ADELAIDE IN-DEPTH ACCIDENT STUDY

1975-1979

PART 3: PEDAL CYCLE ACCIDENTS

by

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INFORMATION RETRIEVAL

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ABSTRACT : This report contains descriptions of the causes and consequences of the pedal cycle accidents contained in a representative sample of road traffic accidents to which an ambulance was called in metropolitan Adelaide. Reviews of the relevant characteristics of the cyclists and drivers, the vehicles, and the road and traffic environment are also included. One-third of these 22 accidents involved a child cyclist who was riding carelessly on a residential street. The other two-thirds mostly involved adult cyclists on arterial roads, and were a consequence of errors made equally by the cyclists and the drivers. Alcohol intoxication was not a significant factor in any of these accidents. Almost all of the cyclists were injured, and their injuries were often very severe. The front of the striking car caused two-thirds of the severe injuries. A number of possible countermeasures and topics worthy of further investigation are listed at the end of the report.

*Non IRRD Keywords

Sponsored by

The Office of Road Safety, Commonwealth Department of Transport and the Australian Road Research Board.

THE UNIVERSITY OF ADELAIDE

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FOREWORD

This study was conducted by the Road Accident Research Unit of the University of Adelaide and was jointly sponsored by the Office of Road Safety, Commonwealth Department of Transport and the Australian Road Research Board.

The general aims were to evaluate the effectiveness of many existing safety measures and to identify other factors related to accident or injury causation in road accidents in metropolitan Adelaide. The areas studied included characteristics of road users, the vehicles and the road and traffic environment.

To achