the speed and unconcern with which they negotiated it. We ended up being most impressed with their skill and set ourselves to describe its characteristics. We eventually realised that one of the main things which was contributing to the overall impression of recklessness was the way children would appear to be walking into a car, stepping out into the road before it reached them and walking towards it. The moment of perceptual reorganisation and insight came when we realised that this behaviour was not dangerous, on the contrary it was a very important part of their skill, since it enabled them to pass very closely behind a car as it passed them and so maximise the gap between them and the next oncoming car. The decision to cross in any given gap is made before that gap has reached the point at which the pedestrian intends to cross. Having seen this behaviour in these children we now see it is used by adults when crossing busy roads". (Howarth and Routledge, 1970)

Young children and adults were observed also and two features of the children's behaviour that could lead to their greater liability to have accidents were noted.

a) Children were observed running into the road without apparently paying attention to the traffic. This behaviour, commonly called "heedlessness" frequently appears on accident report forms as the cause of the accident.

b) Children were observed also, who paid attention to the traffic but crossed the road inefficiently. They hesitated, made false starts, ran dangerously close to cars even while looking directly at them. This behaviour can best be described as lacking in skill.

The strategies used by adults and older children for crossing roads require a very high degree of skill, involving anticipation, judgement of speed and distance, prediction of future positions of cars and self and smooth unhesitating performance of the act of crossing the road. Children can be observed using adult strategies by the age of 11, perhaps attempting them before they have the skill to use them safely. These preliminary observations suggested that it would be worth making quantitative estimates of the following parameters:

a) The size of gaps in traffic through which children of different ages are prepared to pass, measured as a time interval ($t_a$). The accepted gap.

b) The safety margin between them and the approaching car. This is also measured as a time interval ($t_s$). The safety gap.

c) The overt signs of observing traffic as indicated by head and eye movements before crossing the road.

It was hoped that one or more of these measures of behaviour could be related to objective estimates of risk which would be obtained from the studies of the exposure of children to traffic. If one or more of these measures of behaviour showed a clear relationship to the risk run by the different classes of children and if there was a causal explanation for the relationship, then there would be a simple observational criteria which could be used to assess the effects of safety programs.

This was obviously a very tempting goal and after some initially encouraging results from a study of 200 children aged between 5 and 12 crossing a busy major road, a large scale study of 3000 crossings by pedestrians of all ages was carried out at several sites in Nottingham using a Portable Recorder (Appendix 4) developed specially for the purpose.

The results from these behavioural studies were inconclusive and had not, as hoped for, provided any straightforward measures of behaviour which were clearly related to accident risk. The results of the second, larger scale, study had not supported the earlier expectations. Although differences had been found between the sizes of gaps accepted by different groups of the older child pedestrians, which correlated with accident risk, there were no differences for the groups of younger pedestrians where the difference in accident risk was greatest. Also, although the younger children appeared to be crossing less efficiently, this was not reflected in terms of smaller safety margins. It became apparent that the behaviour of the different groups of pedestrians was confounded by the site at which the observations were made. e.g. Some observations were made at sites where there were only older children crossing, while others were made at sites where only young children crossed. In order to eliminate this effect, observations have to be made at sites where all ages of pedestrians can be observed crossing at the same times.

The studies described here take this as a starting point. The overall aims of the research were twofold. Firstly, by seeking causal explanations for the large numbers of accidents to child pedestrians, preventative measures can be more soundly based. Secondly, by developing behavioural measures, related to accident risk, the effectiveness of preventative measures may be assessed. To achieve these aims the relationship between children's behaviour and their accident risk must be understood, and this can only be done by attempting to relate measures of children's road crossing behaviour to measures of their accident risk.

Three studies have been carried out:

a) <u>A Random Site Exposure Study</u>.

A technique has been developed to produce estimates of risk which can be related to different traffic situations over a wide range of locations.

b) <u>An Analysis of Pedestrian Behaviour</u>.

A detailed observation study of pedestrians of all ages crossing at the same site in order to develop useful behaviour measures.

c) <u>Relationship Between Behaviour and Accident Risk</u>.

A large scale study to relate children's crossing behaviour to their accident risk for a wide range of crossing locations.

# CHAPTER 2

## EXPOSURE TO ACCIDENT RISK

A Conceptual Framework for the Analysis of Accident Risk.

Whenever a child enters the roadway, he is putting himself into a potential accident situation. This forms the basis for a conceptual framework of accident risk devised by Professor Howarth and reported by Howarth, Routledge and Repetto-Wright (1974). A full mathematical treatment is given in Appendix 1, and only a summary of the main points appears here. The conceptual framework is applicable to pedestrians of all ages, not just to child pedestrians.

Two measures of risk are defined which can be derived from measures of exposure and accident rates.

The first, $P_{a/r}$ is the probability of a child having an accident when he crosses a road, and is defined as follows:-

$$P_{a/r} = \frac{P_a}{\bar{r}}$$

For a given class of pedestrian, where $P_a$ is the probability of randomly selecting a pedestrian who will have an accident during a given time period, and $\bar{r}$ is the mean number of roads crossed or entered by such a pedestrian in the given time period. The quantity $P_a$ can be derived from available accident statistics by dividing the accident rate for the given time period by the number of pedestrians in the relevant catagory. $\bar{r}$, a measure of exposure, remains to be estimated.

Since $\bar{r}$ refers to the existing pattern of road crossing, $P_{a/r}$ calculated in this way will be the average risk run by children for their present pattern of road crossing. Not all these roads will be equally dangerous to cross, and the main reasons for this are obviously variations in traffic density and speed of vehicles. These factors can be taken into account by observing the density of traffic and the speed of vehicles on the roads crossed by children. The proportion of roadway taken up by traffic can be calculated from the equation:-

$$P_c = \frac{1 + vt_c}{S}$$

where l is the average length of vehicles, S the average spacing, v the average velocity and $t_c$ the time taken by a child to cross the path of a vehicle. Thus $P_c$ is an approximation of the probability that a child will be hit by a vehicle if he enters the roadway at random. As such, it is a measure of the exposure of a child who attempts to cross a particular road, and is independent of the ability of the child or the driver of the vehicle to avoid an accident.

Weighting each road crossing by the quantity $\bar{P}_c$, the average exposure of a given class of children will be given by $\bar{r}\,\bar{P}_c$, for a given time period, where $\bar{P}_c$ is the average of $P_c$ for all the children and the roads they cross. This quantity, $\bar{r}\,\bar{P}_c$, is therefore the average number of vehicles encountered by each child during the given time period, and has been called $\bar{n}_c$.

The second measure of risk, $P_{a/c}$, is the probability of a child having an accident if he encounters a car as he crosses a road and can be estimated as follows:-

$$P_{a/c} = \frac{P_{a/r}}{\bar{P}_c} = \frac{P_a}{\bar{r}\bar{P}_c} = \frac{P_a}{\bar{n}_c}$$

The calculation of $P_{a/c}$ assumes that no child will have more than one accident per encounter with a car, when the number of possible encounters with a car is defined by the way $P_c$ was calculated. It also assumes that the behaviour of children and drivers can only reduce the accident rate. Since hesitation, bad judgement, slowness and falls could all increase the rate above that calculated from $P_c$, it may be less like a probability than the other two and it should be used cautiously.

Accompaniment and Protection.

Children frequently cross roads with adults or with older children. It would seem probable that a young child is less exposed to risk when he is accompanied by an adult. He may also be less at risk when with an older child, although this is a more questionnable assumption. Young children, in particular, may be protected by older brothers and sisters, especially on journeys to and from school, but groups of children may distract each other, rather than protect one another. This raises the question of weighting exposure measures when children are accompanied by other pedestrians.

Unfortunately no information on accompaniment at the time of the accident is included on accident report forms (Stats 19). Pedestrian accident victims are classified only by age and sex. If this information was available, suitable values of $P_a$ could be used to calculate risk measures for groups of accompanied and unaccompanied child pedestrians. The only information about accompaniment at the time of the accident comes from a study of 474 child pedestrian accidents, carried out by the Transport and Road Research Laboratory with the assistance of the Hampshire Constabulary (Grayson 1975). In a supplement to the standard accident report form filled in by police officers when investigating child pedestrian accidents, an attempt was made to find out whether the child was accompanied at the time of the accident. This was done, where possible, either by interviewing the child involved or "reliable" witnessess.

The results indicated that less than half the children were alone at the time of the accident. A third of them were accompanied by either an adult or an older child although this was less common with older children. More than a third of the pre-school children were accompanied by adults at the time of the accident. No significant differences were found between the sexes.

This data is reproduced below (Table 1), and provided the assumption is made that this data, gathered only in Hampshire, can be generalised to other parts of the country, we have a basis for weighting $P_a$ by accompaniment. It should be pointed out, however, that weightings based on relatively uninformed assumptions about the nature of accompaniment or the protection offered by accompanying pedestrians must be treated with caution. When data becomes available from a more detailed Transport and Road Research Laboratory accident "follow-up" study being analysed presently (Storie 1976), it may be possible to weight accident data for accompaniment more reliably.

TABLE 1

Accompaniment by age (percentages)

| | | AGE (years) | | |
|---|---|---|---|---|
| | ALL | 0-4 | 5-9 | 10-14 |
| Alone | 44 | 32 | 44 | 54 |
| With adult | 12 | 38 | 8 | 4 |
| With older child/ren | 20 | 22 | 22 | 11 |
| With other child/ren | 24 | 8 | 26 | 31 |
| Total | 100 | 100 | 100 | 100 |
| BASE | 464 | 85 | 262 | 117 |

Exposure data that is collected by interview or questionnaire can only be weighted in this manner. Nothing is known about the nature of the accompaniment or the protection afforded by the accompanying pedestrian, e.g. when a child says that his mother collected him from school and took him home, one does not know whether they crossed the roads holding hands or whether the child was 100 yards in front of his mother, and she busy talking to a friend. Exposure data gathered by directly observing child pedestrians opens up the possibility for an alternative method of weighting. A subjective assessment of whether an accompanied child is protected when he crosses a road can be made fairly simply. It is thus possible to weight each road crossing on the basis of whether the child was responsible for making the decision to cross a road on his own, rather than relying on anothers judgement. It is still not possible to make an estimate of the absolute reduction in risk provided by others, with which to weight the exposure measures, but these accounts can be used to describe the role played by the child in crossing the road.

Measures of exposure that do not take accompaniment or protection by other pedestrians into account can be thought of as measures of "potential" exposure. e.g. Suppose a child lives 1 mile from his school and the journey involves crossing several minor roads and one major road. The "potential" exposure of the journey can be calculated by disregarding accompaniment and protection. If he makes this journey by himself and uses no crossing aids, e.g. a crossing warden, his "real" exposure on this journey will be equal to his "potential" exposure. If, however, his mother accompanies him across the main road and he only crosses one minor road alone, his "real" exposure will be much less than the "potential" exposure of the journey. The concept of "real" and "potential" exposure is useful in making comparisons of the degree of protection children of different ages and sex recieve on different types or journeys.

The actual methods of weighting for accompaniment or protection adopted for the different exposure studies are discussed later. A brief description of the early exposure studies and a discussion of the advantages and limitations of each technique follows.

Early Exposure Studies.

A. Interviews with Children (Routledge, Repetto-Wright and Howarth, 1974a).

In our first study we interviewed a carefully selected sample of 280 children aged between 5-11 years, about every journey they had made during the previous 24 hours. The sample was designed to cover all types of housing area of children in this age group in the City of Nottingham (total population approximately 300,000). Children were interviewed in their schools by interviewers who had previously familiarised themselves with the area in which the child lived, and the area surrounding the school. Every journey and excursion reported was recorded on a map, with additional details (accompaniment, journey, purpose, etc.) on the questionnaire schedule, and traffic density counts taken on every road crossed.

B. <u>Interviews with parents</u> (Routledge, Repetto-Wright and Howarth, 1974a).

A randomly selected sample amounting to a quarter of the parents of children in the child sample were interviewed. It was not possible to interview the parents about the same 24 hours that the child interview referred to, but estimates of $\bar{n}_c$ and $\bar{r}$ were obtained in the same way, by recording the number of roads crossed on journeys reported, and combining traffic densities of those roads at the appropriate times. Additional information about the parent's attitudes to road safety was obtained.

C. <u>The "Following" Study</u> (Routledge, Repetto-Wright and Howarth 1974b).

A sample of 144 children, identified by coloured badges pinned to to their outdoor coats by their class teacher were discreetly followed home from school in the afternoon by female observers who recorded on concealed tape recorders, information about every occasion that the child entered the carriageway. The subsequent day each child in the sample was interviewed, using the schedule used in the child interview study, about every journey made in the previous 24 hours. Again traffic counts were taken on all roads crossed. Measures of $\bar{r}$ and $\bar{n}_c$ derived from the observation and interviews were compared.

<u>Advantages and Limitations of Each Method.</u>

A. <u>Interviews with Children: Advantages</u>.

1. Estimates of exposure for a period of up to 24 hours or for specific journeys, such as the journey to or from school, can be obtained. The

longer the time period for which accurate estimates of exposure can be obtained, the more reliable the accident statistics to which they are to be related, expecially if a relatively small area is being studied.

2. The precise age of each child in the sample will be known. Since the accident rates change so rapidly between the ages of 5 and 11 precise knowledge of each individual's age is valuable.

3. If the sampling is based on schools, up to 12 children a day can be interviewed about their activities in the previous 24 hours, by one person using the schedule.

4. Additional information about attitudes, knowledge of road safety and related matters can be obtained from the child at the same time as exposure data.

5. A comparison of child and parent interviews and observations (Routledge, Howarth and Repetto-Wright 1974a, 1974b) shows that children provide a more accurate account of their exposure than do their parents. It is probable that parents underestimate the extent of their children's exposure and that this underestimation increases with the child's age and consequent greater independence.

Interviews with Children: Limitations.

1. The method is entirely dependent on the accuracy of the child's report. We have evidence (Routledge, et al 1974b) that repeated questioning by an interviewer familiar with the area can obtain accurately an account of deliberate journeys. Questioning the child about the previous evening's television programmes proved quite an effective means of determining non-exposure after the school journey, but the method underestimates the exposure of children playing out and occasions when children enter the carriageway other than to cross the road. For this reason the method is probably limited to providing exposure data for school days only.

2. Child interviews are limited to a minimum age of 5 years at most.

Fortunately at the age of five very few children appear to be much exposed, especially on school journeys.

3. The protection afforded to the child by a person said to be in accompaniment is sometimes difficult to assess.

4. The attraction of being able to interview conveniently large numbers of children in a school, and for the interviewers to thoroughly familiarise themselves with the local areas is reduced, since it prevents a truly random sampling of children, in a large area such as a city. The accuracy of the sample is entirely dependent on the representativeness of the schools selected.

5. Traffic density counts must be taken on days other than those to which the interviews relate.

B. Interviewing Parents of Children. Advantages.

1. Estimates of exposure over fairly long specific periods can be obtained as with the child interviews, but in addition more general information concerning what the child "usually does" can be obtained.

2. Information about the child's activities at weekends can be obtained, whereas the children had difficulty giving a coherent account of their activities at the weekend when questioned on Monday mornings.

3. As with the child interviews the precise age of each child in the sample is known. Parents can also provide additional information about social and environmental circumstances, and their own attitudes and behaviour regarding road safety, which is unobtainable from the child interviews.

Interviewing Parents of Children: Limitations.

1. Our comparisons indicate that parents tend to underestimate their children's exposure, particularly as the children get older. For example many parents reported that their children went to school by the most obvious and direct route whereas the children reported detours to shops and to call for friends.

2. As with the child interviews no direct measures of the protection afforded by accompanying persons is obtainable. In a number of cases the mother reported that the child was accompanied by an older sibling whereas the child, although agreeing that they left the house together, claimed to have separated on the journey.

3. As with any other survey in which the sampling technique requires that specific individuals be interviewed, obtaining a large sample of parent interviews is time consuming and costly, compared to child interviews in school. For this reason the advantages of stratifying the sample by schools as in the child interviews is not as great, and may be outweighed by the greater accuracy of a truly random sample.

4. As with child interviews, traffic density counts must be taken on days other than those to which the interviews refer.

C. "Following" Study: Advantages.

1. The child is selected in school, therefore the age and other information about the child can be obtained.

2. While the child is observed exposure can be very accurately recorded. For example, playing in the road or gutter, which is omitted from interview responses, can be reported.

3. The accompaniment of the child on each occasion the child enters the carriageway, and even subjective estimates of the protection afforded by any accompanying person can be reported.

4. The precise location of every crossing, for example at a junction or close to a parked vehicle is known.

5. The child's behaviour, and events leading up to road crossing, for example, whether the child stopped at the kerb, ran into the road, was playing or chasing, and to an extent, although not very accurately, whether or not the child looked adequately, can be recorded. In addition, since most children will cross more than one road, an estimate of individual variability in behaviour when crossing is available.

"Following" Study: Limitations.

1. If the children observed are to be randomly selected from school registers, and if their precise age and probable destination on the journey are to be known, considerable co-operation from school staff is required.

2. As with the interview surveys, sampling will again be within a sample of schools, with a consequent reduction in accuracy compared to a truly random sample of children.

3. This technique can probably realistically be adopted only with school children and then only to record exposure on short predictable journey's e.g. after leaving school.

4. The method is rather impracticable for obtaining a very large sample of children. Our experience indicates that a maximum of four observers a day can work at each school. Assuming that the younger children leave school well before the older children each observer can record the activities of, at most, two children.

5. Again traffic density counts must be taken on days other than those when observations were recorded.

An Alternative Technique for Collecting Exposure Data.

Three different methods of collecting exposure data had been used. Of these, only the "following" study estimated exposure from direct observations of children crossing roads, and so provided estimates of risk for different crossing situations, e.g. crossing near parked vehicles or at junctions. The limitations of this technique have been discussed already and it is, unfortunately, neither sufficiently flexible nor cost effective for application on a wider or larger scale. If areas of high risk associated with crossing roads can be identified easily, the considerable financial resources available for pedestrian safety programs and urban planning can be concentrated where they are most needed. For example considerable sums of money are spent on replacing existing 'zebra' crossings by 'pelican' crossing. A technique that enables traffic engineers to easily identify those existing crossings where pedestrians are exposed to high levels of risk could form the basis for a more rational replacement program. At the same time the effectiveness of this new type of crossing could be evaluated, something that has not yet been done adequately.

To meet these requirements a technique is needed that combines the advantages associated with direct observation of pedestrians with a simpler and more flexible sampling procedure. The random site exposure technique was developed for this purpose.

The major problems, of complex administration and lack of flexibility, associated with the following study, stem from the adoption of the 'child' as a sampling unit. By using "road length" as a sampling unit, and observing pedestrians crossing within specified lengths of road, we have a basis for a different technique for collecting exposure data. There are several advantages in this approach:

a) Sampling, a time consuming and nerve racking business in "following" studies, is fast and flexible. Any selected area can be sampled, e.g. comparisons could be made between different types of housing or between towns with different accident rates. (A study of exposure in 3 different towns, being analysed currently, is discussed in Chapter 6). Specific types of roads or 'crossing aids' could also be sampled.

b) Approximately 3 times more crossings by children can be recorded per observer hour than in "following" studies, in addition to obtaining data for pedestrians of all ages.

c) Sampling periods are not restricted to school term time weekdays, neither to short periods of the day.

d) Since it is not necessary to sample children from schools, there are no problems in selecting representative schools and no administrative work required with headmasters and teachers.

e) Observer training is relatively straightforward and no expensive recording equipment is required. Large numbers of observers can be used.

f) Traffic density counts at the observation sites can be made simultaneously or imediately after observations of pedestrians, rather than on different days.

g) Pedestrian behaviour can be observed at the same time.

There are, however, some disadvantages associated with the adoption of'road length' as a sampling unit.

a) It is only possible to estimate variability in pedestrian exposure for different crossing sites or types of site. It is not possible to estimate individual variability as with the earlier studies, since repeated observations of individuals are not made.

b) The ages of the pedestrians must be guessed. There is a particular problem in estimating children's ages, but it can partially be overcome since children of different ages frequently leave school at different times during the afternoon. For example, in Nottingham, it is unusual to see children older than 7 years in the street before 4 p.m. (unless of course they are playing truant). This problem is not so acute when the data is analysed by age group.

c) It is necessary to know or guess in advance how busy a site will probably be, since at sites where pedestrian density is particularly high one observer is unable to cope.

The Random Site Exposure technique has been developed and is used in the study of pedestrians exposure to risk discussed in the next chapter.

# CHAPTER 3

## RANDOM SITE EXPOSURE STUDY.

Introduction and Methodology.

The aim of the Random Site Exposure Study was to develop an inexpensive and staightforward method of estimating pedestrian exposure and risk and more specifically:-

1. To provide estimates of exposure for pedestrians of all ages.
2. To obtain estimates of risk for different crossing situations.
3. To determine where and how frequently children are accompanied and the extent to which they are protected from traffic when accompanied. e.g. How frequently are children really protected from traffic when crossing a road with an adult.
4. To observe the behaviour of pedestrians crossing roads so that an attempt can be made to estimate the importance of 'heedless' behaviour as a cause of accidents.

The reasons for developing a technique which uses 'road length' as a sampling unit have been fully discussed in the previous chapter.

A pilot study was carried out in a section of Nottingham which represented a variety of residential areas. A computer-generated graphic display of random dots was superimposed on a map of this area. Eighteen sites were selected where dots fell squarely in the centre of a road. Observers were positioned at these sites for a 1 hour period between 15.30 and 16.30 hours one schoolday, and were instructed to record the approximate age, sex and accompaniment of all pedestrians crossing within a 20 yd. length of roadway. Approximately 1,000 pedestrians were observed crossing, 50% of whom were judged to be under 14. No major difficulties were reported by the observers in spite of adverse weather conditions and poor light. 1.2 crossings per minute per 20 yd. of roadway were observed. This figure was considered somewhat high owing to the characteristics of the small sample which included several particularly busy crossing sites at junctions. However the feasibility of this approach was established.

For the main study 7 female observers were employed, each of whom had their own transport. 4 had been observers for the "following" study and had gained considerable experience in this type of work. All were provided with scale maps of each site and recording sheets, together with an instruction sheet for reference purposes. (Appendix 3). They were required to locate a specific site, measure out a length of roadway, and to observe road crossings in this length of roadway over a set time period.

Several training sessions were held. It was not possible to carry out a comprehensive evaluation of observer agreement due to considerations of time and cost. However, all the observers were asked to score 20 crossings from a video recording of pedestrians crossing at a particular site. There was generally a high level of agreement on all measures. The subjective judgements of whether the pedestrian looked adequately or crossed heedlessly were the least reliable.and are discussed later. Observers also went out together to the same sites, making their observations independently, and their reports were compared.

The sample of sites was obtained by superimposing a computer-generated graphic display of random dots on a street map of Nottingham City. After experimenting with various dot densities a display with 1,920 dots per square metre was used, superimposed on a map with a scale of 1 cm : 140.8 m ($4\frac{1}{2}$ ins. to the mile). A sample of 200 sites was generated where the dots fell squarely in the centre of roads. This was further reduced by random sampling to 190 sites. Using 7 observers 35 sites could be observed each week, (1 observer per site). It was planned to complete the study during 8 weeks of the school summer term - the maximum number of weeks available, avoiding the beginning and end of term and half term. This size sample gave some spare capacity for doubling up at sites or for observer illness.

Initially observers were instructed to sample a 20 yd. length of road. This was found to be wasteful since at the majority of sites few pedestrians crossed. The observers could quite easily cover a 60 yd. length of road and the sample space was consequently increased for the remaining 155 sites. At sites where high pedestrian densities were anticipated or found on arrival the 60 yd. length of road was divided into suitable sections and extra observers were used. In the latter case where high pedestrian densities were found by the observer on arrival, the additional observations were made the following week at the same time of day. This method was found to be the best compromise in terms of time, cost and reliability of observations. Extra observers were utilised at approximately 5% of the sites.

Selection criteria for the sample 60 yds. of roadway were specified for different road configurations. Where a dot fell directly in the centre of an intersection, a random decision was made as to which road would be used by tossing a coin. Where areas had been redeveloped alternative sites were randomly selected from the sample. Every attempt was made to update the map with new housing developments.

The total mileage of streets in Nottingham City (obtained from the Town Planning Department) was 405.94 miles. The 190 sites sampled covered a total road length of 5.68 miles.(10,000 yds.), this represents a 1.4% sample of all roads in Nottingham City. The raising factor for the sample was 72.45. The two sample periods used were 15.30 - 15.50 and 16.00 - 16.20 hours. Relevant accident statistics were obtained from the Accident Analysis Division at the Transport and Road Research Laboratory.

Observations during both sampling periods were made at the same site on the same day, each observer visiting one site per day.

The site maps showed the location and layout of each observation site, a cross was marked at the mid-point of the site. On arrival at a site the observer would locate this point and pace out a 60 yd. length of roadway, (observers had previously counted the number of paces they took to cover 60 yds.) marking the crossing site by use of suitable landmarks. The observers arrived at each site 10 minutes before the start of the observation period so that they had time to mark out the site and to decide upon the best place to stand. Care was taken to ensure that the observers parked their cars well away from the crossing sites so as not to introduce additional parked vehicles. This technique has subsequently been improved by marking out the sites beforehand.

Observations fell into two categories.

a. <u>Site Variables</u>

| | |
|---|---|
| Site identification number. | |
| Sampling period. | 3.30 - 3.50 or 4.00 - 4.20 |
| Weather conditions. | Dull-fine/wet-dry |
| Crossing location. | i) Crossing at (within 20 yds.) or not at junction.<br>ii) Crossing masked or unmasked by a stationary vehicle. |
| Other special features | e.g. Traffic warden, etc. |

b. <u>Pedestrian Variables</u>

| | |
|---|---|
| Crossing identification number | |
| Age | Estimated to within 1 year. |
| Sex | |
| Accompaniment | Alone or with other pedestrians (also classified). |
| Degree of Protection | Alone, accompanied by an older pedestrian but not protected from traffic by them, accompanied by an older pedestrian and protected from traffic by them. |
| Movement | Running or walking. |

| | |
|---|---|
| Looking | Looking for traffic or not looking. |
| Care taken in crossing | Taking adequate precaution, some precaution, or would probably have been hit by a passing vehicle. |
| Direction of crossing | |
| Other features of crossing | e.g. Pushing a pram, etc. |

A sample recording sheet is shown in Appendix .

Traffic density counts were taken at each site during the 10 minutes immediately following each 20 minute observation period. Vehicles were counted separately for each side of the road. At junction sites, where pedestrians could cross in different places,the traffic density was recorded at each crossing site.

Obviously it would have been preferable to record the traffic density at the same time as making the observations, but this would have been impractical and costly. Observers were asked to look out for gross changes in traffic density between the pedestrian observation period and the traffic observation period. This only occurred in one case when some factory gates opened at 4.25 and flooded an otherwise deserted road with dozens of vehicles, additional observations were made in this instance.

The data from observers recording sheets was punched onto cards, one card per pedestrian. The data was analysed on the University of Nottingham's ICL 1900 computer using the Statistical Package for Social Sciences. (Nie N, Bent D.H.,Hadlai Hull C. 1970) an integrated system of computer programs for the analysis of social science data.

Since the sample unit was 'road length' and not 'child' the exposure estimates have to be calculated in a different way.

For each road crossing or excursion into the carriageway observers recorded the road type (A. B. C. or others), and whether the pedestrian was within 20 yds. of a junction or masked by a stationary vehicle.

This was in accordance with the official accident reporting format.

By counting the number of pedestrians in different age and sex groups crossing the road or going into the carriageway at the sample sites, and from a knowledge of the total length of roads in Nottingham City, estimates of $\bar{r}$ can be obtained, the mean number of roads crossed by a pedestrian of a particular age or sex, (hereafter a road crossing is taken to include excursions into the carriageway) in Nottingham during two 20 minute periods, commencing at 3.30 and at 4.00.

For a particular age/sex group.

$$\bar{r} = \frac{\text{Observed number of road crossings x Raising factor for sample}}{N}$$

$$= \frac{\text{Observed number of road crossings}}{N} \times \frac{l_R}{l_r}$$

Where $l_R$ = Total length of roads in Nottingham City.

$l_r$ = Total length of roads in Sample.

N = Population of Nottingham City for the relevant age/sex group.

Similarly, from a knowledge of the traffic density at each site, an estimate of $\bar{n}_c$, the mean number of vehicles encountered by a pedestrian of a particular age or sex, can be calculated for each observation period.

For each (individual) road crossing $p_c$, the probability of encountering a vehicle when crossing the road is given by:

$$p_c = \frac{l + vt_c}{s}$$

| | | | |
|---|---|---|---|
| Where | $l$ | = mean length of vehicles | (15 ft.) |
| | $v$ | = mean velocity of vehicles | (32 ft/sec.) |
| | $t_c$ | = mean time to cross | (1 sec.) |
| | $s$ | = mean spacing of vehicles | |
| | $s$ | $= \frac{vT}{V}$ | |

Where $T$ = time of traffic count

$V$ = No. of vehicles passing during time T.

For oneway traffic

$$p_c = \frac{V(1 + vt_c)}{vT}$$

For twoway traffic

$$p_c = \frac{1 + vt_c}{vT} \left\{ (V_N + V_o) - V_N . V_o \frac{(1 + vt_c)}{vT} \right\}$$

Where $V_N$ = No. of vehicles passing on nearside during time T.

$V_o$ = No. of vehicles passing on offside during time T.

For a particular group we have for the sample

$$\bar{p}_c = \sum \frac{p_c}{n}$$

Where $n$ = no. of roads crossed.

An estimate of $\bar{n}_c$, the mean no. of vehicles encountered by a pedestrian of a particular age/sex group in Nottingham City, during the two 20 minute periods is given by:

$$\bar{n}_c = \bar{p}_c . \bar{r}$$

It is not possible to calculate measures of variability for $\bar{r}$ and $\bar{n}_c$ for pedestrians of different age/sex groups. The sampling unit is 'road length' and only the total number of pedestrians crossing in a particular time are known. Since pedestrians are actually observed crossing roads two different methods of weighting for accompaniment are possible.

1. Observers recorded who was with a particular child as he sets off from the kerb. Groups of pedestrians

forming on the kerb by chance while waiting to cross were not recorded as accompanying each other. Each road crossing was weighted depending upon the type of accompaniment. The following categories were used:

| | Weighting factor. |
|---|---|
| Alone ... ... ... ... ... . | 1 |
| Group - with 0 - 7 years old ... . | 1 |
| - with 8 - 14 years old ... . | ½ |
| - with adult (over 15 years old). | 0 |

These weightings factors were used in order to compare the results of this study with previous studies. Although as has been discussed in the previous chapter, a better weighting scheme, based on child pedestrians accompaniment at the time of the accident is now possible, this data was not available when the previous studies were analysed.

2. Observers recorded to what extent pedestrians were protected when they crossed a road with another person. From previous observations we had noted that, although children might be with an adult, they may effectively cross the road independently. It is often the case with groups of mothers taking children home from school, they talk amongst themselves and leave the children to their own devices. Each road crossing was weighted depending upon the degree to which the pedestrian was protected. The following categories were used:

| | Weighting factor. |
|---|---|
| Alone ... ... ... ... ... . | 1 |
| Group - Crossing independently ... . | 1 |
| - Protected by another person . | 0 |

The second method of weighting best represents the true exposure of children crossing roads and is used throughout the analysis, except when comparisons are made with previous studies.

Results.

5589 road crossings were observed at 190 sites between 3.30p.m. and 3.50p.m. and 4.00p.m. and 4.20p.m., nearly half of these were made by children under 15 (2485). Exposure and risk measures were calculated for Infant and Junior school children in two ways. Detailed tables of the results described here can be found in Appendix 3.

a) Exposure measures were calculated from the number of road crossings made during the 20 minute period after school ended. The bulk of these road crossings were made by children on their way home from school. Risk measures were estimated by using National Accident Statistics for these two 20 minute periods.

b) The data for the two observation periods were combined and exposure and risk measures were calculated for all pedestrians broken down by age, group and sex.

The data for 7 year olds have had to be omitted from this analysis. The purpose of obtaining these measures of exposure is to relate them to the relevant accident statistics to obtain measures of risk. Approximately half the children who were 7 years old at the time of this study were in Infant Departments, leaving school at 3.30p.m. each day, and the remainder were in Junior Departments, leaving at 4.00p.m. Since the precise proportion of 7 year olds leaving school at 3.30p.m. is not known, and it is certainly not known what proportion of these are still on the streets at 4.00p.m., and so still at risk, measures of exposure for 7 year olds cannot be meaningfully related to the relevant accident statistics for these time periods.

a) Children's exposure and risk during the 20 minute period after school ends.

Figure 3 shows $\bar{r}$, an estimate of the mean number of roads children cross in the 20 minute period after school ends, using both accompaniment weightings. $\bar{r}$ increases with age, boys crossing more roads than girls, the older children cross approximately twice as many roads as the younger children when $\bar{r}$ is weighted for protection. The effect of the protection weighting is to increase $\bar{r}$ for the older children; as children get older, although accompanied by older children and adults, they are more likely to participate actively in crossing the road themselves. This effect is consistant with findings of the earlier "following" study. (Howarth, Routledge, Repetto-Wright 1972).

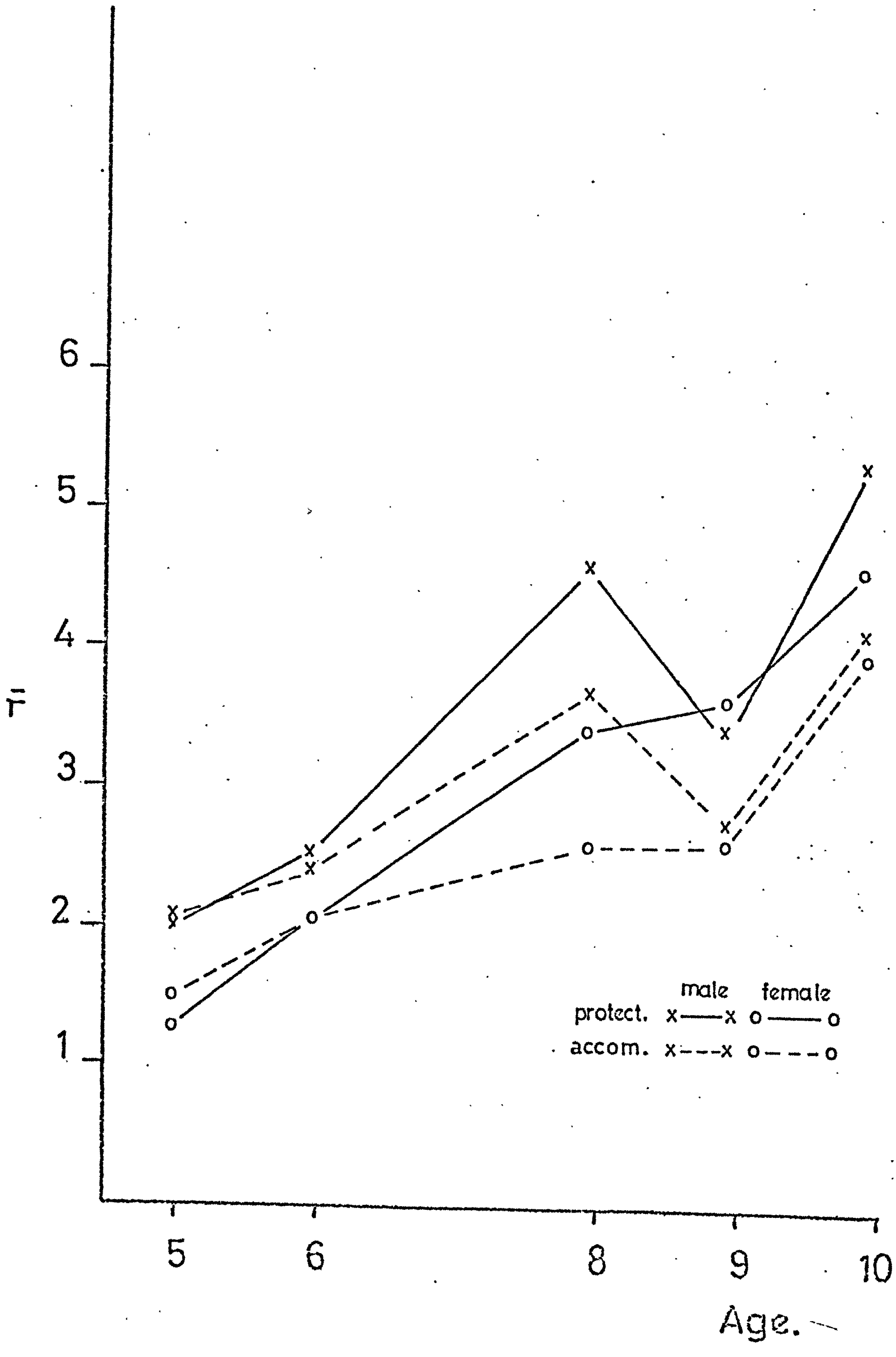
Figure 4 shows $\bar{n}_c$, an estimate of the mean number of cars encountered, using both accompaniment weightings. $\bar{n}_c$ also increases with age, but there is no difference between exposure of the older boys and girls, yet from Figure 3, the young boys are crossing more roads. There are two possible explanations. Girls may cross relatively more on busy roads and so increase their exposure, or alternatively the boys cross more quiet roads and so do not appreciably increase their exposure - since crossing a road with little traffic has a very small effect on the value of $\bar{n}_c$. An analysis of these exposure measures by road type suggests that the latter is true. The effect of the protection weighting is to increase the exposure of all the children. The protection weighting has been used throughout this analysis for the calculations of the measures of risk.

Figure 5 shows $\bar{r}$ and $\bar{n}_c$ for Major (A and B roads) and Minor (other) roads, (Table 1, Appendix 1). Approximately 10 minor roads are crossed

## FIGURE 3.

$\bar{r}$ an estimate of the mean number of roads crossed by Nottingham children during the 20 minute period after school ends weighted by accompaniment and protection.

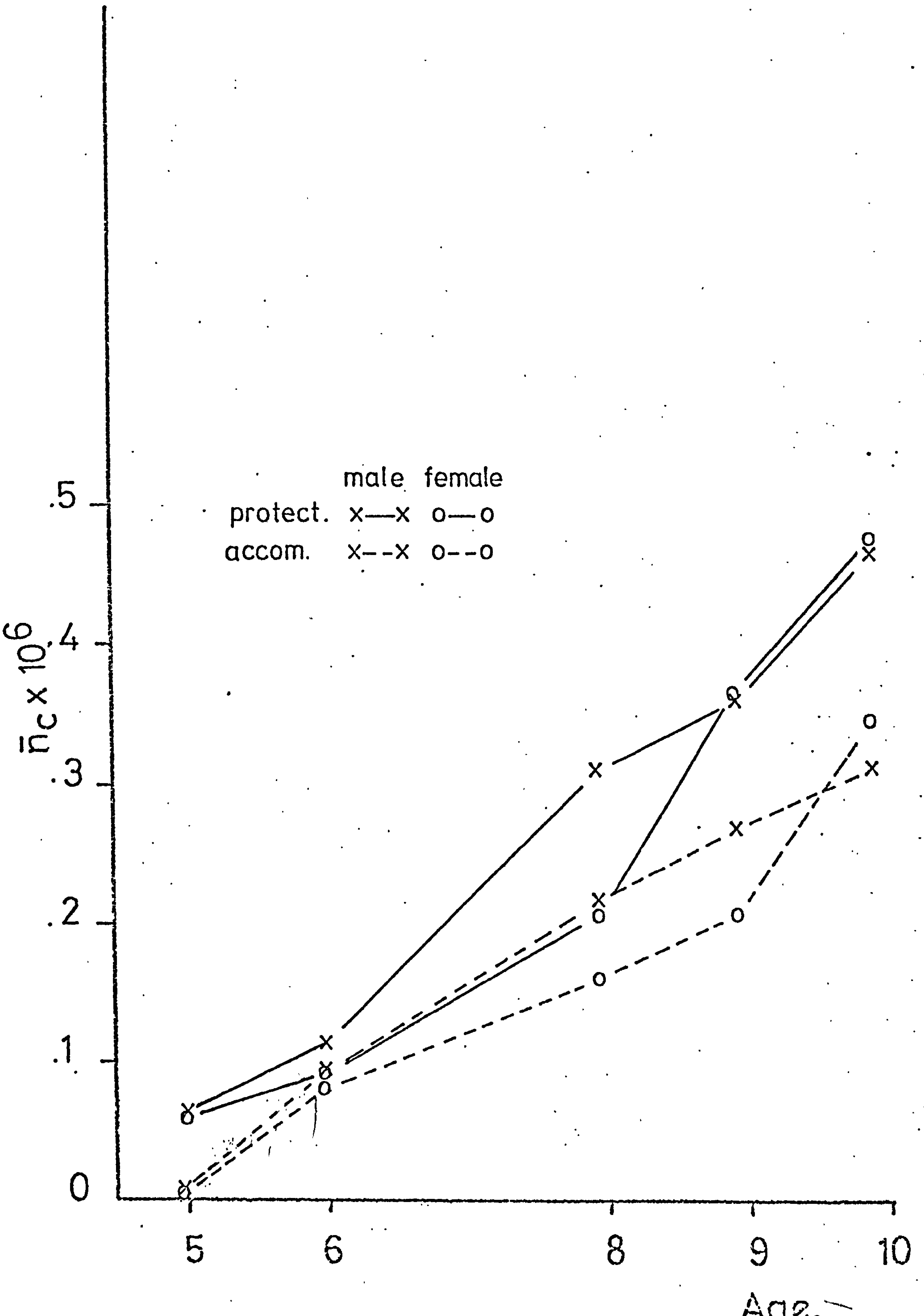
Fig. 3



## FIGURE 4.

$\bar{n}_c$ an estimate of the mean number of cars encountered by Nottingham children during the 20 minute period after school ends, weighted by accompaniment and protection.

Fig.4



male female
protect. x—x o—o
accom. x--x o--o
.5
.4
.3
.2
.1
0
$\bar{n}_c \times 10^6$
5
6
8
9
10
Age.

# F I G U R E 5.

$\bar{r}$ and $\bar{n}_c$ for major and minor roads based on road crossings made by Nottingham children during the 20 minute period after school ends using the protection weighting.

Fig.5

$\bar{n}_c \times 10^6$
.3
.2
.1
0
5
6
8
9
10
$\bar{r}$
5
4
3
2
1
0
male female
major x--x o--o
minor x—x o—o
5
6
8
9
10
Age.

for every major road crossed. It can now be seen that the younger boys appear to be crossing more minor roads, there is no difference in the number of major roads crossed by boys and by girls. Looking at $\bar{n}_c$ we find that major road crossings account for approximately 20% of the younger children's exposure to traffic and for approximately 30% of the older children's exposure. A 3-way analysis of variance for $\bar{r}$ and $\bar{n}_c$ (Table 2) shows that there is a significant increase in $\bar{r}$ ($p < .001$) and $\bar{n}_c$ ($p < .01$) for major and minor roads. The overall sex differences are not significant.

Since relatively few major roads are crossed it is only possible to compare crossing locations on minor roads. Figure 6 shows $\bar{r}$ and $\bar{n}_c$ for different crossing locations on minor roads. A full breakdown of these data are shown in Table 3 and a 4-way analysis of variance in Table 4.

There is a significant increase in both $\bar{r}$ and $\bar{n}_c$ with age ($p < .01$ and $p < .001$ respectively) on minor roads. There is no overall difference in either $\bar{r}$ or $\bar{n}_c$ between the sexes. Most crossings on minor roads are made at junctions, the difference in $\bar{r}$ for crossings made at junctions and more than 20 yds. from junctions is significant ($p < .01$). $\bar{n}_c$, however, is not significantly different - traffic density is higher away from junctions. Just why this is so is not altogether clear. The most likely explanation is that 'through' traffic on minor roads will tend to avoid areas with high densities of junctions e.g. inner city residential areas.

There is a highly significant difference in both $\bar{r}$ and $\bar{n}_c$ near parked vehicles and away from parked vehicles. Most minor road crossings are made away from parked vehicles. The interactions between the two crossing locations and between parked vehicles and age are both significant for $\bar{n}_c$ only ($p < .01$) reflecting the larger number of crossings made near parked cars, at, and away from junctions, and the greater number of older children crossing away from parked vehicles. The three-way

## FIGURE 6.

$\bar{r}$ and $\bar{n}_c$ at different locations on minor roads, based on road crossings made by Nottingham Children during the 20 minute period after school ends using the protection weighting.

at junction
not at junction
pc
npc
pc
npc
·12
·10
·08
·06
·04
·02
0
$\bar{n}_c$ ×10⁶
2
1·5
1·0
0·5
$\bar{r}$
5,6
8-10
age
male female
x——x o- - -o


Fig. 6

interaction between age and both crossing locations is just significant ($p < .05$).

To summarize, most minor road crossings are made at junctions away from parked vehicles and fewest away from junctions, near parked vehicles. There is a consistant effect of age, the older children crossing more roads at each of the crossing locations. 33% of the roads crossed by young boys at junctions are crossed near parked vehicles while only 16% of the girl's crossings at junctions are made near parked vehicles. Most of the extra roads crossed by boys appear to be made at junctions, although this is not a significant effect. When traffic density is considered, children are most exposed when crossing away from parked vehicles. Again most of the difference in exposure between the sexes is found at junctions (N.S.), all the sex difference in exposure for the younger children is accounted for by crossings made at junctions near parked vehicles, 41% of the boys encounters with traffic occur near parked vehicles against 19% of the girls.

Figure 7 shows $p_a$, the probability of having an accident (fatal, serious and slight) during the two 20 minute periods after school ends, for children aged from 5 - 10 years based on the National Accident and Population figures.

The feasability of using Nottingham City accident statistics instead of National accident statistics was considered, however there were insufficient data for this relatively detailed breakdown. At the time detailed breakdowns for Nottingham City were found to be unobtainable, in spite of repeated requests to Nottinghamshire County Council. A comparison of $p_a$'s based on Nottingham City and National accident statistics over (Routledge PhD. thesis 1975, Howarth, Routledge, Repetto-Wright 1972) a 24 hr. period and found that $p_a$ is higher for all age groups in Nottingham, the greatest difference was for the younger children, these data are shown in Table 5.

## FIGURE 7.

$p_a$ the probability of an accident based on the National Accident Statistics for the periods 3.30 p.m. - 3.50 p.m. and 4.00 p.m. - 4.20 p.m. on weekdays during April, May and June between April 1969 and June 1972. $p_a$ for the 20 minute period after school ends is shown by the heavy lines.

Fig. 7

2.5
2.0
1.5
1.0
0.5
0
Pa x $10^6$
male female
3.30.-3.50. x—x o—o
4.00.-4.20. x--x o--o
5
6
8
9
10
age

Calculating $p_a$ from National statistics will result in underestimating the risk to Nottingham City children especially to the younger children. It was hoped that it would be possible to weight the National Statistics on the basis of the distribution of Nottingham City accidents however, the National Accident Statistics were used in all the calculations of risk measures.

$p_a$ has been calculated separately for each time period to correspond with the time Infants (5,6 year olds) and Juniors (8-10 year olds) leave school. Seven year olds have been excluded for the reasons mentioned earlier.

Infants have most accidents during the 20 minute period after school ends, during the winter months 8 year olds have most accidents (Howarth, Routledge and Repetto-Wright 1973). It would seem likely that this difference would be accounted for in terms of exposure, young children being allowed to come home by themselves during the summer more frequently. Although children may be less exposed during the winter months, poor light and weather conditions probably contribute to their increased risk.

$p_{a/r}$, the probability of having an accident when crossing a road, and $p_{a/c}$ the probability of having an accident when a car is encountered for the 20 minute period after school ends can now be calculated. These data are shown in Figure 8 based on $\bar{r}$ and $\bar{n}_c$ weighted for protection and $p_a$ from Figure 7 and Table 1.

$p_{a/r}$ is 5 times greater for the 5 year olds than for the 10 year olds, ($F = 22.24, p < .01$) and $p_{a/c}$ is 15 times greater ($F = 50.68, p < .01$). $p_{a/r}$ and $p_{a/c}$ are respectively 30% and 50% greater for the infant boys than for the girls. Although these data are similar to findings from the earlier exposure studies, the actual values of risk will vary for several reasons. The measures of risk derived from the "interview" and "following" study were higher overall, this was probably because these studies were

# FIGURE 8.

$p_{a/r}$ an estimate of the probability of an accident per road crossing and $p_{a/c}$ an estimate of the probability of an accident given an encounter with a car based on all road crossings made by Nottingham children during the 20 minute period after school ends and the National Accident Statistics.

Fig.8
40
30
20
10
0
Pa/c
5
6
8
9
10
1·25
1·0
·75
·5
·25
0
Pa/r
male
female
x——x
o---o
Age.

carried out in the winter months while the data for the present study were collected during the summer term.

There is sufficient evidence from these data to show that the differences in the accident rates between boys and girls and the differences over age cannot be accounted for by exposure alone and therefore must be looked for elsewhere. Boys, although slightly more exposed, are still more at risk than girls, and young children, who are considerably less exposed than older children, are very much more at risk. There is a very dramatic decrease in risk with age, in spite of crossing many more and busier roads older children have considerably fewer accidents than the younger children.

These differences in risk ($p_{a/c}$) with age and sex are found on both major and minor roads. 3-way analyses of variance for $p_{a/r}$ and $p_{a/c}$ are shown in Table 6. From Figure 9, it can be seen that $p_{a/r}$ is greatest for boys on both major and minor roads. Crossing a major road appears to be much more dangerous than crossing a minor road, this might be expected because of the increased density of traffic. On the other hand there is evidence to suggest that children pay greater attention to traffic on major roads, if this so the risk per encounter with a car ($p_{a/c}$) should be less on the major roads. However, if skill is an important factor, then the greater difficulty of dealing with main road traffic, because of its higher speed and density, should lead to higher risk per encounter on the major roads. $p_{a/c}$ is higher in all cases on major roads suggesting that skill is an important factor in crossing major roads. Whatever difference in behaviour leads to the younger boys having more accidents, it appears to be more prevalent on major roads. The young boys are nearly twice as likely to have an accident as the young girls when crossing major roads but this difference is not so pronounced on the minor roads.

Figure 10 shows $p_{a/r}$ and $p_{a/c}$ by location on minor roads only. Ages

# FIGURE 9.

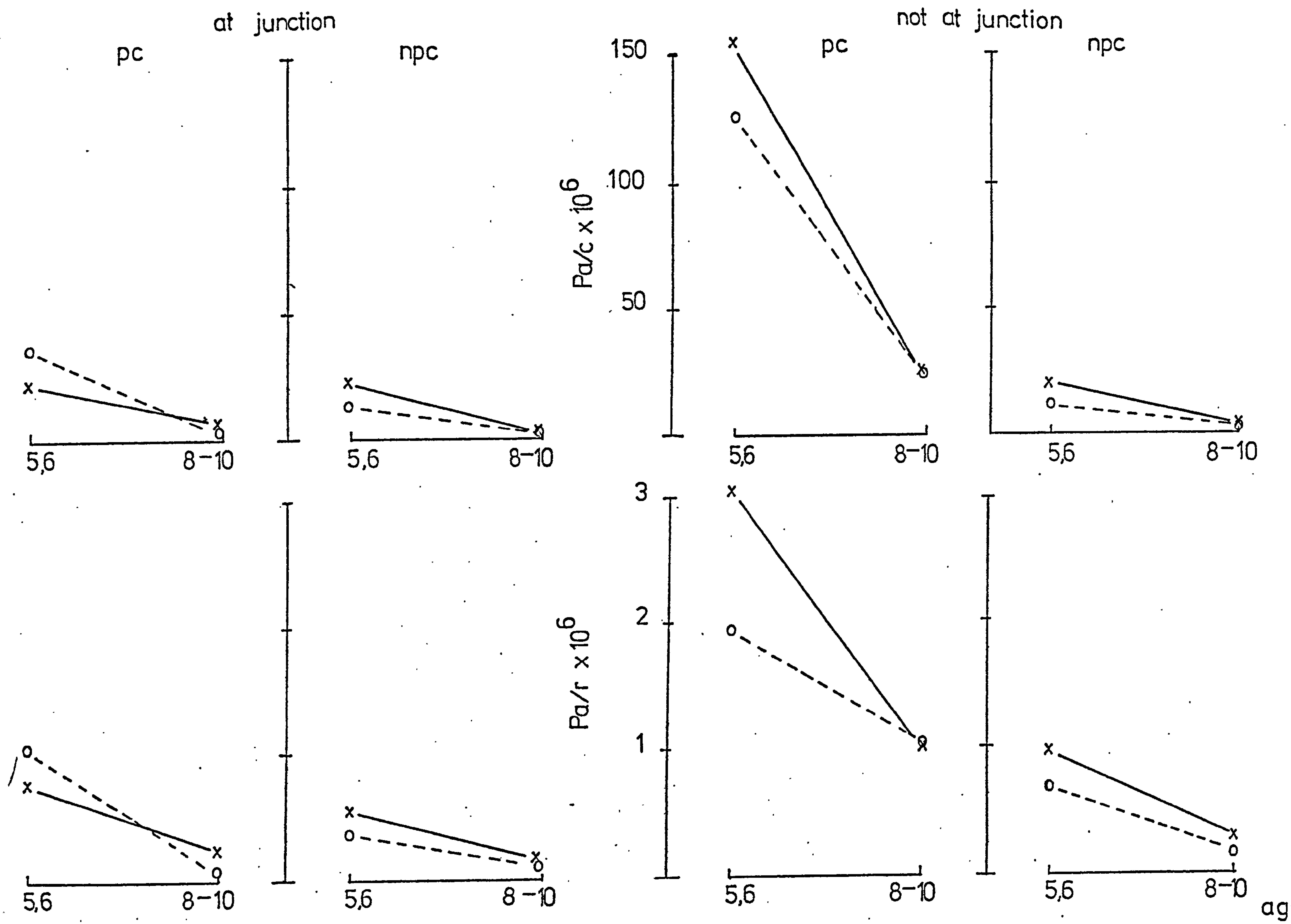
$p_{a/r}$ and $p_{a/c}$ on major and minor roads based on road crossings made by Nottingham children during the 20 minute period after school ends and the National Accident Statistics.

Fig.9

40
30
20
10
0
Pa/c x 10^6
5,6
8–10
5
4
3
2
1
0
Pa/r x 10^6
male female
major x--x o--o
minor x—x o—o
5,6
8–10
Age.

FIGURE 10.

$p_{a/r}$ and $p_{a/c}$ at different crossing locations on minor roads, based on road crossings made by Nottingham children during the 20 minute period after school ends, and the National Accident Statistics.



at junction
not at junction
pc
npc
pc
npc
150
100
50
Pa/c x 10^6
3
2
1
Pa/r x 10^6
5,6
8-10
age


Fig.10

have been combined into two groups, Infants (5-6) and Juniors (8,9,10). It is not possible to perform a similar analysis for major roads because of insufficient data. Children of all ages are considerably more at risk when crossing roads away from junctions near parked cars. This is not due to higher traffic densities. $p_{a/c}$ is also high in this situation. Away from junctions $p_{a/r}$ is 3 times greater for the younger children crossing near parked cars and $p_{a/c}$ approximately 8 times greater. There is a similar increase in risk for the older children.

A possible explanation is that, away from junctions, vehicles tend to be travelling at higher speeds. If a child steps out from behind a parked car in this situation, the driver, who may not have seen the child previously, will have less time to take avoiding action. On clear stretches of road the driver will have more chance of seeing a child about to step into the road in front of him, and so have more time to take avoiding action, the child will also have more chance of seeing or hearing the approaching car. Alternatively children may be more heedless away from junctions. When they cross a road near a junction they may consider it to be a potentially dangerous situation and behave more cautiously. This is discussed later when the behavioural measures are related to $p_{a/c}$ at different locations.

Crossing near parked cars does not appear to be so dangerous at junctions. There is some evidence from the behavioural measures that children are less heedless at junctions. If this is the case, the more cautous behaviour of the children in combination with lower vehicle speeds, will not make crossing by parked cars a particularly hazardous operation. Before drawing any firm conclusion about causes of accidents at junctions more detailed information about accidents and exposure at junctions is needed, for instance whether pedestrians are hit by turning vehicles or by vehicles driving up to or across junctions.

The measures of exposure from the "following" study (Routledge, 1975) can be compared with the measures from the Random Site Study. The two studies were carried out at different times of the year, the "following" study during the Spring term and the Random Site Study during the Summer term. It would seem reasonable to hypothesis that children are allowed more freedom during the lighter and warmer parts of the year, while parents would probably collect infants from school on dark and wet afternoons, they may be quite happy to allow them to come home by themselves during the summer months.

The two studies are not strictly comparable. The "following" study was based on a sample of children who were randomly selected from schools that were considered to be representative of different areas of Nottingham City. Although the schools proportionally represent the different housing areas of the city, the roads in the immediate vicinity of the schools may not be representative of all roads in Nottingham.

The protection weighting was simplified for use in the Random Site Study. In the "following" study children crossing a road could be classified as "partially active/partially protected" and their exposure score would be weighted by 0.5. A crossing by a child was classified in this way if - "the child is not protected, although with an adult; appears to rely on another person or persons crossing at the same time; or crosses alone or when unprotected at a zebra crossing or traffic lights". This category had to be omitted from the Random Site Study in order to reduce the work of the observer. There should not be any major differences between overall scores using both weightings.

$\bar{n}_c$ is higher for all children in the random site study (Table 7), the Infants are twice as exposed and the Juniors 2 - 3 times more exposed.

The probability of having an accident is higher for all children during the summer. If this difference is to be accounted for in terms of exposure alone, children being allowed more freedom during the summer, one would expect the measures of risk to be equal for both studies. This is not the case, $p_{a/r}$ calculated using the "following" study exposure data is higher.for the younger children a $p_{a/c}$ is higher for all the children. It would seem likely that the dark afternoons and poorer weather conditions during the early part of the year contribute to this increased risk.

It is not possible to compare exposure and risk on major and minor roads since this variable was not recorded for the "following" study. However, crossings at different locations on all roads can be compared, (Table 8) although the data from the "following" study is based on a very small sample at this level of analysis. A greater proportion of children were observed crossing near parked cars in the Random Site Study and slightly more children crossed by junctions. $p_{a/c}$ is greater away from junctions based on each set of exposure data, but while $p_{a/c}$ was much higher near parked cars in the "following" study this is not the case in the Random Site Study, where $p_{a/c}$ is approximately equal for both studies.

The differences between the studies could either be real differences in exposure due to different parental attitudes to protecting children at different times of the year, or to the differences in the sampling procedures mentioned earlier. The higher values of $p_{a/c}$ from the "following" study exposure data most probably reflect a real increase in risk during the early part of the year, due to poorer visibility, but may be due to the different sampling method. A properly controlled comparison study would be required to determine whether there are real differences in exposure and risk.

b) Measures of risk and behaviour for pedestrians of all ages.

The Random Site technique enables exposure data for pedestrians of all ages to be collected and it is possible to calculate $p_{a/r}$ and $p_{a/c}$, for pedestrians other than children. These measures have been calculated from the observations of road crossings during both observation periods combined (3.30 - 3.50 and 4.00 - 4.20) and from the National Accident Statistics. Previous studies have been designed to obtain measures of exposure for Infant and Junior school children only.

$p_a$, the probability of an accident was calculated for each of the 14 age and sex groups from the National Accident Statistics for the periods 3.30 p.m. - 3.50 p.m. and 4.00 p.m. - 4.20 p.m. on weekdays during April, May and June between April 1969 and June 1972. These are shown in Tables 9 and 10 together with a full breakdown of the measures of exposure and risk discussed below.

Figure 11 shows $p_{a/r}$ and $p_{a/c}$ for all roads. The 0 - 4 year olds have been omitted to facilitate scaling the graph. The most striking feature of this graph is the difference between adults and children, $p_{a/c}$ is 40 times greater for the 5 - 7 year olds and 10 times greater for the 8 - 10 year olds. Both $p_{a/r}$ and $p_{a/c}$ decrease with age until adulthood, elderly pedestrians are more at risk. $p_{a/r}$ and $p_{a/c}$ are greater for males during early childhood and adulthood but not during adolescence or old age.

Looking at these measures separately for major and minor roads, (Figure 12) it can be seen that $p_{a/r}$ is greater on major roads for all pedestrians. The most likely reason for this increase in risk is the greater traffic density on the Major roads. If traffic density is linearly related to $p_a$ then we should expect that $p_{a/c}$ is the same on both major and minor roads for any particular group of pedestrians. This is the case for the adult pedestrian who appears to cope equally well with dense and light traffic. However, $p_{a/c}$ is much greater for young children on major roads, they do not cope as well with dense traffic. $p_{a/c}$ is only independent of road type for the adult pedestrian. There is a similar relationship with $p_{a/r}$ and $p_{a/c}$ on major and minor roads for 5 - 10 year olds in a previous interview study (Routledge, Repetto-Wright and Howarth 1973a). This is convincing evidence for the need to protect

# FIGURE 11

$p_{a/r}$ and $p_{a/c}$ based on all road crossings made by pedestrians in Nottingham between 3.30 p.m. and 3.50 p.m. and 4.00 p.m. and 4.20 p.m. during term time weekdays and the National Accident Statistics.

Fig.11
male x——x
female o- - -o
20
10
0
Pa/c
5-7
8-10
11-14
15-19
20-59
60+
1
0·5
0
Pa/r
5-7
8-10
11-14
15-19
20-59
60+
age

FIGURE 12.

$p_{a/r}$ and $p_{e/c}$ on major and minor roads based on road crossings made by pedestrians in Nottingham between 3.30 p.m. and 3.50 p.m. and 4.00 p.m. and 4.20 p.m. during term time weekdays and the National Accident Statistics.

Fig.12


40
30
20
10
0
Pa/c x 10^6
5-7
8-10
11-14
15-19
20-59
60+
8
7
6
5
4
3
2
1
0
Pa/r x 10^6
male female
major x---x o---o
minor x—x o—o
5-7
8-10
11-14
15-19
20-59
60+
age

young children on busy roads. It should be remembered that the majority of children observed in these time periods were on their way home from school and were probably particularly well protected on major roads by adults and crossing wardens. Without this protection the number of accidents to children crossing major roads would probably be much greater.

Figures 13 and 14 show $p_{a/r}$ and $p_{a/c}$ for different crossing locations on minor roads. A complete breakdown is given in Table 10. There is no single situation which is more dangerous for all pedestrians. Young children are most at risk away from junctions near parked cars, the safest place for them to cross is at a junction away from parked cars. Adults are most at risk away from junctions and parked cars and are equally safe at other locations. Children are more at risk near parked cars, while adults are less at risk if anything, when they cross near a parked car. These differences in risk are not necessarily due to dangers present in some situations and not in others. It is necessary to know something about pedestrians behaviour at these different situations. It was previously suggested that the high risk to children away from junctions may be due to higher traffic speeds, or, on the other hand to children behaving "heedlessly" in this situation.

c) Some parameters of crossing behaviour.

In an attempt to look at pedestrians behaviour in these different types of crossing situations some basic behavioural measures were recorded by the observers.

## FIGURE 13.

$p_{a/r}$ at different crossing locations on minor roads, based on road crossings made by pedestrians in Nottingham between 3.30 p.m. and 3.50 p.m. and 4.00 p.m. and 4.20 p.m. during term time weekdays and the National Accident Statistics.

Fig.13

NOT AT / PC
NOT AT / NPC
AT / PC
AT / NPC
male x——x
female o---o
Pa/r x 10^6
2·0
1·5
1·0
0·5
0
5-7
8-10
11-14
15-19
20-59
60+
age

## F I G U R E 14.

$p_{a/c}$ at different crossing locations on minor roads based on road crossings made by pedestrians in Nottingham between 3.30 p.m. and 3.50 p.m. and 4.00 p.m. and 4.20 p.m. during term time weekdays and the National Accident Statistics.

Fig. 14

NOT AT / PC
NOT AT / NPC
60
50
40
30
20
10
0
Pa/c x 10^6
male x—x
female o---o
5-7
8-10
11-14
15-19
20-59
60+
age
AT / PC
AT / NPC
20
10
0
Pa/c x 10^6

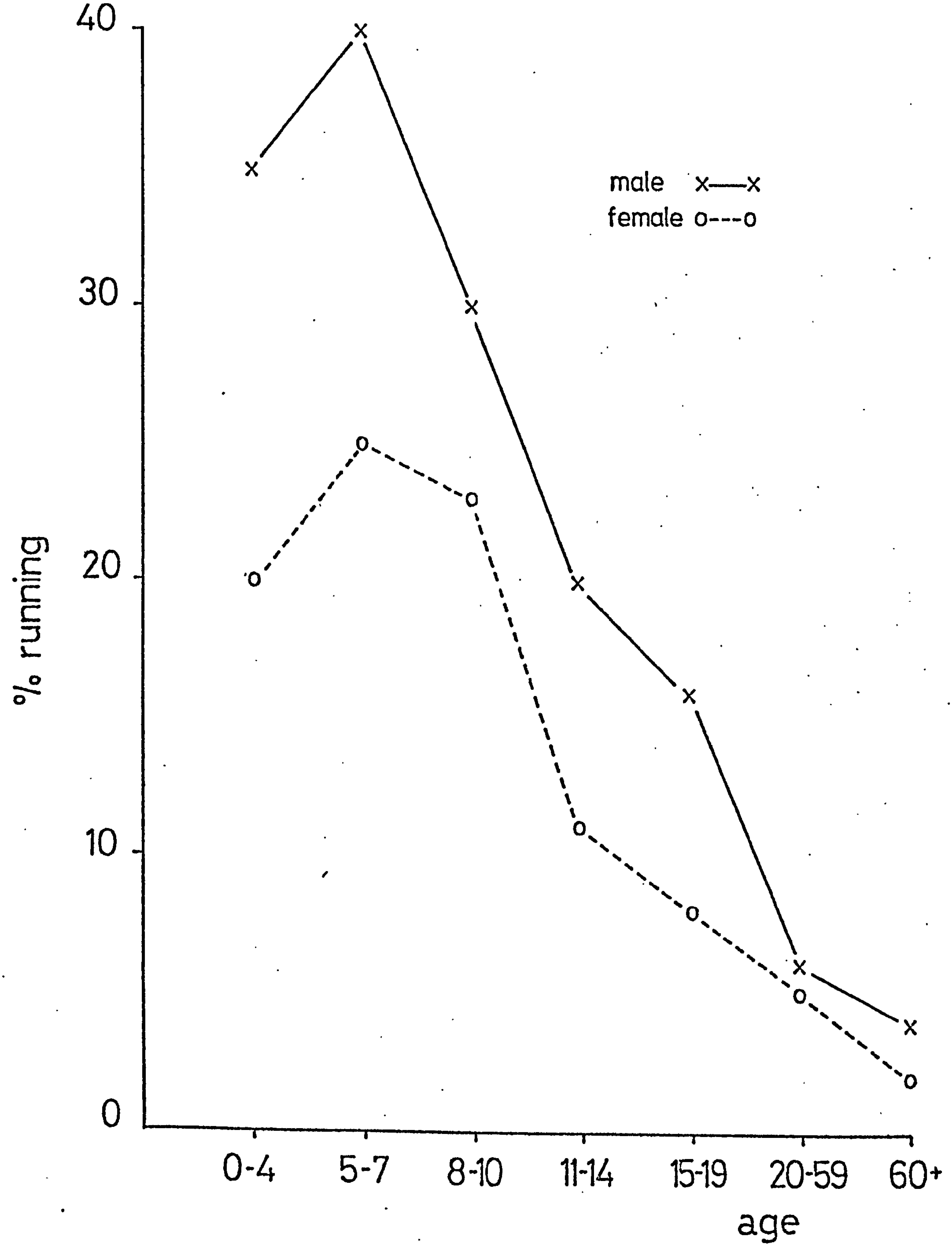
The observers recorded three features of pedestrian's behaviour as they approached and crossed roads. Whether pedestrians looked adequately, whether they ran or walked across the road and whether they were "heedless". Observers were instructed to code pedestrians as behaving "heedlessly" if they considered the pedestrian was not paying attention and would have been hit by a car, had one been passing at the time, assuming the driver took no avoiding action. It is straight forward to decide whether a pedestrian runs or walks across the road - since this is a relatively objective measure; but assessments of adequate looking and of heedlessness are very subjective - it is only possible to judge whether a pedestrian appears to be looking or paying attention. A satisfactory level of agreement was obtained between observers by careful selection of the criteria for each measure, during training sessions agreement between observers was found to be 90% for running/walking, 80% for heedlessness and 75% for looking adequately. When assessing whether a pedestrian looks adequately or behaves "heedlessly" an observer cannot be certain that the pedestrian did not glance up the road before stepping off the kerb or would have heard an approaching car and so stopped before going into the road. This will lead to overestimates of inadequate looking and "heedless" behaviour. It is tempting to assume that an unaccompanied 5 year old will be more heedless than an unaccompanied 10 year old. Young children just do not look as if they ought to be crossing roads by themselves, even though they may be very careful. Similarly a child who rushes about on the pavement and jumps up and down on the kerb may be judged to be "heedless" when he is in fact paying full attention to the traffic. Despite these limitations the measures are useful for making gross comparisons of behaviour at different crossing situations. Comparisons between different groups, may well be vulnerable to any age or sex interactions due to observer stereotyping.

Figures 15, 16 and 17 show the percentages of all unprotected pedestrians ('alone' and 'in a group but unprotected') running across the road, not

# FIGURE 15.

Percentage of pedestrians running across the road by age and sex based on the whole sample.

Fig.15.

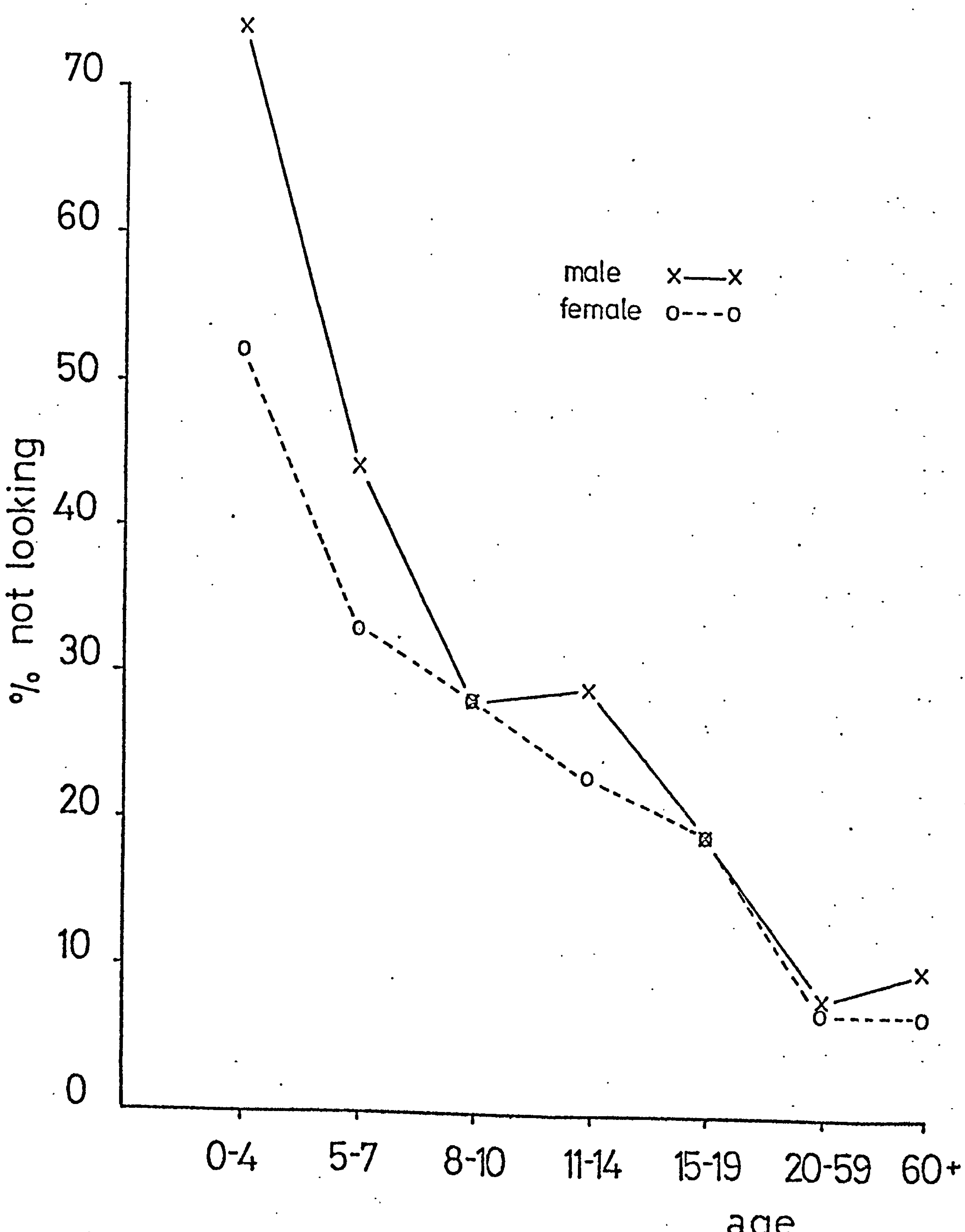


40
30
20
10
0
% running
male x——x
female o---o
0-4
5-7
8-10
11-14
15-19
20-59
60+
age

# FIGURE 16.

Percentage of pedestrians not looking adequately before crossing the road by age and sex based on the whole sample.

Fig.16

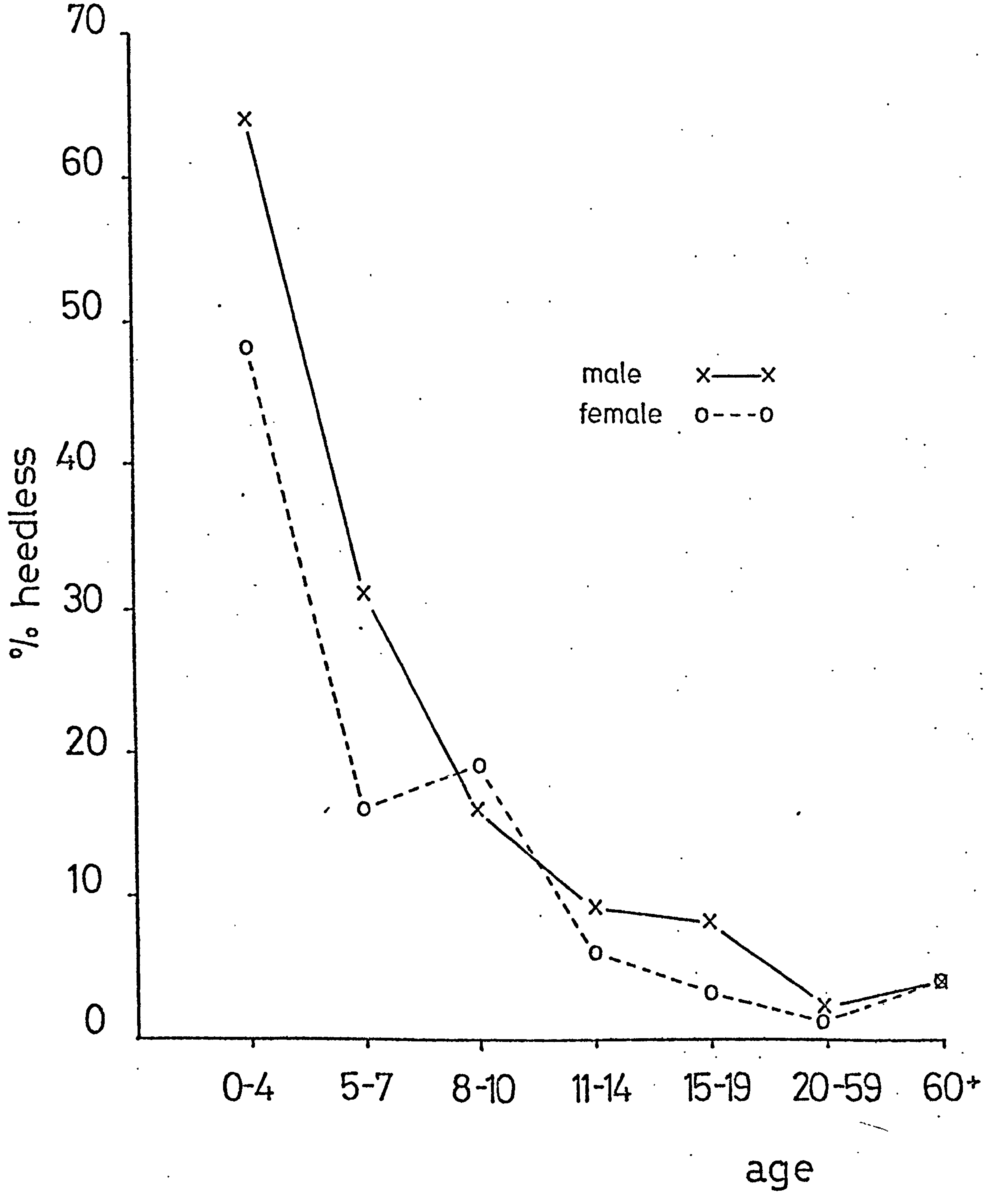


70
60
50
40
30
20
10
0
% not looking
male x—x
female o---o
0-4
5-7
8-10
11-14
15-19
20-59
60+
age

# FIGURE 17.

Percentage of pedestrians crossing the road heedlessly by age and sex based on the whole sample

Fig.17


70
60
50
40
30
20
10
0
% heedless
male x——x
female o---o
0-4
5-7
8-10
11-14
15-19
20-59
60+
age

looking adequately and crossing heedlessly. Males run more frequently at all ages, they also look less and are more heedless. There is a dramatic effect of age on all three measures, young pedestrians run more frequently, look less and are more heedless. It is hard to believe that these very large changes in behaviour with age are all due to observer bias.

Children are more cautious on major roads than on minor roads (Table 11), they run less, look more frequently and are less heedless. Adults are equally cautious on both major and minor roads, but they run much more frequently across major roads. In previous studies we have observed adults and older children running across busy major roads, frequently having anticipated a gap in the traffic. This strategy enables pedestrians to cross relatively safely and without delay in busy traffic. Young children do not appear to adopt this strategy on major roads.

An analysis of behaviour on minor roads (Table 12), shows that pedestrians are more heedless away from junctions ($\chi^2 = 47.40$ with 1 d.f. $p < .001$), they also run more away from junctions ($\chi^2 = 45.29$ with 1 d.f. $p < .001$). The 5 to 7 year old boys are particularly heedless away from junctions, 42%, while only 20% of the girls cross heedlessly. This sex difference is highly significant ($\chi^2 = 9.25$ with 1 d.f. $p < .01$). These boys are also more heedless at junctions ($\chi^2 = 5.91$ with 1 d.f. $p < .02$).

There are no consistent differences in the behaviour of pedestrians crossing near or away from parked cars, although there is a tendency for pedestrians to be more heedless away from parked cars.

The distribution of the behaviour measures are remarkably similar in shape to the distribution of $p_{a/c}$ with respect to age and sex (Figure 11). Table 13 shows the sample correlation coefficients (r) for $p_{rp}$, $p_{ip}$ and $p_{hp}$ with $p_{a/c}$ for major, minor and all roads where:-

$p_{rp}$ - probability of running on the part of the pedestrian

$p_{ip}$ - probability of looking inadequately on the part of the pedestrian.

$p_{hp}$ - probability of heedlessness on the part of the pedestrian.

The behavioural measures correlate highly with $p_{a/c}$ on minor roads, but not on major roads. $p_{hp}$ is most closely correlated with $p_{a/c}$ ($r = .85$). This high correlation suggests that heedless behaviour may be implicated to a greater degree in minor road accidents, but a great deal of caution must be exercised in interpreting these data. Certainly children are less heedless on major roads. It is probable that they discriminate between "safe" and "dangerous" crossing situations in the same way as adults and so are aware of the increased danger from traffic on major roads. The large number of observations of children behaving heedlessly on minor roads may not necessarily mean that they will be heedless in a dangerous situation. e.g. when a car is approaching. Nevertheless the large difference in behaviour of different groups of pedestrians and the high correlation of $p_{hp}$ and $p_{a/c}$, suggests that heedless behaviour may be more important as a cause of accidents on minor roads.

Table 13 also shows the sample correlation coefficients for $p_{rp}$, $p_{ip}$ and $p_{hp}$ with $p_{a/c}$ for different crossing locations on minor roads. The measures are all closely correlated.

d) Comparison of the Protection afforded to Infants, their risk in crossing roads, and their behaviour during the 20 minute period after school ends and during a 20 minute period later in the afternoon.

Both the Random Site Study and the "Following" study observed children during the 20 minute period after school ends, measures of exposure and behaviour may be different at other times of day. It would seem reasonable to hypothesis that children receive more protection on the way home from school than at any other time of day, since crossing patrols are provided on busy roads for children on their way home and mothers frequently collect young children from school. If the children go out after getting home, they may not be accompanied by adults or by older children, and there may be no crossing patrols to help them across busy roads. Traffic densities may have also increased especially in the late afternoon as the rush hour gets under way.

As mentioned previously, Infant school children in Nottingham (5-7 year olds) leave at 3.30 while the primary school children (8-11 year olds) leave at 4.00. Observations of infants were made during the 20 minute period starting at 4.00 as well as during the 20 minute period after they leave school, making comparisons of Infants exposure risk during these two periods possible. Since crossing wardens are still on duty at this time and mothers may be collecting other children from school, one would expect any increase in risk due to a decrease in protection to be minimal. At other times of day it may well be much higher.

Table 14 shows the percentage of major and minor roads crossed by infants when protected by other pedestrians or by crossing wardens, during both time periods. Children are protected most when crossing roads immediately after leaving school, in 47% of their road crossings : at 4.00 they are protected only 29% of the time. Most of this difference is accounted for by crossings made on minor roads, the degree of protection on major roads is not significantly different (Fishers Exact Test $p < .21$ N.S.) over both periods. Children are protected more on major roads, in approximately 55-60% of road crossings. Although children are less exposed at 4.00, they cross only one third of the number of roads they cross at 3.30, those children who do go out are less protected. This difference in the degree of protection is significant on minor roads ($\chi^2 = 18.06$ with 1 df $p < .001$).

Exposure was also calculated using the accompaniment weighting.

Since this was not significantly different from exposure calculated using the protection weighting we have used the latter weighting only.

On the way home from school children are protected by other pedestrians or by crossing wardens in 65% of their exposure to traffic, and at 4.00 in only 50% of their exposure. Once again this reduction in protection at 4.00 is mainly accounted for by crossings made on minor roads, the degree of p rotection on major roads is not significantly different over both periods. (Fishers Exact Test $p < .25$ N.S.). Children are more protected from traffic when they cross major roads, in 60-70% of their exposure to traffic. Traffic density is higher on major roads at 4.00. (Table 15).

Girls are more protected than boys at both times, the difference being greatest at 4.00, when they are protected to nearly the same degree as they are after they come out of school. It would appear that parents continue to protect girls from traffic on major roads if they go out having come home from school.

$p_{a/r}$ and $p_{a/c}$ can be calculated for each time period using the National Accident Statistics (Figure 7). These data are shown in Table 16. The risk when crossing a road is greater at 4.00 for both boys and girls, however the risk per car encounter is only greater for the girls. These results should be viewed with some caution since risk has been calculated using National Accident Statistics not Nottingham City Accident statistics. In comparing two short time periods in this way there may be some characteristics of the accidents particular to Nottingham City that will not be reflected in the National Accident Statistics, e.g. variations in the times children leave school. However, there is some evidence from the values of $p_{a/r}$ that children are more at risk at 4.00. They are certainly less well protected.

Children do not appear to be more or less heedless at 4.00, Table 17, neither do they run more or look less frequently.

Summary

Exposure data has been obtained for pedestrians of all ages in Nottingham and risk, $p_{a/r}$ and $p_{a/c}$ have been calculated for pedestrians other than children for the first time. Risk continues to decline with age until adulthood before rising for the elderly pedestrians. The ability to cross roads safely continues to improve long after children develop basic road crossing skills. The adults are much less at risk than either the 11-14 year olds or the 15-19 year olds. The very high level of risk for the young and the elderly is clearly shown (Figure 11). The difference in the numbers of accidents to boys and girls cannot be accounted for in terms of differential exposure.

There is convincing evidence for the need to protect young children on busy roads. Whereas adults cope equally well with both dense and light traffic, children do not; they are disproportionatly at risk on major roads. Children tend to cross most minor roads at junctions, away from stationary vehicles; they are most at risk on these roads crossing between parked cars away from junctions.

The behavioural measures show that heedless behaviour is highly correlated with accident risk on minor roads but not on major roads, suggesting that heedless behaviour may be implicated to a greater degree in minor road accidents. These data also revealed differences between the behaviour of boys and girls, differences in crossing behaviour may, therefore, account for the differences in their accident risk.

The results from this study are generally consistent with findings from previous studies. Boys are more at risk than girls and younger children more at risk than older children. The differences in the absolute values of the risk measures can be attributed to differences in sampling (the "following" study was not a true random sample) and to variations in exposure and accident rates between the first 3 months of the year and the summer. Observations for the "following" study were made during the spring term and for the "Random Site" study during the summer term. There was evidence that children are more at risk during the winter months the most likely explanation for this is the poorer visibility.

The Random Site Exposure Study was an attempt to devise a simple and economic technique for estimating pedestrians exposure.and behaviour, using "road length" instead of "children" as a sampling unit. The advantages and disadvantages of this approach were discussed in the previous chapter. The only difficulty encountered, was in attempting to obtain detailed accounts of crossing behaviour at the same time as exposure data. Simple measures of crossing behaviour can be recorded but attempts to record more complex sequences of behaviour were unsucessful. The technique is, however, ideal for obtaining exposure data for different groups of pedestrians or for pedestrians crossing in different locations. An application of the technique to a study of pedestrians in different cities is described in the final chapter.

# CHAPTER 4

## OBSERVATION STUDIES OF CHILD PEDESTRIAN BEHAVIOUR

Previous Studies and Techniques.

Early expectations of finding behavioural measures that could be related easily to accidents had not been borne out by subsequent studies, although they had provided some valuable insights into the nature of road crossing skills. Neither the size of gap accepted by pedestrians nor the safety margins they left when crossing in front of vehicles, were related clearly enough to accidents to be used as criteria of road crossing performance. The findings of these early studies have been outlined in Chapter 1. and have been reported in detail elsewhere. (Howarth, Routledge and Repetto-Wright 1971, 1972, Routledge, PhD. thesis, 1975) However, a discussion of the observation techniques developed and the limitations of these early studies is relevant to the design of the study to be reported here.

On the basis of some encouraging results from an analysis of video recordings of 200 children crossing a busy main road, and from a simulation study of children crossing through gaps in traffic, a large scale analysis of 3000 road crossings was planned. A portable event recorder was developed, which enabled observers to code information directly onto magnetic tape. These tapes could later be analysed directly by computer. A full description of the system is given in Appendix 4. Observers recorded movements of both pedestrians and vehicles at a large number of sites, and from these recordings, accepted gaps ($t_a$) and safety gaps ($t_s$) were calculated. Estimates of the age and sex of pedestrians and accompaniment, together with a measure of heedlessness in relation to the distance away of vehicles, were recorded also.

The collection of these data had involved several major problems. The first problem was to locate roads where sufficient numbers of children could be observed crossing and which carried sufficient traffic for the type of analysis to be possible. It is easy to observe children crossing minor roads in large numbers but, by definition, there is rarely traffic in their vicinity. The second problem is related to the first and concerns the sampling and comparison of groups which may have been observed under different conditions. The first observations of young children crossing, had been made at one, somewhat atypical, site and comparisons made with older pedestrians crossing at another site. The data used to make the comparison came from a study of adult pedestrians by Cohen, Dearnaley and Hansel (1955). By using the portable event recorders many different sites could be sampled and pedestrians of all ages observed. However, it did not prove possible to control for the different numbers of observations of each age group at each site. Sites had been selected specifically because young children could be observed crossing at them so they may not have been typical of those where older pedestrians crossed.

Several attempts, using different techniques, had been made to classify "heedless" behaviour which frequently appears on accident report forms as a cause of accidents. e.g. "The child ran 'heedlessly' into the road from behind a stationary vehicle". Behaviour was classified as "heedless" when observers considered that the pedestrian was not paying attention and would have been hit by a vehicle, had one been passing at the time, assuming the driver took no avoiding action. By definition, attempts to predict accident rates from the observed incidence of "heedless" behaviour will result in overestimations, since in many instances, drivers would be able to take avoiding action. On the basis of comparisons of observations made on major and minor roads, there is evidence that children are more "heedless" when no cars are around. This is also shown in the behavioural measures analysed in the Random Site Study (Table 10, Appendix 3), where less evidence for "heedless" behaviour was observed on major roads where children usually crossed in the presence of traffic. Unless therefore, only "heedless" behaviour by pedestrians in the presence of traffic can be observed, the usefullness of the approach is limited. It is difficult to observe very young children crossing in traffic on minor roads. There are additional problems in classifying behaviour as "heedless". There is no way of distinguishing real "heedless" behaviour, where the child is not aware of the traffic from apparantly "heedless" behaviour, which is a skillful, albeit risky, road crossing. It is very hard to observe slight headmovements, let alone eye movements, when a child is running across a road. Similarly, as mentioned earlier, observers may be influenced by the common stereotype of childish behaviour, so that a child jumping or skipping at the kerb, may be judged to be heedless when in fact he is paying attention to the traffic. Observers may also be biased by a child's age, for example, an unaccompanied 4 year old just doesn't look safe crossing a road. There have been occasions when observers have helped very young children across the road - they felt they could not just stand by and watch!

The results from all these different studies of child behaviour tend to be confusing and in some cases contradictory. Although, children can be seen crossing roads inefficiently when paying attention to the traffic, none of the behaviour measures reflect this. There also appears to be a relationship between "heedless" behaviour by children and traffic density on the basis of observations on major and minor roads.

The question, arising from these studies, that has the most important implications for Road Safety Eduction, is whether children do behave differently on roads with different traffic densities. In order to answer this question a detailed observation study of children crossing in traffic was designed to examine the crossing behaviour of different groups of pedestrians in greater detail.

Design of a new behavioural study - The Noel Street Study.

The Noel Street Study was designed so that pedestrians of all ages could be observed crossing in traffic at the same site. Video-recording the pedestrians and super-imposing a commentary was found to be the best method of data collection.

Five different methods of observing pedestrians had been used in previous studies. Filming or video-recording are the most obvious choice for naturalistic studies of this nature since they provide a permanent record. Colour film is generally easier to analyse than video recordings; particularly when looking for small head movements and estimating the age and sex of pedestrians. However, the use of colour film, which provides the better quality data, is restricted by the cost of film. Unless sites can be found where large numbers of pedestrians are crossing, or time lapse cameras can be used, the expense cannot be justified. Unlike video tapes, film cannot be viewed immediately since processing may take up to several weeks at certain times of the year. This is important, since rapid feedback on the quality of the recordings enables any errors in camera angle or filming technique to be quickly rectified. In addition, video-tape can be edited and re-used to save time in analysing the data and the cost of tapes. These considerations make video-recording the obvious choice. Colour video-systems are now available, but at considerable cost, and would be ideal for this type of study.

A problem that arises in both filming and video-recording road crossing, is that of selecting a suitable field of view. Many events that may influence a pedestrian's decision to cross a road may occur some way off. For example, a pedestrian may wait for a car which then parks or turns into a side road outside the field of view of the camera. To anyone analysing the film it would appear that he waited for no particular reason. This limitation can be overcome by the use of wide angle lenses or multiple camera systems, both of which introduce additional problems of cost and of finding suitable places to mount cameras. Panning the camera is also unsuitable, as important events affecting the crossing can easily be missed. A video-recording system incorporating a zoom lens was found to be the best solution. The lens could be set at a wide angle, and the zoom used to obtain close ups of pedestrians when required. A running commentary was superimposed on the video-recording so that events occurring outside the field of view of the camera were recorded. This was found to be most useful.

After making preliminary observations at several sites, one in particular was found to be most suitable. The site was near a junction on a secondary feeder road from the city at a point where it passed through a high density housing area. The road was straight and there were no pedestrian crossing aids nearby. Infant, junior and secondary schools in the immediate vicinity ensured that there were children of all ages crossing. Plenty of adults were crossing at the same time. Since no other site was found that had such a good age distribution of pedestrians, all the video-recordings were made at this one site.

A portable video-recording system was used to make permanent records to be analysed at a later date. Initially the recordings were made by filming through a one-way screen mounted in the rear of a small van; this was found to be unsatisfactory and the majority of recordings were made from the first floor window of a nearby public house. Pedestrians could be observed crossing from both sides of the road. The video camera was well concealed and no pedestrians appeared to notice that they were being observed. Twenty, 2-hour periods were spent recording on weekday afternoons between 3.30p.m. and 5.30p.m. during four weeks in the summer term. Recordings and commentaries were only made when there was pedestrian activity, so as to avoid tape wastage. The video-recordings were subsequently analysed and three types of measures were recorded:

a) <u>Pedestrian variables.</u>

1. Estimated age of pedestrian. - for children, this was made easier by knowing the times local schools finished each day.
2. Social situation of pedestrian. - pedestrians were classified as being alone, in a peer group, with an adult or in mixed groups of children.
3. Protection within groups. - if the pedestrian relied upon another person within the group to make the decision to cross the road, he was classified as being "protected". When a pedestrian crossed with a group, but appeared to make the decision to cross independently, he was classified as "unprotected".
4. Crossing when masked by a stationary or parked vehicle. - Accident report forms (stats 19) record whether "masked by a stationary vehicle" was a contributing factor in pedestrian accidents. An attempt was made to record whether pedestrians were masked from the view of approaching drivers when they were about to cross. In practice this meant noting whether they crossed close to parked vehicles. Each pedestrian was recorded as crossing "masked by a parked car" or "not masked by a car".

b) <u>Subjective measures of crossing behaviour.</u>

Each road crossing was divided into three stages and the pedestrians behaviour was recorded as follows

i). Approaching the crossing. (to within lm. of the kerb).

Movement - Running, walking or dawdling.

Looking - A count was made of headmovements directed up or down the road.

Cars passing - The number of cars passing and their direction of travel was recorded.

ii). In the kerb area. (approximately 1m. either side of the kerb).

Movement - Stopping, continuing at the same pace, slowing down.

Position on kerb (if stopped) - in roadway, on kerb, on pavement.

Looking - A count was made of headmovements directed up or down the road.

False starts - The number of times a pedestrian appeared to start to cross then changed his mind was recorded.

Cars passing - The number of cars passing and their direction of travel was recorded.

iii). Crossing the road.

Movement - Running, walking, dawdling.

Direction - At right angles to the kerb or diagonally.

Looking - A count was made of headmovements directed up or down the road.

Cars passing - The numbers of cars passing and their direction of travel was recorded.

c) Measures of interaction of pedestrians with vehicles.

Size of first gap. - This is the gap in traffic presented to the pedestrian on arrival at the kerb; the time (secs.) between the pedestrian's arrival at the kerb and the arrival of the first vehicle from either direction. The first gap is the accepted gap ($t_a$) if the pedestrian crosses in front of this vehicle, i.e. no cars pass before he crosses the road. If the pedestrian does not cross, it is recorded as a rejected gap ($t_r$).

Delay or anticipation ($t_d$) - When crossing in the first gap this is the time spent at the kerb before starting to cross i.e. it is only possible to delay when crossing in the first gap. When a pedestrian waits for traffic to pass before crossing he can either anticipate or delay crossing in the accepted gap $t_d$ can therefore be positive or negative and is the time from the pedestrian starting to cross to the arrival of the car passing immediately after he crosses.

Safety gap ($t_s$) - the time from the pedestrian leaving the path of the next vehicle to pass to the arrival of that vehicle; i.e. it is a measure of the safety margin of the road crossing.

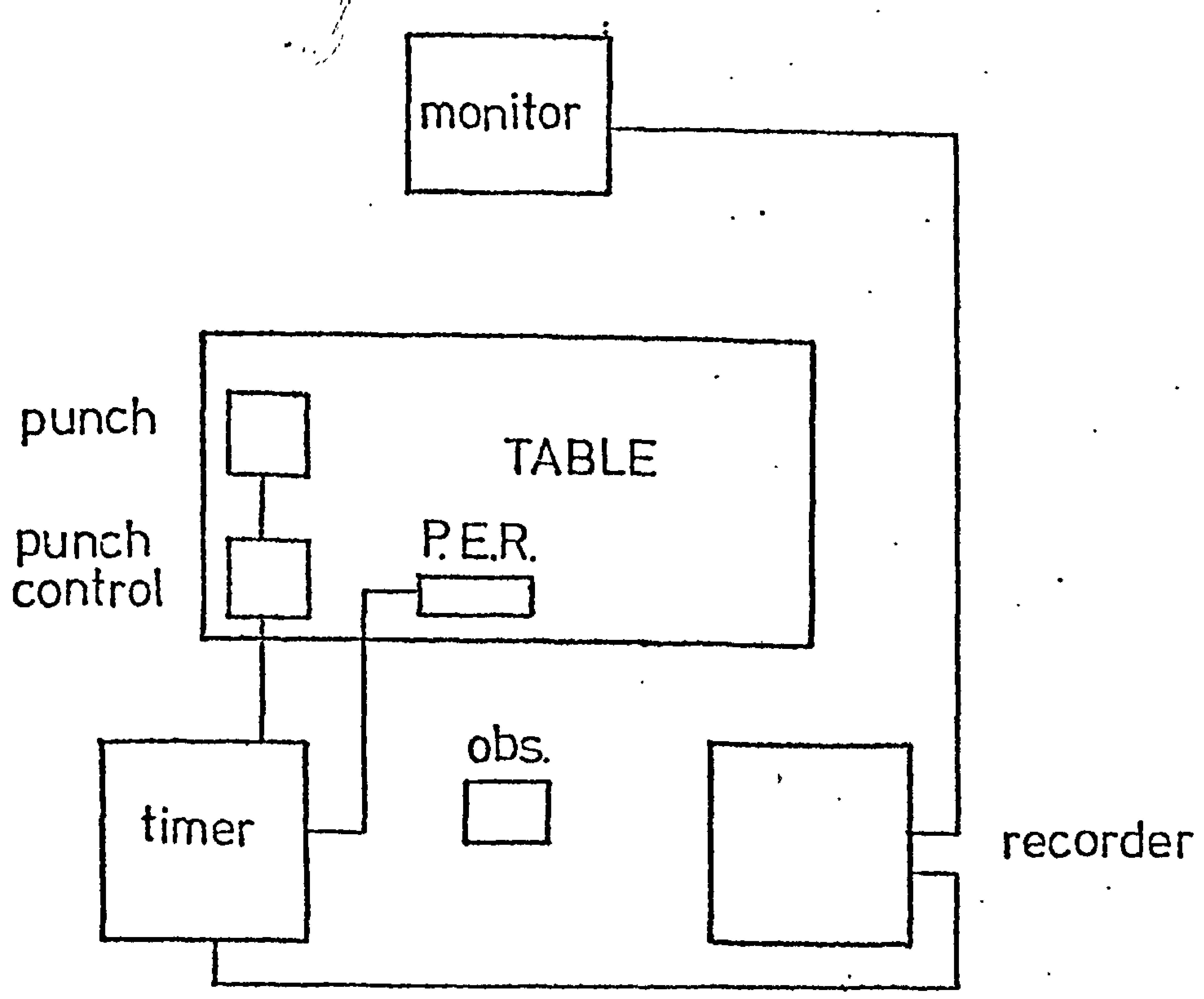
Time spent on kerb ($t_k$) - The total time a pedestrian waited on the kerb was recorded.

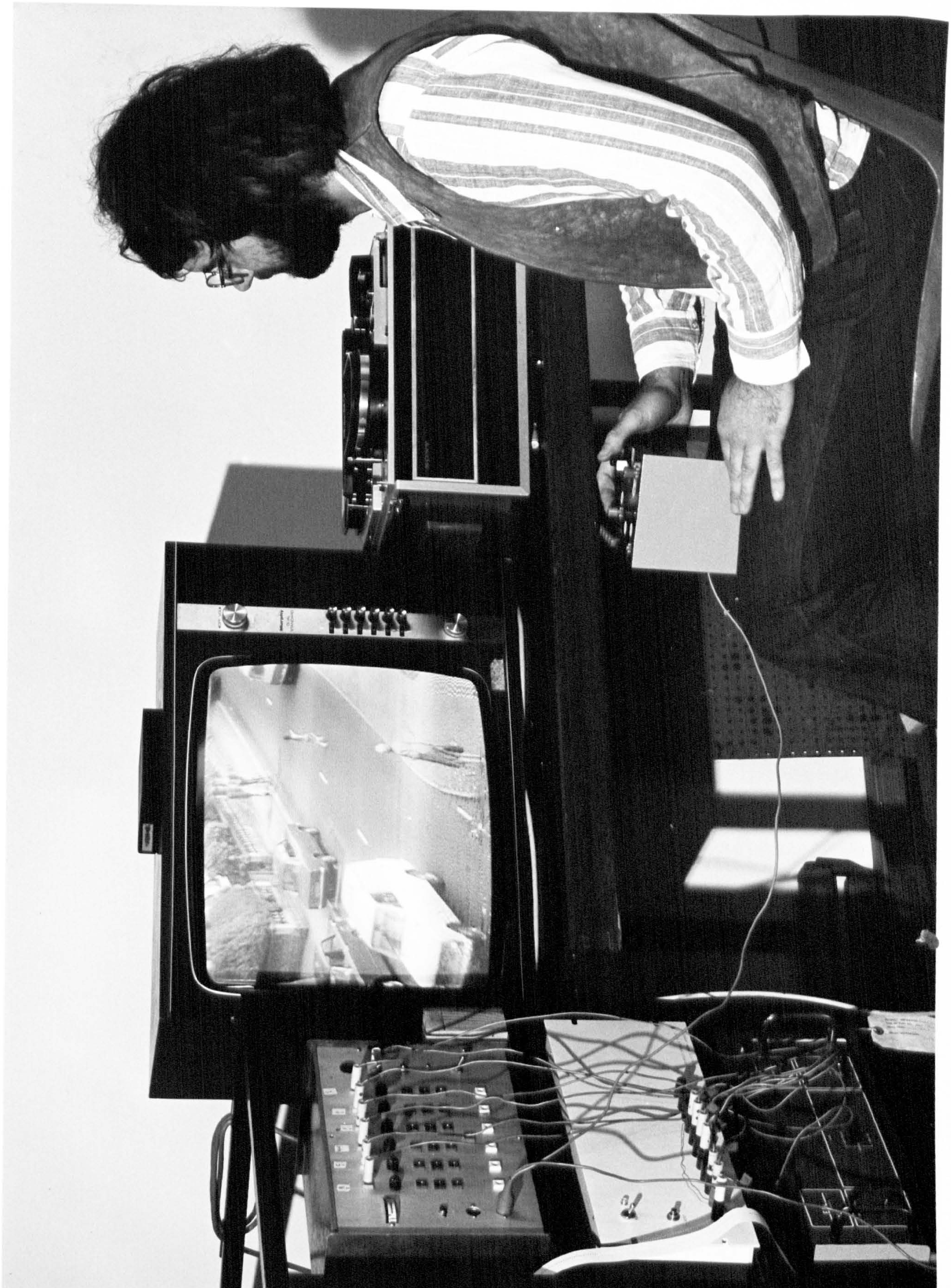
Time in carriageway ($t_c$) - the time from leaving the kerb area to leaving the offside carriageway.

These measures were recorded on coding sheets. Timing of gaps was achieved by using the portable event recorders (Appendix 4) outputting directly onto paper tape via a decoder and timer. A diagram of the analysis system and a photograph of the system in use is shown overleaf. The video recorder was modified to allow frame by frame analysis for counting headmovements. This system was found to be satisfactory when used in conjunction with the commentary. The main weakness lies in the relatively poor definition available from the video recordings, making the analysis of headmovements difficult.

Observer reliability was tested by repeated analysis of several tapes. Reliability was good for the simple subjective measures of crossing behaviour, ranging from 95% to 100% but was lower for the number of headmovements 80%. The Standard Error for timing gap sizes ranged from

ANALYSIS SYSTEM





0.3 to 0.7 seconds. The mean traffic density at the site was high, approximately 700 vehicles per hour, although this is not classed as a major road (A or B road).

Results.

The analysis will be presented in two parts. The first is concerned with the more objective measures of road crossing 'performance' derived from timing vehicles and pedestrians - measures of interaction of pedestrians with vehicles. The second attempts, on the basis of the subjective measures of pedestrian behaviour e.g. stopping and looking, to develop an overall measure suitable for making comparisons of the crossing strategies used by different groups of pedestrians or by pedestrians crossing at different locations.

Nearly 1,200 pedestrians were observed crossing at this site, 700 crossed unaccompanied while 470 crossed with another or other pedestrians. 766 children under 15 years were observed.

a) How pedestrians interact with traffic

The probability that a pedestrian will cross a particular road will be dependent upon the size of the gaps in the traffic . The probability that a pedestrian will cross in a given size of gap can be estimated fairly simply from an analysis of the size of gaps accepted or rejected.

The first observation study (Howarth, Routledge and Repetto-Wright 1972) and a study of adult pedestrians by Cohen et al, (1955), both estimated the probability of pedestrians crossing in given gap sizes in traffic by comparing the numbers of accepted gaps with the total numbers of gaps rejected. Analysing the data this way, biases comparisons between different groups of pedestrians, since those pedestrians who allow most vehicles to pass before crossing, contribute most readings, leading to an overestimation of the caution of the group as a whole. A more accurate analysis can be achieved by considering only the first gap in the traffic as the pedestrian arrives at the kerb. In this way each pedestrian contributes one reading only. A considerable number of observations are needed for this method of analysis and our early study was based on only a relatively small number of observations.

The second, larger study of pedestrian gap acceptance (Howarth, Routledge and Repetto-Wright 1972, Routledge 1975) analysed first gaps only. However, $t_a$ was calculated separately for nearside traffic and for offside traffic. This will also lead to overestimations of the caution of groups of pedestrians. Pedestrians make judgements about traffic approaching from both directions, and a gap on one side of the road that might otherwise be accepted, may be rejected because of an approaching vehicle on the other side of the road. This explains why some adults apparantly rejected gaps of 10 seconds or more. An alternative method of analysis is to consider only the smallest gap i.e. the nearest vehicle. This makes the assumption that pedestrians base their decision to cross on this one vehicle, and this may not be the case when two vehicles are approximately the same way off in either direction. There was unfortunately insufficient data for a more detailed analysis of this situation. However, at this site the difference in gap size in each direction, was very rarely less than 2 seconds, so it is a reasonable assumption to make with these data.

Figures 18, 19, 20 show the probability of crossing through different size gaps in traffic on arrival at the kerb, for different groups of unaccompanied pedestrians. (See also Table 1 Appendix 4). The data is well fitted by the Integral of the Normal Distribution (values of Chi-square are given for each graph, p - N.S. indicates that the curve is a good fit). In order to test the null hypothesis that all pedestrians will cross through the same size gaps with equal probabilities, the 50% quantile, together with upper and lower 95% confidence limits have been calculated (Table 2). The null hypothesis can best be tested by comparing the quantiles for different age groups of pedestrians. There are no appropriate non-parametric tests, unless data is discarded, since the distribution of gap sizes is different for each age group.

The 50% quantile is significantly different for the 11-14 year olds when compared with that for the 0-10 year olds ($p < .05$). 50% of 11-14 year olds accepted a gap size of 4.6 seconds, the corresponding gap size for the 0-10 year old children is 5.9 seconds, and for the adults, 5.3 seconds. The elderly pedestrians appear to require larger gaps than any other age group before they will cross, however, this is based on a small number of observations. There are no differences between the 0-7 year olds and 8-10 year olds. As only 70, 0-7 year olds were observed, (this is reflected in the variability of the 50% quantile), the data for these two groups has been combined (Figure 19).

The interpretation of these data is not straightforward. Certainly the 11-14 year olds are the most adventurous group, in that many will accept very small gaps in traffic - 50% when presented with a 3 second gap actually crossed. The adults appear to be more "cautious", only 12.5% crossing in 3 second gaps. While the younger children (0-10 year olds) are also more "cautious" than the older children, the 50% quantile is the same as for the adults; there is however, more variability in the distribution of the probability of the 0-10 year olds accepting gaps of different sizes. 11% and 30% of the 0-10 year olds cross in 2 and 3 second gaps respectively compared with corresponding figures of 0% and 12.5% for the adults.

Although these distributions of accepted gaps do describe the observed behaviour of pedestrians, they do not provide an explanation for the greater number of accidents to the younger children (and the elderly). If crossing in small gaps is dangerous then the 11-14 year olds presumably would be most at risk. Since this is not the case, the most likely explanation is that they have developed the necessary skills and have the confidence to cross in relatively small gaps in traffic. There is some evidence that the younger children although apparantly more "cautious" as a group may occasionally cross in very small gaps in traffic, one 5 year old and one 8 year old were each observed crossing in a gap of 2 seconds, having seen the oncoming traffic! No other pedestrian was seen to cross in a gap this small.

It is difficult to make direct comparison of these data with previous studies for the reasons mentioned earlier in this chapter. However the relationships between the different age groups are the same. Previously it had been found that 10-12 year olds tended to cross in smaller gaps than 5-9 year olds. (Routledge et al 1976). These data were compared with adults crossing a one-way stream of traffic (Cohen et al 1955), who not surprisingly, accepted even smaller gaps in traffic. Both these studies recorded all the gaps rejected by pedestrians, so the quantiles for all the groups of pedestrians were larger than those of the present study. The second, large scale study of pedestrians (Routledge 1975, Routledge et al 1976) found that 12-15 year olds were the most adventurous, followed by adults and young children. No difference was found between the 0-7 year olds and the 8-10 year olds.

Figure 21 and table 3 shows the probability of crossing through different size first gaps in traffic on arrival at the kerb for boys and girls (0-14 year olds). There is no significant difference between the two groups at the 50% quantile but boys tend to cross in smaller first gaps. Figure 22 shows the same data for adult males and females. The difference between these two groups is highly significant ($p < .01$). The 50% quantiles together with the confidence limits are shown in table 2. There are no significant differences for either sex between children and adults.

A high proportion of boys crossed in small gaps. 10% crossed in 2 seconds gaps and 45% in 3 second gaps. The corresponding figures for the girls were 0% and 28%. The adult females are most "cautious" only 18% crossing in 4 second gaps compared with 35% of male adults.

The finding, that males tend to cross in smaller gaps than females is also consistant with the findings of the earlier studies. Figure 23 and table 4, shows the same data, for children in groups. Children (0-10 year olds) crossing in peer groups are compared with children (0-10 year old) crossing with adults. When compared with Figure 19(a) (0-10 year olds unaccompanied) it can be seen that children with adults cross in much larger gaps. There is no significant difference between the two groups of accompanied children, but children in peer groups tend to cross in slightly smaller gaps. Groups of children and children with adults cross in relatively large gaps in traffic, none of the former crossed in a gap smaller than 5 seconds and none of the latter crossed in a gap smaller than 6 seconds. 50% of the unaccompanied 0-10 years only crossed in 6 second gaps.

Summarising these data:

1) The unaccompanied 11-14 year olds are prepared to cross in smaller gaps in traffic than other pedestrians. 50% of both adults and young children (0-10 year olds) will cross in gaps sizes between 5 and 6 seconds. Both the adults and the young children are more "cautious" than the 11-14 year olds, but there is some evidence that very young children occasionally cross in very small gaps.

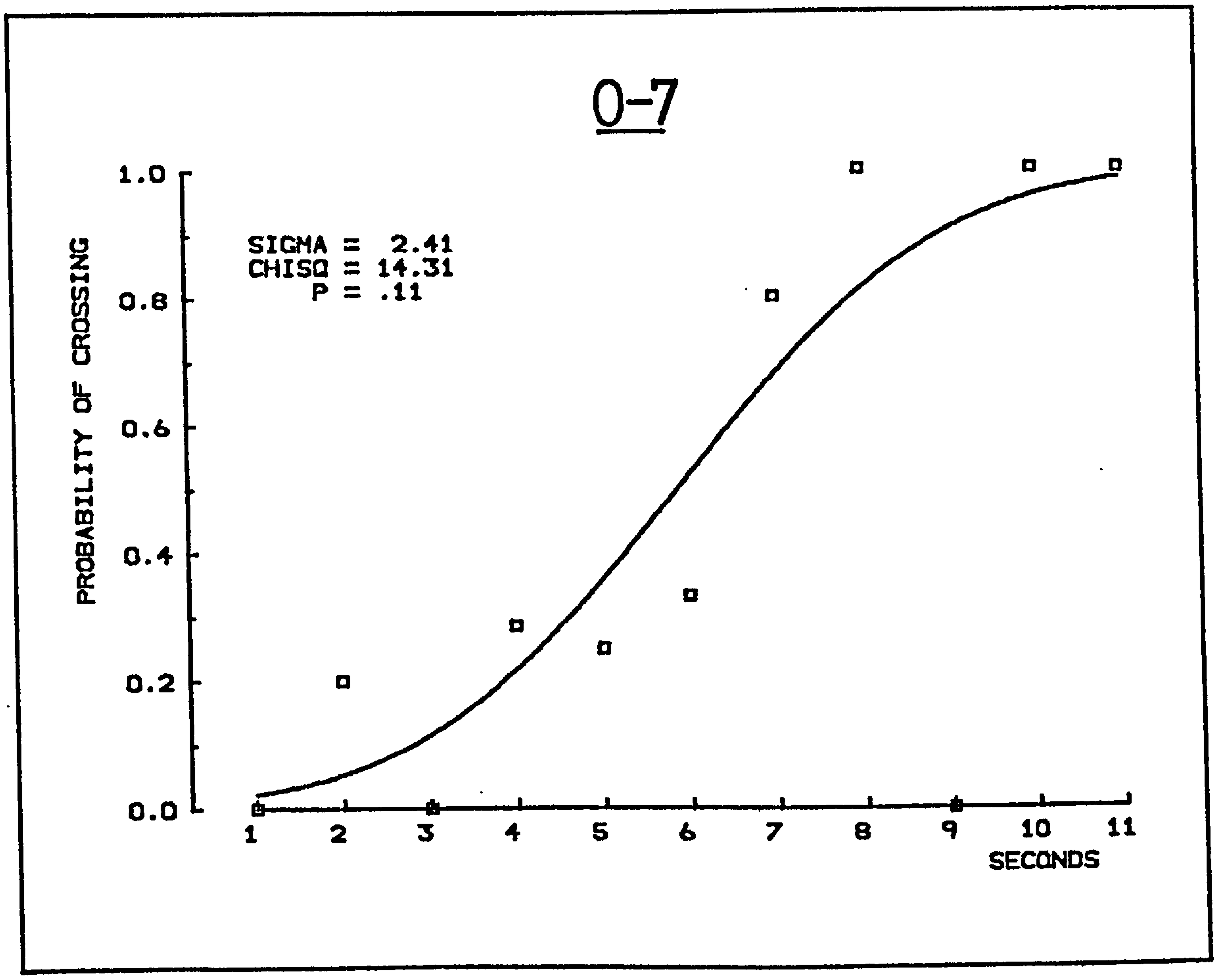
2) The adult females are more "cautious" in their choice of accepted gap than adult males.

3) Children with adults cross in larger gaps than unaccompanied children.

## FIGURE 18

Probability of unaccompanied 0-7 and 8-10 year olds crossing through different size first gaps on arrival at the kerb.

Fig.18


0-7
SIGMA = 2.41
CHISQ = 14.31
P = .11
PROBABILITY OF CROSSING
1.0
0.8
0.6
0.4
0.2
0.0
1
2
3
4
5
6
7
8
9
10
11
SECONDS

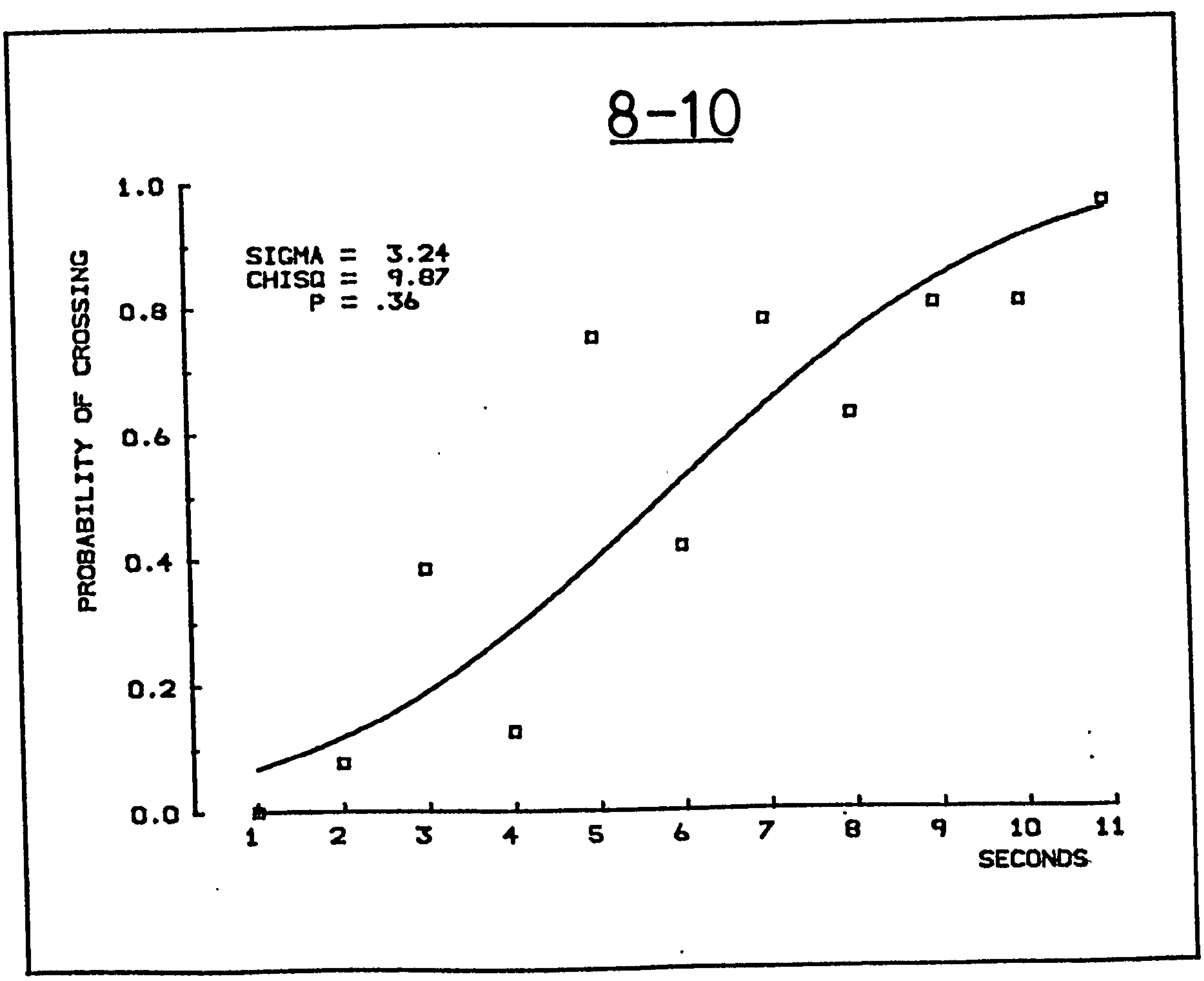
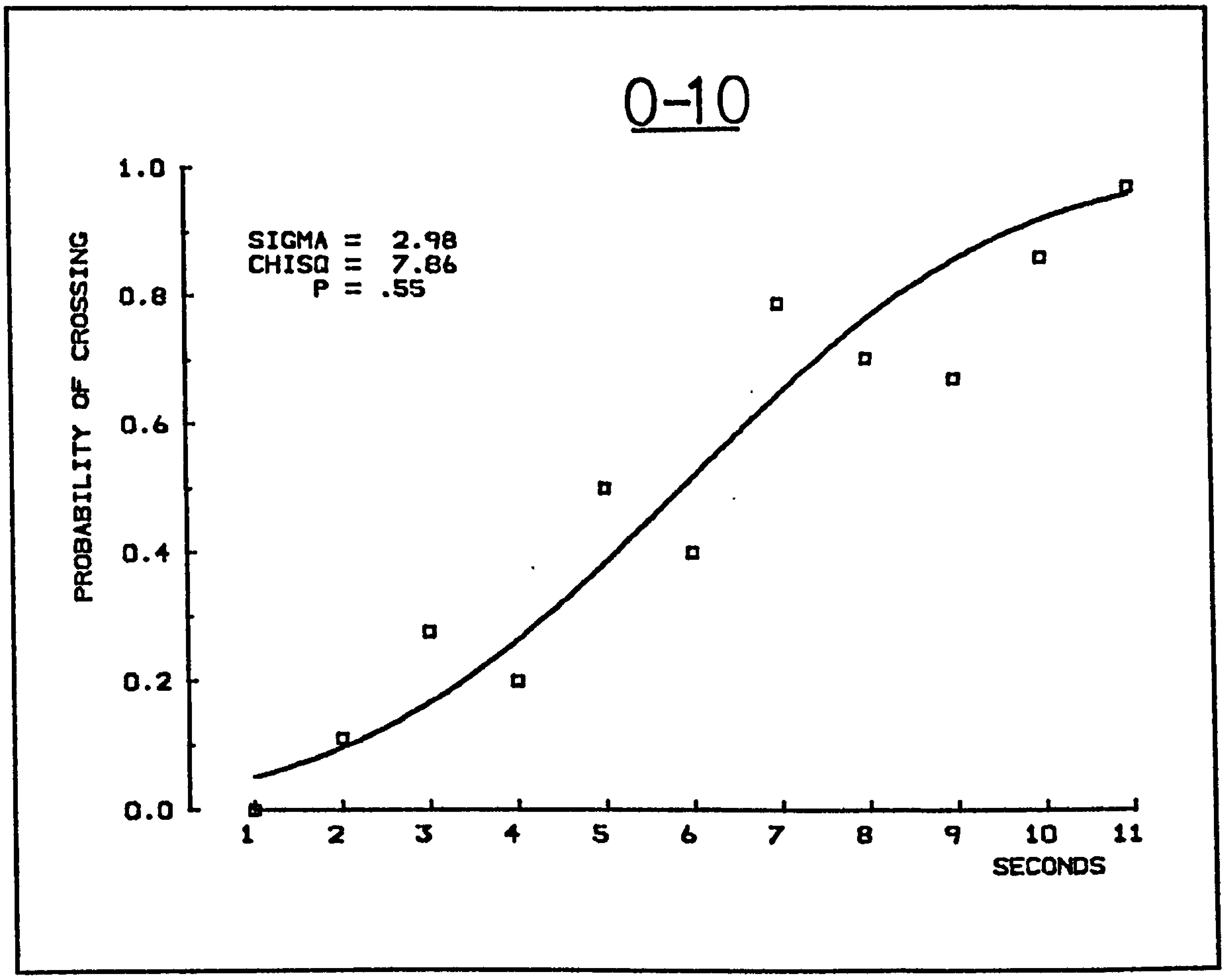

8-10
SIGMA = 3.24
CHISQ = 9.87
P = .36
PROBABILITY OF CROSSING
1.0
0.8
0.6
0.4
0.2
0.0
1
2
3
4
5
6
7
8
9
10
11
SECONDS

FIGURE 19

Probability of unaccompanied 0-10 and 11-14 year olds crossing through different size forst gaps on arrival at the kerb.

Fig.19


0-10
SIGMA = 2.98
CHISQ = 7.86
P = .55
PROBABILITY OF CROSSING
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11
SECONDS

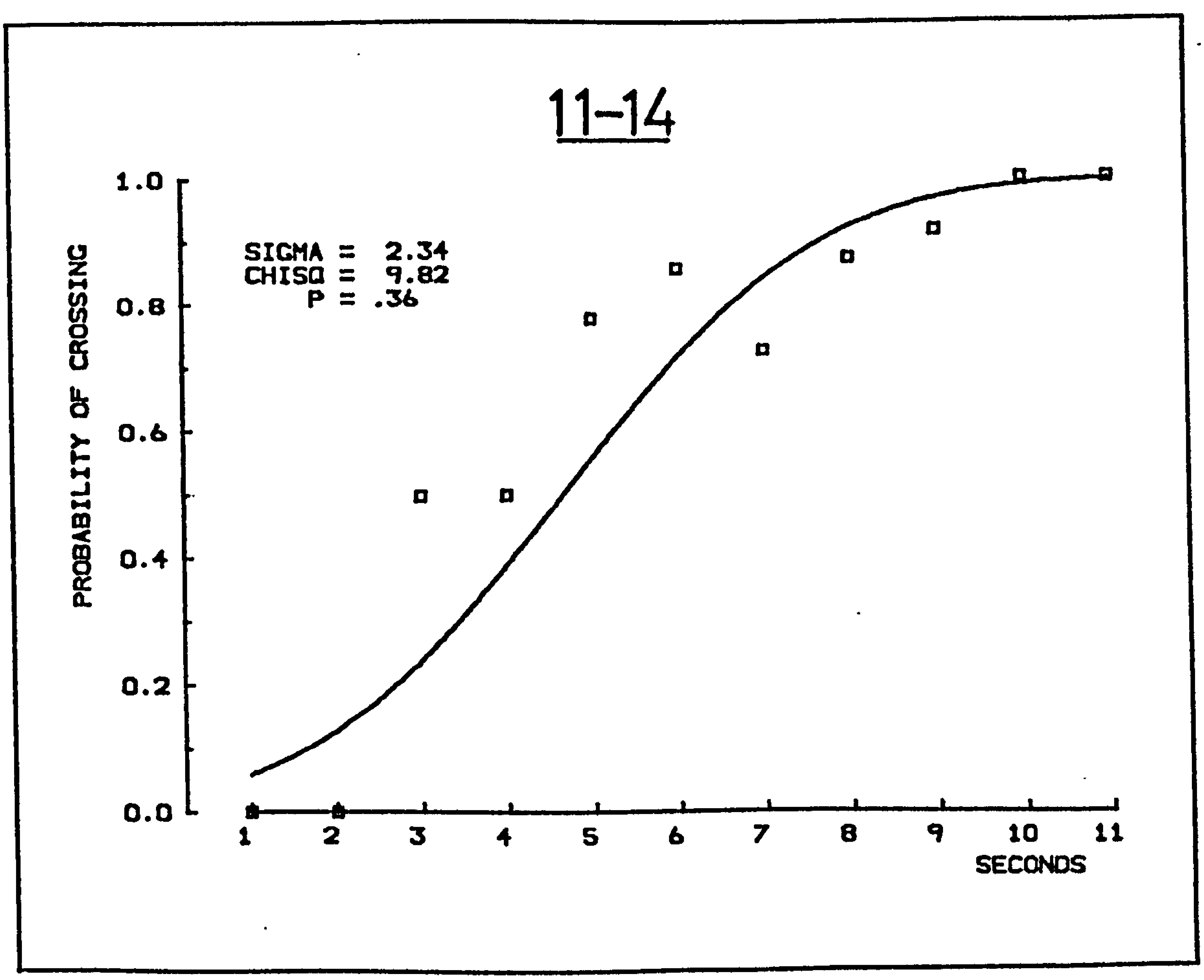
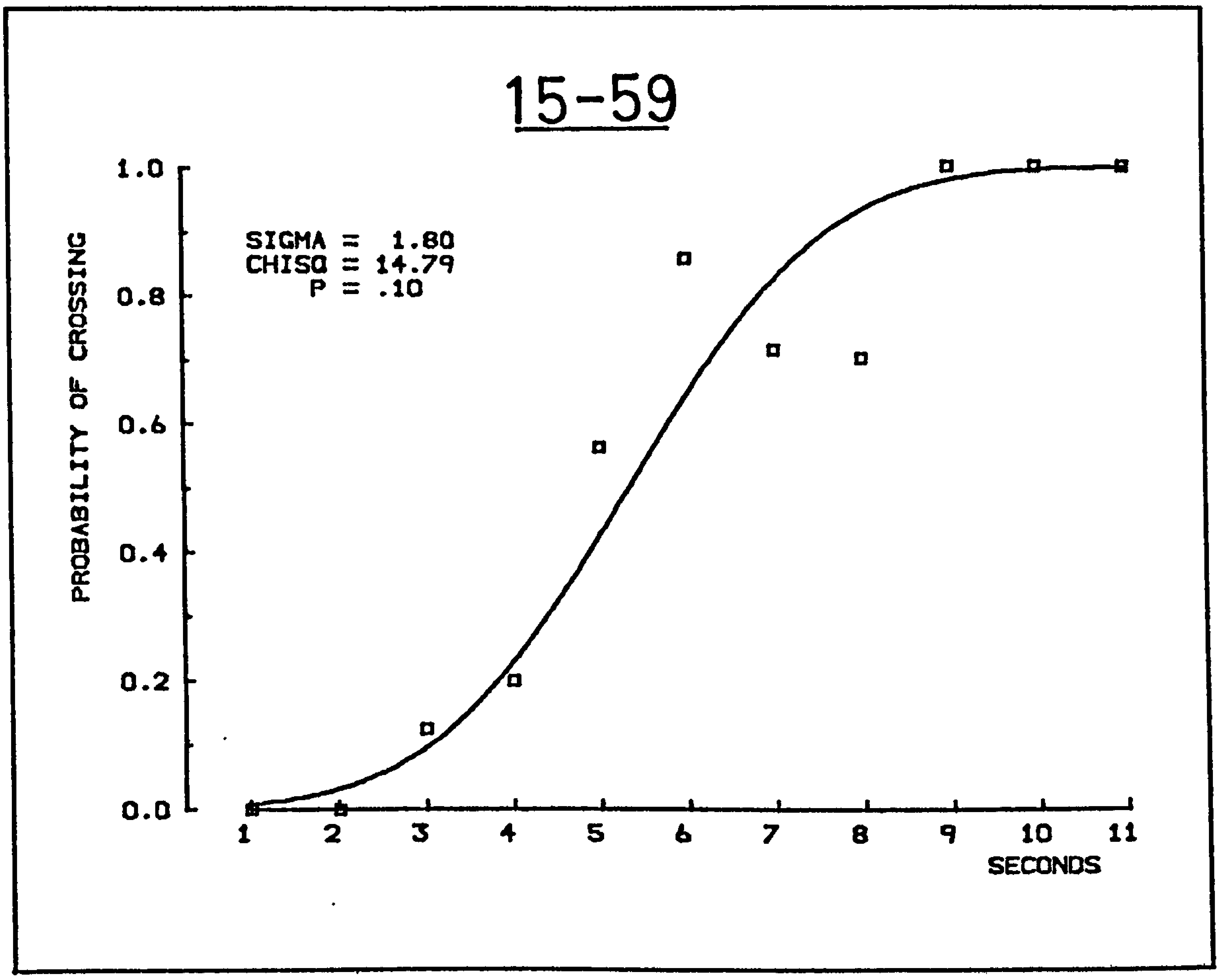

11-14
SIGMA = 2.34
CHISQ = 9.82
P = .36
PROBABILITY OF CROSSING
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11
SECONDS

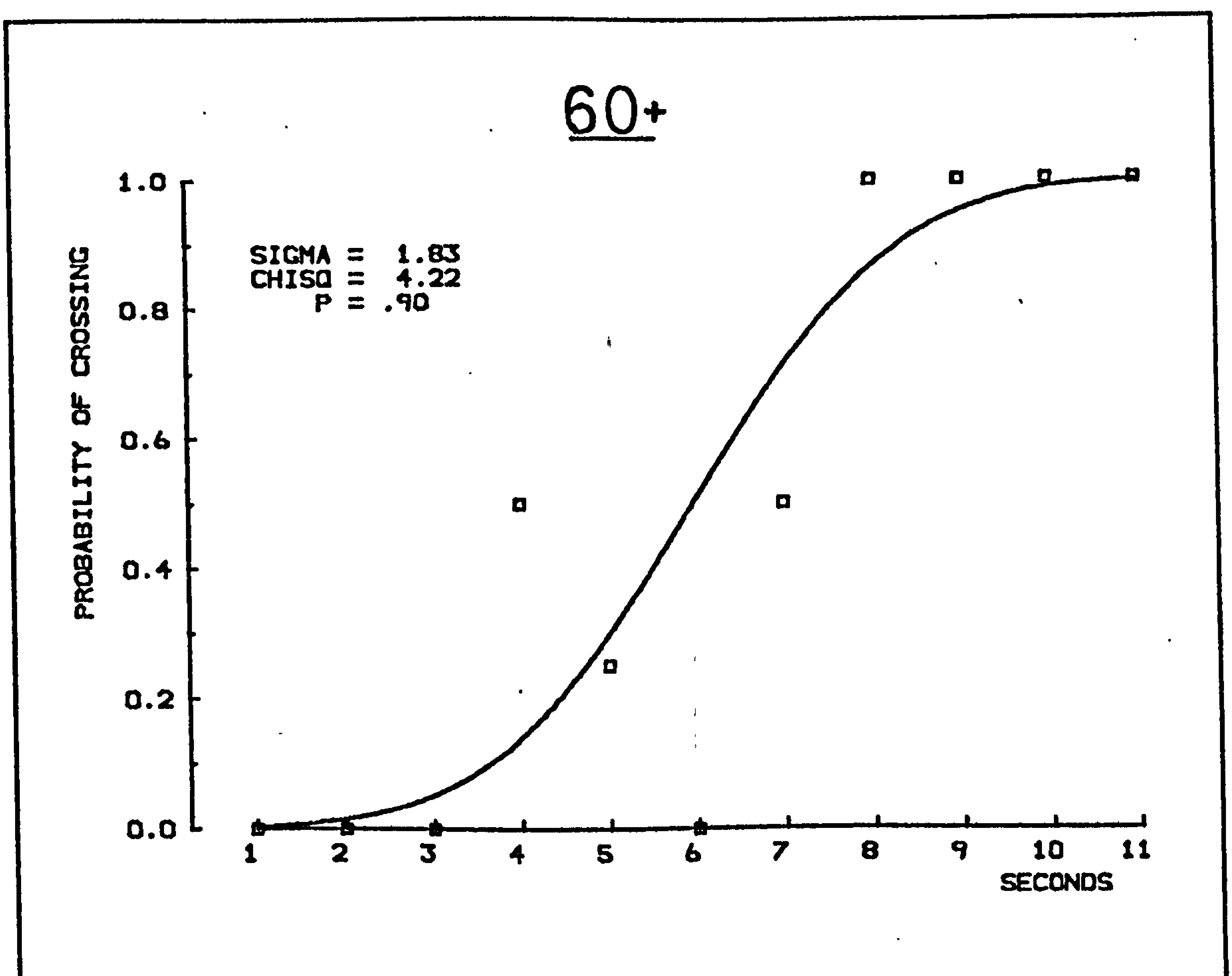
FIGURE 20

Probability of unaccompanied 15-59 and 60+ year olds crossing through different first size gaps on arrival at the kerb.

Fig.20



15-59
SIGMA = 1.80
CHISQ = 14.79
P = .10
PROBABILITY OF CROSSING
1.0
0.8
0.6
0.4
0.2
0.0
1
2
3
4
5
6
7
8
9
10
11
SECONDS

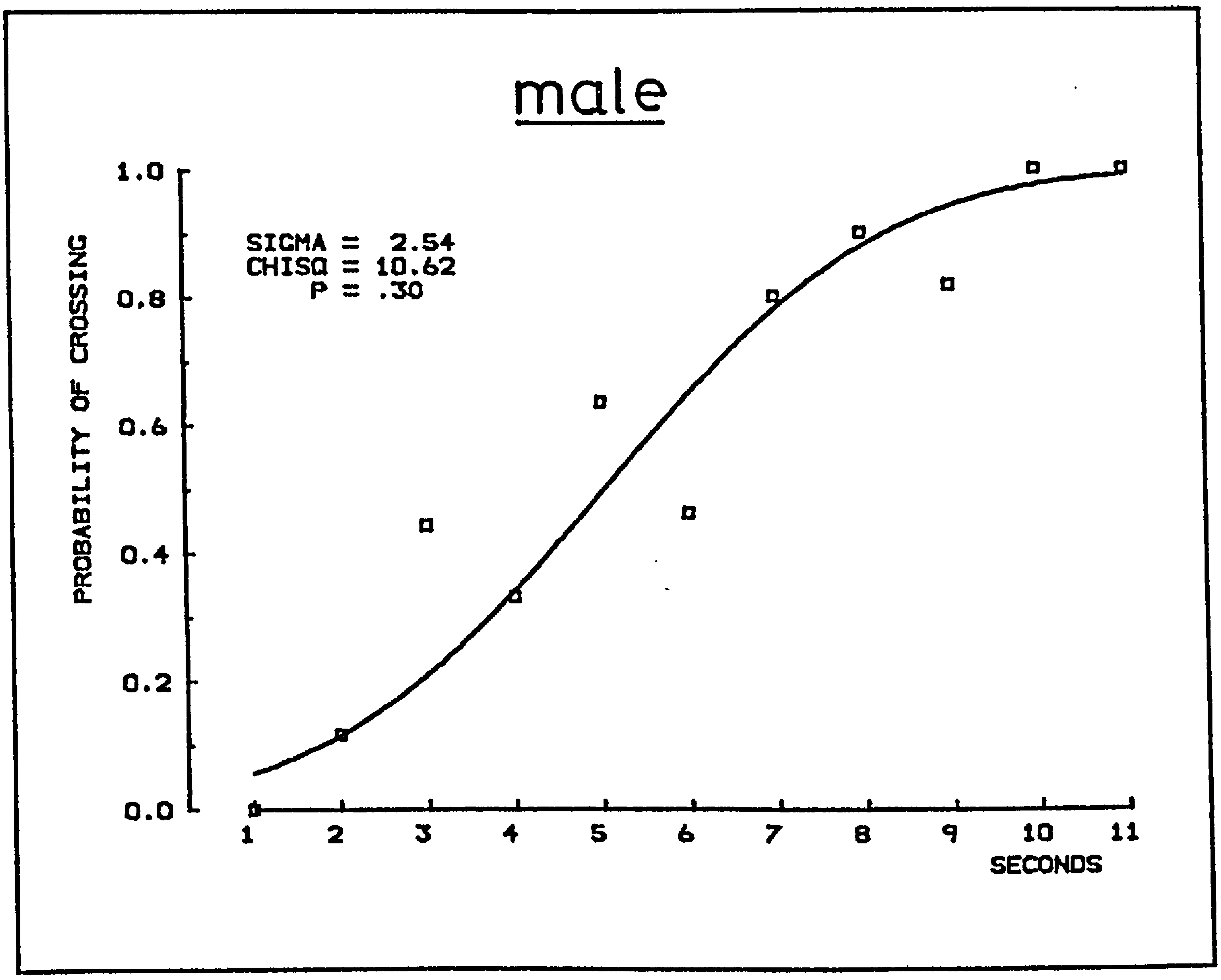



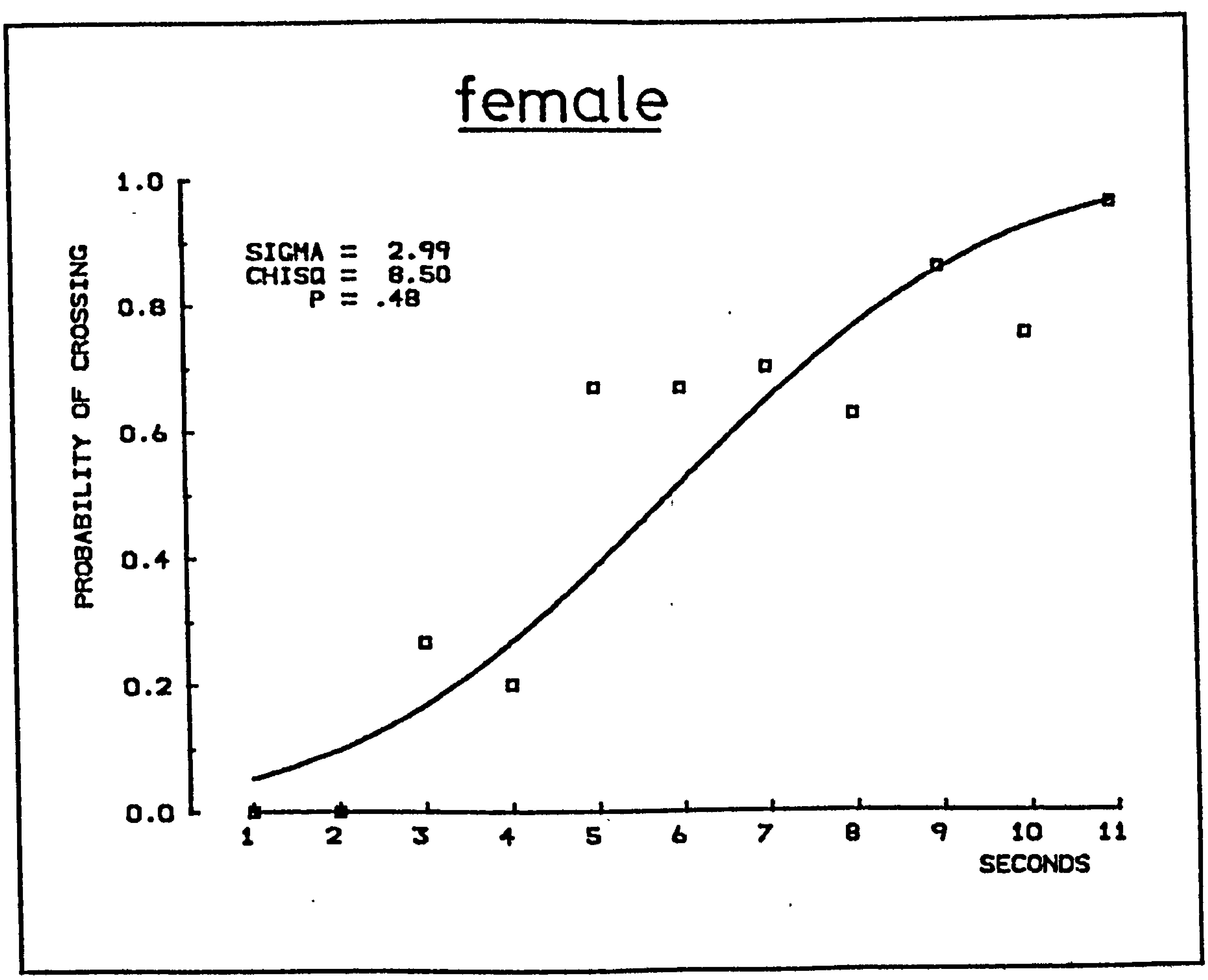
60+
SIGMA = 1.83
CHISQ = 4.22
P = .90
PROBABILITY OF CROSSING
1.0
0.8
0.6
0.4
0.2
0.0
1
2
3
4
5
6
7
8
9
10
11
SECONDS

## F I G U R E 21

Probability of unaccompanied male, 0-14 year olds and female 0-14 year olds crossing through different size first gaps on arrival at the kerb.

Fig. 21

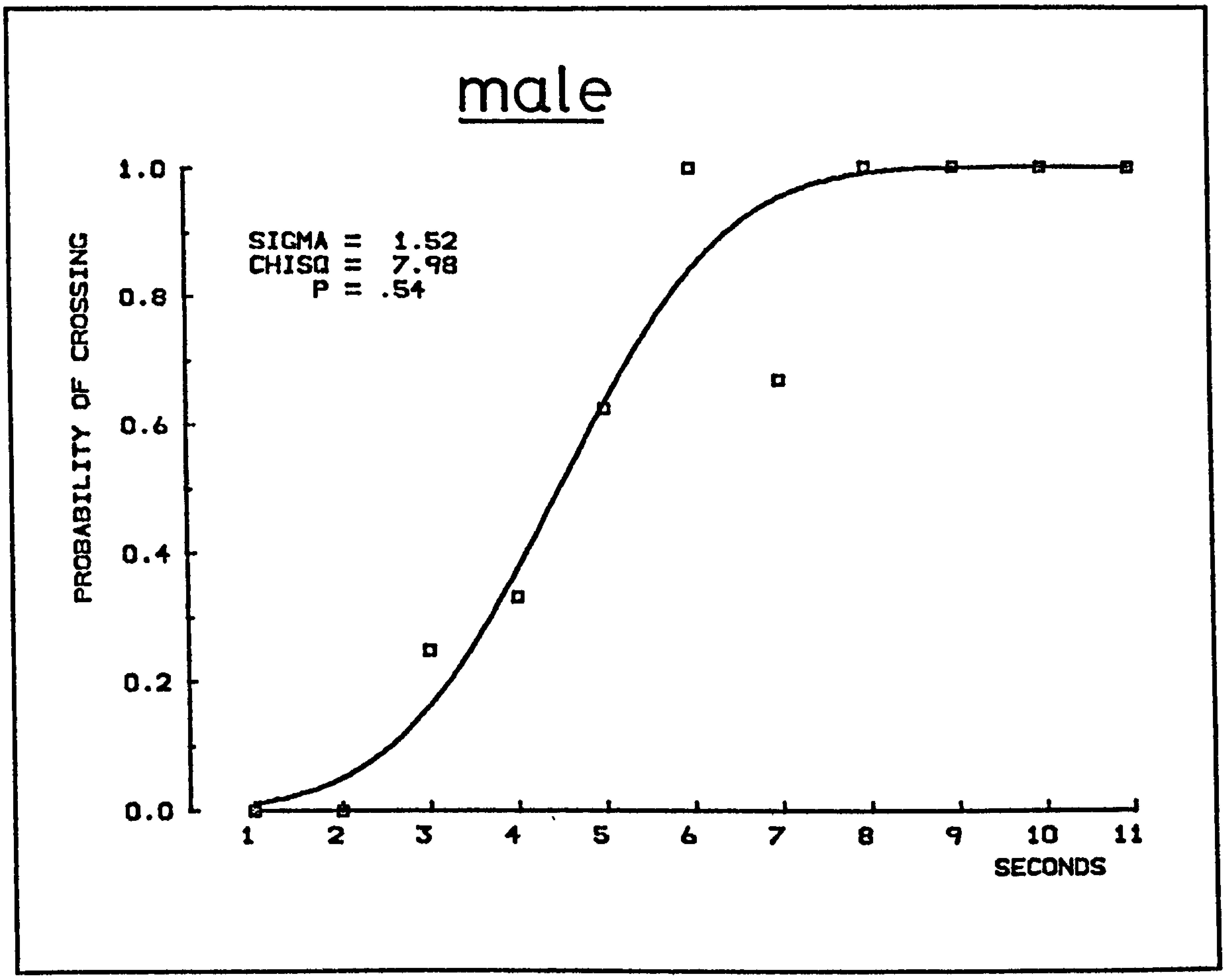

male
SIGMA = 2.54
CHISQ = 10.62
P = .30
PROBABILITY OF CROSSING
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11
SECONDS


female
SIGMA = 2.99
CHISQ = 8.50
P = .48
PROBABILITY OF CROSSING
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11
SECONDS

## F I G U R E 22

Probability of unaccompanied male adults (15+) and female adults (15+) crossing through different size first gaps on arrival at the kerb.

fig. 22.


male
1.0
0.8
0.6
0.4
0.2
0.0
PROBABILITY OF CROSSING
SIGMA = 1.52
CHISQ = 7.98
P = .54
1 2 3 4 5 6 7 8 9 10 11
SECONDS

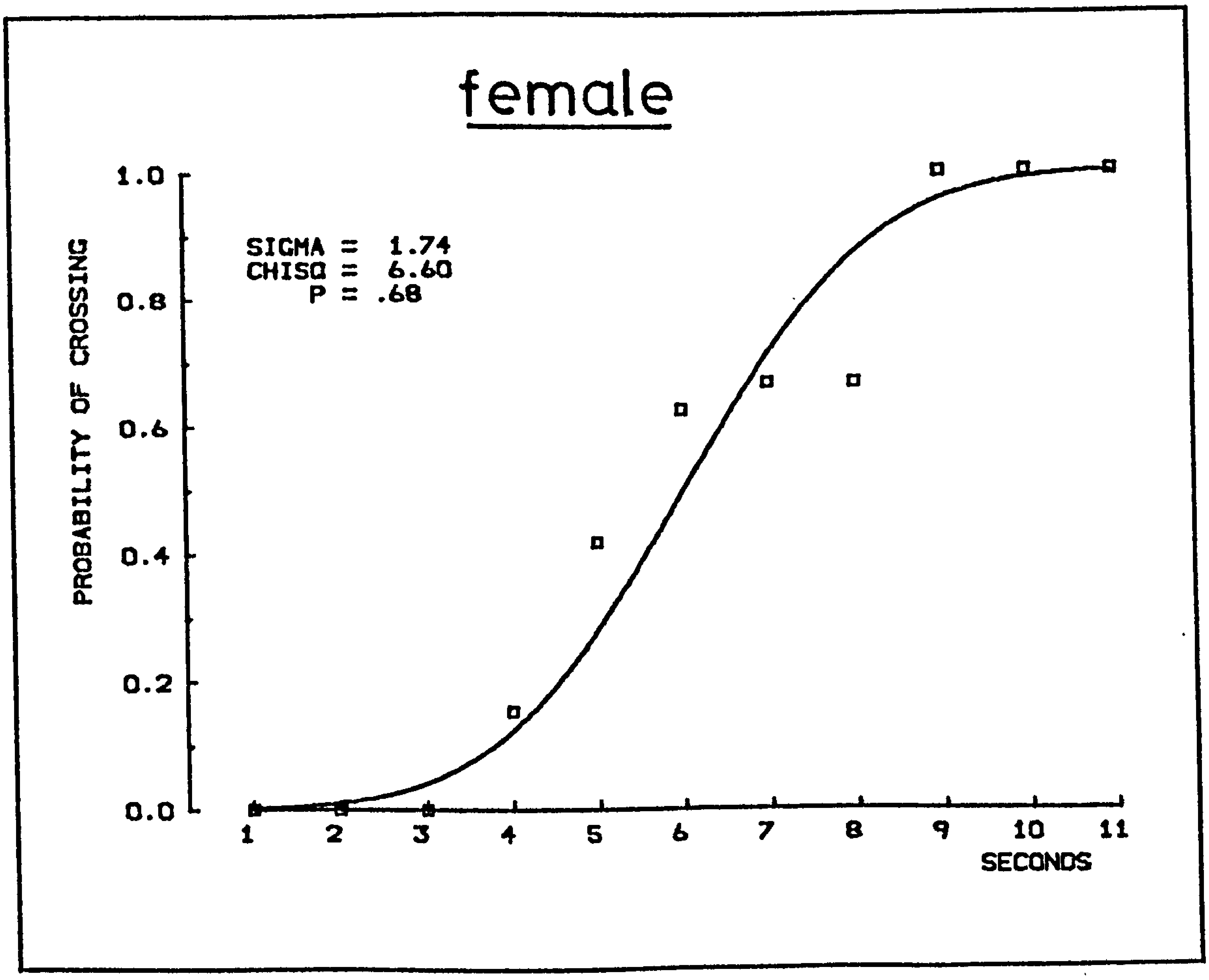
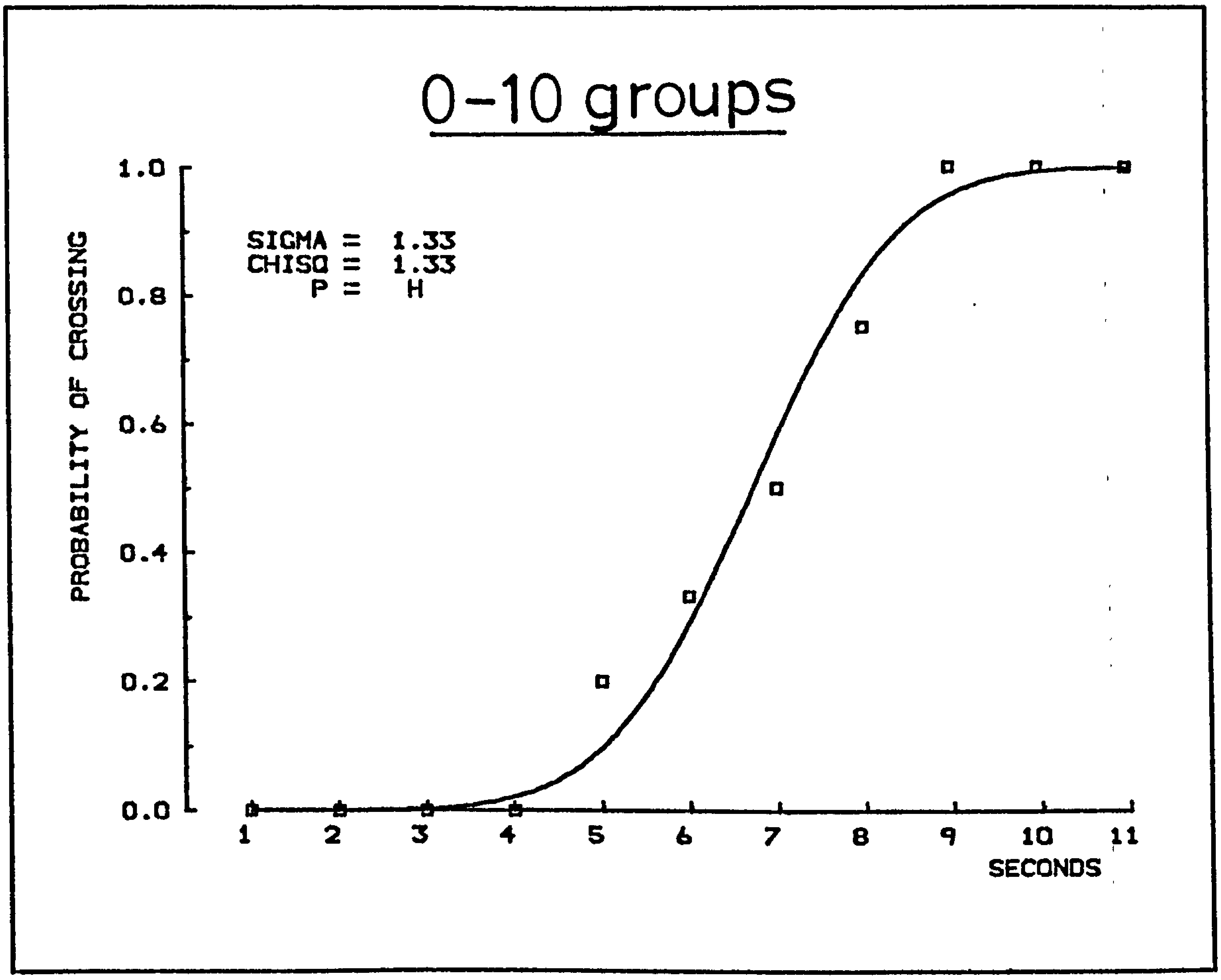
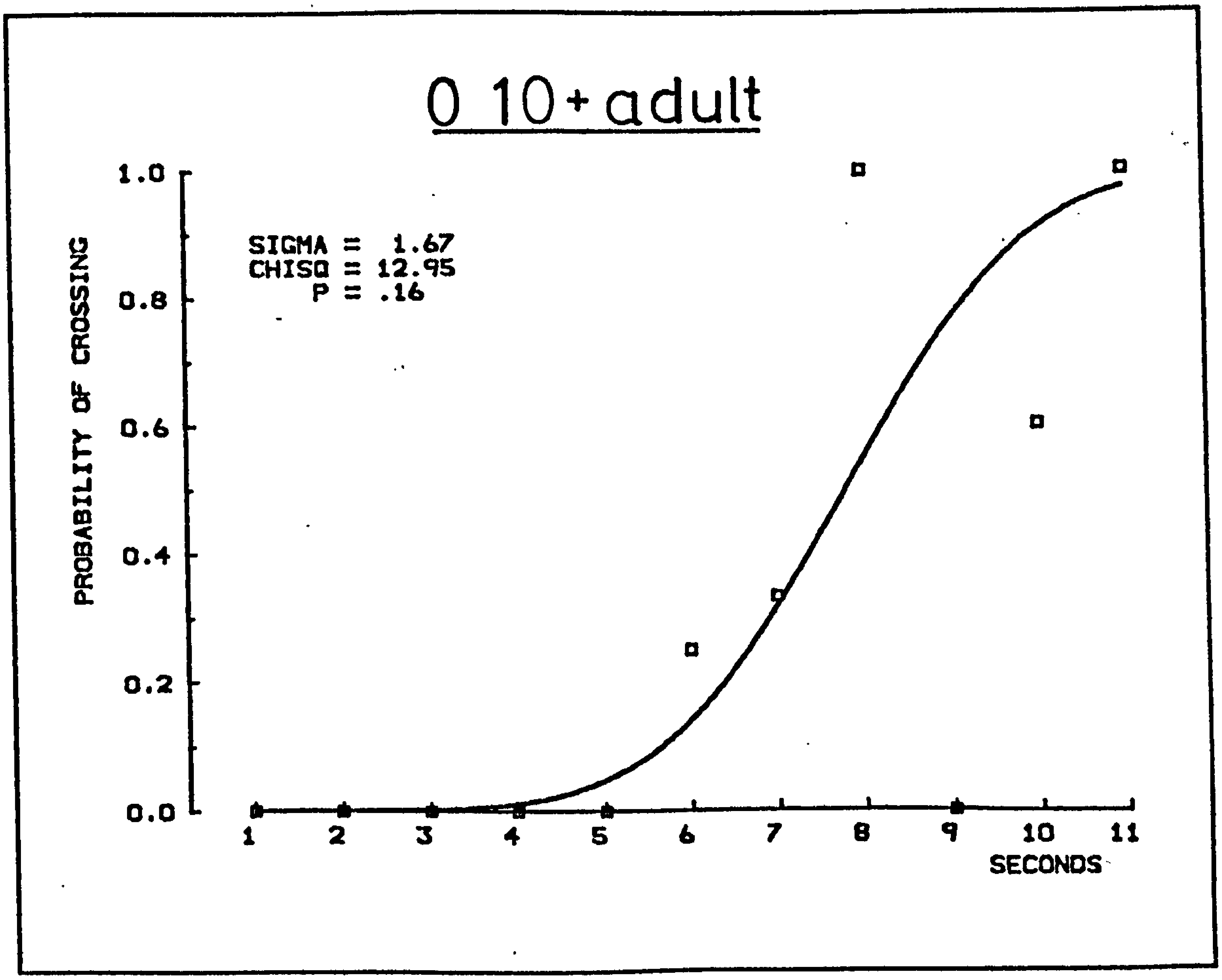

female
1.0
0.8
0.6
0.4
0.2
0.0
PROBABILITY OF CROSSING
SIGMA = 1.74
CHISQ = 6.60
P = .68
1 2 3 4 5 6 7 8 9 10 11
SECONDS

FIGURE 23

Probability of 0-10 year olds in groups and 0-10 year olds with an adult crossing through different size first gaps in traffic.

Fig. 23


0-10 groups
PROBABILITY OF CROSSING
1.0
0.8
0.6
0.4
0.2
0.0
SIGMA = 1.33
CHISQ = 1.33
P = H
1 2 3 4 5 6 7 8 9 10 11
SECONDS


0 10+adult
PROBABILITY OF CROSSING
1.0
0.8
0.6
0.4
0.2
0.0
SIGMA = 1.67
CHISQ = 12.95
P = .16
1 2 3 4 5 6 7 8 9 10 11
SECONDS

In the earlier studies of pedestrian behaviour an attempt was made to find a measure that reflected the skill and efficiency of pedestrians crossing through paps in traffic. It was argued on the basis of casual observations of children and adults crossing roads that the "skilled" pedestrian would make most use of a gap in the traffic by anticipating the arrival of the vehicle defining the start of the gap. By crossing closely behind this vehicle the safety margin between himself and the next approaching vehicle would be maximised. This safety margin was called the safety gap($t_s$), and was considered to be an absolute measure of the risk in crossing a road - since a safety gap of zero is, by definition, an accident. Comparisons of safety gaps for groups of pedestrians differentially at risk (age groups) initially suggested that the high risk groups left smaller safety margins (Howarth, Routledge and Repetto-Wright 1972). A large scale replication of the study failed to confirm this result. (Routledge 1975). The random site study had shown that young children run across roads far more frequently than older pedestrians (Figure 15, Chapter 3). The failure to describe the anticipatory behaviour of the more "skillful" pedestrian in terms of the safety gap could therefore be explained by the young children possibly waiting for a car to pass, and then rushing across the road. If, instead of recording the safety gap, the time from the moment a vehicle defining the start of a gap passes, to the moment the pedestrian starts to cross is measured, the anticipatory behaviour of different groups, or the lack of it, should become evident. This quantity, called pedestrian delay($t_d$), can be either positive or negative depending upon whether the pedestrian anticipates crossing behind a vehicle (leaving the kerb before the vehicle passes) or waits till it has passed.

The distributions of delay for unaccompanied pedestrians crossing through gaps in traffic are shown for different age groups in Figure 24. The means for each age/sex group are also plotted in Figure 25. Table 5

## F I G U R E 24

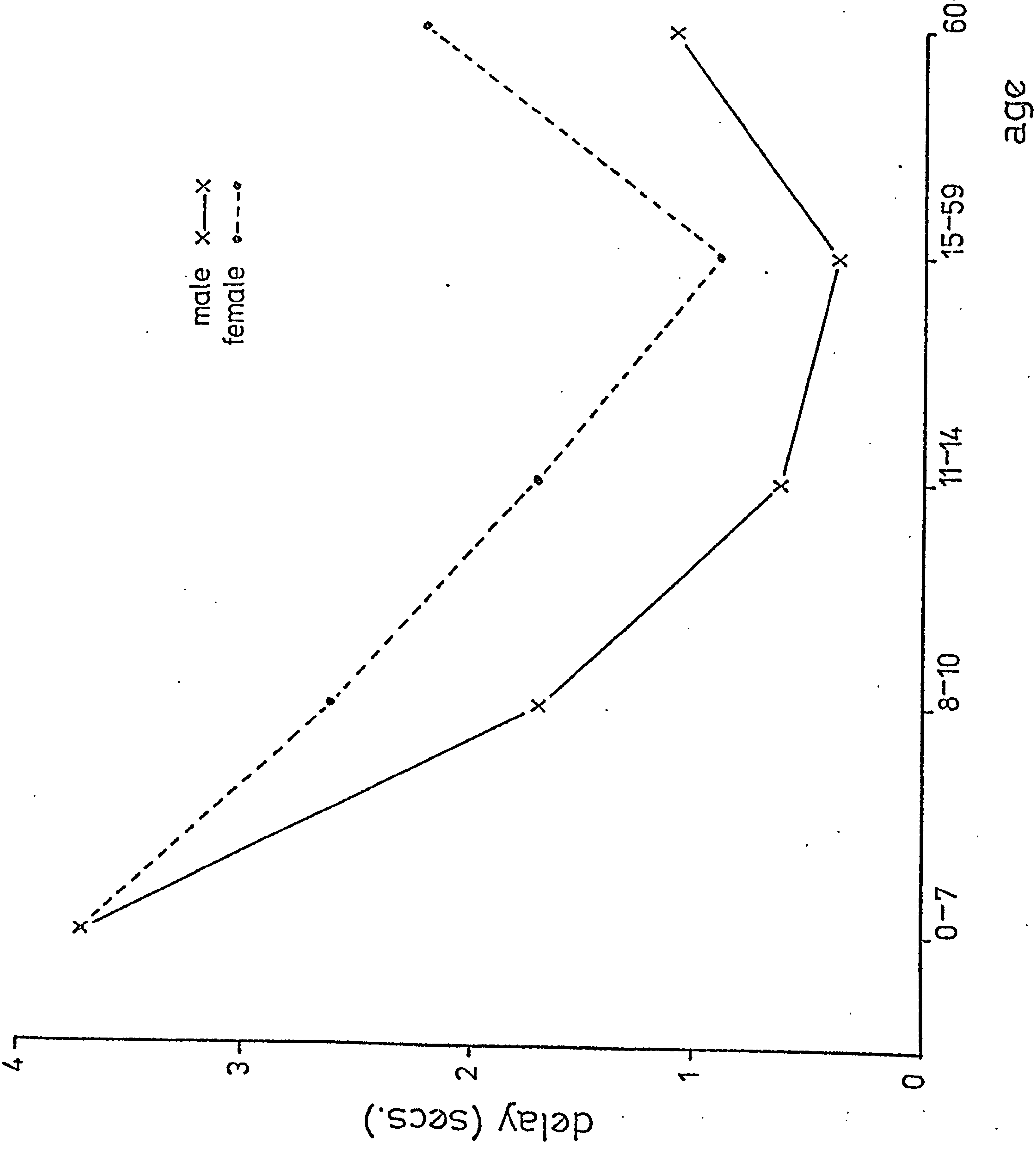
Distribution of delay/anticipation for different age groups of unaccompanied pedestrians crossing through gaps in traffic.


Fig. 24
% Crossing
40
20
0
60+
15–59
11–14
8–10
0–7
7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8
+
delay
–
anticipation

FIGURE 25

Mean delay/anticipation for age and sex groups of unaccompanied pedestrian crossing through gaps in traffic.

Fig.25



shows the means and S.E.'s.

There is a significant effect of age, older pedestrians (with the exception of the elderly) delay less when crossing through gaps in traffic. The distributions of $t_d$ are significantly different for all age groups ($p < .01$, t-test). The elderly pedestrians delay longer than the adults. Whereas adults only delay between ½ and 1 second before starting to cross, the young children delay on average 4 seconds before crossing.

With the exception of the youngest age group, 0-7 year olds, the difference between the distributions of $t_d$ for each sex are significantly different at each age group. Males delay less than females ($p < .01$, t-test).

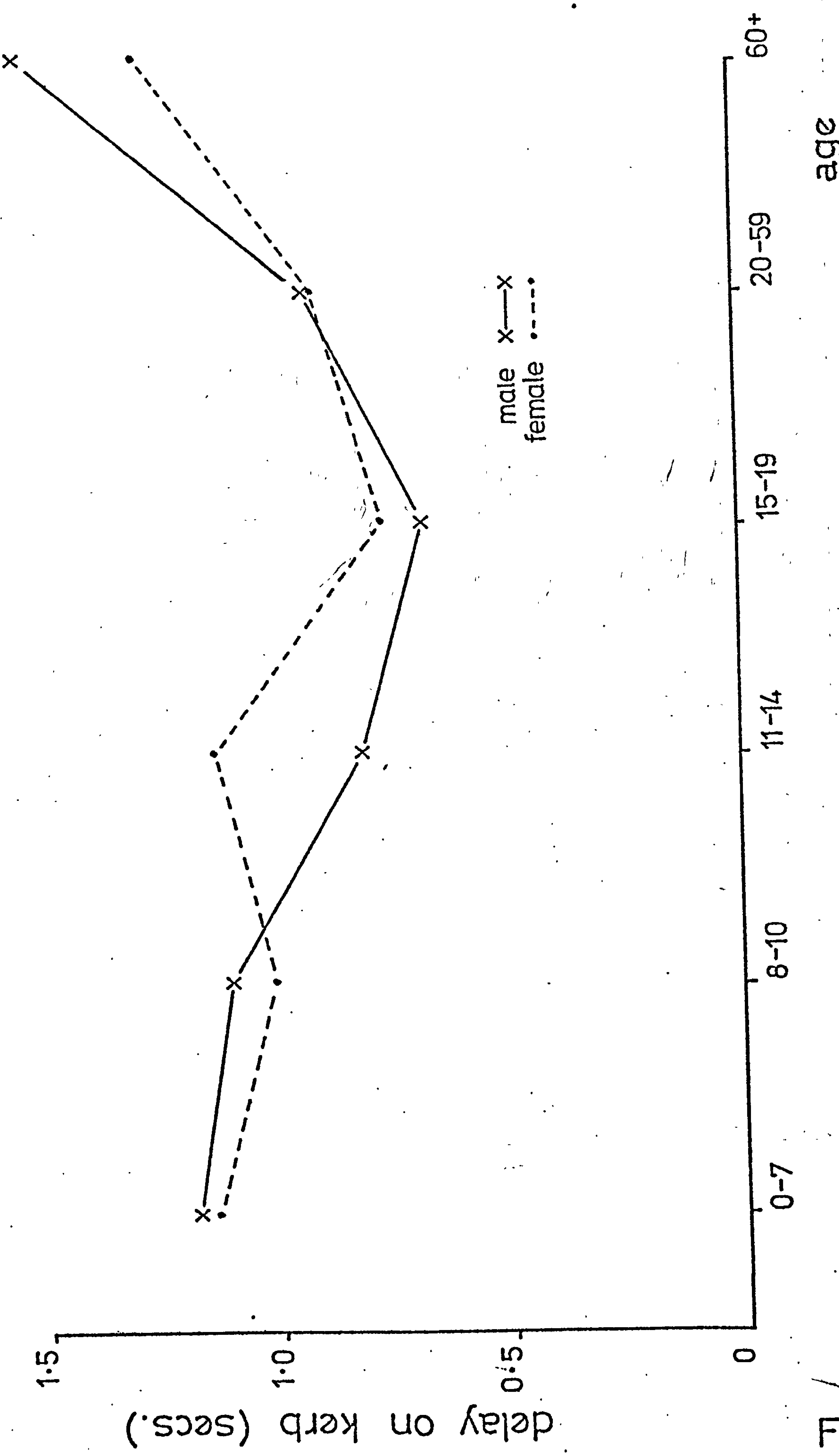
The delay on the kerb before crossing in the first gap in traffic is shown in Figure 26. The effect of age is not significant. When there are no vehicles around children delay little longer than adults; when there are vehicles passing and the crossing is made between them, children delay much longer than adults. This suggests that a young child's decision to cross through a gap in traffic is influenced, not only by the approaching vehicle but also by the vehicle defining the gap.

Children in groups and children with adults delay less than unaccompanied 0-10 year olds. (Table 6). This is somewhat surprising since it might be expected that they would take longer to organise themselves getting across the road. Since both groups cross in larger gaps they may have had more time to prepare for the crossing. Figure 27 shows the mean delay for different age groups when crossing through gaps defined by the passage of nearside and offside vehicles. When about to cross behind a vehicle approaching on the offside of the road, a pedestrian can anticipate the gap by starting to cross the nearside of the road before the vehicle arrives. The more experienced pedestrians appear to do this, they anticipate more when crossing through offside gaps, the young children do not make this distinction, they delay an

## F I G U R E 26

Meam Delay on Kerb for Sex and Age Groups
of unaccompanied pedestrians, before crossing
in the first gap in traffic.

Fig. 26



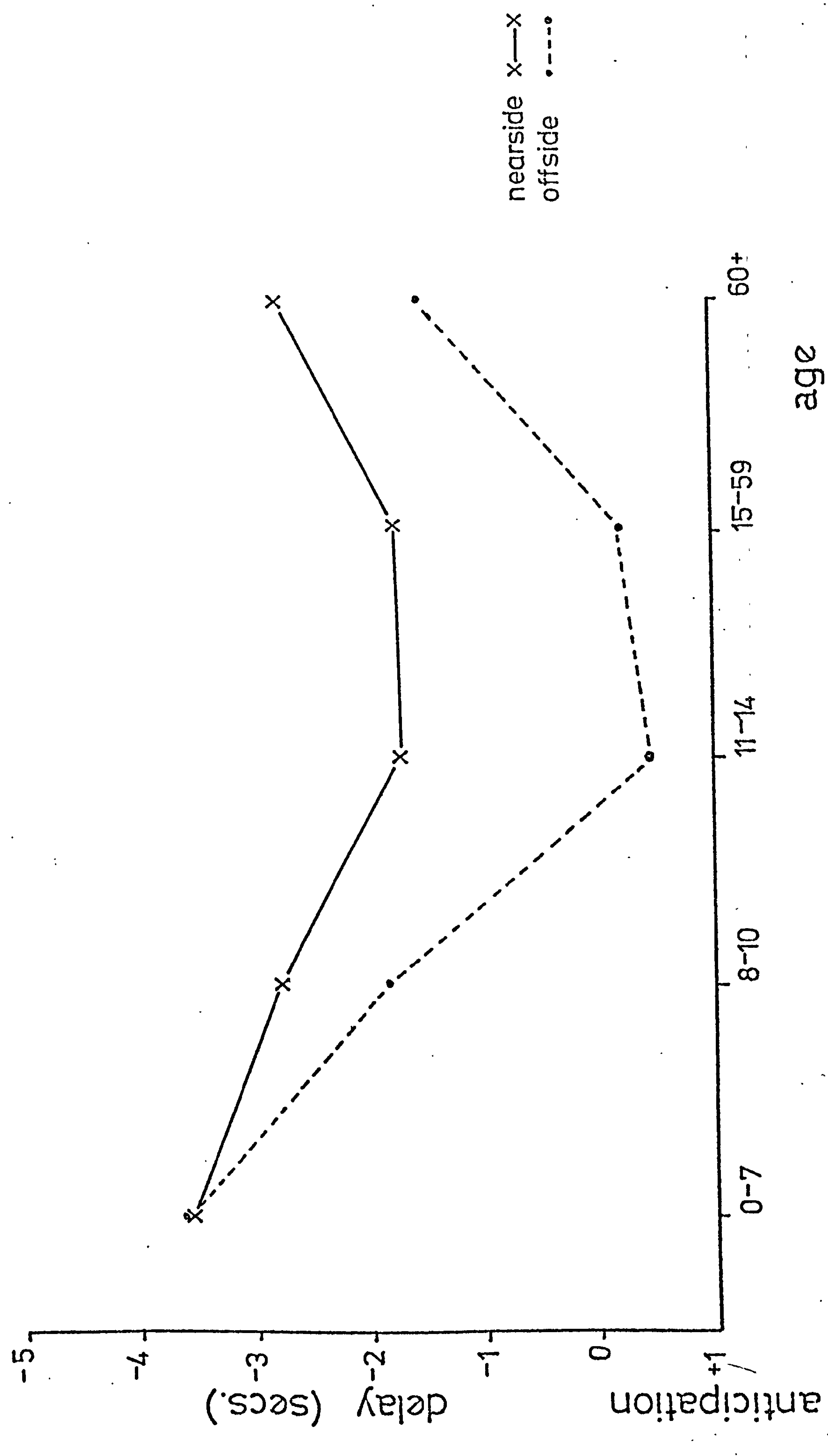
delay on kerb (secs.)
1·5
1·0
0·5
0
age
0-7
8-10
11-14
15-19
20-59
60+
male x——x
female •- - - -•


FIG. 3.

## F I G U R E 27

Mean delay/anticipation for sex and age groups of unaccompanied pedestrians crossing through gaps in nearside traffic and offside traffic.

Fig. 27


nearside x—x
offside •----•
age
0–7
8–10
11–14
15–59
60+
anticipation
delay (secs.)
-5
-4
-3
-2
-1
0
+1

equal time for both types of gap.

The total time spent on the kerb decreases with age (Table 7) 0-7 year olds waited 17 seconds on average before crossing, adults waited only 7 seconds on average. There is no sex differences for the youngest and the oldest pedestrians, however, the older boys and male adults wait less than the older girls and adult females.

Children spend less time actually in the road (Table 8) 0-7 year olds take 3 seconds, on average, to cross the road, adults take 4 seconds. There are no sex differences. This difference is due to the children running across the road more frequently.

All these measures suggest greater skill on the part of the more experienced pedestrians. Young children, although apparantly eager to cross the road quickly, do not interact with the traffic to their best advantage. They spend longer waiting to cross and do not always take the advantage of the gaps in traffic when they do cross.

b) Subjective measures of pedestrian behaviour.

Previous classifications of "safe" and "heedless" road crossing behaviour were based on observers subjective impressions of the road crossing as a whole. These were related to accident risk in an attempt to estimate the importance of "heedless" as a cause of road accidents (Routledge 1975). The correlations of "heedless" behaviour and accident risk ($p_{a/c}$) obtained from the Random Site Study (Table 13 Appendix 3) suggest that "heedless" as a cause of accidents may be more important on minor roads. (Correlation of $p_{hp}$ with $p_{a/c}$ of .85 on minor roads and of .57 on major roads). In this analysis no attempt is made to classify directly pedestrians as "safe" or "heedless", each crossing has been carefully analysed by dividing into three stages and describing pedestrians behaviour in each stage. A summary of these individual measures follows, detailed tables of results are shown in Tables 9, 10 and 11.

Approaching the kerb.

Boys run more frequently than girls and young pedestrians more than older pedestrians. 25% of the 0-7 year old boys and 9% of the girls run up to the kerb. Only 2% of adults run.

Only 55% of the 0-7 year olds looked during the approach to the kerb while 97% of adults looked. There were no significant sex differences. The mean number of head movements made, also increased steadily with age, approximately twice as many head movements are made by adults as by young children.

It would appear that as pedestrians become more experienced, they assess the crossing situation in advance so placing themselves in a position to take full advantage of a favourable traffic situation, the younger less experienced pedestrian tended to go straight up to the kerb before paying much attention to the traffic.

At the kerb.

Twice as many 0-7 year olds stop at the kerb as adults, this further supports the previous argument. The more experienced pedestrians modify their pace and continue if the traffic situation allows. Females tend to stop more frequently, at all ages.

The percentage of pedestrians looking when at the kerb, after having stopped, remains constant over age. Females tend to look more than males. A high proportion of the 11-14 year old boys do not appear to look. The mean number of head movements made also remains constant, though there is a tendency for older males to make fewer head movements. Adults make less than twice as many head movements at the kerb as they do during the approach; children, however, make more than 4 times as many.

Crossing the road.

Young pedestrians run across the road most frequently. 56% of the 0-7 year olds run while only 8% of the adults run. Males tend to run slightly more than females.

The majority of pedestrians crossed directly; approximately 75% of the under 15 years and 90% of the adults.

The 0-7 year olds looked most frequently while crossing the road, they also made more head movements. The number of head movements made by the older groups was approximately constant.

From these and other observations it is apparent that there are considerable differences in the ways in which pedestrians cross roads and different strategies are used. An adult in a hurry will cross a busy road through a small gap in the traffic with the minimum of delay with apparent safety and ease. A young child equally anxious to cross the same road may stand on the kerb for a considerable time before committing himself to cross in a not particularly safe gap and may then run across the road with head down disregarding the traffic. Whereas the adult is able to interact with the traffic environment and probably initiated the crossing sequence before arriving anywhere near the kerb, the child is adopting a passive role and is unable to interact with the traffic in this way.

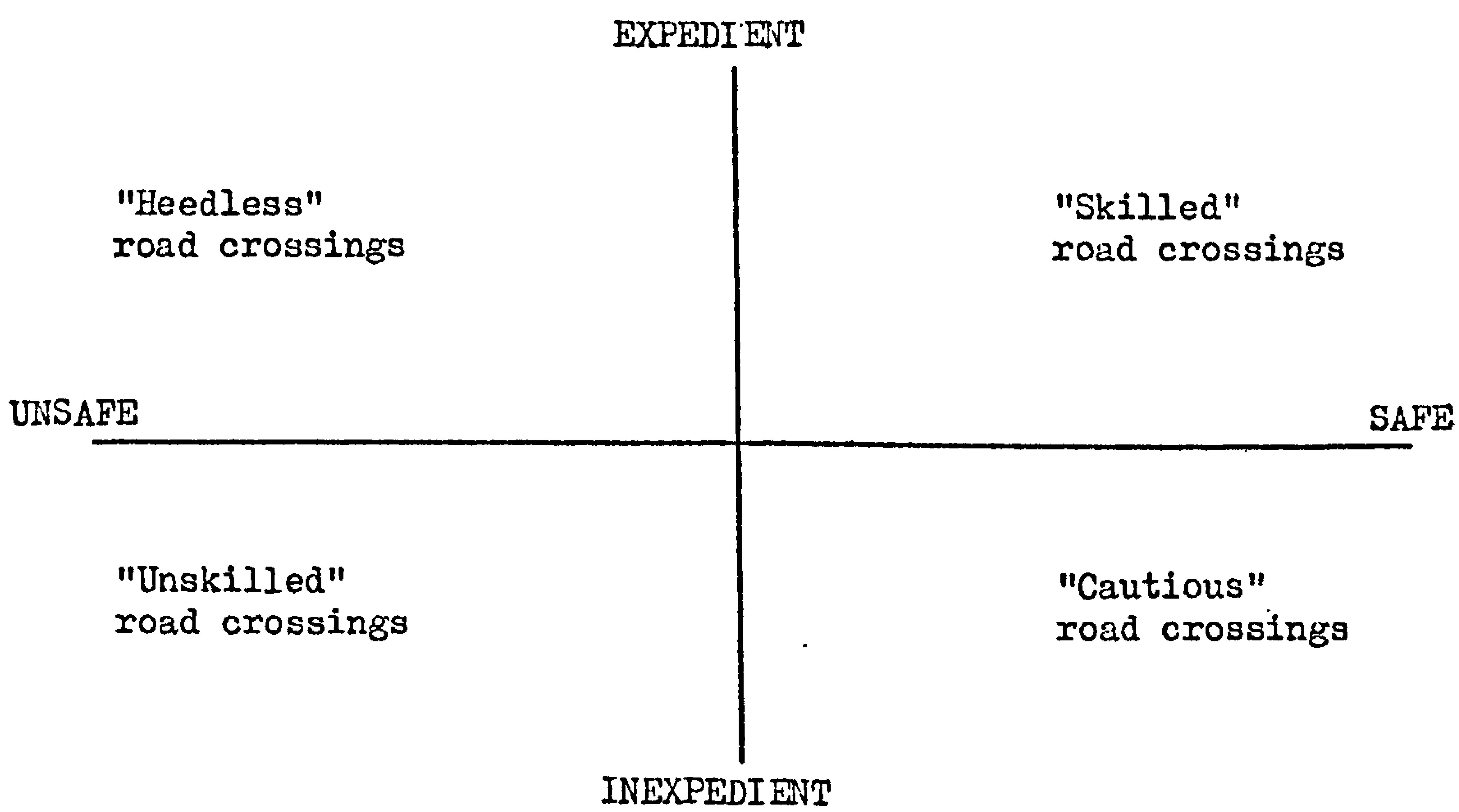
A "cautious" child may religiously follow the directions of the Green Cross Code before crossing, although there may not be a car in sight, while the "heedless" child will run straight across the road without having paused to consider the potential risk involved. In the first instance the child is obviously being very safe albeit taking somewhat longer than needed to cross the road, the second child gets across the road fast, achieving his goal with minimum delay, but is exposing himself to considerable danger.

In order to examine these differences in behaviour between different groups of pedestrians and behaviour in different road crossing situations a simple model to classify crossing strategies has been devised.

The "skillful" pedestrian, making a road crossing, is essentially correctly organising a sequence of activities. This involves the organisation of sequences of visual and auditory information e.g. estimations of vehicle speeds and organisation of the correct sequence of responses. This sequence is not predeterminable, since the pedestrian is continually monitoring new visual and auditory information in order to determine the correct response. Each of these responses is directed towards a short term goal e.g. the first thing to do before crossing a road is to decide where to cross. Thus the overall sequence of movements made by the pedestrian will be determined by the responses made towards each of these short term goals. The level of skill achieved will to some extent be reflected by these component processes. However, the sequence of activities will also depend upon the overall goal, e.g. is it more important to cross the road as soon as possible to catch a waiting bus, or is it more important to wait till the road can be crossed safely. An "unskilled" road crossing could be the result of a failure to properly organise the visual and auditory information or to a failure to respond correctly.

Accepting this definition of a "skillful" road crossing, "skilled" or attempts at "skilled" road crossings are only possible when a pedestrian's attention is directed towards the crossing situation. What are commonly termed "heedless" road crossings will only occur when a pedestrian pays no attention to the traffic, thus distinguishing it from an "unskilled" crossing. To a large extent, the attention paid to crossing the road, will depend upon the reason for wanting to cross the road in the first place e.g. if a child's attention is primarily directed towards retrieving a football, the road crossing may be of secondary importance.

Two factors are of paramount importance and are common to all road crossings. The safety of the crossing and the time taken to cross the road. It should be possible to classify every road crossing in terms of these two factors i.e. how safe was the crossing and how expediently was it carried out. Expedient or inexpedient crossings are defined as a road crossing achieved with the minimum or maximum of delay. By measuring these two factors on two bi-polar scales and presenting them orthogonally we have the following model.




Here are some examples of how different types of crossings would fit this model.

A "skilled" adult pedestrian who assess the traffic situation before arriving at the kerb, selects a gap in the traffic he intends to cross through and executes the road crossing smoothly and safely would cross both safely and expediently.

A child intent on getting a runaway ball, paying no attention to the crossing situation, would cross the road expediently, i.e. with the minimum of delay, but unsafely.

An elderly pedestrian might be very cautious, taking great care to stop and look for traffic, but might spend longer than he need waiting to cross. The crossing would be both unsafe and inexpedient.

Provided it is possible to scale these two factors, comparisons can be made between the behaviour of different groups of pedestrians and between behaviour at different crossing locations. The use of this model does not assume any basic skills on the part of the pedestrian, it is equally appropriate to apply this model to a two year old crawling across the road or to a "skilled" adult pedestrian. The scoring system developed is based on assigning positive, negative or zero scores on each dimension for different actions of each pedestrian as in Figure 28.

These derived measures of behaviour have been calculated for different age and sex groups of unaccompanied children, Figure 29. (Means and Standard Errors have been plotted for each group). All the children and adults cross safely at this site, the girls are safer than the boys. The older children appear to cross more "skillfully" than the younger children, who tend to be more "cautious". The adults, both male and female, are most "skillfull", crossing both expediently and safely. These data are shown in Table 12.

Figure 30, shows the behavioural measures for children crossing in groups, crossing with adults and crossing unaccompanied. In groups, the children are slightly less expedient, with adults they are safer. A more detailed breakdown of groups of children is shown in Table 13. The mixed group of 0-7 and 8-10 year olds is the least safe group.

Alternative methods for weighting and scoring the individual components and sequences of crossing behaviour were considered. It is possible to devise more complex scoring systems, based not only on observed behaviour but on interactions with traffic e.g. anticipation/delay, that would better describe this process. However, since a primary aim of the research is to develop measures that can be used as criteria for assessing the effectiveness of remedial programs, it is important that the measures adopted are derived from data that can be easily collected and scored.

## FIGURE 28

| | Unsafe<br>- 1 | 0 | Safe<br>+ 1 |
|---|---|---|---|
| Expedient<br>+ 1 | Running on approach and continuing to run. | Running on, approach and slowing down. | Looking on approach. |
| 0 | Not looking at kerb.<br>Running across the road. | Not looking while crossing.<br>Walking across the road. | Looking at the kerb.<br>Looking while crossing the road.<br>Stopping at kerb when traffic is approaching. |
| Inexpedient<br>+ 1 | False start. | Not looking on approach. | Stop at kerb when no traffic is approaching. |

FIGURE 29

Derived behavioural measures for unaccompanied pedestrians by age and sex groups.

Fig. 29

# F I G U R E  30

Derived behavioural measures for pedestrians crossing in groups.

Fig. 30

0-10
WITH ADULTS
0-10
ALONE
0-10
IN GROUPS
safe
2·5
2·0
1·5
1·0
0·5
expedient
1·0
0·5
0
-0·5

These derived measures do describe the observed differences in strategies used by different groups of pedestrians and observers do not need to make subjective judgements of the "riskiness" or "heedlessness" of road crossings.

# CHAPTER 5

## THE RELATIONSHIP BETWEEN CROSSING BEHAVIOUR AND ACCIDENT RISK.

INTRODUCTION

The Random Site Study had confirmed the finding from the early exposure studies (Routledge et al 1976) that differences in the accident rates of child pedestrians could not be accounted for in terms of differential exposure. Young children are most at risk; boys are more at risk than girls; crossing major roads is more dangerous for children than crossing minor roads. The observation study of pedestrians crossing a busy road (chapter 4) had revealed differences in the way children and adults crossed roads. There was little evidence of "heedless" behaviour on the part of children. Children were paying attention to the traffic and mistakes appeared to be caused by errors of judgement. One 8 year old girl had a very "near miss". She stopped near the kerb, looked for traffic in both directions and then nearly walked straight under an approaching car. An accident was only avoided by the driver braking heavily and the child retreating from the path of the vehicle at the last moment. This was clearly not a case of "dashing out into the road without looking".

The purpose of this research has been to look for causal explanations for the large numbers of accidents to young pedestrians and to develop measures for assessing the effectiveness of preventative measures. In order to do this the nature of the relationship between crossing behaviour and accident risk needs to be understood. If children do stop at the kerb, look for traffic and then get run over, we should be considering alternative and/or additional preventative measures. What is not known from the observation study, is whether the behaviour of the children observed crossing the busy road was typical of their behaviour when crossing elsewhere. The earlier attempts to classify children's behaviour on different types of roads (Routledge 1975) discussed in the previous chapter, suggest this is not the case.

There are two possible approaches to observing child pedestrians crossing at different sites:

a) Observations can be made at selected sites either by filming or by direct observation.

b) Children can be selected and then observed crossing at different sites.

The problems involved in designing observation studies have been fully discussed in the previous chapter. Filming techniques can only be carried out at sites where relatively large numbers of children cross, since it becomes time consuming and uneconomic if large numbers of observations are needed. Direct observation of road crossing had been used in the Random Site Study. Using one observer it was found that only very basic observations could be made, more detailed descriptions of behaviour could not be gathered with any degree of accuracy, since the observer was processing too much information at any one time. Some unsucessful attempts were made using two observers, but difficulties were encountered in co-ordinating observations on selected pedestrians.

The technique developed for collecting exposure data by "following" children home from school (Routledge et al 1974(b) ) was a possible alternative. Direct observation using this technique enables observers to obtain quite detailed descriptions of children's crossing behaviour, since their attention is only directed towards one child. Measures of gaps sizes and pedestrian anticipation/delay cannot be obtained in this manner, and some problems do arise in accurately recording whether the child is looking, since the observer may not be standing at the best vantage point. If children are to be observed crossing at a number of different types of sites the "following" technique is the only choice.

The study to be described here formed part of a new series of studies of child pedestrians carried out for the Transport and Road Research Laboratory. The contract, under the directorship of Professor Howarth and Dr. Routledge had four principal aims.

a) To examine the relationship between childrens' road crossing behaviour and their accident risk.

b) To compare the road crossing behaviour of children who are differentially exposed to risk.

c) To investigate the desireability and feasability of reducing childrens' accident risk by reducing their exposure.

d) To compare exposure measures of child pedestrians in towns with widely differing accident rates.

Four independent but inter-related studies were designed. Twelve Junior schools were selected in Nottingham City. Four from each of three different residential areas, namely central, suburban and estate. Nottingham City can be divided conveniently into these different areas and this classification had been adopted in previous studies (Routledge et al. 1974(b) ). From each school 12 boys and 12 girls from each of the age groups 5,6,8,9 and 10 were randomly selected. Seven year olds were ommitted for the reasons mentioned in Chapter 3. A total of 720 children were selected. Direct measures of exposure and behaviour were obtained for half these children. They were followed for a 20 minute period after they left school. The same children were interviewed at school the subsequent day, together with the remaining 360 children who acted as controls. A random site study was carried out in the catchment area of each school simultaneously. The parents of all the children who were followed were interviewed at a later date. The four studies concerned with the first 3 aims can be summerized as follows:

a) "Following" study - 360 selected children were followed for a 20 minute period after leaving school. This primarily would provide measures of childrens road crossing behaviour at a variety of sites. Exposure measures based on this sample of children could also be obtianed.

b) "Interview" study - 720 children were interviewed at school and asked about their activities and movements the previous day, the remaining 360 were selected as controls. These interviews provided estimates of childrens' exposure over 24 hours, giving a more accurate estimate of childrens overall exposure than exposure estimates based on a 20 minute period after school.

c) Random Site Study - This was carried out in the catchment areas of each of six schools. By carrying out an exposure study at the same time as the "following study" a comparison could be made of the exposure estimates derived from each of the studies.

d) Parent Interviews - The parents of the 360 children who were followed in the first study were interviewed at a later date. The interviews with parents were designed to assess their attitudes towards and knowledge of their children's exposure to risk, and to investigate the feasability of reducing children's accident risk by reducing their exposure.

This was an ambitious program. It is only intended here to describe and discuss in detail findings relating to the first study - the relationship between accident risk and childrens crossing behaviour. Findings from the other studies will be discussed briefly in the final chapter.

<u>Design and Methodology of Following Study</u>.

a) Selection and Identification of children.

The twelve schools had been selected as being "representative" of each area. Some were schools that had co-operated in previous studies, but all the schools chosen said they would be pleased to take part and without exception, the head teachers and staff were extremely helpful. The children, who had been randomly selected from the school lists at each school, were to be identified by the observers by means of badges. Different coloured badges, brightly printed in "Dayglow" colours, and bearing the legend "DON'T DROP LITTER" were issued by the class teachers to all the children in their class. This was arranged so that only one or two classes a day got the badges. The four children who were to be followed each day, 2 boys and 2 girls, were each given a red or a green badge (one red and one green for each sex). The rest of the children in the class were given different coloured badges. Red and green badges had been chosen so that they were easily distinguishable from the others. Teachers were asked to hand out the badges to the children in their class making sure that the children who were to be given the red and green badges did not think they were being selected for any special reason.

In an attempt to make sure that the children wore their badges and did not swap them with other children, the class teachers were asked to tell the child that, provided they wore their badges home and brought them back the following day without having lost or changed them, the whole class, at the end of the week, would receive badges that they could then keep. This also ensured that the previous day's red and green badges were removed from circulation.

Every attempt was made, beforehand, to find out which school exit the children were likely to use, so that they could be easily spotted on leaving school.

b) Observers.

Four female observers were used, two of whom had previously had experience of observing children. Their task was to identify a particular child by the colour of the badge and the sex of the child. Several mothers were usually waiting for their children outside the school gates, and the observers were able to remain fairly inconspicuous. Each observer carried a small portable tape-recorder and a microphone concealed in a scarf around their neck or under the lapel of their coat. As soon as they spotted their allocated child they commenced recording an account of all the child's activities for a 20 minute period after school finished.

c) Observations and recordings.

Children's behaviour was recorded by the observers so that the behavioural measures developed in the last chapter could be scored for each road crossing. By means of the recorded running commentary, observers noted the child's behaviour at the three stages of the crossing. As the child approached the kerb the observer would note down whether the child was running, walking, skipping etc. and whether the child looked for traffic. In the area in the immediate vicinity of the kerb the observers recorded whether the child stopped, continued at the same pace or slowed down, and whether he looked for traffic. While actually crossing the road the observers noted whether the child ran or walked and again whether he looked for traffic. Details of accompaniment protection, crossing locations were also recorded. A specimen tape record for a crossing might read as follows:-

"Jan is walking up Greencroft Avenue by herself on the right hand pavement and is approaching the junction with Talbot Street.... She walks straight up to the kerb and stops.... she didn't look before.... now she's looking both ways up and down Talbot Street.... seems to be waiting for something.... bicycle goes past her on the nearside and she runs across the road.... does not look again. No parked cars around, no traffic!"

The tape-recordings were transcribed by the observers as soon as they arrived home that day. The details for the recordings were transcribed directly on to a map to show the route each child took.

Every excursion into the roadway was numbered, this corresponded with a transcription sheet giving details of each road crossing (see Appendix 6). The data was then coded and put onto punched cards.

d) Traffic density counts.

Estimates of traffic density counts came from two sources. A comprehensive collection of traffic density counts for many roads in Nottingham had been built up from previous studies, and for many of the roads used by the children in the sample, the required traffic density counts were available. As some of these counts were made some time ago care was taken to look for the possible changes in traffic density due to redevelopment schemes or traffic engineering projects. Traffic density counts were also taken by the Random Site observers during or at the end of both 20 minute observation periods. Additional counts were made as required at the same time of day.

e) Data analysis.

The data analysis was carried out on the University of Nottingham's ICL 1900 computer using the Statistical Package for Social Sciences (Nie, N. Bent, D. Hull, C. 1970) an integrated system of computer programs for the analysis of survey data. Accident statistics used for calculating risk measures were based on accidents to child pedestrians in Nottingham City from 1969 to 1973 inclusive. These were obtained from the Accident Investigation Division of Transport and Road Research Laboratory.

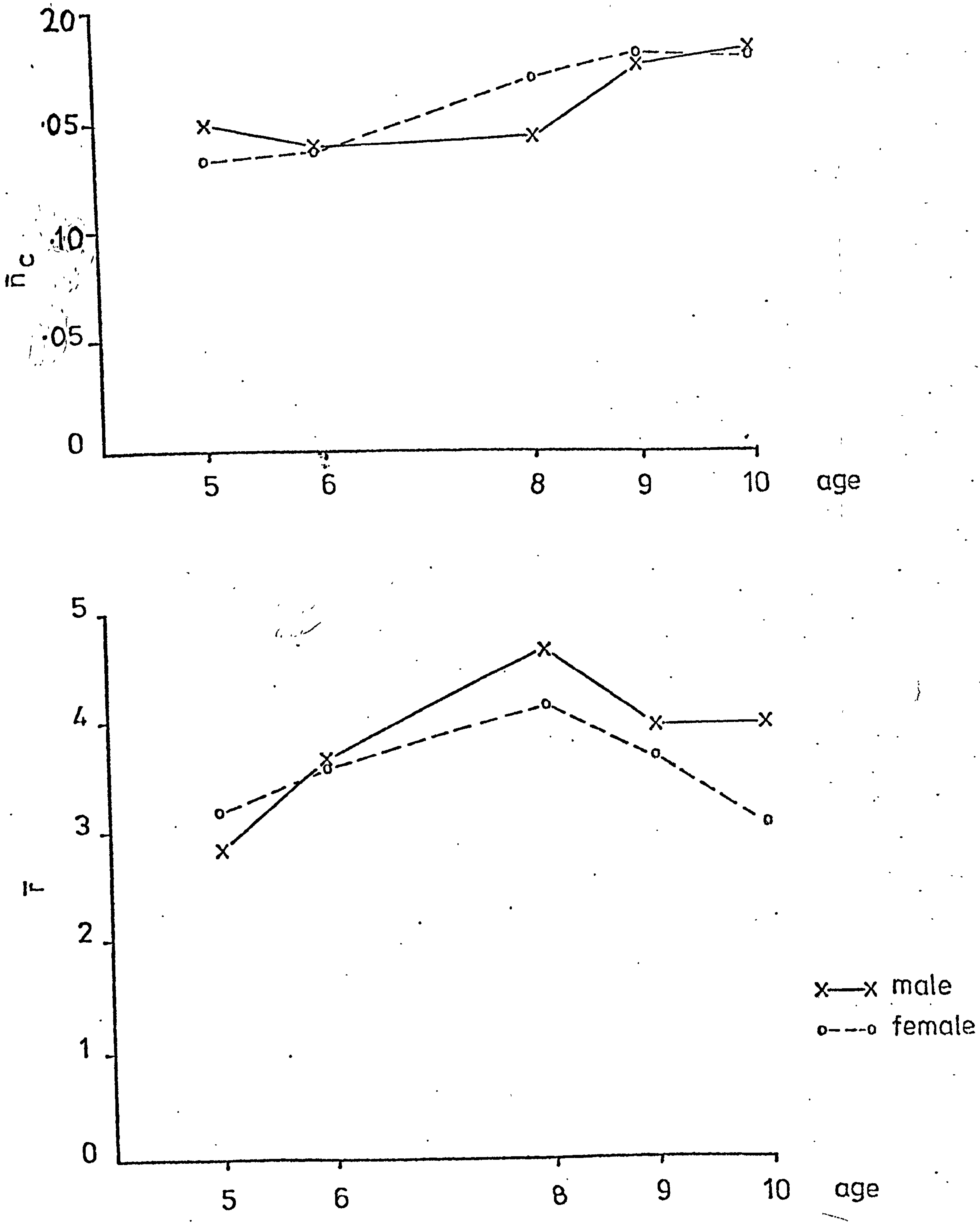
<u>Exposure of children in the sample.</u>

The 360 children followed by the observers crossed 1318 roads during the 20 minute period after school ended. The mean number of roads crossed are shown in Figure 31, $\bar{n}_c$ is also shown (Table 1, Appendix 5). The children crossed nearly 4 roads on average during this 20 minute period. The majority of these crossings were made by children on their way home from school. This is the "potential" exposure of the children as defined in

FIGURE 31

Potential exposure $\bar{r}$ and $\bar{n}_c$ by age and sex.

FIG. 31



Chapter 2: it does not take into account any protection provided by other adults, older children or crossing wardens. There are no significant age or sex differences, but the younger boys do tend to cross slightly fewer roads.

Figure 32 shows the "real" exposure of the children in the sample. The protection weighting has been used as before. These data are also shown in Table 2. The younger children are best protected, their real exposure is only $\frac{1}{3}$ of their "potential" exposure. Although these children cross approximately the same number of roads as the children in the Random Site Study (Figure 3), the roads they cross are less busy (Figure 4). This may be due to a bias in the sample of schools towards schools located in less busy areas. This cannot be easily checked.

The schools in the sample were located in three different areas. A central area consisting in the main, of high density, older terraced property and new high density developments. Few of these houses have gardens and in general there are poor play facilities. The central area includes the main shopping area of Nottingham. Two large council estates together with several small mixed housing estates make up the estate category. These are both pre and post war developments, primarily residential with reasonably good play facilities for younger children. The houses nearly all have gardens. The suburban area is made up of the remainder of the city and is therefore a mixture of different types of housing. Approximately 10,000 children live in each area.

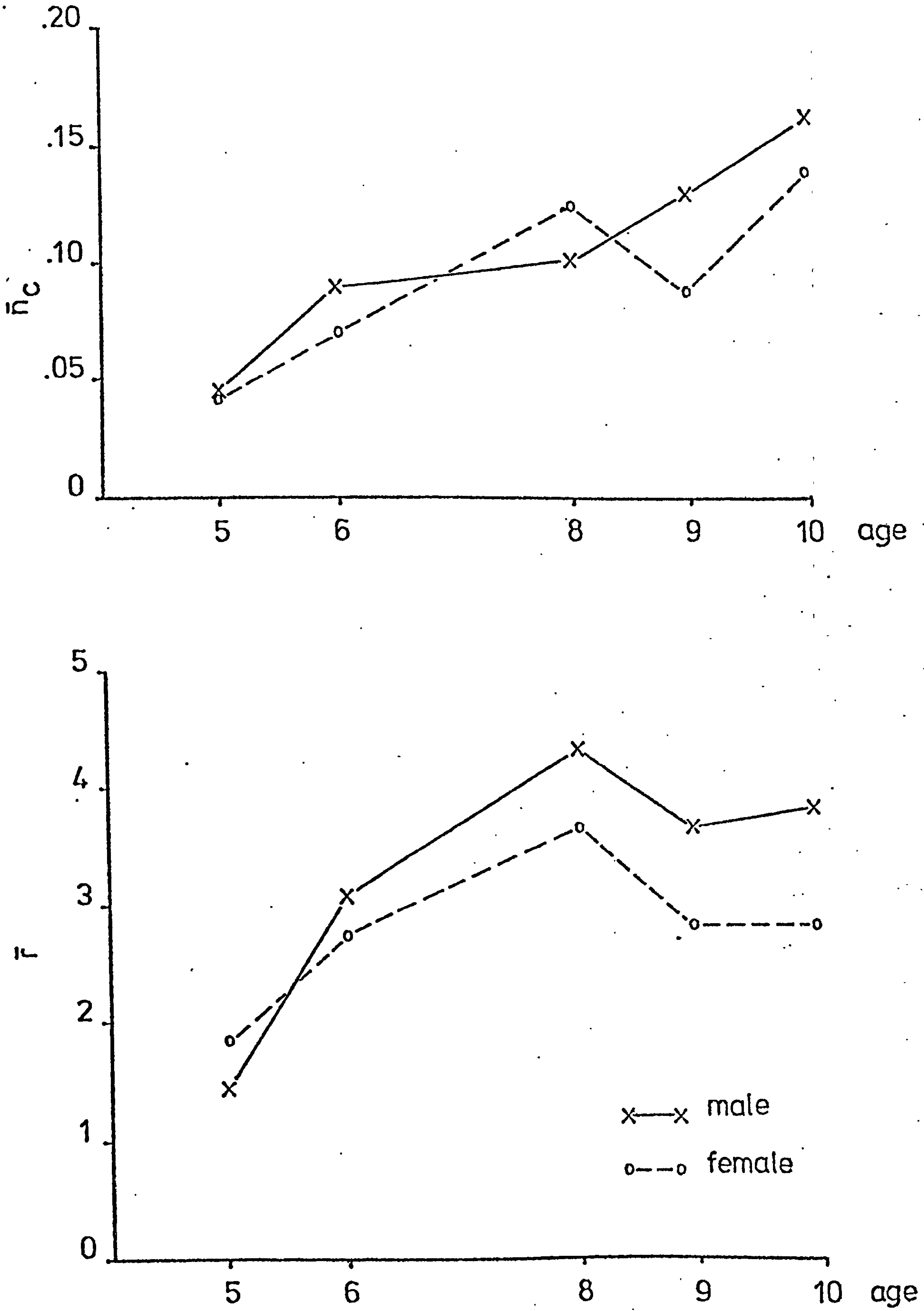
The 'potential' exposure of the children has been calculated for each area, Figure 33 (Table 3). There are no major differences between the areas, but children living on estates tend to cross more roads than children living in the central area. Although the older children in the central area cross fewer roads, these roads are busier.

This is a somewhat surprising finding, since one might expect the

# FIGURE 32

Real exposure, $\bar{r}$ and $\bar{n}_c$ by age and sex.

Fig.32

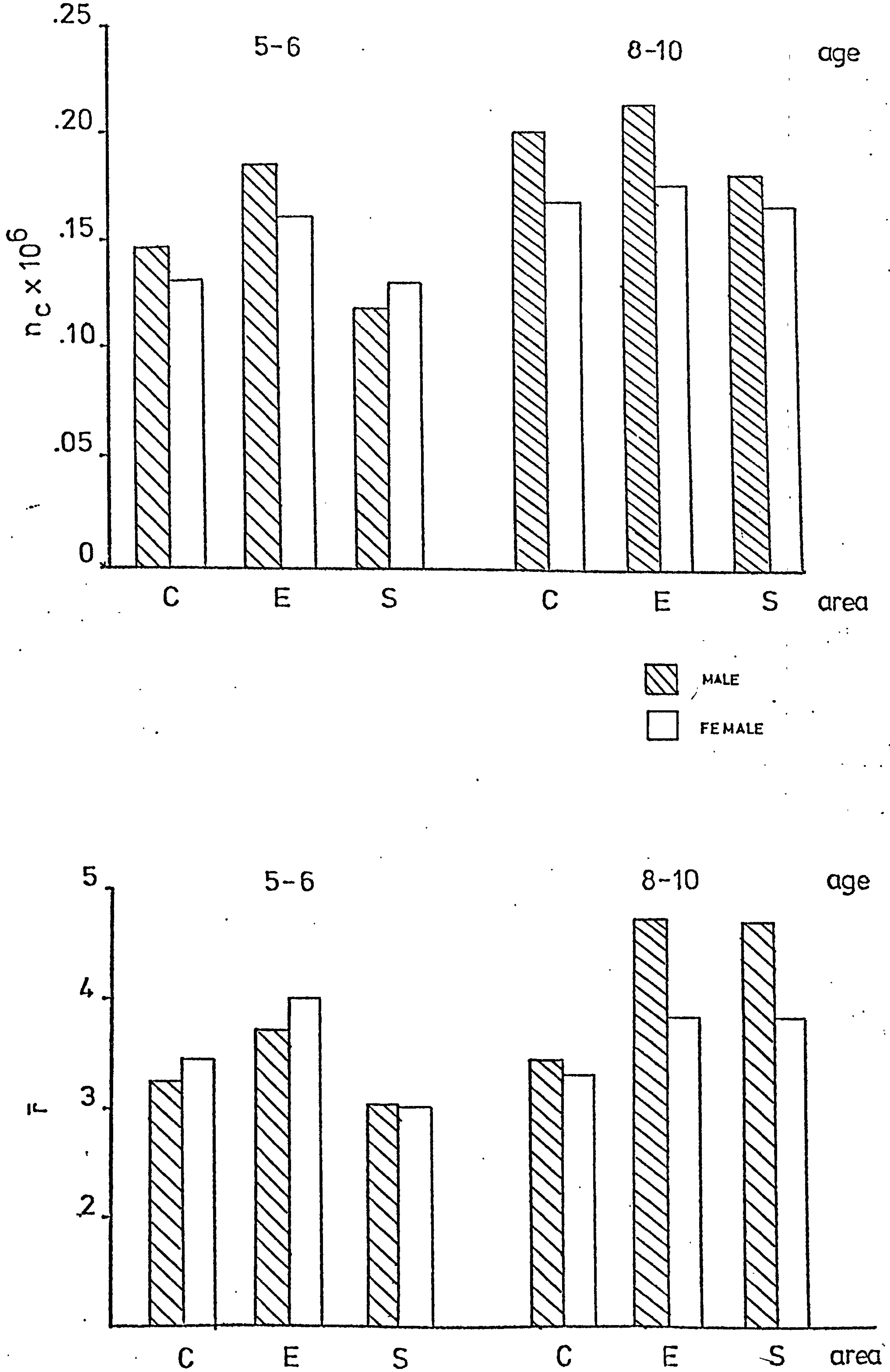


.20
.15
.10
.05
0
$\bar{n}_c$
5
6
8
9
10
age
5
4
3
2
1
0
$\bar{r}$
5
6
8
9
10
age
male
female

FIGURE 33

Potential exposure, $\bar{r}$ and $\bar{n}_c$ by age and sex for different areas of Nottingham.

FIG. 33



.25
.20
.15
.10
.05
0
$n_c \times 10^6$
5-6
8-10
age
C
E
S
C
E
S
area
MALE
FEMALE
5
4
3
.2
r
5-6
8-10
age
C
E
S
C
E
S
area

children in the central areas to be potentially more exposed to traffic and to have to cross more and busier roads. However, since housing densities and population densities are high in the central area, the catchment areas of the schools tend to be small, the boundaries frequently being defined by main roads.

The real exposure of the children in the three areas is similar (Figure 34). The 5-6 year olds living in the estate area are more protected than the other children.

$p_a$ has been calculated for each of these areas from accident statistics supplied by the Accident Investigation Division of TRRL and from local population statistics.

The risk estimates $p_{a/r}$ and $p_{a/c}$, were calculated in the usual way and are shown in Figure 35 (Table 3). There are clearly very large differences between the three areas, the greatest difference being between the central and estate areas. The boys are more at risk than the girls and older children more at risk than the younger children. The differences between the number of accidents to boys and girls, children living in different areas and children of different ages, clearly cannot be explained in terms of differential exposure.

There are three possible explanations for these differences between the areas.

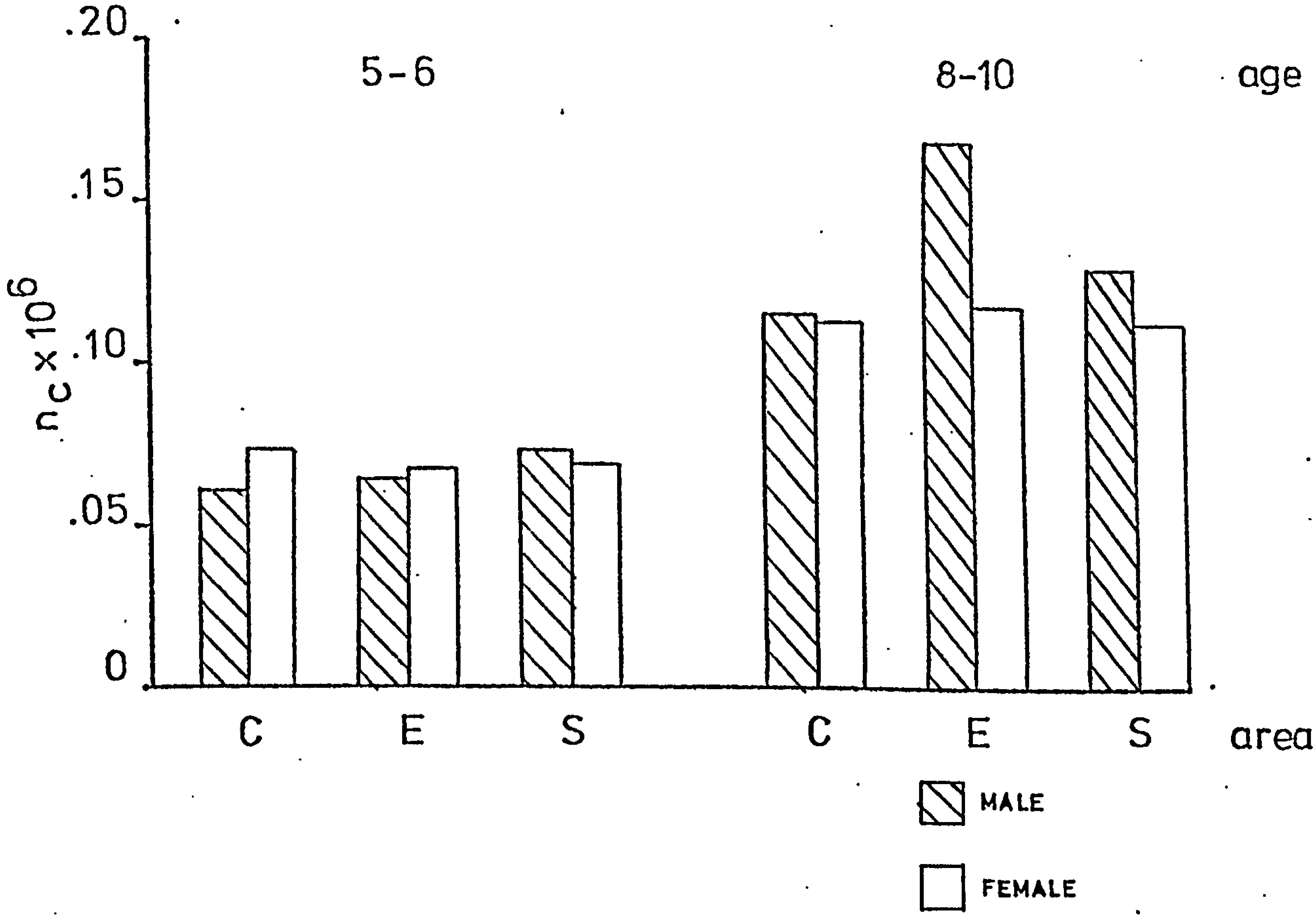
1. Behaviour. Children living in the central area behave more dangerously than other children.
2. Distribution of crossing locations. There is evidence from previous studies that risk of crossing the road is different at different crossing locations (Howarth, Routledge and Repetto-Wright, R., 1972).

   If the distribution of crossing locations in the central area is biased towards the more risky crossing locations, the accident risk estimates for the areas as a whole will

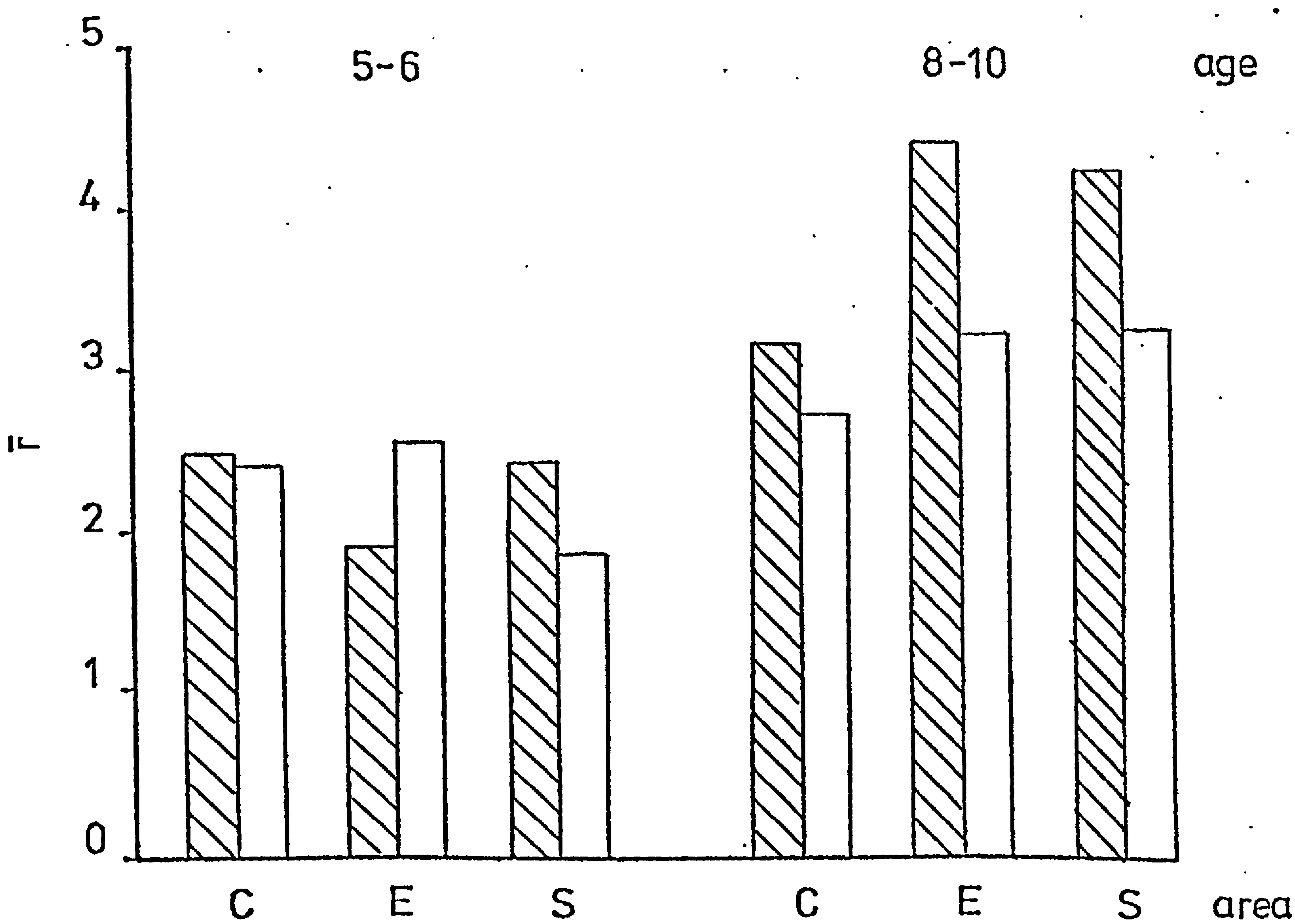
## F I G U R E 34

Real exposure $\bar{r}$ and $\bar{n}_c$ by age and sex for different areas of Nottingham.

FIG. 34



.20
.15
.10
.05
0
$n_c \times 10^6$
5-6
8-10
age
C
E
S
C
E
S
area
MALE
FEMALE

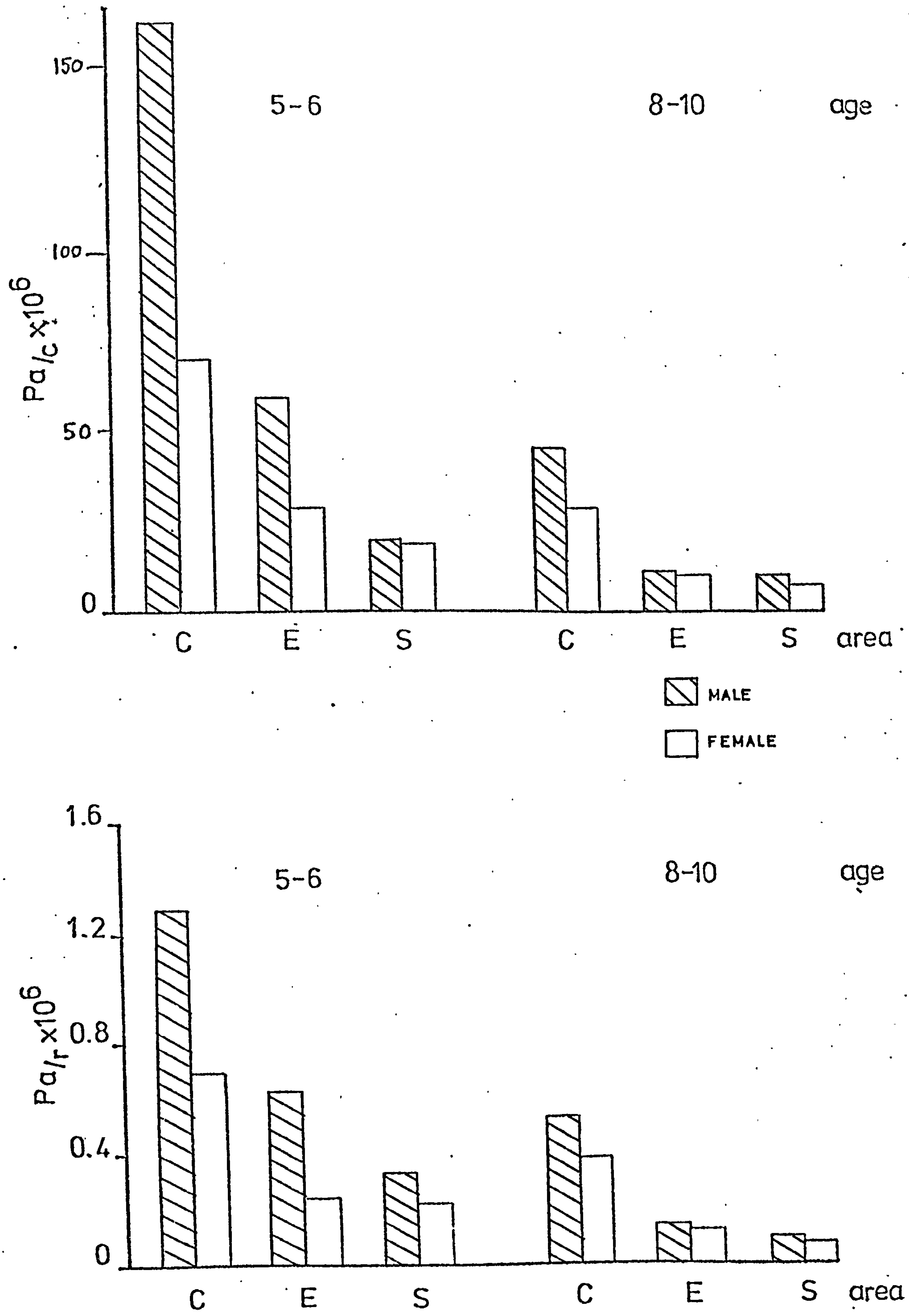



5
4
3
2
1
0
$\bar{r}$
5-6
8-10
age
C
E
S
C
E
S
area

## FIGURE 35

Real risk, $P_{a/r}$ and $P_{a/c}$ by age groups and sex for different areas of Nottingham.

FIG.35


150
100
50
0
$Pa_{/c} \times 10^6$
5-6
8-10
age
C
E
S
C
E
S
area
MALE
FEMALE
1.6
1.2
0.8
0.4
0
$Pa_{/r} \times 10^6$
5-6
8-10
age
C
E
S
C
E
S
area

reflect this bias. In calculateng $p_{a/r}$ and $p_{a/c}$ possible differences in the distribution of crossing locations have not been taken into account.

3. Other reasons. If neither of the two previous explanations or a combination of both account for the differences between the areas we must look elsewhere. There are possibly more subtle differences in crossing locations that make some locations potentially more dangerous than others.

Crossing behaviour at different locations.

A breakdown of the basic behavioural measures by age and sex, for all the roads crossed, are shown in Tables 4,5 and 6. Boys ran up to the kerb more frequently than the girls ($\chi^2 = 5.3$ with 1 d.f., $p < .05$), they also stopped more ($\chi^2 = 23.8$ with 1 d.f., $p < .001$) and while at the kerb they looked more frequently ($\chi^2 = 18.6$ with 1 d.f., $p < .001$). There was no significant effect of age on any of these measures, although there was a tendency for the older children to look more and run less.

In order to compare the strategies children used crossing at different locations, measures of the "safety" and "expediency" of each crossing were calculated as before (Chapter 4). Sequences of behaviour were scored in the same way (see Figure 27). 1086 road crossings were scored, 233 crossings were discarded since all the information required to score both for "safety" and for "expediency" were not obtained. No particular group of children or crossing location was overepresented by missing data.

The first analysis looks at the relationship between each of the two derived behavioural measures and traffic density. Traffic density has been calculated as vehicles passing per hour and plotted on a log. scale. Figure 36 shows how the "safety" of each crossing varies with traffic density for both boys and girls. As the traffic density of the roads increases, the childrens road crossings are "safer" ($F = 20.11$ (1, 1,085) $p < .001$). The girls are "safer" than the boys on the roads having lower

FIGURE 36

Behaviour measures by traffic density

for unaccompanied children. "Safe" - "Unsafe".


Fig. 36

traffic densities, on the busiest roads both boys and girls are equally "safe". "Expediency", Figure 37, decreased with traffic density ($F = 8.50$ (1,1085) $p < .01$) and the girls are less "expeditious" on all roads. The observers had attempted to record whether traffic was approaching as the child arrived at the kerb, but unfortunately there were insufficient data to carry out this analysis.

Figure 38 shows these derived behavioural measures plotted orthogonally for age and sex groups on major and on minor roads. (Table 7). Standard errors are plotted for each point. Since "safety" and "expediency" are positively correlated, they must be treated cautiously. However, there are large differences between the behaviour of the children on major roads and on minor roads. Children cross the major roads fairly efficiently i.e. both "safely" and "expeditiously", the younger children are relatively inefficient, they are neither particularly "safe" nor "expedient". The behaviour of children on minor roads appears to be relatively "unsafe", and the boys are least "safe" on these roads.

The children crossing at the site observed in the previous chapter, which can be considered to be classified as a major road, were equally "safe" but crossed more "expeditiously". The most likely explanation for this difference is that the observers may have failed always to record when a child looked for traffic during the approach to the kerb. This is difficult to observe, since frequently a pedestrian will be able to glance up and down the road very quickly and the observer is not always standing in the best place to observe these types of head movements. Alternatively the site may not have been typical of the major road sites in the sample. Some of the crossings made by children in the sample were made at zebra crossings and traffic lights. There was unfortunately insufficient data to carry out a more detailed analysis.

The behavioural measures have been calculated for children crossing at different locations on minor road, the means and S.E.'s for children

# FIGURE 37

Behaviour measures by traffic density for unaccompanied children. "Expedient" - "Inexpedient".

Fig. 37

log10 veh/hr
1000
100
10
0
-0.5
-1.0
expedient
inexpedient
MALE
FEMALE

FIGURE 38

Behaviour measures on major and minor roads by age and sex.


safe
unsafe
expedient
inexpedient
+0·5
0
-0·5
0·5
1·0
1·5
2·0
-0·5
8–10
5–6
MAJOR
MINOR

Fig. 38

crossing at junctions and not at junctions, when masked, unmasked by stationary vehicles are shown in Table 8. In every case the girls are more "cautious" than the boys, they are "safer" and more "expedient". Both boys and girls are more cautious when crossing at junctions, they appear to be most "heedless" crossing away from junctions, especially near parked vehicles. The classification of crossing masked by a parked vehicle must be treated cautiously since this is based on the observers subjective assessments. However, it does appear that children cross more cautiously at junctions which correlates with their reduced accident risk at junctions.

The behavioural measures were also calculated for children in the 3 different areas of the city (Table 9). There is no evidence for any differences in behaviour. The greater risk to the children living in the central area cannot be explained by differences in their behaviour.

# CHAPTER 6

## DISCUSSION AND CONCLUSIONS.

Although young children are involved in large numbers of accidents as pedestrians, considering the complexity of the task they face when crossing a road, and the inherant dangers present in the traffic environment, they cope surprisingly well. The likelihood of a 5 year old having an accident when crossing a road, based on the exposure of children in Nottingham, is approximately once in every 1 million road crossing. However, older pedestrians cope even better, the likelihood of an adult being involved in an accident as a pedestrian when crossing a road is only once in every 10 million road crossings.

A primary aim of these studies has been to find out why young children are so much more at risk than other pedestrians. In addition, an attempt has been made to develop techniques by which the effectiveness of preventative measures may be assessed. The approach adopted has been to observe the normal road crossing behaviour of both children and other pedestrians and to relate measures of their behaviour to measures of their accident risk.

The Random Site Study provided estimates of exposure for all age and sex groups of pedestrians, which could be quantitatively related to the relevant accident statistics. Measures of risk were calculated for pedestrians crossing at different locations. After making a detailed study of pedestrian's behaviour crossing a busy road, a method of describing the strategies used by pedestrians was developed. This did not rely on observer's subjective judgements of the "riskiness" or "heedlessness" of road crossings. The final study attempted to relate these measures of behaviour to measures of accident risk, by observing children crossing at different locations.

Although the findings from these studies are by no means conclusive, they do have implications for road safety education and for reducing accidents to children as pedestrians. This will be discussed later. Furthermore, techniques have been developed that can be used to estimate pedestrian risk.

The importance of obtaining accurate estimates of accident risk was recognised earlier (Howarth et al 1974) and is an important investigative tool. One of the major problems in estimating risk to pedestrians is related to the accident data. Since accidents are rare events, accident data for several years usually has to be combined for age and sex groups of pedestrians and for different locations, in order to obtain reliable estimates of accident risk. This is a particular problem when estimating accident risk for specific locations, e.g. crossing between parked cars away from junctions during the afternoon in Nottingham. The more detailed the breakdown of the accident data, the more ambiguous and unreliable they become. Other problems arise from the use of accident data e.g. crossing while masked by a stationary vehicle is in itself ambiguous, since the classification relies almost entirely on the subjective appraisal of witnesses. There are also considerable limitations in the quality of the available accident statistics at these levels of analysis, since small errors are grossly magnified.

A technique is about to be investigated that may overcome these shortcomings in the accident data. The feasability of using risk estimates at particular crossing sites obtained by studying the "conflicts" between pedestrian and vehicles, is being investigated.

A traffic "conflicts" technique has been developed and evaluated to study vehicle-vehicle interactions, Perkins (1968), Baker (1972), Spicer (1971, 1973). The technique was developed primarily for measuring traffic accident potential at intersections and to provide the kind of information needed as a basis for the design of safety improvements. The technique has also been applied to study pedestrian-vehicle interactions, Güttinger and Kraay (1976). They tested certain hypotheses about the design of residential 'yards' and the "conflicts" technique was developed and evaluated in these somewhat unusual environments.

Although most studies of vehicle-vehicle interactions have found that conflicts are significantly related to accidents, the correlations might be explained by the dependence of both conflicts and accidents, on traffic density. While the validity of this type of approach must still be in doubt, conventional accident analysis techniques are no more reliable especially, as has already been mentioned, in situations where there is a paucity of accident data.

Residential areas are an example of the type of situation where a real accident problem exists with child pedestrians, but since the accidents are widely distributed, conventional accident analysis techniques cannot be employed with any confidence, since accident data from a variety of sites has to be pooled. It is in these areas that "conflict" studies may provide more reliable estimates of risk, so that the types of situation in which children are most at risk can be identified. Since nearly all accident remedial work carried out by traffic engineers at the moment, is done on the basis of identifying and treating accident "black spots", it is an approach that has a practical appeal.

The random site exposure technique developed in Chapter 3 has been used to investigate differences in accident rates in different cities. This was mentioned in the previous chapter. Several improvements have been made to the technique. Earlier this year, as part of a recent contract with the Transport and Road Research Laboratory, an investigation was carried out into differences in accident rates in 3 cities. Nottingham, Kingston-upon-Hull and Bradford, while having approximately the same size populations, have widely differing accident rates for child pedestrians. Children in Hull have a very low accident rate, while children living in Bradford have a high accident rate. In order to see whether these differences in accident rates can be explained in terms of differences in exposure a random site exposure study was carried out in each city. A study was also carried out in Nottingham, which has an intermediate accident rate.

These three studies were carried out simultaneously during the school summer term. Several modifications were made on the basic technique, which improved it's reliability and simplified the administration. 120 sites were sampled in each of the three cities. This was done as previously by superimposing a random dot display on street maps of each city. Pedestrians were observed crossing at each site for two hours between 3.30 and 5.30p.m. on weekday afternoons. 12 observers were used each day in each city. They were taken to and from the site each day by mini-bus. Each site was surveyed during the morning and in some cases marked out with chalk. This proved to be most worthwhile, since it minimised errors made by observers in locating sites. Each site consisted of a 60 yard length of road and where necessary was divided into sections at and away from junctions. An example of a map and scoring sheet together with the instructions for the observers are shown in Appendix 6. Accident data for the relevant time periods could be used for each city, since no detailed breakdowns of accident data were needed. These data are being analysed at present, in all 25,000 pedestrians were observed.

The reasons why the analyses of accepted gaps and the safety margins in the early studies (Howarth et al 1972, Routledge, 1975) did not indicate the increase in skill and efficiency in traffic with age expected from the initial observations, have been largely explained by the "Noel Street Study" (Chapter 4). Analysis of the size of first gaps accepted, confirmed that younger children cross in larger gaps than older pedestrians; groups were also much more cautious in their choice of gap. There was however some evidence that the younger children were less consistent and would occasionally cross in very small gaps. A 5 year and an 8 year old boy were each observed accepting a gap of only 2 seconds, having seen the approaching vehicle!

It was argued in these earlier studies on the basis of casual observations that a "skilled" pedestrian would make most use of a gap in the traffic by anticipating the arrival of the vehicle defining the start of the gap. This led to measurements of the safety gap ($t_s$) for different groups of pedestrians. The failure to describe the anticipatory behaviour of the more "skillful" pedestrians in terms of the safety gap has been resolved by recording the delay ($t_d$). If, instead of recording the safety gap, the time from the moment a vehicle defining the start of a gap passes, to the moment the pedestrian starts to cross is measured, it is seen that the more "skillful" pedestrians do in fact anticipate the arrival of gaps in traffic. This is not reflected in terms of safety gaps because the young, less "skillful", pedestrian tends to run across the road and so compensate for the reduced gap size.

Although the derived behavioural measures developed in Chapter 4 leave much to be desired, they do describe the strategies pedestrians used on the basis of fairly simple and clearly defined subjective measures. They do not rely on very subjective measures of "riskiness" or "heedlessness" as in previous studies, (Routledge 1975) and provide a technique for comparing children's behaviour, fairly simply, in different crossing situations.

It is hoped that these measures can be used to assess the effectiveness of remedial measures by means of "before and after studies", e.g. for instruction in the use of the Green Cross Code; and for comparing children's crossing behaviour at different locations. While the temporal measures of crossing performance are useful in studying the ways in which pedestrians interact with traffic and develop crossing stategies on busy roads, they cannot be used to describe crossing behaviour on minor roads, where there is little traffic, and children frequently pay little attention to crossing.

The problems associated with observing children's behaviour in traffic on minor roads have not been resolved. Large numbers of observations of children crossing minor roads are needed in order to get sufficient data to compare behaviour when traffic is approaching, with behaviour when no traffic is present. However, since in over 90% of all crossings made by children on minor roads there are no cars approaching, the observed strategies children tend to develop on these roads, i.e. "heedlessness" are continually being reinforced.

The studies reported here have important implications for road safety education and for any measures aimed at reducing the numbers of accidents to child pedestrians.

There are three ways of reducing the number of child pedestrian accidents:

a) Training children to cross roads safely.

b) By reducing children's exposure to risk.

c) Changing driver behaviour in the presence of children.

a) <u>Training children to cross roads safely</u>. These studies suggest that road safety training for children should be aimed at reducing their exposure to accident risk. It appears that there is a contradiction between the way children are instructed to cross roads and the way in which experienced pedestrians cross. Children are taught to stop at the kerb and then to start to look for traffic. Adults seldom arrive at the kerb without previously having assessed the traffic. Since it is probable that most children do not possess sufficient skill or experience to adopt this strategy, it is safer to instruct them to go to the kerb and stop before doing anything else. However, children clearly learn to adopt the adult strategy without instruction and indeed, contrary to the way in which they are explicitly instructed to cross. On major roads it would seem important that this transition process be more fully understood since there is, at the moment, a mismatch in the information they recieve from parents, schools and advertisments and the information they gain from their own experiences and from their own observations of older pedestrians.

Children behave quite differently on quiet, minor roads, there is more evidence of "heedless" behaviour, and since quite frequently these roads are being used by the children as an extention of the pavement, it is unrealistic to expect them to behave otherwise. Conventional training programs are unlikely to have much effect on children's behaviour on these roads.

Children most certainly learn to cross roads by experience. A preliminary analysis of the study of children's road crossing behaviour and their 24 hour esposure estimates, outlined in Chapter 5, derived from interviews with the children, suggests that road crossing behaviour is correlated with exposure. Children who cross more roads appear to cross more "skillfully". A major problem in training children to cross roads, is therefore, to give them this experience without exposing them unduly to risk.

b) Reducing children's exposure to risk. A reduction in childrens' exposure to risk can be achieved in several ways. The exposure study shows that children are more at risk on major roads. From the behavioural study young children appear to behave cautiously on these roads, but have difficulty in coping with traffic. There is, therefore, a strong arguement for remedial measures aimed at segregating traffic and pedestrians on these roads. There is little to be gained from training children to stop at the kerb and look for traffic if they are unable to make a correct decision when to cross. Children's exposure can best be reduced on these roads by provision of crossing facilities. Training schemes and propaganda, could therefore, be aimed at getting children to use crossing facilities or alternatively help from older pedestrians. Parents have an important role to play in reducing childrens' exposure.

The research program outlined in Chapter 5 included an interview study designed to discover how much parents can and do influence children's exposure. The study confirmed earlier findings (Routledge et al 1974(b) ) that the parents knowledge of their childrens routes on journeys is frequently assumed.

In answer to the question "How much would parents sacrifice in order to reduce exposure?" the answer has to be"Very little". The majority of parents both work, frequently in full time jobs which are not geared to allow meeting children from school. Often it is financial pressures which force this situation. Furthermore, parents see their children as more capable of coping with traffic situations than they are, and so long as this state of affairs exists parents will, superficially at least, be satisfied with their present arrangements for the child's journeys to and from school. While parents are aware of the general hazards of crossing roads they are frequently unaware of the specific problems their own children may encounter on their journeys locally.

It would appear that there is little that can be done directly, to reduce childrens exposure on minor roads. Risk is low per road crossing and children need to be mobile. Any restrictions on their movements are not only impractical but undesireable.

c) Changing driver behaviour in the presence of children. Perhaps the most neglected factor in child pedestrian accidents is the driver. While studying the behaviour of children it has become apparent that the behaviour of drivers is also worthy of study. Drivers do not appear to adapt their driving style to pedestrians. Traffic is the accepted feature of the traffic environment to which pedestrians must adapt. On major roads vehicles are the primary road users, however, on minor roads, e.g. on estates, pedestrians, and more especially children, are frequently the principal users of the traffic environment; vehicles are secondary users and should not automatically be given priority. If it is accepted that children will run into the road occasionally without first looking up and down a usually empty road for traffic we have an alternative remedial measure. e.g. If residential areas were given the legal status of pedestrian crossings, it would be the drivers responsibility to avoid accidents not the child's.

The most commonly reported cause of accidents to child pedestrians as recorded on accident report forms runs as follows, "The child ran heedlessly into the road from behind a parked car, and the driver was unable to avoid an accident". It is suggested that this should frequently read, "The child ran heedlessly into the road, and the driver failed to avoid an accident."

# APPENDIX 1

# The Green Cross Code

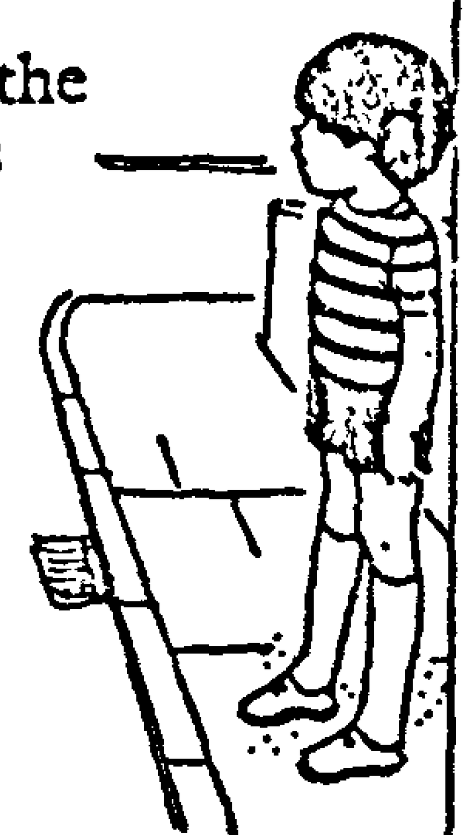
Here are some notes to help you explain the *Green Cross Code* to your child.

## 1. First find a safe place to cross, then stop.

Here are some safe crossing places: *subways; footbridges; Zebra crossings; Pelican crossings; traffic lights; by a policeman; near a lollipop man or a traffic warden.* If you can't find any of these safe crossing places choose one where you can see clearly along the road in both directions. *Don't try to cross near parked cars* because you won't see anything coming. Always give drivers a chance to see you clearly.

## 2. Stand on the pavement near the kerb.

Don't stop on the very edge of the pavement. Traffic often comes in closer than you'd expect. Find a position where you can see what's coming, but where you're in no danger.

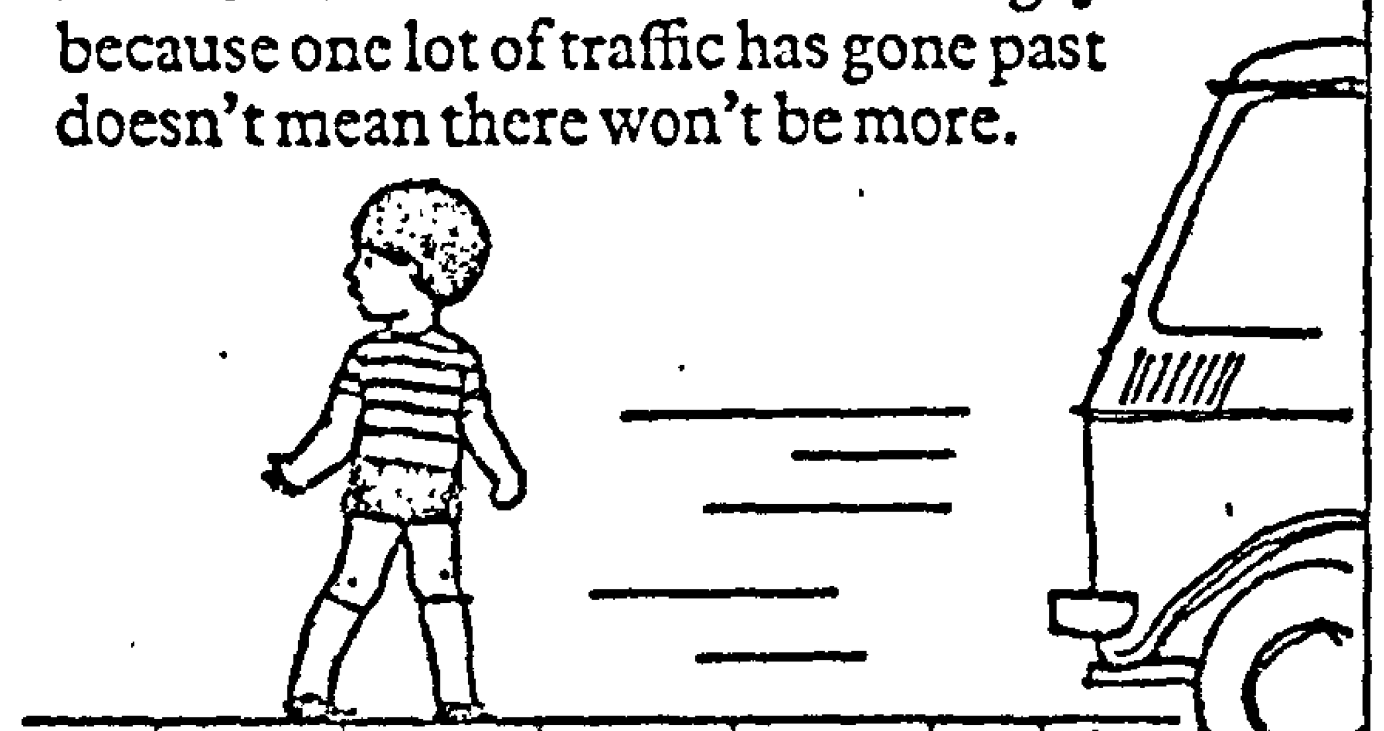


## 3. Look all round for traffic and listen.

Traffic may be coming from all directions, so look down every road. Listen too, because often you can hear traffic before you can see it. Keep your eyes and ears open, that's why you've got them.

## 4. If traffic is coming let it pass. Look all round again.

Let oncoming traffic pass if it's coming fast or if it's near. Always let traffic pass when you're not sure how safe it is to cross. Then look all round again and listen to make sure no other traffic is coming. Just because one lot of traffic has gone past doesn't mean there won't be more.



## 5. When there is no traffic near, walk straight across the road.

It's safe to cross when there is no traffic near. If there is some traffic in the distance don't cross unless you're absolutely sure you've got plenty of time. Work out how fast the traffic is coming. When it's safe, walk straight across the road — DON'T RUN, you might fall over.

## 6. Keep looking and listening for traffic while you cross.

Once you're crossing the road, keep looking and listening just in case some traffic suddenly comes along.

Finally, take your child around the pedestrian crossings, footbridges, subways and school crossing patrols in your area and show him how to use them.

**This leaflet will help you save your child's life. You'll be glad you used it.**

# A P P E N D I X  2

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# An Analysis of Road Accidents Involving Child Pedestrians.

By C.I. Howarth, D.A. Routledge and R. Repetto-Wright

Department of Psychology, University of Nottingham, Nottingham,

## A conceptual framework

In order to evaluate the relative importance of such different factors as age, sex, experience and exposure to traffic, we needed a framework by which quantitative estimates of these factors could be related and evaluated in relation to their effects on accident rates. Our immediate priority was to obtain quantitative measures of exposure to traffic of the groups of pedestrians with which we are concerned, which would enable us to estimate absolute risk and which could be related to other observable features of pedestrian behaviour, such as gap acceptance and heedlessness.

Suitable data are available, eg from the Transport and Road Research Laboratory's 50 point census, so that vehicle accidents can be presented in the form of accidents per vehicle, accidents per vehicle/mile and accidents per passenger/mile. This enables one to compare the riskiness of different traffic situations such as motorways and major roads. The exposure of pedestrians has not been tackled so systematically. Valuable studies have been reported (Mackie 1962, Mackie and Older, 1965, Jacobs and Wilson, 1967) in which pedestrian risk has been measured on particular busy roads, but the major emphasis in these studies has been on the risk for pedestrians in general of crossing at particular types of location, eg near junctions and zebra crossings, rather than on pedestrians who are most at risk overall. For example, no breakdown of risk estimates within the under 16 years age category is available.

These studies calculate risk by dividing the number of pedestrian accidents at a particular location over a period of time, by the number of pedestrians observed at the same location during a short period. We decided that the most useful statistics for child pedestrians would be:-

(1) the accident rate per pedestrian day, which would enable us to compare the risks run by different classes of pedestrian at different seasons, or in different localities where accident statistics are only available for different periods of time;

(2) accidents per road crossing, which would enable us to compare the riskiness of crossing different types of road for different classes of pedestrian;

(3) accidents per encounter with a vehicle which would enable us to compare the riskiness of an encounter between a pedestrian and a vehicle in different traffic situations for different classes of pedestrian.

The third statistic can be thought of as being derived from the second after an allowance has been made for the traffic density and speed in the different situations. All three statistics can be derived from the raw accident figures in the following way.

Accidents per pedestrian day.

Let $n_a$ be the number of accidents occurring in a given period of time to children of a given age, sex, etc on a particular type of road;

$N$ be the number of such pedestrians in the population. To a first approximation we have assumed that all children in the age range are potentially pedestrians;

$D$ be the number of days over which the accident statistic $n_a$ has been gathered.

Then, assuming a standard binomial distribution, the probability, $\Pi_a$, of selecting a child at random in the population of that category who will have an accident on the appropriate type of road on a single day can be estimated from the proportion

$$p_a = \frac{n_a}{N.D} \quad . \qquad (1)$$

and the variance will be given by

$$s^2_{p_a} = \frac{p_a\,(1-p_a)}{ND} \quad . \qquad (2)$$

Several assumptions are implied here. One is that $\Pi_a$ is constant over the particular population so that every child is equally "accident prone" and each day is equally dangerous. It is therefore a measure of the average daily "risk" to children in a particular category. Secondly, that one child's accident or escape is not affected by that of any other, nor by his own on any previous day. Since $p_a$ is very small, this assumption seems justified. Thirdly, the probability that some children will have more than one accident in a day is also very small.

Accidents per road crossing.

Let $r$ be the observed number of times a child in the appropriate category crosses the particular kind of road in a day.

$\mu_r$ be the average number of such crossings in a day for children in the category. If $M$ children are observed, then $\mu_r$ is estimated by

$$\bar{r} = \frac{\Sigma r}{M} \quad . \qquad (3)$$

and the sampling variance of $\bar{r}$ can be obtained in the usual way

$$s^2_{\bar{r}} = \frac{1}{M}\left(\frac{\Sigma r^2}{M-1} - \bar{r}^2\right) \qquad (4)$$

Then, assuming a binomial distribution, the estimate, $p_{ar}$, of the probability, $\Pi_{ar}$, of an accident on a given crossing of the road by a child can be obtained in the following way.

The probability that a child has an accident on a day when he would cross r times is

$$1 - (1 - \Pi_{ar})^{r} \quad . \qquad (5)$$

Then $\Pi_a$ is the average of this over the r distribution. Assuming r to be of a Poisson distribution

$$\Pi_a = 1 - e^{-\mu_r \Pi_{ar}} \qquad (6)$$

This leads to the estimator

$$p_{ar} = -(1/\bar{r})\ln(1 - p_a) \qquad (7)$$

for $\Pi_{ar}$.

Using the power series for e we have

$$\Pi_a = 1 - (1 - \mu_r \Pi_{ar} + \frac{\mu_r^2 \Pi_{ar}^2}{2} - \frac{\mu_r^3 \Pi_{ar}^3}{3} \quad \ldots$$

Since $\mu_r \Pi_{ar}$ will be very small, we may ignore terms after the second, hence

$$\Pi_a \approx \mu_r \Pi_{ar} \qquad (8)$$

Similarly, we know that

$$\ln(1 + x) = x - \frac{x^2}{2} + \frac{x^3}{3} - \frac{x^4}{4} \quad \ldots$$

If x is very small we may ignore terms after the first, hence

$$p_{ar} \approx \frac{p_a}{\bar{r}} \quad . \qquad (9)$$

Since $p_a$ and $\bar{r}$ are based on different observations, the variance of $\Pi_{ar}$ will be estimated by

$$\frac{s^2_{p_{ar}}}{p^2_{ar}} = \frac{s^2_{p_a}}{p^2_a} + \frac{s^2_{\bar{r}}}{\bar{r}^2} - 2\,\frac{s_{p_a}}{p_a} \cdot \frac{s_{\bar{r}}}{\bar{r}}\,\rho\left[p_a . \bar{r}\right] \qquad (10)$$

The symbol for the population value, $\rho$, is used to avoid confusion with r, the number of roads crossed.

We have used the approximation

$$\frac{s^2_{p_{ar}}}{p^2_{ar}} = \frac{s^2_{p_a}}{p^2_a} + \frac{s^2_{\bar{r}}}{\bar{r}^2} \qquad (11)$$

which assumes that $p_a$ and $\bar{r}$ are uncorrelated. Since $\rho$ is probably positive, equation (11) is likely to give an overestimate of the variance of $p_{ar}$.

Accidents per encounter with a vehicle

Not all roads are equally dangerous to cross and one of the main reasons for this is obviously the variations in traffic density and speed. It would be useful if this factor could be eliminated from the calculation of risk, so that the effect of other variables can be estimated. The simplest way to do this is to calculate the probability that, given a particular density and speed of traffic, the pedestrian would encounter a vehicle while crossing the road, ie by calculating the proportion of the road length taken up by moving traffic. We have called this proportion $p_c$ and it can be calculated as follows.

Let $\ell$ be the average length of vehicles

$s$ the average spacing of the vehicles

$v$ the average velocity of the vehicles

$t_c$ the average time taken by a child to cross the path of a vehicle.

Then if the vehicles are stationary $p_c$ will be given by

$$p_c = \frac{\ell}{s} \quad .$$

Since traffic will be moving, this equation must be modified to allow for the possibility that the vehicle may hit a child moving across the road in front of it. This gives

$$p_c = \frac{\ell + vt_c}{s} \text{ when } \ell + vt_c < s, \qquad (12)$$

and $p_c = 1.0$ when $\ell + vt_c \geqslant s$.

Mayne (1963) has provided a more complex model for the collision probability, at various traffic densities and speeds, for a heedless pedestrian, in which various assumptions are made about the ability of drivers to avoid a collision. We are here making the assumption that neither pedestrian nor driver takes any avoiding action, ie both traffic and pedestrian are assumed to be objects moving at constant speed at right angles to one another. This will, of course, considerably overestimate the probability of a collision. We justify this rather curious assumption on the grounds that we are attempting to provide a measure of exposure that is independent of the skill of different categories of pedestrian in avoiding an accident. No data are available from which to estimate the ability of drivers to avoid a collision but there are no clear grounds for supposing that drivers are more likely to avoid a collision, independently of the pedestrians' behaviour, with one category of pedestrian rather than another. It is possible that drivers are differentially cautious in the presence of some pedestrians rather than others, but if this is so, it seems likely that drivers will be more cautious with regard to the very youngest children and that the measure will overestimate the relative skill of these children in avoiding collisions.

We can now estimate the number of cars a given pedestrian will encounter in the course of a day by summing the values of $p_c$ for all the roads crossed by that pedestrian in a day. If this quantity be called $n_c$ then

$$n_c = \Sigma p_c \qquad (13)$$

Over a given sample of M children the mean number of cars encountered in a day will be

$$\bar{n}_c = \frac{\Sigma n_c}{M} \qquad (14)$$

and its sampling variance will be given in the usual way

$$s^2_{\bar{n}_c} = \frac{1}{M}\left(\frac{\Sigma n_c^2}{M-1} - \bar{n}_c^2\right) \quad . \qquad (15)$$

In a manner similar to the estimation of $\Pi_{ar}$ we can now estimate the average risk, $\Pi_{a/c}$, of an accident given an encounter with a car. If the estimate of $\Pi_{a/c}$ be called $p_{a/c}$ then

$$p_{a/c} = 1 - (1/\bar{n}_c)\, \ln(1 - p_a) \quad . \qquad (16)$$

Again, since $p_a$ will be very small

$$p_{a/c} \approx \frac{p_a}{\bar{n}_c} \qquad (17)$$

Since $\Pi_{a/c}$ is a proportion, it is tempting to calculate its variance in the usual way. However, since it is calculated from data from two different sources, it is probably safer to calculate its variance by combining the two as follows

$$\frac{\sigma^2_{\Pi_{a/c}}}{\Pi^2_{a/c}} = \frac{\sigma^2_{p_a}}{p_a^2} + \frac{\sigma^2_{\bar{n}_c}}{\bar{n}_c^2} - 2\frac{\sigma_{p_a}}{p_a} \cdot \frac{\sigma_{\bar{n}_c}}{\bar{n}_c}\,\rho\left[p_a, \bar{n}_c\right] \quad . \qquad (18)$$

We have approximated this by

$$\frac{s^2_{p_{a/c}}}{p^2_{a/c}} = \frac{\sigma^2_{p_a}}{p_a^2} + \frac{\sigma^2_{\bar{n}_c}}{\bar{n}_c^2} \quad , \qquad (19)$$

and, since the correlation between $p_a$ and $\bar{n}_c$ is probably positive, equation (19) will, if anything, give an overestimate of $s^2_{p_{a/c}}$ so that any conclusions supported by these statistics are likely to be valid.

It has been noted that $p_a$, $p_{ar}$ and $p_{a/c}$ do not entirely behave like probabilities. $p_a$ is given by the ratio of $\frac{n_a}{N\,D}$ . It would have a maximum value of 1.0 if we could assume that no child could have more than one accident per day. This is certainly not the case but it must be so rare that we are entitled to ignore it. Similarly $p_{ar}$ assumes that no child will have more than one accident per road crossing. In this case, multiple accidents will be even more rare. $p_c$ as defined can be greater than one. It is calculated, rather unjustifiably, from $\ell + vt_c$ as an average figure. But more complete descriptions of the effects of variation in car spacing (giving some spaces less than $\ell + vt_c$) and of avoiding action by cars would be very complex indeed.

Similarly, the equations are obviously incorrect for two-lane roads at high densities of traffic, but will be approximately justified at low densities. While explicitly recognising that $p_c$ is only an approximation, and that it is not really a probability, we nevertheless feel justified in using it as we have, since these errors seem to be relatively small for most of the sample we have been using. The values of $p_c$ we have obtained for major roads, minor roads and all roads combined vary between 0.01 and 0.6 with a mean of .16. On a two-lane road two cars may arrive at the same point at the same time but from opposite directions, so that equation (12) produces an overestimate of the true value of $p_c$ where

$$p_{c_{corrected}} = p_c - p_{c_1} \cdot p_{c_2} ,$$

where $p_{c_1}$ and $p_{c_2}$ are respectively the values of $p_c$ for the nearside and farside of the road and $p_c$ is the approximate value used in our equations. At $p_c = 0.2$ the value of $p_{c_{corr.}}$ is overestimated by 5% and at $p_c = 0.04$ by 1%

The calculation of $p_{a/c}$ assumes that no child will have more than one accident per encounter with a car, when the number of possible encounters with a car is defined by the way we calculated $p_c$. It also assumes that the behaviour of children and drivers can only reduce the accident rate. Since hesitation, bad judgement, slowness and falls could all increase the rate above that calculated from $p_c$, it may be less like a probability than the other two and it should be used cautiously.

# APPENDIX 3

# TABLE 1

## ROAD CROSSINGS, EXPOSURE AND RISK FOR THE 20 MINUTE PERIOD AFTER SCHOOL ENDS.

| | MAJOR ROADS | | | | | | MINOR ROADS | | | | | | ALL ROADS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | $p_a x10^6$ | n | $\bar{r}$ | $\bar{n}_c$ | $p_a/r x10^6$ | $p_a/c x10^6$ | $p_a x10^6$ | n | $\bar{r}$ | $\bar{n}_c$ | $p_a/r x10^6$ | $p_a/c x10^6$ | $p_a x10^6$ | n | $\bar{r}$ | $\bar{n}_c$ | $p_a/r x10^6$ | $p_a/c x10^6$ |
| | | | | | | | Male | | | | | | | | | | | |
| 5 | 0.71 | 5 | 0.14 | 0.015 | 5.22 | 46.61 | 1.81 | 68 | 1.85 | 0.043 | 0.98 | 42.55 | 2.52 | 73 | 1.98 | 0.058 | 1.27 | 43.45 |
| 6 | 0.66 | 5 | 0.14 | 0.018 | 4.85 | 36.22 | 1.66 | 88 | 2.39 | 0.098 | 0.69 | 16.92 | 2.33 | 93 | 2.53 | 0.116 | 0.92 | 20.09 |
| 5,6 | 0.69 | 10 | 0.14 | 0.017 | 4.93 | 40.07 | 1.76 | 156 | 2.12 | 0.070 | 0.83 | 25.04 | 2.45 | 166 | 2.26 | 0.087 | 1.08 | 27.07 |
| 8 | 0.85 | 16 | 0.44 | 0.114 | 1.95 | 7.45 | 1.11 | 153 | 4.16 | 0.196 | 0.27 | 5.67 | 1.95 | 169 | 4.60 | 0.310 | 0.42 | 6.33 |
| 9 | 0.80 | 11 | 0.30 | 0.108 | 2.67 | 7.38 | 0.73 | 115 | 3.13 | 0.250 | 0.23 | 2.92 | 1.53 | 125 | 3.43 | 0.358 | 0.45 | 4.25 |
| 10 | 0.63 | 17 | 0.51 | 0.164 | 1.23 | 3.85 | 0.74 | 160 | 4.82 | 0.299 | 0.15 | 2.48 | 1.37 | 177 | 5.33 | 0.463 | 0.26 | 2.96 |
| 8,9,10 | 0.76 | 44 | 0.39 | 0.121 | 1.95 | 6.30 | 0.86 | 428 | 4.02 | 0.247 | 0.21 | 3.49 | 1.62 | 472 | 4.43 | 0.368 | 0.37 | 4.26 |
| | | | | | | | Female | | | | | | | | | | | |
| 5 | 0.40 | 4 | 0.11 | 0.015 | 3.56 | 26.56 | 0.99 | 41 | 1.15 | 0.033 | 0.86 | 29.63 | 1.39 | 45 | 1.26 | 0.048 | 1.10 | 28.96 |
| 6 | 0.41 | 6 | 0.17 | 0.023 | 2.43 | 18.15 | 0.94 | 67 | 1.88 | 0.075 | 0.50 | 12.48 | 1.35 | 73 | 2.05 | 0.098 | 0.66 | 13.78 |
| 5,6 | 0.41 | 10 | 0.14 | 0.019 | 2.93 | 21.86 | 0.97 | 108 | 1.52 | 0.054 | 0.64 | 17.81 | 1.37 | 118 | 1.66 | 0.073 | 0.83 | 17.36 |
| 8 | 0.60 | 5 | 0.14 | 0.047 | 4.27 | 12.82 | 0.70 | 117 | 3.29 | 0.155 | 0.21 | 4.53 | 1.29 | 122 | 3.43 | 0.202 | 0.38 | 6.39 |
| 9 | 0.48 | 9 | 0.25 | 0.060 | 1.90 | 8.01 | 0.45 | 120 | 3.37 | 0.307 | 0.13 | 1.47 | 0.93 | 129 | 3.62 | 0.367 | 0.26 | 2.53 |
| 10 | 0.45 | 18 | 0.56 | 0.181 | 0.81 | 2.49 | 0.40 | 145 | 4.50 | 0.292 | 0.09 | 1.37 | 0.85 | 163 | 4.58 | 0.473 | 0.19 | 1.80 |
| 8,9,10 | 0.51 | 32 | 0.31 | 0.093 | 1.65 | 5.47 | 0.52 | 382 | 3.70 | 0.250 | 0.14 | 2.08 | 1.03 | 414 | 4.01 | 0.343 | 0.26 | 2.36 |

# TABLE 2

3-way analysis of variance of $\bar{r}$ and $\bar{n}_c$ on major and minor roads for the 5-10 year olds, using the protection weighting.

$\bar{r}$

| Source | DF 1 | VE | F | DF 2 | P |
|---|---|---|---|---|---|
| A (Roads) | 1 | 39.424 | 803.276 | 4 | 0.001 |
| B (Sex) | 1 | 0.233 | 4.753 | 4 | N.S. |
| C (Age) | 4 | 1.946 | 39.663 | 4 | 0.01 |
| A.B. | 1 | 0.233 | 4.753 | 4 | N.S. |
| A.C. | 4 | 1.276 | 26.005 | 4 | 0.01 |
| B.C. | 4 | 0.043 | 0.886 | 4 | N.S. |
| A.B.C. | 4 | 0.049 | | | |

$\bar{n}_c$

| Source | DF 1 | VE | F | DF 2 | P |
|---|---|---|---|---|---|
| A (Roads) | 0 | 0.050 | 64.754 | 4 | 0.01 |
| B (Sex) | 1 | 0.001 | 0.855 | 4 | N.S. |
| C (Age) | 4 | 0.029 | 38.512 | 4 | 0.01 |
| A.B. | 1 | * | 0.290 | 4 | N.S. |
| A.C. | 4 | 0.004 | 5.376 | 4 | N.S. |
| B.C. | 4 | 0.001 | 0.772 | 4 | N.S. |
| A.B.C. | 4 | 0.001 | | | |

* less than .001

TABLE 3

ROAD CROSSINGS, EXPOSURE AND RISK FOR THE 20 MINUTE PERIOD AFTER SCHOOL ENDS,

ON MINOR ROADS ONLY.

| | Parked Car | | | | | | No Parked Car | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | $p_a x10^6$ | n | $\bar{r}$ | $\bar{n}_c$ | $p_{a/r}$ $x10^6$ | $p_{a/c}$ $x10^6$ | $p_a x10^6$ | n | $\bar{r}$ | $\bar{n}_c$ | $p_{a/r}$ $x10^6$ | $p_{a/c}$ $x10^6$ |
| **AT JUNCTIONS** | | | | | | | | | | | | |
| **Male** | | | | | | | | | | | | |
| 5 | 0.36 | 12 | 0.33 | 0.011 | 1.10 | 31.51 | 0.49 | 33 | 0.90 | 0.022 | 0.55 | 21.36 |
| 6 | 0.34 | 24 | 0.65 | 0.023 | 0.52 | 14.88 | 0.54 | 38 | 1.03 | 0.025 | 0.52 | 21.77 |
| 5,6 | 0.36 | 36 | 0.49 | 0.017 | 0.73 | 21.18 | 0.52 | 71 | 0.97 | 0.024 | 0.54 | 21.91 |
| 8 | 0.19 | 35 | 0.95 | 0.030 | 0.20 | 6.44 | 0.35 | 67 | 1.82 | 0.104 | 0.19 | 3.37 |
| 9 | 0.16 | 25 | 0.68 | 0.029 | 0.24 | 5.60 | 0.27 | 47 | 1.28 | 0.091 | 0.21 | 2.97 |
| 10 | 0.16 | 27 | 0.81 | 0.034 | 0.20 | 4.69 | 0.29 | 83 | 2.50 | 0.112 | 0.12 | 2.58 |
| 8,9,10 | 0.17 | 87 | 0.82 | 0.031 | 0.21 | 5.52 | 0.30 | 197 | 1.85 | 0.102 | 0.16 | 2.93 |
| **Female** | | | | | | | | | | | | |
| 5 | 0.17 | 5 | 0.14 | 0.005 | 1.21 | 34.57 | 0.31 | 24 | 0.67 | 0.018 | 0.46 | 17.02 |
| 6 | 0.17 | 6 | 0.17 | 0.004 | 1.01 | 40.00 | 0.27 | 37 | 1.04 | 0.026 | 0.26 | 10.04 |
| 5,6 | 0.17 | 11 | 0.16 | 0.005 | 1.06 | 35.96 | 0.29 | 61 | 0.86 | 0.022 | 0.34 | 13.08 |
| 8 | 0.08 | 27 | 0.75 | 0.022 | 0.11 | 3.64 | 0.20 | 51 | 1.43 | 0.056 | 0.14 | 3.58 |
| 9 | 0.04 | 21 | 0.59 | 0.014 | 0.07 | 2.82 | 0.12 | 47 | 1.32 | 0.106 | 0.09 | 1.36 |
| 10 | 0.07 | 29 | 0.90 | 0.048 | 0.08 | 1.44 | 0.15 | 64 | 1.98 | 0.099 | 0.08 | 1.51 |
| 8,9,10 | 0.06 | 77 | 0.75 | 0.029 | 0.08 | 2.04 | 0.16 | 162 | 1.57 | 0.087 | 0.10 | 1.84 |
| **NOT AT JUNCTIONS** | | | | | | | | | | | | |
| **Male** | | | | | | | | | | | | |
| | Parked Car | | | | | | No Parked Car | | | | | |
| 5 | 0.41 | 7 | 0.19 | 0.003 | 2.15 | 119.63 | 0.55 | 16 | 0.44 | 0.004 | 1.26 | 126.38 |
| 6 | 0.32 | 2 | 0.05 | 0.001 | 5.88 | 217.86 | 0.47 | 24 | 0.65 | 0.048 | 0.72 | 9.86 |
| 5,6 | 0.37 | 9 | 0.12 | 0.002 | 3.08 | 154.17 | 0.51 | 40 | 0.54 | 0.026 | 0.94 | 19.62 |
| 8 | 0.21 | 12 | 0.33 | 0.008 | 0.64 | 24.75 | 0.35 | 39 | 1.06 | 0.054 | 0.33 | 6.47 |
| 9 | 0.12 | 8 | 0.22 | 0.004 | 0.55 | 30.64 | 0.19 | 35 | 0.95 | 0.128 | 0.20 | 1.49 |
| 10 | 0.10 | 11 | 0.33 | 0.008 | 0.30 | 12.58 | 0.19 | 39 | 1.17 | 0.142 | 0.16 | 1.34 |
| 8,9,10 | 0.15 | 31 | 0.29 | 0.006 | 0.52 | 25.00 | 0.24 | 113 | 1.06 | 0.108 | 0.23 | 2.22 |
| **Female** | | | | | | | | | | | | |
| 5 | 0.25 | 2 | 0.06 | 0.000 | 4.17 | ∞ | 0.26 | 10 | 0.28 | 0.010 | 0.93 | 25.70 |
| 6 | 0.26 | 7 | 0.20 | 0.004 | 1.32 | 60.08 | 0.24 | 17 | 0.48 | 0.040 | 0.50 | 5.98 |
| 5,6 | 0.25 | 9 | 0.13 | 0.002 | 1.92 | 125.00 | 0.25 | 27 | 0.38 | 0.025 | 0.66 | 10.00 |
| 8 | 0.22 | 13 | 0.37 | 0.010 | 0.60 | 21.51 | 0.21 | 26 | 0.73 | 0.066 | 0.29 | 3.16 |
| 9 | 0.08 | 4 | 0.11 | 0.001 | 0.71 | 71.17 | 0.21 | 48 | 1.35 | 0.183 | 0.16 | 1.14 |
| 10 | 0.07 | 9 | 0.26 | 0.006 | 0.25 | 10.91 | 0.11 | 43 | 1.33 | 0.131 | 0.08 | 0.84 |
| 8,9,10 | 0.13 | 26 | 0.25 | 0.006 | 0.52 | 22.13 | 0.18 | 117 | 1.13 | 0.127 | 0.16 | 1.42 |

# TABLE 4.

4-way analysis of variance of $\bar{r}$ and $\bar{n}_c$ at different locations on minor roads only for the 5-10 year olds, using the protection weighting

$\bar{r}$

| Source | DF 1 | VE | F | DF 2 | P |
|---|---|---|---|---|---|
| A (Junction) | 1 | 2.190 | 46.859 | 4 | 0.01 |
| B (Parked Car) | 1 | 5.112 | 109.373 | 4 | 0.001 |
| C (Sex) | 1 | 0.116 | 2.495 | 4 | N.S. |
| D (Age) | 4 | 0.784 | 16.776 | 4 | 0.01 |
| A.B. | 1 | 0.072 | 1.546 | 4 | N.S. |
| A.C. | 1 | 0.077 | 1.657 | 4 | N.S. |
| A.D. | 4 | 0.093 | 1.991 | 4 | N.S. |
| B.C. | 1 | 0.001 | 0.026 | 4 | N.S. |
| B.D. | 4 | 0.177 | 3.797 | 4 | N.S. |
| C.D. | 4 | 0.023 | 0.498 | 4 | N.S. |
| A.B.C. | 1 | 0.001 | 0.026 | 4 | N.S. |
| A.B.D. | 4 | 0.042 | 0.904 | 4 | N.S. |
| A.C.D. | 4 | 0.003 | 0.065 | 4 | N.S. |
| B.C.D. | 4 | 0.028 | 0.607 | 4 | N.S. |
| A.B.C.D. | 4 | 0.046 | | | |

$\bar{n}_c$

| Source | DF 1 | VE | F | DF 2 | P |
|---|---|---|---|---|---|
| A (Junction) | 1 | * | 0.268 | 4 | N.S. |
| B (Parked Car) | 1 | 0.036 | 357.950 | 4 | 0.001 |
| C (Sex) | 1 | * | 0.180 | 4 | N.S. |
| D (Age) | 4 | 0.006 | 62.864 | 4 | 0.001 |
| A.B. | 1 | 0.002 | 26.360 | 4 | 0.01 |
| A.C. | 1 | 0.001 | 4.763 | 4 | N.S. |
| A.D. | 4 | * | 4.185 | 4 | N.S. |
| B.C. | 1 | * | 0.337 | 4 | N.S. |
| B.D. | 4 | 0.004 | 40.256 | 4 | 0.01 |
| C.D. | 4 | * | 1.433 | 4 | N.S. |
| A.B.C. | 1 | * | 1.107 | 4 | N.S. |
| A.B.D. | 4 | 0.001 | 6.862 | 4 | 0.05 |
| A.C.D. | 4 | * | 1.540 | 4 | N.S. |
| B.C.D. | 4 | * | 3.141 | 4 | N.S. |
| A.B.C.D. | 4 | * | | | |

* less than .001

## TABLE 5

$P_a \times 10^6$ for fatal, serious and slight accidents throughout the year.

| | MALE | | FEMALE | |
|---|---|---|---|---|
| Age | Nottm. | NATIONAL | Nottm. | NATIONAL |
| 5 | 35.9 | 19.2 | 19.5 | 10.1 |
| 6 | 31.3 | 21.0 | 16.7 | 10.8 |
| 7 | 28.5 | 19.8 | 18.8 | 10.2 |
| 8 | 19.8 | 17.3 | 13.5 | 9.6 |
| 9 | 20.3 | 13.8 | 13.5 | 9.0 |
| 10 | 13.8 | 11.3 | 9.5 | 7.9 |

## TABLE 6

3-way analysis of variance of $p_{a/r}$ and $p_{a/c}$ on major and minor roads for the 5-10 year olds, using the protection weighting.

$p_{a/r}$

| Source | DF 1 | VE | F | DF2 | P |
|---|---|---|---|---|---|
| A (Roads) | 1 | 30.7024 | 39.565 | 4 | 0.01 |
| B (Sex) | 1 | 0.6055 | 0.780 | 4 | N.S. |
| C (Age) | 4 | 2.5699 | 3.312 | 4 | N.S. |
| A.B. | 1 | 0.2928 | 0.377 | 4 | N.S. |
| A.C. | 4 | 1.0221 | 1.317 | 4 | N.S. |
| B.C. | 4 | 0.8533 | 1.100 | 4 | N.S. |
| A.B.C. | 4 | 0.7760 | | | |

$p_{a/c}$

| Source | DF1 | VE | F | DF2 | P |
|---|---|---|---|---|---|
| A (Roads) | 1 | 122.6116 | 7.768 | 4 | 0.05 |
| B (Sex) | 1 | 148.7306 | 9.423 | 4 | 0.05 |
| C (Age) | 4 | 799.9089 | 50.681 | 4 | 0.01 |
| A.B. | 1 | 7.7128 | 0.489 | 4 | N.S. |
| A.C. | 4 | 22.6650 | 1.436 | 4 | N.S. |
| B.C. | 4 | 63.9665 | 4.053 | 4 | N.S. |
| A.B.C. | 4 | 15.7832 | | | |

# TABLE 7

Comparison of the measures of exposure and risk with "following" study, all roads crossed.

| Random Site Study. | | | | | |
|---|---|---|---|---|---|
| Male | $p_a x10^6$ | $\bar{r}$ | $\bar{n}_c$ | $p_{a/r} x10^6$ | $p_{a/c} x10^6$ |
| 5,6 | 2.43 | 2.26 | 0.087 | 1.08 | 27.93 |
| 8,9,10 | 1.62 | 4.30 | 0.364 | 0.38 | 4.45 |
| Female | | | | | |
| 5,6 | 1.38 | 1.66 | 0.073 | 0.83 | 18.90 |
| 8,9,10 | 1.02 | 4.02 | 0.343 | 0.25 | 2.97 |
| "Following" Study. | | | | | |
| Male | | | | | |
| 5,6 | 1.87 | 3.13 | 0.049 | 0.60 | 38.16 |
| 8,9,10 | 1.49 | 3.22 | 0.095 | 0.46 | 15.68 |
| Female | | | | | |
| 5,6 | 0.90 | 1.65 | 0.033 | 0.55 | 27.27 |
| 8,9,10 | 0.88 | 3.54 | 0.151 | 0.25 | 5.83 |

# TABLE 8

Comparison of the measures of exposure and risk with "following" study, on all roads crossed, at different locations.

| | At Junctions | | | | | Not at Junctions | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Random Site Study.** | | | | | | | | | | |
| Male | $p_a \times 10^6$ | $\bar{r}$ | $\bar{n}_c$ | $p_a/\bar{r} \times 10^6$ | $p_a/c \times 10^6$ | $p_a \times 10^6$ | $\bar{r}$ | $\bar{n}_c$ | $p_a/\bar{r} \times 10^6$ | $p_a/c \times 10^6$ |
| 5,6 | 1.22 | 1.59 | 0.058 | 0.77 | 21.03 | 1.21 | 0.67 | 0.028 | 1.81 | 43.21 |
| 8,9,10 | 0.91 | 2.84 | 0.209 | 0.32 | 4.35 | 0.71 | 1.46 | 0.155 | 0.49 | 4.58 |
| Female | | | | | | | | | | |
| 5,6 | 0.67 | 1.16 | 0.045 | 0.58 | 14.89 | 0.71 | 0.51 | 0.027 | 1.39 | 26.30 |
| 8,9,10 | 0.53 | 2.56 | 0.185 | 0.21 | 2.86 | 0.46 | 1.46 | 0.159 | 0.32 | 2.89 |
| **"Following" Study** | | | | | | | | | | |
| Male | | | | | | | | | | |
| 5,6, | 0.93 | 2.65 | 0.040 | 0.35 | 23.25 | 0.94 | 0.65 | 0.008 | 1.45 | 117.50 |
| 8,9,10 | 0.81 | 2.26 | 0.075 | 0.36 | 10.80 | 0.68 | 0.96 | 0.020 | 0.71 | 34.00 |
| Female | | | | | | | | | | |
| 5,6, | 0.46 | 1.21 | 0.025 | 0.38 | 18.40 | 0.43 | 0.40 | 0.007 | 1.08 | 61.43 |
| 8,9,10 | 0.48 | 2.91 | 0.130 | 0.16 | 3.69 | 0.40 | 0.63 | 0.025 | 0.63 | 16.00 |

| | Parked Car | | | | | No Parked Car | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Random Site Study.** | | | | | | | | | | |
| Male | $p_a \times 10^6$ | $\bar{r}$ | $\bar{n}_c$ | $p_a/\bar{r} \times 10^6$ | $p_a/c \times 10^6$ | $p_a \times 10^6$ | $\bar{r}$ | $\bar{n}_c$ | $p_a/\bar{r} \times 10^6$ | $p_a/c \times 10^6$ |
| 5,6 | 0.96 | 0.75 | 0.037 | 1.28 | 25.95 | 1.52 | 1.51 | 0.050 | 1.01 | 30.40 |
| 8,9,10 | 0.49 | 1.29 | 0.116 | 0.38 | 4.22 | 1.13 | 3.00 | 0.247 | 0.38 | 4.57 |
| Female | | | | | | | | | | |
| 5,6 | 0.53 | 0.42 | 0.026 | 1.26 | 20.38 | 0.85 | 1.24 | 0.047 | 0.69 | 18.09 |
| 8,9,10 | 0.31 | 1.10 | 0.068 | 0.28 | 4.56 | 0.71 | 2.92 | 0.275 | 0.24 | 2.58 |
| **"Following" Study.** | | | | | | | | | | |
| Male | | | | | | | | | | |
| 5,6 | 0.63 | 0.65 | 0.010 | 0.97 | 63.00 | 1.24 | 2.48 | 0.039 | 0.50 | 31.79 |
| 8,9110 | 0.43 | 0.59 | 0.009 | 0.73 | 47.78 | 1.06 | 2.63 | 0.086 | 0.40 | 12.33 |
| Female | | | | | | | | | | |
| 5,6 | 0.33 | 0.17 | 0.002 | 1.94 | 165.00 | 0.57 | 1.48 | 0.031 | 0.39 | 18.39 |
| 8,9,10 | 0.28 | 0.54 | 0.014 | 0.52 | 20.00 | 0.60 | 3.00 | 0.137 | 0.20 | 4.38 |

# TABLE 9

Road Crossings, Exposure and Risk for the whole sample (both periods combined).

| | Major | | | | | | Minor | | | | | | All Roads | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Male | $p_a x10^6$ | n | $\bar{r}$ | $\bar{n}_c$ | $p_a/\bar{r} x10^6$ | $p_a/c x10^6$ | $p_a x10^6$ | n | $\bar{r}$ | $\bar{n}_c$ | $p_a/\bar{r} x10^6$ | $p_a/c x10^6$ | $p_a x10^6$ | n | $\bar{r}$ | $\bar{n}_c$ | $p_a/\bar{r} x10^6$ | $p_a/c x10^6$ |
| 0 - 4 | 0.25 | 1 | 0.01 | 0.001 | 25.00 | 176.68 | 0.78 | 28 | 0.15 | 0.003 | 5.26 | 276.59 | 1.03 | 29 | 0.16 | 0.003 | 6.44 | 343.33 |
| 5 - 7 | 1.29 | 20 | 0.18 | 0.038 | 7.09 | 33.75 | 2.72 | 346 | 3.15 | 0.116 | 0.86 | 23.35 | 4.01 | 366 | 3.33 | 0.154 | 1.20 | 26.04 |
| 8 - 10 | 1.03 | 65 | 0.61 | 0.174 | 1.69 | 5.94 | 1.24 | 438 | 4.12 | 0.251 | 0.30 | 4.94 | 2.27 | 503 | 4.73 | 0.425 | 0.48 | 5.34 |
| 11 - 14 | 0.51 | 122 | 0.92 | 0.265 | 0.56 | 1.92 | 0.35 | 360 | 2.70 | 0.167 | 0.13 | 2.09 | 0.87 | 482 | 3.62 | 0.432 | 0.24 | 2.01 |
| 15 - 19 | 0.20 | 128 | 0.76 | 0.263 | 0.26 | 0.76 | 0.09 | 162 | 0.96 | 0.080 | 0.09 | 1.12 | 0.29 | 290 | 1.72 | 0.343 | 0.17 | 0.85 |
| 20 - 50 | 0.09 | 396 | 0.40 | 0.142 | 0.23 | 0.63 | 0.04 | 606 | 0.61 | 0.063 | 0.01 | 0.63 | 0.13 | 1002 | 1.01 | 0.203 | 0.13 | 0.64 |
| 60+ | 0.21 | 93 | 0.31 | 0.126 | 0.68 | 1.66 | 0.06 | 116 | 0.38 | 0.033 | 0.16 | 1.84 | 0.28 | 209 | 0.69 | 0.159 | 0.41 | 0.76 |

| Female | $p_a x10^6$ | n | $\bar{r}$ | $\bar{n}_c$ | $p_a/\bar{r} x10^6$ | $p_a/c x10^6$ | $p_a x10^6$ | n | $\bar{r}$ | $\bar{n}_c$ | $p_a/\bar{r} x10^6$ | $p_a/c x10^6$ | $p_a x10^6$ | n | $\bar{r}$ | $\bar{n}_c$ | $p_a/\bar{r} x10^6$ | $p_a/c x10^6$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 - 4 | 0.15 | 3 | 0.02 | 0.005 | 8.93 | 27.80 | 0.44 | 28 | 0.16 | 0.003 | 2.81 | 127.50 | 0.59 | 31 | 0.18 | 0.008 | 3.28 | 73.75 |
| 5 - 7 | 0.74 | 18 | 0.17 | 0.030 | 4.37 | 24.30 | 1.54 | 261 | 2.45 | 0.096 | 0.63 | 16.09 | 2.29 | 279 | 2.62 | 0.126 | 0.87 | 18.17 |
| 8 - 10 | 0.71 | 35 | 0.34 | 0.100 | 2.09 | 7.09 | 0.71 | 391 | 3.79 | 0.250 | 0.19 | 2.84 | 1.42 | 426 | 4.11 | 0.350 | 0.35 | 4.06 |
| 11 - 14 | 0.72 | 92 | 0.72 | 0.260 | 1.00 | 2.77 | 0.47 | 277 | 2.16 | 0.151 | 0.22 | 3.10 | 1.19 | 369 | 2.88 | 0.411 | 0.41 | 2.90 |
| 15 - 19 | 0.16 | 106 | 0.66 | 0.271 | 0.24 | 0.59 | 0.08 | 174 | 1.08 | 0.067 | 0.07 | 1.20 | 0.24 | 280 | 1.74 | 0.338 | 0.14 | 0.71 |
| 20 - 59 | 0.09 | 490 | 0.49 | 0.185 | 0.18 | 0.49 | 0.04 | 102 | 1.10 | 0.086 | 0.04 | 0.47 | 0.13 | 592 | 1.59 | 0.271 | 0.08 | 0.48 |
| 60+ | 0.21 | 53 | 0.12 | 0.045 | 1.80 | 4.62 | 0.10 | 178 | 0.39 | 0.031 | 0.26 | 3.19 | 0.30 | 731 | 0.51 | 0.076 | 0.59 | 3.95 |

TABLE 10

ROAD CROSSINGS, EXPOSURE AND RISK FOR THE WHOLE SAMPLE (BOTH PERIODS COMBINED)

ON MINOR ROADS ONLY.

| | Parked Car | | | | | | No Parked Car | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | $p_a$ x$10^6$ | n | $\bar{r}$ | $\bar{n}_c$ | $p_{a/r}$ x$10^6$ | $p_{a/c}$ x$10^6$ | $p_a$ x$10^6$ | n | $\bar{r}$ | $\bar{n}_c$ | $p_{a/r}$ x$10^6$ | $p_{a/c}$ x$10^6$ |
| **AT JUNCTIONS** | | | | | | | | | | | | |
| **Male** | | | | | | | | | | | | |
| 0-4 | 0.112 | 5 | 0.027 | 0.001 | 4.23 | 132.08 | 0.178 | 12 | 0.064 | 0.002 | 2.78 | 359.5 |
| 5-7 | 0.499 | 86 | 0.783 | 0.022 | 0.64 | 22.77 | 0.791 | 155 | 1.410 | 0.049 | 0.56 | 16.02 |
| 8-10 | 0.214 | 88 | 0.827 | 0.031 | 0.26 | 7.00 | 0.435 | 202 | 1.900 | 0.104 | 0.23 | 4.17 |
| 11-14 | 0.052 | 47 | 0.353 | 0.017 | 0.15 | 3.07 | 0.120 | 217 | 1.630 | 0.106 | 0.07 | 1.13 |
| 15-19 | 0.007 | 24 | 0.142 | 0.016 | 0.05 | 0.44 | 0.039 | 103 | 0.608 | 0.051 | 0.06 | 0.77 |
| 20-59 | 0.003 | 135 | 0.135 | 0.011 | 0.02 | 0.28 | 0.016 | 287 | 0.287 | 0.031 | 0.05 | 0.52 |
| 60+ | 0.005 | 23 | 0.076 | 0.006 | 0.07 | 0.86 | 0.035 | 62 | 0.205 | 0.016 | 0.17 | 2.14 |
| **Female** | | | | | | | | | | | | |
| 0-4 | 0.068 | 7 | 0.039 | 0.001 | 1.74 | 69.80 | 0.118 | 13 | 0.073 | 0.002 | 1.62 | 53.94 |
| 5-7 | 0.251 | 46 | 0.432 | 0.013 | 0.58 | 20.00 | 0.482 | 126 | 1.184 | 0.047 | 0.41 | 11.30 |
| 8-10 | 0.092 | 80 | 0.776 | 0.029 | 0.12 | 3.11 | 0.214 | 165 | 1.601 | 0.088 | 0.13 | 2.43 |
| 11-14 | 0.064 | 39 | 0.304 | 0.020 | 0.21 | 3.16 | 0.171 | 186 | 1.451 | 0.107 | 0.12 | 1.59 |
| 15-19 | 0.014 | 37 | 0.229 | 0.014 | 0.06 | 1.06 | 0.034 | 102 | 0.632 | 0.046 | 0.05 | 0.74 |
| 20-59 | 0.004 | 261 | 0.261 | 0.014 | 0.02 | 0.30 | 0.020 | 598 | 0.598 | 0.048 | 0.03 | 0.40 |
| 60+ | 0.011 | 49 | 0.108 | 0.008 | 0.10 | 1.39 | 0.055 | 95 | 0.209 | 0.019 | 0.27 | 2.94 |
| **NOT AT JUNCTIONS** | | | | | | | | | | | | |
| **Male** | | | | | | | | | | | | |
| 0-4 | 0.205 | 2 | 0.011 | * | 18.64 | ∞ | 0.288 | 9 | 0.048 | * | 6.04 | ∞ |
| 5-7 | 0.567 | 26 | 0.237 | 0.018 | 2.40 | 31.53 | 0.859 | 79 | 0.719 | 0.027 | 1.19 | 31.44 |
| 8-10 | 0.205 | 31 | 0.291 | 0.007 | 0.70 | 30.59 | 0.617 | 117 | 1.100 | 0.110 | 0.56 | 5.61 |
| 11-14 | 0.052 | 48 | 0.360 | 0.015 | 0.14 | 3.52 | 0.130 | 48 | 0.360 | 0.032 | 0.36 | 4.06 |
| 15-19 | 0.009 | 15 | 0.089 | 0.009 | 0.10 | 1.04 | 0.039 | 20 | 0.118 | 0.005 | 0.33 | 7.89 |
| 20-59 | 0.005 | 125 | 0.125 | 0.017 | 0.04 | 0.28 | 0.018 | 59 | 0.059 | 0.005 | 0.31 | 3.81 |
| 60+ | 0.006 | 19 | 0.063 | 0.007 | 0.10 | 0.81 | 0.018 | 12 | 0.040 | 0.003 | 0.45 | 5.98 |
| **Female** | | | | | | | | | | | | |
| 0-4 | 0.110 | 0 | 0 | 0 | ∞ | ∞ | 0.158 | 8 | 0.045 | * | 3.31 | 661.61 |
| 5-7 | 0.380 | 29 | 0.273 | 0.006 | 1.39 | 66.28 | 0.432 | 60 | 0.564 | 0.035 | 0.77 | 12.36 |
| 8-10 | 0.170 | 26 | 0.252 | 0.006 | 0.67 | 29.31 | 0.235 | 120 | 1.164 | 0.128 | 0.20 | 1.83 |
| 11-14 | 0.081 | 23 | 0.179 | 0.007 | 0.45 | 11.91 | 0.151 | 29 | 0.226 | 0.015 | 0.67 | 9.83 |
| 15-19 | 0.005 | 14 | 0.087 | 0.003 | 0.06 | 1.63 | 0.026 | 21 | 0.130 | 0.005 | 0.20 | 4.96 |
| 20-59 | 0.004 | 104 | 0.104 | 0.008 | 0.04 | 0.51 | 0.014 | 139 | 0.139 | 0.016 | 0.10 | 0.87 |
| 60+ | 0.003 | 11 | 0.024 | 0.002 | 0.12 | 1.77 | 0.011 | 23 | 0.051 | 0.003 | 0.21 | 3.14 |

* less than .001

# TABLE 11

| Age | Major Roads Male % | Major Roads Male n | Major Roads Female % | Major Roads Female n | Major Roads Total % | Major Roads Total n | Minor Roads Male % | Minor Roads Male n | Minor Roads Female % | Minor Roads Female n | Minor Roads Total % | Minor Roads Total n | All Roads Male % | All Roads Male n | All Roads Female % | All Roads Female n | All Roads Total % | All Roads Total n |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Percentage of Pedestrians running across the Road.** | | | | | | | | | | | | | | | | | | |
| 0-4 | 100 | 1 | 33 | 3 | 50 | 4 | 32 | 22 | 18 | 22 | 25 | 44 | 35 | 23 | 20 | 25 | 27 | 48 |
| 5-7 | 35 | 20 | 11 | 18 | 24 | 38 | 40 | 327 | 26 | 262 | 34 | 589 | 40 | 347 | 25 | 280 | 33 | 627 |
| 8-10 | 21 | 66 | 28 | 35 | 24 | 101 | 32 | 419 | 23 | 377 | 28 | 796 | 30 | 485 | 23 | 412 | 27 | 897 |
| 11-14 | 25 | 119 | 12 | 85 | 20 | 204 | 19 | 336 | 11 | 258 | 16 | 594 | 20 | 455 | 11 | 343 | 16 | 798 |
| 15-19 | 17 | 128 | 11 | 105 | 14 | 233 | 15 | 165 | 6 | 169 | 10 | 334 | 16 | 293 | 8 | 274 | 12 | 567 |
| 20-59 | 11 | 395 | 10 | 496 | 11 | 891 | 3 | 583 | 3 | 1107 | 3 | 1690 | 6 | 978 | 5 | 1503 | 5 | 2481 |
| 60+ | 9 | 92 | 6 | 54 | 8 | 146 | 1 | 114 | 1 | 181 | 1 | 295 | 4 | 206 | 2 | 235 | 3 | 441 |
| ALL | 15 | 821 | 11 | 796 | 13 | 1617 | 19 | 1966 | 10 | 2376 | 14 | 4342 | 18 | 2787 | 10 | 3172 | 14 | 5959 |
| **Percentage of Pedestrians not looking adequately.** | | | | | | | | | | | | | | | | | | |
| 0-4 | 0 | 1 | 0 | 3 | 0 | 4 | 77 | 22 | 60 | 20 | 70 | 42 | 74 | 23 | 52 | 23 | 63 | 46 |
| 5-7 | 11 | 18 | 0 | 16 | 6 | 34 | 45 | 334 | 35 | 253 | 41 | 587 | 43 | 352 | 33 | 269 | 39 | 621 |
| 8-10 | 13 | 56 | 12 | 34 | 13 | 90 | 31 | 408 | 29 | 369 | 30 | 777 | 29 | 464 | 28 | 403 | 29 | 867 |
| 11-14 | 20 | 118 | 7 | 87 | 11 | 205 | 33 | 301 | 30 | 209 | 32 | 510 | 29 | 419 | 23 | 296 | 27 | 715 |
| 15-19 | 19 | 130 | 8 | 105 | 14 | 235 | 20 | 153 | 26 | 165 | 23 | 318 | 20 | 283 | 19 | 270 | 20 | 553 |
| 20-59 | 2 | 393 | 2 | 488 | 2 | 881 | 12 | 597 | 9 | 1093 | 10 | 1690 | 8 | 990 | 7 | 1581 | 7 | 2571 |
| 60+ | 1 | 94 | 0 | 54 | 0 | 148 | 17 | 116 | 9 | 178 | 12 | 294 | 10 | 210 | 8 | 232 | 9 | 442 |
| ALL | 8 | 810 | 4 | 787 | 6 | 1597 | 27 | 1931 | 19 | 2287 | 23 | 4218 | 21 | 2741 | 15 | 3074 | 18 | 5815 |
| **Percentage of Heedless Pedestrians** | | | | | | | | | | | | | | | | | | |
| 0-4 | 0 | 1 | 0 | 3 | 0 | 4 | 64 | 22 | 55 | 22 | 60 | 44 | 61 | 23 | 53 | 25 | 57 | 48 |
| 5-7 | 17 | 18 | 6 | 16 | 12 | 34 | 32 | 333 | 18 | 256 | 26 | 589 | 31 | 351 | 17 | 272 | 25 | 623 |
| 8-10 | 9 | 44 | 13 | 32 | 11 | 76 | 16 | 404 | 20 | 367 | 18 | 771 | 15 | 448 | 19 | 399 | 17 | 847 |
| 11-14 | 7 | 111 | 1 | 73 | 5 | 184 | 10 | 336 | 7 | 256 | 9 | 592 | 9 | 447 | 6 | 329 | 8 | 776 |
| 15-19 | 13 | 128 | 2 | 98 | 8 | 226 | 4 | 166 | 3 | 171 | 3 | 337 | 8 | 294 | 3 | 269 | 6 | 563 |
| 20-59 | 2 | 359 | 1 | 461 | 1 | 820 | 1 | 596 | 1 | 1092 | 1 | 1688 | 1 | 955 | 1 | 1553 | 1 | 2508 |
| 60+ | 2 | 93 | 2 | 54 | 2 | 147 | 6 | 116 | 5 | 176 | 5 | 292 | 4 | 209 | 4 | 230 | 4 | 459 |
| ALL | 5 | 754 | 2 | 737 | 4 | 1491 | 12 | 1973 | 8 | 2243 | 10 | 4216 | 10 | 2727 | 7 | 2980 | 8 | 5707 |

## TABLE 12

| Age | Parked Car | | | | | | No Parked Car | | | | | | At Junction | | | | | | Not at Junction | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | | Female | | Total | | Male | | Female | | Total | | Male | | Female | | Total | | Male | | Female | | Total | |
| | % | n | % | n | % | n | % | n | % | n | % | n | % | n | % | n | % | n | % | n | % | n | % | n |
| **Percentage of Pedestrians running across the Road.** | | | | | | | | | | | | | | | | | | | | | | | | |
| 0-4 | 0 | 7 | 29 | 7 | 14 | 14 | 47 | 15 | 13 | 15 | 30 | 30 | 25 | 12 | 20 | 15 | 22 | 27 | 40 | 10 | 14 | 7 | 29 | 17 |
| 5-7 | 45 | 107 | 35 | 72 | 37 | 189 | 38 | 218 | 21 | 181 | 30 | 399 | 36 | 222 | 21 | 166 | 29 | 388 | 50 | 97 | 32 | 87 | 42 | 184 |
| 8-10 | 36 | 116 | 19 | 104 | 28 | 220 | 30 | 300 | 24 | 271 | 27 | 571 | 31 | 275 | 18 | 230 | 25 | 505 | 33 | 141 | 31 | 145 | 32 | 286 |
| 11-14 | 22 | 94 | 7 | 62 | 16 | 156 | 16 | 238 | 12 | 195 | 14 | 433 | 17 | 237 | 9 | 205 | 13 | 442 | 20 | 95 | 15 | 52 | 18 | 147 |
| 15-19 | 16 | 37 | 6 | 51 | 9 | 98 | 15 | 122 | 6 | 116 | 11 | 238 | 15 | 126 | 6 | 132 | 11 | 258 | 15 | 33 | 6 | 35 | 10 | 68 |
| 20-59 | 3 | 232 | 2 | 360 | 3 | 592 | 3 | 342 | 3 | 721 | 3 | 1063 | 2 | 417 | 3 | 842 | 2 | 1259 | 5 | 157 | 4 | 239 | 5 | 396 |
| 60+ | 2 | 41 | 2 | 60 | 1 | 101 | 0 | 72 | 0 | 118 | 0 | 190 | 0 | 83 | 0 | 144 | 0 | 227 | 3 | 30 | 3 | 34 | 3 | 64 |
| ALL | 20 | 628 | 9 | 716 | 14 | 1344 | 19 | 1307 | 10 | 1617 | 14 | 2924 | 17 | 1372 | 7 | 1734 | 12 | 3106 | 24 | 563 | 16 | 599 | 20 | 1162 |
| **Percentage of Pedestrians not looking adequately.** | | | | | | | | | | | | | | | | | | | | | | | | |
| 0-4 | 57 | 7 | 43 | 7 | 50 | 14 | 87 | 15 | 69 | 13 | 79 | 28 | 67 | 12 | 46 | 13 | 56 | 25 | 90 | 10 | 86 | 7 | 88 | 17 |
| 5-7 | 43 | 102 | 40 | 72 | 42 | 174 | 47 | 224 | 34 | 172 | 41 | 396 | 42 | 224 | 32 | 159 | 38 | 383 | 55 | 102 | 42 | 85 | 49 | 187 |
| 8-10 | 37 | 114 | 27 | 104 | 32 | 218 | 28 | 291 | 30 | 263 | 29 | 554 | 33 | 269 | 29 | 225 | 31 | 494 | 27 | 136 | 30 | 142 | 28 | 278 |
| 11-14 | 48 | 85 | 18 | 60 | 36 | 145 | 27 | 212 | 35 | 148 | 30 | 360 | 33 | 207 | 35 | 158 | 34 | 365 | 33 | 90 | 14 | 50 | 26 | 140 |
| 15-19 | 21 | 39 | 36 | 50 | 29 | 89 | 21 | 108 | 21 | 113 | 21 | 221 | 21 | 112 | 22 | 128 | 21 | 240 | 23 | 35 | 40 | 35 | 31 | 70 |
| 20-59 | 12 | 255 | 14 | 358 | 13 | 613 | 13 | 333 | 6 | 710 | 8 | 1043 | 15 | 406 | 8 | 828 | 10 | 1234 | 7 | 182 | 11 | 240 | 10 | 422 |
| 60+ | 19 | 42 | 7 | 59 | 12 | 101 | 16 | 73 | 10 | 116 | 13 | 189 | 19 | 84 | 10 | 142 | 13 | 226 | 13 | 31 | 6 | 33 | 9 | 64 |
| ALL | 28 | 644 | 22 | 710 | 24 | 1354 | 27 | 1256 | 18 | 1535 | 22 | 2791 | 27 | 1314 | 17 | 1653 | 22 | 2967 | 27 | 586 | 23 | 592 | 25 | 1178 |
| **Percentage of Heedless Pedestrians.** | | | | | | | | | | | | | | | | | | | | | | | | |
| 0-4 | 29 | 7 | 31 | 7 | 43 | 14 | 80 | 15 | 53 | 15 | 67 | 30 | 67 | 12 | 47 | 15 | 56 | 27 | 60 | 10 | 71 | 7 | 65 | 17 |
| 5-7 | 34 | 104 | 18 | 71 | 27 | 175 | 32 | 222 | 18 | 177 | 26 | 399 | 28 | 226 | 17 | 163 | 24 | 389 | 42 | 100 | 20 | 85 | 37 | 185 |
| 8-10 | 17 | 116 | 9 | 102 | 13 | 218 | 16 | 285 | 24 | 264 | 20 | 549 | 16 | 263 | 16 | 221 | 16 | 484 | 17 | 138 | 25 | 145 | 21 | 283 |
| 11-14 | 14 | 89 | 8 | 61 | 11 | 150 | 7 | 243 | 7 | 194 | 7 | 437 | 6 | 240 | 6 | 204 | 6 | 444 | 20 | 92 | 10 | 51 | 17 | 143 |
| 15-19 | 0 | 39 | 0 | 51 | 0 | 90 | 5 | 121 | 4 | 118 | 5 | 239 | 4 | 125 | 2 | 134 | 3 | 259 | 3 | 35 | 9 | 35 | 6 | 70 |
| 20-59 | 4 | 254 | 1 | 354 | 1 | 508 | 2 | 333 | 1 | 712 | 1 | 1045 | 1 | 405 | 1 | 828 | 1 | 1233 | 1 | 182 | 2 | 238 | 1 | 420 |
| 60+ | 5 | 42 | 2 | 58 | 3 | 100 | 7 | 73 | 6 | 118 | 6 | 191 | 8 | 84 | 4 | 142 | 6 | 226 | 0 | 31 | 6 | 34 | 3 | 65 |
| ALL | 12 | 651 | 5 | 704 | 8 | 1355 | 12 | 1292 | 9 | 1598 | 10 | 2890 | 11 | 1355 | 6 | 1707 | 8 | 3062 | 16 | 588 | 12 | 595 | 14 | 1183 |

TABLE 13

Sample correlation coefficients (r) for the behavioural measures with $p_{a/c}$ for major and minor roads, based on the whole sample.

| | Major Roads | | Minor Roads | | All Roads | |
|---|---|---|---|---|---|---|
| | r | df | r | df | r | df |
| $p_{rp}$ | .51 | 10 | .75 | 10 | .76 | 10 |
| $p_{ip}$ | -.07 | 10 | .72 | 10 | .76 | 10 |
| $p_{hp}$ | .57 | 10 | .85 | 10 | .85 | 10 |

(the 0-4 age group have been excluded due to the small number of observations).

## T A B L E 14

% of roads crossed by Infants when protected.

| | Major | | | | Minor | | | | Total | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3.30 | | 4.00 | | 3.30 | | 4.00 | | 3.30 | | 4.00 | |
| | % | n | % | n | % | n | % | n | % | n | % | n |
| Male | 56.5 | 23 | 37.5 | 8 | 39.1 | 256 | 21.2 | 104 | 40.5 | 279 | 22.3 | 112 |
| Female | 63.0 | 27 | 75.0 | 8 | 52.0 | 225 | 35.3 | 68 | 53.2 | 252 | 39.5 | 76 |
| Combined | 59.8 | 50 | 56.3 | 16 | 45.1 | 481 | 26.7 | 172 | 46.5 | 531 | 29.3 | 188 |

## T A B L E 15

% of cars encountered by Infants when protected.

| | Major | | | | Minor | | | | Total. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3.30 | | 4.00 | | 3.30 | | 4.00 | | 3.30 | | 4.00 | |
| | % | n | % | n | % | n | % | n | % | n | % | n |
| Male | 69.1 | 3.98 | 39.3 | 2.98 | 59.0 | 12.54 | 33.7 | 4.58 | 61.7 | 16.52 | 35.1 | 7.56 |
| Female | 74.5 | 5.27 | 77.7 | 2.86 | 63.2 | 10.58 | 48.2 | 2.04 | 67.3 | 15.85 | 65.5 | 4.90 |
| Combined | 71.8 | 9.25 | 58.5 | 5.84 | 61.1 | 23.12 | 41.0 | 6.62 | 64.5 | 32.37 | 50.3 | 12.46 |

## T A B L E 16

Risk to Infants based on National Accident Statistics.

| | 3.30 | | 4.00 | |
|---|---|---|---|---|
| | $p_{a/r}$ | $p_{a/c}$ | $p_{a/r}$ | $p_{a/c}$ |
| Male | 1.08 | 27.07 | 1.43 | 25.57 |
| Female | 0.83 | 17.36 | 1.56 | 42.08 |

## T A B L E 17

Probability of running, inadequate lookings and heedlessness.

| | 3.30 | | | 4.00 | | |
|---|---|---|---|---|---|---|
| | $p_{rp}$ | $p_{ip}$ | $p_{hp}$ | $p_{rp}$ | $p_{ip}$ | $p_{hp}$ |
| Male | 0.42 | 0.43 | 0.15 | 0.47 | 0.36 | 0.15 |
| Female | 0.35 | 0.25 | 0.05 | 0.30 | 0.30 | 0.08 |

SITE........................ NAME..................................

AT JUNCTION DATE..................................

NOT AT JUNCTION TIME..................................

WEATHER..............................

| | P | G | AGE | | | | | | NOTES |
|---|---|---|---|---|---|---|---|---|---|
| | | M F | | R W | L N | S ? H | ↑ ↓ | P O | |
| | | M F | | R W | L N | S ? H | ↑ ↓ | P O | |
| | | M F | | R W | L N | S ? H | ↑ ↓ | P O | |
| | | M F | | R W | L N | S ? H | ↑ ↓ | P O | |
| | | M F | | R W | L N | S ? H | ↑ ↓ | P O | |
| | | M F | | R W | L N | S ? H | ↑ ↓ | P O | |
| | | M F | | R W | L N | S ? H | ↑ ↓ | P O | |
| | | M F | | R W | L N | S ? H | ↑ ↓ | P O | |
| | | M F | | R W | L N | S ? H | ↑ ↓ | P O | |
| | | M F | | R W | L N | S ? H | ↑ ↓ | P O | |
| | | M F | | R W | L N | S ? H | ↑ ↓ | P O | |
| | | M F | | R W | L N | S ? H | ↑ ↓ | P O | |
| | | M F | | R W | L N | S ? H | ↑ ↓ | P O | |
| | | M F | | R W | L N | S ? H | ↑ ↓ | P O | |
| | | M F | | R W | L N | S ? H | ↑ ↓ | P O | |
| | | M F | | R W | L N | S ? H | ↑ ↓ | P O | |
| | | M F | | R W | L N | S ? H | ↑ ↓ | P O | |
| | | M F | | R W | L N | S ? H | ↑ ↓ | P O | |
| | | M F | | R W | L N | S ? H | ↑ ↓ | P O | |
| | | M F | | R W | L N | S ? H | ↑ ↓ | P O | |
| | | M F | | R W | L N | S ? H | ↑ ↓ | P O | |
| | | M F | | R W | L N | S ? H | ↑ ↓ | P O | |
| | | M F | | R W | L N | S ? H | ↑ ↓ | P O | |
| | | M F | | R W | L N | S ? H | ↑ ↓ | P O | |
| | | M F | | R W | L N | S ? H | ↑ ↓ | P O | |
| | | M F | | R W | L N | S ? H | ↑ ↓ | P O | |
| | | M F | | R W | L N | S ? H | ↑ ↓ | P O | |
| | | M F | | R W | L N | S ? H | ↑ ↓ | P O | |
| | | M F | | R W | L N | S ? H | ↑ ↓ | P O | |
| | | M F | | R W | L N | S ? H | ↑ ↓ | P O | |
| | | M F | | R W | L N | S ? H | ↑ ↓ | P O | |
| | | M F | | R W | L N | S ? H | ↑ ↓ | P O | |
| | | M F | | R W | L N | S ? H | ↑ ↓ | P O | |
| | | M F | | R W | L N | S ? H | ↑ ↓ | P O | |
| | | M F | | R W | L N | S ? H | ↑ ↓ | P O | |
| | | M F | | R W | L N | S ? H | ↑ ↓ | P O | |

## NOTES FOR OBSERVERS.

Name......................

No. of steps you take in 10 yds. = ...................

1. Check List.

Stop-watch

Recording Sheets

Pen

Map

Clipboard

2. Time Scale.

| | |
|---|---|
| 3.30 - 3.50 | observation of pedestrians |
| 3.50 - 4.00 | traffic count |
| 4.00 - 4.20 | observation of pedestrians (new sheet) |
| 4.20 - 4.30 | traffic count |

3. Coding.

Priorities

1) Age/Sex and grouping
2) Direction/parked car.
3) Responsibility.
4) Heedlessness.
5) Run/walk - Look/not look.

Age - children before 4.00 probably infants i.e. 5 - 7

Indicate groups by brackets.

Code pedestrians as groups if they are walking together or talking to each other e.g. families, friends. Do not count groups who form at the kerb because they happen to have arrived at the same time and are waiting for vehicles to pass.

Direction

↑ - crossing away from you, mark where you are standing on the map.

↓ - crossing towards you.

Parked car

Only code for a parked car if there is a parked car within 20 yds. of the pedestrian on their right hand side, on the side of the road from which they are crossing (on their nearside right) i.e. they would possibly be masked by the parked car. In narrow streets pedestrians may be masked by a parked car on their nearside left.

Code - 0 if no parked car within 20 yds.

Responsibility.

Only code groups for responsibility, not pedestrians alone. Place a tick outside bracket against pedestrians who are responsible for getting themselves across the road.

Run/Walk.

Refers to mode of crossing road, include skip, etc. with run. Code run if the pedestrian runs during any part of the crossing.

Look/Not look.

Code: look - if pedestrian looks adequately in the circumstances.

not look - Does not look at all. Pays no attention to the traffic (if there is any)

? - Not sure.

Leave blank if missed.

Heedlessness

Code: H - if pedestrian would probably have been hit by a car had one been passing at the time.

S - if pedestrian took adequate precautions to cross the road safely.

? - if pedestrian took some precautions.

Leave blank if missed.

Traffic Count

Count the number of vehicles passing through the area marked on your map on each side of the road during the two 10 min. periods (mark times on each map). Include all powered vehicles i.e. no cycles.

# APPENDIX 4

Description of Portable Event Recorder (PER)

Essentially the device consists of two system components:

(i) A small portable unit consisting of an array of switches; 6 oscillators with frequencies of approximately 1,2,3,4, 5 and 6 kc; batteries and voltage regulator and a small inexpensive portable tape recorder.

(ii) A static unit consisting of 6 filters; 6 detectors; 6 driver 6 relays; 6 pulse formers; a regulated power supply; and an automatic gain-controlled amplifier.

Events can be recorded in the field with the portable unit, by a single observer. When the buttons are pressed tones from the oscillators are recorded on magnetic tape. There are six different tones, therefore six channels. When the tapes are replayed into the static laboratory unit, the filters route the tone to the correct detector, driver and relay. The output from the relays, which can be fed into the computer, are a reproduction of the button-pressing in the field. The computer measures the time intervals between combinations of the following events:

the arrival of the pedestrian at the kerb;
stepping off the kerb;
crossing the path of cars on the nearside and offside of the road;
arrival of successive vehicles at the pedestrian's path in the near and offside lanes of the road.

# TABLE 1

## Number of Unaccompanied Pedestrians Crossing in the First Traffic Gap

| gap size (secs) | 0 - 7 | | | | | | 8 - 10 | | | | | | 11 - 14 | | | | | | 15 - 59 | | | | | | 60+ | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | | F | | All | | M | | F | | All | | M | | F | | All | | M | | F | | All | | M | | F | | All | |
| | C | T | C | T | C | T | C | T | C | T | C | T | C | T | C | T | C | T | C | T | C | T | C | T | C | T | C | T | C | T |
| 0 | - | 2 | - | 8 | - | 10 | - | 11 | - | 8 | - | 19 | - | 13 | - | 7 | - | 20 | - | 9 | - | 13 | - | 22 | - | 2 | - | 2 | - | 4 |
| 1 | - | 4 | - | 5 | - | 9 | - | 5 | - | 6 | - | 11 | - | 9 | - | 3 | - | 12 | - | 13 | - | 23 | - | 36 | - | - | - | 3 | - | 3 |
| 2 | 1 | 3 | - | 2 | 1 | 5 | 1 | 6 | - | 7 | 1 | 13 | - | 8 | - | 3 | - | 11 | - | 9 | - | 23 | - | 32 | - | - | - | 1 | - | 1 |
| 3 | - | 2 | - | 3 | - | 5 | 1 | 2 | 4 | 11 | 5 | 13 | 3 | 5 | - | 1 | 3 | 6 | 3 | 10 | - | 14 | 3 | 24 | - | 2 | - | - | - | 2 |
| 4 | - | 1 | 2 | 6 | 2 | 7 | 1 | 4 | - | 4 | 1 | 8 | 2 | 4 | - | - | 2 | 4 | 2 | 8 | 2 | 12 | 4 | 20 | 1 | 1 | - | 1 | 1 | 2 |
| 5 | 1 | 4 | - | - | 1 | 4 | - | - | 3 | 4 | 3 | 4 | 6 | 7 | 1 | 2 | 7 | 9 | 4 | 5 | 5 | 11 | 9 | 16 | 1 | 3 | - | 1 | 1 | 4 |
| 6 | 1 | 3 | - | - | 1 | 3 | 1 | 5 | 4 | 7 | 5 | 12 | 4 | 5 | 2 | 2 | 6 | 7 | 7 | 7 | 5 | 7 | 12 | 14 | - | - | - | 1 | - | 1 |
| 7 | 3 | 4 | 1 | 1 | 4 | 5 | 4 | 6 | 3 | 3 | 7 | 9 | 5 | 5 | 3 | 6 | 8 | 11 | 1 | 1 | 4 | 6 | 5 | 7 | 1 | 2 | - | - | 1 | 2 |
| 8 | 2 | 2 | - | - | 2 | 2 | 3 | 4 | 2 | 4 | 5 | 8 | 4 | 4 | 3 | 4 | 7 | 8 | 2 | 2 | 5 | 8 | 7 | 10 | 1 | 1 | 1 | 1 | 2 | 2 |
| 9 | - | 1 | - | - | - | 1 | 2 | 3 | 2 | 2 | 4 | 5 | 7 | 7 | 4 | 5 | 11 | 12 | 2 | 2 | 5 | 5 | 7 | 7 | 1 | 1 | 1 | 1 | 2 | 2 |
| 10 | 2 | 2 | - | - | 2 | 2 | 1 | 1 | 3 | 4 | 4 | 5 | 2 | 2 | - | - | 2 | 2 | 4 | 4 | 4 | 4 | 8 | 8 | 1 | 1 | - | - | 1 | 1 |
| 11 | - | - | - | - | - | - | - | - | 3 | 3 | 3 | 3 | - | - | - | - | - | - | 2 | 2 | 3 | 3 | 5 | 5 | - | - | 2 | 2 | 2 | 2 |
| 12+ | 8 | 8 | 10 | 10 | 18 | 18 | 20 | 20 | 21 | 23 | 41 | 43 | 37 | 37 | 9 | 9 | 48 | 48 | 42 | 42 | 48 | 48 | 90 | 90 | 1 | 1 | 3 | 3 | 4 | 4 |
| Total | 18 | 36 | 13 | 35 | 31 | 71 | 34 | 67 | 45 | 86 | 79 | 153 | 70 | 106 | 22 | 42 | 92 | 148 | 69 | 120 | 79 | 177 | 148 | 297 | 7 | 14 | 7 | 16 | 14 | 30 |

T - Total number of first gaps of a particular size occurring.

C - Number of pedestrians crossing in a particular size of first gap.

# TABLE 2

50% Quantiles and Upper and Lower Confidence Limits for the Fitted Normal Integrals of the Probability of Crossing in First Gaps, for Different Age and Sex Groups.

## Unaccompanied Pedestrians, Sex Combined.

| Age | n | 50% Quantile | Lower 95% Confidence Limit | Upper 95% Confidence Limit |
|---|---|---|---|---|
| 0-7 | 71 | 5.869 | 4.729 | 7.137 |
| 8-10 | 153 | 5.821 | 4.871 | 6.695 |
| 0-10 | 224 | 5.884 | 5.169 | 6.576 |
| 11-14 | 148 | 4.652 | 3.758 | 5.452 |
| 15-59 | 297 | 5.331 | 4.483 | 5.898 |
| 60+ | 30 | 5.971 | 4.199 | 7.916 |

## Unaccompanied Pedestrians.

| Age/Sex | n | 50% Quantile | Lower 95% Confidence Limit | Upper 95% Confidence Limit |
|---|---|---|---|---|
| MALE | | | | |
| 0-14 | 209 | 5.035 | 4.308 | 5.711 |
| 15+ | 163 | 4.481 | 3.852 | 5.280 |
| FEMALE | | | | |
| 0-14 | 134 | 5.862 | 5.065 | 6.684 |
| 15+ | 193 | 6.011 | 5.402 | 6.696 |

## Pedestrians in Groups, Sex Combined.

| Group | n | 50% Quantile | Lower 95% Confidence Limit | Upper 95% Confidence Limit |
|---|---|---|---|---|
| 0-10 in Peer group | 106 | 6.726 | 5.888 | 7.750 |
| 0-10 with adults | 98 | 7.792 | 6.803 | 8.620 |

## T A B L E 3

**Number of Unaccompanied Pedestrians Crossing in the First Traffic Gap**

| gap size (secs) | Under 15 | | | | Over 15 | | | | All Ages | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | | F | | M | | F | | M | | F | |
| | C | T | C | T | C | T | C | T | C | T | C | T |
| 0 | - | 26 | - | 23 | - | 17 | - | 15 | - | 43 | - | 38 |
| 1 | - | 18 | - | 14 | - | 13 | - | 26 | - | 31 | - | 40 |
| 2 | 2 | 17 | - | 12 | - | 9 | - | 24 | 2 | 26 | - | 36 |
| 3 | 4 | 9 | 4 | 15 | 3 | 12 | - | 14 | 7 | 21 | 4 | 29 |
| 4 | 3 | 9 | 2 | 10 | 3 | 9 | 2 | 13 | 6 | 18 | 4 | 23 |
| 5 | 7 | 11 | 4 | 6 | 5 | 8 | 5 | 12 | 12 | 19 | 9 | 18 |
| 6 | 6 | 13 | 6 | 9 | 7 | 7 | 5 | 8 | 13 | 20 | 11 | 17 |
| 7 | 12 | 15 | 7 | 10 | 2 | 3 | 4 | 6 | 14 | 18 | 11 | 16 |
| 8 | 9 | 10 | 5 | 8 | 3 | 3 | 6 | 9 | 12 | 13 | 11 | 17 |
| 9 | 9 | 11 | 6 | 7 | 3 | 3 | 6 | 6 | 12 | 14 | 12 | 13 |
| 10 | 5 | 5 | 3 | 4 | 5 | 5 | 4 | 4 | 10 | 10 | 7 | 8 |
| 11 | - | - | 3 | 3 | 2 | 2 | 5 | 5 | 2 | 2 | 8 | 8 |
| 12+ | 65 | 65 | 40 | 42 | 43 | 43 | 51 | 51 | 108 | 108 | 91 | 93 |
| Total | 122 | 209 | 80 | 163 | 76 | 134 | 86 | 193 | 198 | 343 | 166 | 356 |

T - Total number of first gaps of a particular size occurring.

C - Number of pedestrians crossing in a particular size of first gap.

## TABLE 4

**Number of Child Pedestrians Unaccompanied and in Groups, Crossing in the First Traffic Gap**

| gap size (secs) | 0-10 in Groups | | 0-10 unaccompanied | | 0-10 + Adults | |
|---|---|---|---|---|---|---|
| | C | T | C | T | C | T |
| 0 | 0 | 13 | 0 | 29 | 0 | 13 |
| 1 | 0 | 19 | 0 | 20 | 0 | 10 |
| 2 | 0 | 11 | 2 | 18 | 0 | 8 |
| 3 | 0 | 10 | 5 | 18 | 0 | 6 |
| 4 | 0 | 9 | 3 | 15 | 0 | 3 |
| 5 | 1 | 5 | 3 | 8 | 0 | 7 |
| 6 | 1 | 3 | 6 | 15 | 1 | 4 |
| 7 | 2 | 4 | 11 | 14 | 2 | 6 |
| 8 | 3 | 4 | 7 | 10 | 3 | 3 |
| 9 | 4 | 4 | 4 | 6 | 0 | 1 |
| 10 | 1 | 1 | 6 | 7 | 3 | 5 |
| 11 | 1 | 1 | 3 | 3 | 4 | 4 |
| 12+ | 20 | 20 | 59 | 61 | 28 | 28 |
| Total | 33 | 106 | 109 | 224 | 37 | 98 |

T - Total number of first gaps of a particular size occurring.

C - Number of pedestrians crossing in a particular size of first gap.

## TABLE 5

Means and S.D.'s of delay/anticipation for unaccompanied pedestrians crossing through gaps in traffic by age and sex group.

### MALE

| Age | No. Crossing | Mean | S.E. |
|---|---|---|---|
| 0-7 | 18 | +3.74 | 0.59 |
| 8-10 | 33 | +1.71 | 0.48 |
| 11-14 | 35 | +0.63 | 0.38 |
| 15-59 | 51 | +0.36 | 0.11 |
| 60+ | 6 | +1.10 | 1.61 |

### FEMALE

| | | | |
|---|---|---|---|
| 0-7 | 21 | +3.70 | 0.61 |
| 8-10 | 41 | +2.66 | 0.39 |
| 11-14 | 19 | +1.75 | 0.44 |
| 15-59 | 93 | +0.89 | 0.22 |
| 60+ | 9 | +2.22 | 0.96 |

## TABLE 6

Means and S.D.'s of delay/anticipation for children in peer groups and with adults crossing through gaps in traffic.

| | No. crossing | Mean | S.E. |
|---|---|---|---|
| 0-10 unaccompanied | 113 | 2.75 | 0.26 |
| 0-10 in groups | 73 | 1.48 | 0.36 |
| 0-10 with adults | 57 | 1.28 | 0.38 |

TABLE 7

Unaccompanied Pedestrians Only
Mean time spent on kerb.

| Age | M | F | T |
|---|---|---|---|
| 0 - 7 | 17.7 | 17.3 | 17.5 |
| 8 - 10 | 8.7 | 11.0 | 10.0 |
| 11 - 14 | 6.7 | 8.7 | 7.4 |
| 15 - 19 | 5.2 | 7.0 | 6.1 |
| 20 - 59 | 4.3 | 8.7 | 6.5 |
| 60+ | 8.9 | 8.7 | 8.8 |

TABLE 8

Unaccompanied Pedestrians Only
Mean time spent in the road

| Age | M | F | T |
|---|---|---|---|
| 0 - 7 | 3.2 | 2.9 | 3.0 |
| 8 - 10 | 3.3 | 3.0 | 3.1 |
| 11 - 14 | 3.7 | 3.3 | 3.6 |
| 15 - 59 | 3.9 | 4.1 | 4.0 |
| 60+ | 4.6 | 5.8 | 5.3 |

# TABLE 9

## Behaviour during the approach to the kerb
## Unaccompanied Pedestrians

| | 0 - 7 | | | | | | 8 - 10 | | | | | | 11 - 14 | | | | | | 15 - 59 | | | | | | 60+ | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | | F | | All | | M | | F | | All | | M | | F | | All | | M | | F | | All | | M | | F | | All | |
| Movement | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| Run | 9 | 25 | 3 | 9 | 12 | 17 | 10 | 14 | 8 | 9 | 18 | 12 | 10 | 9 | 5 | 12 | 15 | 10 | 6 | 5 | 1 | 1 | 7 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| Walk | 17 | 47 | 27 | 77 | 44 | 62 | 57 | 80 | 73 | 84 | 130 | 83 | 92 | 86 | 36 | 86 | 128 | 86 | 115 | 95 | 180 | 99 | 295 | 98 | 14 | 100 | 17 | 100 | 31 | 100 |
| Dawdle | 10 | 28 | 5 | 14 | 15 | 21 | 4 | 6 | 6 | 7 | 10 | 6 | 5 | 5 | 1 | 2 | 6 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 36 | 100 | 35 | 100 | 71 | 100 | 71 | 100 | 87 | 100 | 158 | 101 | 107 | 100 | 42 | 100 | 149 | 100 | 121 | 100 | 181 | 100 | 302 | 100 | 14 | 100 | 17 | 100 | 31 | 100 |
| Looking | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Not look | 15 | 42 | 17 | 49 | 32 | 45 | 9 | 13 | 12 | 14 | 21 | 13 | 7 | 7 | 4 | 10 | 11 | 7 | 4 | 3 | 6 | 3 | 10 | 3 | 0 | 0 | 1 | 6 | 1 | 3 |
| Look | 21 | 58 | 18 | 51 | 39 | 55 | 62 | 87 | 75 | 86 | 137 | 87 | 100 | 93 | 38 | 90 | 138 | 93 | 117 | 97 | 175 | 97 | 292 | 97 | 14 | 100 | 16 | 94 | 30 | 97 |
| Total | 36 | 100 | 35 | 100 | 71 | 100 | 71 | 100 | 87 | 100 | 158 | 100 | 107 | 100 | 42 | 100 | 149 | 100 | 121 | 100 | 181 | 100 | 302 | 100 | 14 | 100 | 17 | 100 | 31 | 100 |

## Mean number of Head movements

| M | F | All | M | F | All | M | F | All | M | F | All | M | F | All |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.86 | 0.74 | 0.80 | 1.30 | 1.33 | 1.32 | 1.41 | 1.40 | 1.41 | 1.41 | 1.52 | 1.48 | 1.71 | 1.59 | 1.65 |

# TABLE 10

## Behaviour at the Kerb
## Unaccompanied Pedestrians

| | 0 - 7 | | | | | | 8 - 10 | | | | | | 11 - 14 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | | F | | All | | M | | F | | All | | M | | F | | All | |
| Stopping | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| Halt | 22 | 61 | 25 | 71 | 47 | 66 | 32 | 45 | 48 | 55 | 80 | 51 | 24 | 22 | 17 | 40 | 41 | 28 |
| Slowdown | 5 | 14 | 5 | 14 | 10 | 14 | 10 | 14 | 15 | 17 | 25 | 16 | 20 | 19 | 14 | 33 | 34 | 23 |
| Continue | 9 | 25 | 5 | 14 | 14 | 20 | 29 | 41 | 24 | 28 | 53 | 34 | 63 | 59 | 11 | 26 | 74 | 50 |
| Total | 36 | 100 | 35 | 99 | 71 | 100 | 71 | 100 | 87 | 100 | 158 | 101 | 107 | 100 | 42 | 99 | 149 | 101 |
| Looking | | | | | | | | | | | | | | | | | | |
| Not look | 5 | 23 | 3 | 12 | 8 | 17 | 7 | 22 | 6 | 13 | 13 | 16 | 16 | 67 | 1 | 6 | 17 | 41 |
| Look | 17 | 77 | 22 | 88 | 39 | 83 | 25 | 78 | 42 | 88 | 67 | 84 | 8 | 33 | 16 | 94 | 24 | 59 |
| Total | 22 | 100 | 25 | 100 | 47 | 100 | 32 | 100 | 48 | 101 | 80 | 100 | 24 | 100 | 17 | 100 | 41 | 100 |

| | 15 - 59 | | | | | | 60+ | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | | F | | All | | M | | F | | All | |
| Stopping | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| Halt | 37 | 31 | 69 | 38 | 106 | 35 | 6 | 43 | 8 | 47 | 14 | 45 |
| Slowdown | 26 | 21 | 50 | 28 | 76 | 25 | 4 | 29 | 8 | 47 | 12 | 39 |
| Continue | 58 | 48 | 62 | 34 | 120 | 40 | 4 | 29 | 1 | 6 | 5 | 16 |
| Total | 121 | 100 | 181 | 101 | 302 | 100 | 14 | 101 | 17 | 100 | 31 | 100 |
| Looking | | | | | | | | | | | | |
| Not look | 9 | 24 | 11 | 16 | 20 | 16 | 0 | 0 | 0 | 0 | 0 | 0 |
| Look | 28 | 76 | 58 | 84 | 86 | 84 | 6 | 100 | 8 | 100 | 14 | 100 |
| Total | 37 | 100 | 69 | 100 | 106 | 100 | 6 | 100 | 8 | 100 | 14 | 100 |

## Mean number of Head Movements.

| 0 - 7 M | 0 - 7 F | 0 - 7 All | 8 - 10 M | 8 - 10 F | 8 - 10 All | 11 - 14 M | 11 - 14 F | 11 - 14 All | 15 - 59 M | 15 - 59 F | 15 - 59 All | 60+ M | 60+ F | 60+ All |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.39 | 3.97 | 3.68 | 2.87 | 2.94 | 2.91 | 2.19 | 3.00 | 2.42 | 2.05 | 3.00 | 2.62 | 3.36 | 3.29 | 3.32 |

# TABLE 11

Behaviour while crossing
Unaccompanied Pedestrians.

| | 0 - 7 | | | | | | 8 - 10 | | | | | | 11 - 14 | | | | | | 15 - 59 | | | | | | 60 + | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | | F | | All | | M | | F | | All | | M | | F | | All | | M | | F | | All | | M | | F | | All | |
| Movement | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| Run | 22 | 61 | 18 | 51 | 40 | 56 | 31 | 44 | 40 | 46 | 71 | 45 | 26 | 24 | 8 | 19 | 34 | 23 | 15 | 12 | 9 | 5 | 24 | 8 | 0 | 0 | 0 | 0 | 0 | 0 |
| Walk | 14 | 39 | 17 | 49 | 31 | 44 | 40 | 56 | 47 | 54 | 87 | 55 | 81 | 76 | 34 | 81 | 115 | 77 | 106 | 88 | 172 | 95 | 278 | 92 | 14 | 100 | 17 | 100 | 31 | 100 |
| Total | 36 | 100 | 35 | 100 | 71 | 100 | 71 | 100 | 87 | 100 | 158 | 100 | 107 | 100 | 42 | 100 | 149 | 100 | 121 | 100 | 181 | 100 | 302 | 100 | 14 | 100 | 17 | 100 | 31 | 100 |
| Direction | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Straight | 29 | 81 | 26 | 74 | 55 | 76 | 53 | 75 | 71 | 82 | 124 | 79 | 77 | 72 | 32 | 76 | 109 | 73 | 112 | 93 | 167 | 92 | 279 | 92 | 12 | 86 | 14 | 82 | 26 | 84 |
| Diagonal | 7 | 19 | 9 | 26 | 16 | 25 | 18 | 25 | 16 | 18 | 34 | 22 | 30 | 28 | 10 | 24 | 40 | 27 | 9 | 7 | 14 | 8 | 23 | 8 | 2 | 14 | 3 | 18 | 5 | 16 |
| Total | 36 | 100 | 35 | 100 | 71 | 99 | 71 | 100 | 87 | 100 | 158 | 101 | 107 | 100 | 42 | 100 | 149 | 100 | 121 | 100 | 181 | 100 | 302 | 100 | 14 | 100 | 17 | 100 | 31 | 100 |
| Looking | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Not look | 10 | 28 | 13 | 37 | 23 | 32 | 37 | 52 | 49 | 56 | 86 | 54 | 47 | 44 | 22 | 52 | 69 | 46 | 54 | 45 | 83 | 46 | 137 | 45 | 6 | 43 | 9 | 53 | 15 | 48 |
| Look | 26 | 72 | 22 | 63 | 48 | 68 | 34 | 48 | 38 | 44 | 72 | 46 | 60 | 56 | 20 | 48 | 80 | 54 | 67 | 55 | 98 | 54 | 165 | 55 | 8 | 57 | 8 | 47 | 16 | 52 |
| Total | 36 | 100 | 35 | 100 | 71 | 100 | 71 | 100 | 87 | 100 | 158 | 100 | 107 | 100 | 42 | 100 | 149 | 100 | 121 | 100 | 181 | 100 | 302 | 100 | 14 | 100 | 17 | 100 | 31 | 100 |

Mean number of Head Movements

| | 0 - 7 | | | 8 - 10 | | | 11 - 14 | | | 15 - 59 | | | 60 + | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | F | All | M | F | All | M | F | All | M | F | All | M | F | All |
| | 0.83 | 0.74 | 0.79 | 0.65 | 0.53 | 0.58 | 0.63 | 0.60 | 0.62 | 0.64 | 0.67 | 0.66 | 1.07 | 0.65 | 0.84 |

TABLE 12

Derived Behavioural Measures for Unaccompanied Pedestrians By Age And Sex Groups.

MALE

| | | Safe/ Unsafe | | Expeditious/ Inexpeditious | |
|---|---|---|---|---|---|
| Age | No. Crossings | Mean | S.D. | Mean | S.D. |
| 0-7 | 36 | 1.44 | 1.64 | -0.11 | 0.87 |
| 8-10 | 33 | 1.45 | 1.50 | 0.52 | 0.78 |
| 11-14 | 107 | 1.40 | 1.27 | 0.82 | 0.93 |
| 15-19 | 76 | 1.37 | 1.06 | 0.95 | 0.90 |
| 20-59 | 45 | 1.93 | 1.02 | 0.22 | 0.94 |
| 60+ | 14 | 2.57 | 0.98 | 0.79 | 0.94 |

FEMALE

| | | Safe/ Unsafe | | Expeditious/ Inexpeditious | |
|---|---|---|---|---|---|
| Age | No. Crossings | Mean | S.D. | Mean | S.D. |
| 0-7 | 35 | 1.86 | 1.15 | -0.34 | 0.89 |
| 8-10 | 87 | 1.83 | 1.21 | 0.34 | 0.94 |
| 11.14 | 42 | 2.07 | 1.16 | 0.45 | 1.03 |
| 15-19 | 65 | 1.85 | 1.10 | 0.68 | 0.91 |
| 20-59 | 116 | 2.11 | 0.93 | 0.71 | 0.84 |
| 60+ | 17 | 2.65 | 0.68 | 0.24 | 0.73 |

TABLE 13

Derived Behavioural Measures for

Pedestrians Crossing in Groups, Unprotected.

| | | Safe/ Unsafe | | Expeditious/ Inexpeditious | |
|---|---|---|---|---|---|
| Age Groups | No. Crossings | Mean | S.D. | Mean | S.D. |
| 0-7 | 59 | 1.93 | 1.01 | -0.39 | 0.74 |
| 0-7 and 8-10 | 34 | 1.15 | .94 | -0.24 | 0.55 |
| 8-10 | 133 | 1.50 | 1.07 | 0.19 | 0.88 |
| 0-7 with adult | 226 | 1.56 | 1.06 | 0.03 | 0.84 |
| 8-10 with adult | 96 | 2.10 | 1.08 | 0.24 | 1.00 |
| 0-10 unaccompanied | 199 | 1.63 | 1.04 | 0.16 | 0.76 |

# APPENDIX 5

# TABLE 1

Potential exposure and risk by age, sex and road type.

| Age | n | $\bar{r}$ | $\bar{n}_c$ | n | $\bar{r}$ | $\bar{n}_c$ | n | $\bar{r}$ | $\bar{n}_c$ |
|---|---|---|---|---|---|---|---|---|---|
| | Major | | | Minor | | | All roads | | |
| Male | | | | | | | | | |
| 5 | 11 | .305 | .072 | 90 | 2.50 | .080 | 101 | 2.81 | .149 |
| 6 | 12 | .333 | .066 | 120 | 3.33 | .080 | 132 | 3.67 | .139 |
| 8 | 5 | .139 | .033 | 162 | 4.50 | .113 | 167 | 4.64 | .144 |
| 9 | 12 | .333 | .079 | 131 | 3.64 | .098 | 143 | 3.97 | .175 |
| 10 | 15 | .417 | .095 | 128 | 3.56 | .096 | 143 | 3.97 | .183 |
| Tot | 55 | .306 | .069 | 633 | 3.52 | .095 | 686 | 3.81 | .160 |
| Female | | | | | | | | | |
| 5 | 10 | .278 | .066 | 103 | 2.86 | .069 | 113 | 3.14 | .132 |
| 6 | 13 | .361 | .070 | 117 | 3.25 | .075 | 130 | 3.61 | .137 |
| 8 | 13 | .361 | .082 | 136 | 3.78 | .091 | 149 | 4.14 | .170 |
| 9 | 13 | .361 | .086 | 119 | 3.31 | .096 | 132 | 3.67 | .176 |
| 10 | 9 | .250 | .059 | 100 | 2.78 | .106 | 109 | 3.03 | .160 |
| Tot | 58 | .322 | .073 | 575 | 3.19 | .086 | 633 | 3.52 | .155 |

# TABLE 2

Real exposure and risk by age, sex and road type.

| Age | n | $\bar{r}$ | $\bar{n}_c$ | n | $\bar{r}$ | $\bar{n}_c$ | n | $\bar{r}$ | $\bar{n}_c$ |
|---|---|---|---|---|---|---|---|---|---|
| Male | | Major | | | Minor | | | All roads | |
| 5 | 2 | .056 | .013 | 51 | 1.42 | .030 | 53 | 1.47 | .043 |
| 6 | 8 | .222 | .040 | 103 | 2.86 | .049 | 111 | 3.08 | .089 |
| 8 | 2 | .056 | .013 | 153 | 4.25 | .085 | 155 | 4.31 | .099 |
| 9 | 7 | .194 | .046 | 125 | 3.47 | .083 | 132 | 3.67 | .128 |
| 10 | 13 | .361 | .082 | 124 | 3.44 | .086 | 137 | 3.81 | .167 |
| Tot | 32 | .178 | .039 | 556 | 3.09 | .068 | 588 | 3.27 | .105 |
| Female | | | | | | | | | |
| 5 | 1 | .028 | .007 | 66 | 1.83 | .035 | 67 | 1.86 | .041 |
| 6 | 7 | .194 | .031 | 91 | 2.53 | .040 | 98 | 2.72 | .071 |
| 8 | 8 | .222 | .049 | 124 | 3.44 | .072 | 132 | 3.67 | .121 |
| 9 | 5 | .139 | .033 | 96 | 2.67 | .056 | 101 | 2.81 | .087 |
| 10 | 8 | .222 | .053 | 92 | 2.56 | .087 | 100 | 2.78 | .139 |
| Tot | 29 | .161 | .034 | 469 | 2.61 | .057 | 498 | 2.77 | .091 |

TABLE 3

Real exposure and risk by age, sex and area for major and minor roads combined.

| | n | $\bar{r}$ | $\bar{n}_c$ | $p_{a/c}$ x$10^6$ | $p_{a/r}$ x$10^6$ | n | $\bar{r}$ | $\bar{n}_c$ | $p_{a/c}$ x$10^6$ | $p_{a/r}$ x$10^6$ | n | $\bar{r}$ | $\bar{n}_c$ | $p_{a/c}$ x$10^6$ | $p_{a/r}$ x$10^6$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALL ROADS | | | | | | | | | | | | | | | |
| Male | Central | | | | | Estate | | | | | Suburban | | | | |
| 5,6 | 60 | 2.50 | .060 | 161.13 | 3.88 | 46 | 1.92 | .063 | 57.63 | 1.89 | 58 | 2.42 | .073 | 18.90 | 0.99 |
| 8,9,10 | 114 | 3.17 | .114 | 43.86 | 1.59 | 159 | 4.42 | .168 | 11.19 | 0.42 | 153 | 4.25 | .128 | 9.78 | 0.30 |
| Tot. | 174 | 2.90 | .093 | 74.40 | 2.40 | 205 | 3.42 | .126 | 20.64 | 0.75 | 211 | 3.52 | .106 | 16.35 | 0.48 |
| Female | | | | | | | | | | | | | | | |
| 5,6 | 58 | 2.42 | .073 | 68.49 | 2.07 | 62 | 2.58 | .067 | 28.02 | 0.72 | 45 | 1.88 | .068 | 18.42 | 0.66 |
| 8,9,10 | 98 | 2.72 | .112 | 27.36 | 1.14 | 116 | 3.22 | .116 | 9.93 | 0.36 | 117 | 3.25 | .111 | 6.90 | 0.24 |
| Tot. | 156 | 2.60 | .096 | 40.17 | 1.47 | 178 | 2.97 | .098 | 14.79 | 0.48 | 162 | 2.70 | .078 | 12.39 | 0.36 |

# TABLE 4

## BEHAVIOUR ON APPROACH TO KERB

### WALKING BEHAVIOUR

| | MALE | | | FEMALE | | |
|---|---|---|---|---|---|---|
| Age | % Walking | % Running | N | % Walking | % Running | N |
| 5 | 71 | 29 | 52 | 82 | 18 | 67 |
| 6 | 76 | 24 | 108 | 80 | 20 | 97 |
| 8 | 62 | 38 | 154 | 73 | 27 | 129 |
| 9 | 86 | 15 | 131 | 87 | 13 | 97 |
| 10 | 72 | 28 | 133 | 77 | 23 | 88 |
| Tot. | 73 | 27 | 578 | 79 | 21 | 478 |

### LOOKING BEHAVIOUR

| | MALE | | | FEMALE | | |
|---|---|---|---|---|---|---|
| Age | % Looking | % Not Looking | N | % Looking | % Not Looking | N |
| 5 | 6 | 94 | 52 | 8 | 92 | 64 |
| 6 | 5 | 95 | 108 | 7 | 93 | 98 |
| 8 | 7 | 93 | 148 | 7 | 93 | 119 |
| 9 | 14 | 86 | 127 | 11 | 89 | 90 |
| 10 | 9 | 91 | 130 | 8 | 92 | 85 |
| Tot. | 8 | 92 | 565 | 8 | 92 | 456 |

# TABLE 5

## BEHAVIOUR AT THE KERB

### ACTION AT KERB

| | MALE | | | | FEMALE | | | |
|---|---|---|---|---|---|---|---|---|
| Age | % Stopping | % Slowing down | % Continuing | N | % Stopping | % Slowing down | % Continuing | N |
| 5 | 14 | 14 | 73 | 52 | 33 | 5 | 63 | 67 |
| 6 | 15 | 5 | 81 | 109 | 17 | 10 | 72 | 98 |
| 8 | 7 | 9 | 84 | 152 | 23 | 7 | 70 | 128 |
| 9 | 12 | 10 | 78 | 131 | 20 | 9 | 71 | 97 |
| 10 | 10 | 8 | 82 | 133 | 22 | 9 | 69 | 88 |
| Tot. | 11 | 9 | 80 | 577 | 22 | 8 | 70 | 478 |

### LOOKING BEHAVIOUR

| | MALE | | | FEMALE | | |
|---|---|---|---|---|---|---|
| Age | % Looking | % Not Looking | N | % Looking | % Not Looking | N |
| 5 | 34 | 66 | 53 | 35 | 65 | 65 |
| 6 | 15 | 85 | 105 | 28 | 72 | 88 |
| 8 | 15 | 85 | 151 | 39 | 61 | 122 |
| 9 | 36 | 64 | 124 | 32 | 68 | 90 |
| 10 | 23 | 77 | 132 | 37 | 63 | 86 |
| Tot. | 23 | 77 | 565 | 35 | 65 | 451 |

# TABLE 6

## BEHAVIOUR DURING CROSSING

### WALKING BEHAVIOUR

| | MALE | | | FEMALE | | |
|---|---|---|---|---|---|---|
| Age | % Walking | % Running | N | % Walking | % Running | N |
| 5 | 59 | 42 | 53 | 65 | 35 | 66 |
| 6 | 69 | 32 | 108 | 62 | 38 | 98 |
| 8 | 58 | 42 | 154 | 61 | 39 | 129 |
| 9 | 74 | 26 | 131 | 75 | 25 | 97 |
| 10 | 65 | 35 | 133 | 69 | 31 | 88 |
| Tot. | 65 | 35 | 579 | 66 | 34 | 478 |

### LOOKING BEHAVIOUR

| | MALE | | | FEMALE | | |
|---|---|---|---|---|---|---|
| Age | % Looking | % Not Looking | N | % Looking | % Not Looking | N |
| 5 | 17 | 83 | 53 | 15 | 85 | 65 |
| 6 | 20 | 80 | 100 | 13 | 87 | 86 |
| 8 | 15 | 86 | 152 | 20 | 80 | 119 |
| 9 | 25 | 75 | 121 | 21 | 79 | 90 |
| 10 | 15 | 85 | 130 | 23 | 77 | 87 |
| Tot. | 18 | 82 | 556 | 19 | 81 | 447 |

## TABLE 7

Behavioural Measures By Age and Sex Groups By Road Type.

| Age Group | | Male | | | | Female | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | S | | E | | S | | E | |
| | | Mean | S.E. | Mean | S.E. | Mean | S.E. | Mean | S.E. |
| 5-6 | Major | +0.700 | 0.40 | -0.800 | 0.25 | +0.750 | 0.53 | -0.625 | 0.46 |
| | Minor | -0.494 | 0.12 | -0.253 | .05 | -0.134 | 0.12 | -0.344 | 0.07 |
| | All Roads | -0.421 | 0.12 | -0.287 | 0.05 | -0.091 | 0.12 | -0.358 | 0.07 |
| 8-10 | Major | +1.708 | 0.38 | 0.000 | 0.17 | +2.105 | 0.29 | -0.316 | 0.24 |
| | Minor | -0.527 | 0.07 | -0.065 | .04 | -0.077 | 0.08 | -0.215 | 0.05 |
| | All Roads | -0.401 | 0.07 | -0.061 | 0.03 | +0.048 | 0.09 | -0.221 | 0.05 |

S = Safe/Unsafe

E = Expeditious/Inexpeditious

TABLE 8

Behavioural Measures By Age and Sex

For Different Locations on Minor Roads.

| Location | MALE | | | | FEMALE | | | |
|---|---|---|---|---|---|---|---|---|
| | S | | E | | S | | E | |
| | Mean | S.E. | Mean | S.E. | Mean | S.E. | Mean | S.E. |
| At junctions, masked | -0.345 | 0.09 | -0.138 | 0.06 | +0.375 | 0.14 | -0.313 | 0.09 |
| At junctions, unmasked | -0.348 | 0.08 | -0.182 | 0.06 | -0.061 | 0.11 | -0.274 | 0.07 |
| Not at junctions, masked | -0.718 | 0.17 | -0.138 | 0.06 | -0.158 | 0.10 | -0.193 | 0.07 |
| Not at junctions, unmasked | -1.041 | 0.10 | -0.061 | 0.05 | -0.253 | 0.08 | -0.267 | 0.04 |

S = Safe/Unsafe

E = Expeditious/Inexpeditious

TABLE 9

Behavioural Measures By Age and Sex Groups

For Different Areas of Nottingham. (All Roads).

| Age Group | | Male S Mean | Male S S.E. | Male E Mean | Male E S.E. | Female S Mean | Female S S.E. | Female E Mean | Female E S.E. |
|---|---|---|---|---|---|---|---|---|---|
| 5-6 | Central | -0.400 | 0.18 | -0.267 | 0.08 | -0.069 | 0.20 | -0.448 | 0.13 |
| | Estate | -0.783 | 0.22 | -0.196 | 0.08 | -0.468 | 0.17 | -0.161 | 0.11 |
| | Suburban | -0.155 | 0.21 | -0.379 | 0.11 | +0.400 | 0.23 | -0.511 | 0.13 |
| | Total | -0.421 | 0.12 | -0.287 | 0.05 | -0.091 | 0.12 | -0.358 | 0.07 |
| 8-10 | Central | -0.377 | 0.14 | -0.202 | 0.07 | -0.092 | 0.16 | -0.173 | 0.09 |
| | Estate | -0.415 | 0.12 | +0.044 | 0.05 | +0.129 | 0.14 | -0.198 | 0.09 |
| | Suburban | -0.405 | 0.13 | -0.065 | 0.06 | +0.085 | 0.14 | -0.282 | 0.07 |
| | Total | -0.401 | 0.07 | -0.061 | 0.03 | +0.048 | 0.09 | -0.221 | 0.05 |

S = Safe/Unsafe

E = Expeditious/Inexpeditious

SITE.

| | | |
|---|---|---|
| 1. | Name of road | .................................... |
| 2. | Crossing aids | none/ped. crossing/traffic lights/warden<br>pelican/ped. operated light. |
| 3. | Location | at/not junction/D.K. |
| 4. | Stationary vehicles | masked/not masked/D.K. |

CROSSING

| | | |
|---|---|---|
| 5. | Manoeuvre | crossing/carriageway |
| 6. | Alone<br>(If Yes, complete the following):- | Yes/No |
| | Accompaniment | Sex |
| | | Age |
| | | Protection |
| 7. | Traffic | traffic approaching/road clear |
| 8. | Gap (only if traffic) | cross in front of cars/behind cars/ between cars |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sex | | | | | | | | |
| Age | | | | | | | | Child |
| Protection | | | | | | | | |

BEHAVIOUR (only if alone or unprotected)

a) APPROACH

| | | |
|---|---|---|
| 9. | Movement | run/walk |
| 10. | Looking | look for traffic/not look/D.K. |

b) KERB

| | | |
|---|---|---|
| 11. | Action | stop/slow down/continue |
| 12. | Looking | look for traffic/not look/D.K. |
| 13. | False start(s) | No(s) ........................ |

c) ROAD

| | | |
|---|---|---|
| 14. | Movement | run/walk |
| 15. | Looking | look for traffic/not look/D.K. |

GENERAL

| | |
|---|---|
| 16. | Reason for crossing ........................................ |
| 17. | Comments. |

| | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | | | | | |

1. Observer ..........................
2. School ..........................
3. Time 3.30 - 4.00
4. Name of child ......................
5. Address ..................................................................

6. Age 5 6 7 8 9 10
7. Sex M F
8. Day M. Tu. Wed. Thur. Fri.
9. Date ..............................

10. Time child leaves school ..............................
11. Time child arrives home .............................. Not home
12. Journey time home, direct .............................. Not home
indirect .............................. Not home

(If Indirect)

13. Places visited ..............................

(If Child goes out after arriving home)

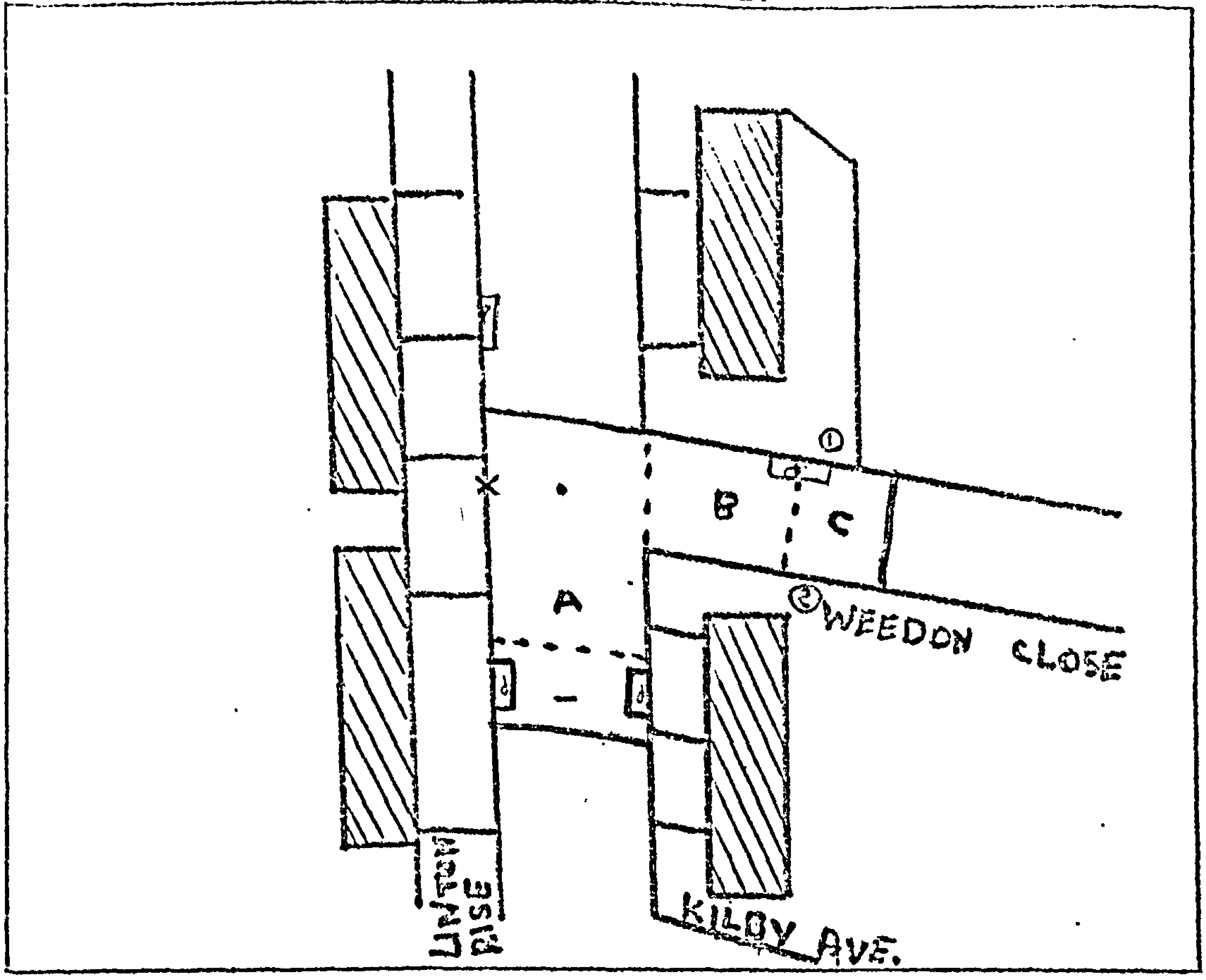
14. Places visited ..............................
15. Purpose of journey ..............................
16. Time Out ..............................

17. Comments ..............................................................

..........................................................................

..........................................................................

# A P P E N D I X 6




SITE NO. ----------------

OBSERVER ----------------

DATE ----------------

TIME ----------------

WEATHER ----------------

CITY ----------------

| CROSSING IDENTITY NUMBER | PEDESTRIAN | | | | CROSSING | | | TRAFFIC | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|
| | SEX | AGE | PROT | GR.P | SECTOR | DIRECT | MASK | | |
| | M F | | | | A B C – | ∧ V – | M O | Y N | |
| | M F | | | | A B C – | ∧ V – | M O | Y N | |
| | M F | | | | A B C – | ∧ V – | M O | Y N | |
| | M F | | | | A B C – | ∧ V – | M O | Y N | |
| | M F | | | | A B C – | ∧ V – | M O | Y N | |
| | M F | | | | A B C – | ∧ V – | M O | Y N | |
| | M F | | | | A B C – | ∧ V – | M O | Y N | |
| | M F | | | | A B C – | ∧ V – | M O | Y N | |
| | M F | | | | A B C – | ∧ V – | M O | Y N | |
| | M F | | | | A B C – | ∧ V – | M O | Y N | |
| | M F | | | | A B C – | ∧ V – | M O | Y N | |
| | M F | | | | A B C – | ∧ V – | M O | Y N | |
| | M F | | | | A B C – | ∧ V – | M O | Y N | |
| | M F | | | | A B C – | ∧ V – | M O | Y N | |
| | M F | | | | A B C – | ∧ V – | M O | Y N | |
| | M F | | | | A B C – | ∧ V – | M O | Y N | |
| | M F | | | | A B C – | ∧ V – | M O | Y N | |
| | M F | | | | A B C – | ∧ V – | M O | Y N | |
| | | | | | | | | | |

# Pedestrian Study Notes

THE UNIVERSITY OF NOTTINGHAM
DEPARTMENT OF PSYCHOLOGY
CHILD ACCIDENT RESEARCH UNIT

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1. Background

14,000 pedestrians are killed or seriously injured in this country every year - 6,000 of these are children. We are a small research unit in the Psychology Department, working on a contract for the Transport and Road Research Laboratory, investigating the problem of child pedestrian accidents. As a part of this work we need to know the risk different groups of pedestrians run in crossing the road at various types of locations. e.g. is it more risky to cross at a junction or to cross from between parked cars? We therefore need information on the numbers of pedestrians crossing and vehicle flows at various sites. We are doing this by taking observations at particular times of the day at different sites. We hope to have 12 observers each day.

2. What you will be doing

Timetable

2.30 - 3.20 All observers will meet outside the Portland building where Angela will be waiting with a mini bus. She will leave at 2.30 prompt (we can't wait for anyone) and drop everyone off at their allocated sites. Each person will be given recording sheets together with a map of their site. We would like everybody to have a watch of some sort, these will be syncronised each day before the observation periods.

3.20 - 5.30 Observation and recording of pedestrian and vehicle movements.

The two observation periods are arranged as follows:

| | |
|---|---|
| 3.30 - 3.50 | (Pedestrian observations) |
| 3.50 - 4.00 | (Traffic observations) |
| 4.00 - 4.20 | (Pedestrian observations) |
| 4.20 - 4.30 | (Traffic observations) |
| 4.30 - 4.50 | (Pedestrian observations) |
| 4.50 - 5.00 | (Traffic observations) |
| 5.00 - 5.20 | (Pedestrian observations) |
| 5.20 - 5.30 | (Traffic observations) |

5.30 - 6.00 All the observers will be collected and returned to the campus (or dropped off on the way if preferred). You will be home by 6.30 at the latest, probably a bit earlier on some days.

3. Observations

Sites and maps.

If you look at the recording sheets (last 2 pages) you will see that the 1st page has a map of a typical observation site - we have marked on a few features to enable you to locate the site precisely. A cross has been marked on the map where we would like you to stand in order to get the best view (you may find you have to stand in a different place at certain locations, e.g. if a lorry is obstructing your view).

The observation area is the area of the roadway defined by the green lines on the map. If you also have dotted green lines marked (as in the example) see section below marked "Sector". The total length of roadway under observation is 60 yards. On arrival at the site you will pace out 30 yards from the dot marked on the map (do not confuse this with the cross - that is where you stand). We will get you to pace out 30 yards beforehand so that you know how many steps to take. Choose some suitable objects that will mark the edges of your area, and that you can see clearly, e.g. a lampost, a garden gate, remember if you choose a parked car it may drive off!

Draw on the map any parked cars or special features you think might be important e.g. roadworks. If a parked car moves off or another arrives during the observation period we should like you to make a note of this, either in the comment column or on the map itself. Obviously, if there is a great deal of movement of parked vehicles you will not be able to do this very accurately so just indicate the sections of road where there is a lot of movement of parking vehicles.

Pedestrian Observations

Every pedestrian crossing or going into the road within the 60 yard area is to be counted. The following observations are recorded for every pedestrian.

Crossing Identity Number - Leave this blank - we will be numbering this later.

Pedestrian.

Sex - Place a circle round M or F as appropriate.

Age - Estimate the age of the pedestrian as best you can, to the neatest year. As a guide - infant school children (5-7yrs.old) leave school at 3.30 and juniors (7-11yrs. old) leave at 4.00 Children wearing uniforms are usually 11+.

Prot - Protection. For pedestrians in groups only. A pedestrian in a group is defined as being protected if not actively participating in crossing. e.g. a young child holding its mothers hand or an elderly person being helped actoss the road if a member or members of a group are protected place a ✓ in this column.

GR.P - Group. This column is used to label pedestrians crossing in a group. A group is necessarily rather loosley defined in terms of social contact between the individuals. If two or more ind individuals happen to arrive at the kerb at the same time we do not count this as a group. Draw a line to indicate the members of each group in the example (on the 1st page of the recording sheet the 1st group has 2 members followed by 3 individuals crossing then a group of 4).

Crossing

Sector. You may find your map is marked with more than 1 green line (see example). This situation will arise at junctions only. We want to know where pedestrians are crossing in relation to junctions. If you are at one of these sites, in addition to pacing out the 60 yd. observation area, mark out the area within 20 yds. of the junction as well. These are labelled on the maps as A, B etc. Ring one of the letters as appropriate depending on the sector in which the pedestrian enters the roadway. If you are not at a junction site do not fill this column in.

Direction of crossing

Λ Indicates a pedestrian crossing away from your side of the road. Look at the example - if you are standing at a junction imagine the kerb continuing round the corner so a pedestrian crossing from 1 to 2 would be crossing away from you when you are standing at X.

V Indicates a pedestrian crossing towards you.

\- This symbol covers such actions as walking along the road, playing in the road or gutter, lying in the road rather than crossing from one side to the other. etc. If possible give details in the comment column.

Mask Masking by parked vehicles.

M - If you consider that a pedestrian would be hidden or partially hidden from the view of any vehicle driving along, as he steps into the roadway, circle letter M (masked). This is most likely to occur when a pedestrian steps out behind a vehicle parked on the nearside of the road. In the example a pedestrian crossing from 1 to 2 would probably be masked by the parked vehicle.

O - If the pedestrian is unmasked by any parked vehicle circle O.

Traffic

Y - If traffic is approaching i.e. in view, as the pedestrian crosses the road circle Y.

N - If no traffic is approaching circle N.

## Comments

Please record any details or comments you think might be relevant either to a specific crossing or to the site as a whole.
There are four separate pedestrian observation periods, so use a fresh map sheet to start each time (the observation times are marked on each sheet).
The four 20 mins. pedestrian observation periods are

3.30 - 3.50, 4.00 - 4.20, 4.30 - 4.50, 5.00 - 5.20

## Traffic Counts

Traffic density counts are made on separate maps for each observation period. i.e. you will have separate maps for the periods 3.50 - 4.00 4.20 - 4.30, 4.50 - 5.00, 5.20 - 5.30.

During the 10 mins. traffic observation periods count the number of vehicles (excluding push bikes) travelling in the direction marked by the arrows. See example.

If the traffic flow differs considerably from the previous pedestrian observation period e.g. people start going home from a factory, make a note of this.

## BIBLIOGRAPHY

Arbous, A.G., Kerrich, J.E., (1953), "The phenomenon of Accident Proneness", Industrial Medicine & Surgery, 22, 141-148.

Backett, E.M. & Johnson, A.M., (1959), "Social patterns of road accidents to children", British Medical Journal, 1 : 409-413.

Burton, L., (1968), "Vulnerable Children", London, Routledge and Kegan Paul.

Cohen, J., Dearnley, E.J. & Hansel, C.E.M., (1955), "The risk taken in crossing a road", Operational Research Quarterley, 6 : 3 : 120-127.

Colborne, H.V., (1972), "Factors affecting the safety of young children as pedestrians", A thesis for the degree of MSc. at the University of Salford.

Colborne, H.V., (1973), "Factors affecting the safety of young children as pedestrians", Transport and Road Research Laboratory Technical Note RN 794,

Council of Europe, (1972), "Accidents in Childhood as a Public Health Problem", Strasbourg.

Douglas, J.W.B. & Bloomfield, J.M., (1958), "Children under 5", London, Allen & Unwin.

Ekstrom, G., Gastrin, U. & Quist, O., (1966), "Traffic injuries and accident proneness in childhood", Proceedings of the Second Congress of the International Association for Accident & Traffic Medicine, Stockholm. Skanetryck A.B, Malmo, 1967, 2, 95-98.

Finlayson, Helen M., (1972), "Children's Road Behaviour and Personality". British Journal of Educational Psychology, Vol. 42: 3 : 225-232.

Gordon, J.E., (1949), "The Epidemiology of Accidents", American Journal of Public Health, 39 : pp 504-515.

Grayson, G.B., (1975), "The Hampshire Child Pedestrian Study", Transport and Road Research Laboratory. Laboratory Report 668.

Grayson, G.B., (1975), "Observation of pedestrian behaviour at four sites", Transport and Road Research Laboratory. Laboratory Report 670.

Greenwood, M. & Woods, H.M., (1919), "The incidence of industrial accidents upon individuals with special reference to multiple accidents", Industrial Health Research Board, Report No. 4. H.M.S.O.

Greenwood. M. & Yule, C.V., (1920), "An enquiry into the nature of frequency distributions of repeated accidents". Journal of the Royal Statistical Society, Vol. 83, p. 255.

Haddon, W., Suchman, E.A. & Klein, D., (1964), "Accident Research", New York, Harper & Row.

Harrington, J. (1968), "A Comparative Study of the Road-Crossing Behaviour of Elderly and Young Adult Pedestrians in an Urban Traffic System". Unpublished B.A. thesis. University of Birmingham.

Havard, J.D.J., (1974), "Child Pedestrian Casualties as a Public Health Problem", Reprinted from Medicine, Science, and the Law, 1974.

Heimstra, N.W., Nicols, J. & Martin, G., (1969), "An experimental methodology for analysis of child pedestrian behaviour", Pediatrics, 44(5) Part 2, 832-38.

Hole, V., (1966), "Children's play on Housing Estates". National Building Studies Research Paper 39. Ministry of Technology, Building Research Station.

Holme, A. & Massie, P., (1970), "Children's Play : A study of needs and opportunities", Michael Joseph Ltd., London.

Hoskins, W.G., (1955), "The making of the English Landscape", Hodder & Stoughton, London.

Howarth, C.I. & Routledge, D.A., (1970), "The Behaviour of children crossing roads", Department of Psychology, University of Nottingham, Unpublished.

Howarth, C.I., Routledge, D.A. & Repetto-Wright, R. (1971), "The identifacation of factors leading to road accidents in young children as pedestrians". Department of Psychology, University of Nottingham, Unpublished.

Howarth, C.I., Routledge, D.A. & Repetto-Wright, R., (1972), "The Importance of Skill in Child Pedestrian Accidents". Progress Report, Department of Psychology, University of Nottingham. Unpublished.

Howarth, C.I., Routledge, D.A. & Repetto-Wright, R. (1974), "An Analysis of Road Accidents Involving Child Pedestrians", Ergonomics, Vol. 17, No. 3, 319-330.

Jacobs, H.H., (1961), "Conceptual and Metholological Problems in Accident Research", In Behavioural Approaches to Accident Research, New York : Association for the Aid of crippled Children, pp. 3-25.

Jacobs, G.D. & Wilson, D.G., (1967), "A study of Pedestrian Risk in Crossing busy roads in Four Towns". Road Research Laboratory, Report LR 106. Crowthorne.

Johnson, H.D. & Munden, J.M., (1957), "Effect of Instruction on Children's Routed to and from School". Department of Scientific and Industrial Research. Road Research Laboratory, Research Note No. RN/3109. 1957.

Kolbuszewski, J., Mackay, G.M., Fonseka, C.P., Blair, I. & Clayton, A.B., (1969), "Causes and effects of road accidents", University of Birmingham, Department of Transportation and Environmental Planning, Departmental Publication No. 33.

Langford, W.S., Gilder, R., Wilking, B.S., Genn, M.M. & Sherrill, H.H., (1953), "Pilot Study of Childhood accidents : Preliminary Report". Paediatrics, 11, 405-413.

Levin, P.J. & Bruce, A.J., (1968), "The Location of Primary Schools", Building Research Station Current Papers No. 39/68.

Marcus, I.M., Wilson, W., Kraft, I., Swander, D., Southerland, F. & Schulhofer, E., (1960), "An interdisciplinary approach to accident patterns in children". Monographs of the Society for Research in Child Development, Vol. 25, No. 2.

Mellinger, G.D. & Manheimer, D.I., (1966), "An Exposure-Coping Model of Accident Liability among Children", Journal of health & Social Behaviour, 8, 96-106.

Ministry of Transport, Scottish Development Department and Welsh Office, (1976), "Road Accidents in Great Britain 1974", London, H.M.S.O.

Ministry of Transport, Scottish Development Department and Welsh Office, (1977), "Road Accidents in Great Britain 1975", London, H.M.S.O.

Newson, J., & Newson, E., (1976), "Seven Year Olds in the Home Environment", London George Allen & Unwin.

Nie, N., Bent, D.H. & Hull, C., (1970), "Statistical Package for the Social Sciences", McGraw-Hill.

Pease, K., & Preston, B., (1967), "Road Safety Education for Young Children", British Journal Educational Psychology, 37, 305-313.

Read, J.H., Bradley, E.J., Moridon, J.D., Lewall, D. & Clarke, D.A., (1963), "The epidemiology and prevention of traffic accidents involving child pedestrians", Canadian Medical Assoc. Journal. (89), 687-701.

Routledge, D.A., Repetto-Wright, R. & Howarth, C.I., (1974(a) ), "The Exposure of Young Children to Accident Risk as Pedestrians", Ergonomics, Vol. 17, No. 4, 457-480.

Routledge, D.A., Howarth, C.I. & Repetto-Wright, R., (1974(b) ), "A comparison of Interviews and Observations to Obtain Measures of Children's Exposure to Risk as Pedestrians", Ergonomics, 1974, Vol. 17, No. 5. 623-638.

Routledge, D.A., (1975), "The Behaviour of Child Pedestrians". A thesis for the degree of Ph.D. at the University of Nottingham.

Routledge, D.A., Repetto-Wright, R., & Howarth, C.I., (1976), "The development of road crossing skill by child pedestrians", Proceedings of the International Conference on Pedestrian Safety, 1976, Technion, Israel Institute of Technology, Israel.

Routledge, D.A., Repetto-Wright, R., & Howarth, C.I., (1976(a) ), "Four techniques for measuring the exposure of young children to accident risk as pedestrians", Proceedings of the International Conference on Pedestrian Safety, 1976, Technion, Israel Institute of Technology, Israel.

Sadler, J., (1972), "Children and Road Safety : A Survey Amongst Mothers", Report No. SS.450, London, H.M.S.O.

Sandels, S., (1968), "Children in Traffic", Elek Books Ltd., London.

Sargent, K.J. & Sheppard, D., (1971), "Developing a crossing code (2) Designing and Evaluating the Code", Transport and Road Research Laboratory Technical Note TN 598.

Shaw, L. & Sichel, H., (1971), "Accident Proneness", International Series of Monographs in Experimental Psychology, Vol. 11, Pergamon Press.

Skandia, (1971), "The Skandia Report : A Report on Children in Traffic". Summary in English, Skandia Insurance Company Ltd, Stockholm.

Storie, V.J., (1977), "Male and female car drivers : Differences observed in accidents", Transport and Road Research Laboratory, Laboratory Report 761.

Watson, A.H., (1971), "Recent Trends in Casualties to Young People in Road Accidents", Report of Second Conference of Governmental Experts on Road Safety Education in Schools.

Yaksich, S., (1960), "A Study of Pedestrian Fatalities in Washington, D.C.", Washington, D.C. : American Automobile Association Traffic Engineering and Safety Department.

CONFLICT STUDIES.

Baker, W.T., (1972), "An Evaluation of the Traffic Conflicts Technique", Highway Research Record.

Güttinger, V.A. and Kraay, J.H., (1976), "Operationalisation, methodological problems and the use of the technique in two field situations in Delft". Contributed to OECD Special Research Group on Pedestrian Safety.

Perkins, S.R., (1968), "Traffic Conflict Characteristics - Accident Potential at Intersections." Highway Research Record.

Spicer, B.R., (1971), "A study of traffic conflicts at a rural dual carriageway intersection." Transport and Road Research Laboratory Report 410.

Spicer, B.R., (1973), "A study of traffic conflicts at six intersections," Transport and Road Research Laboratory Report 551.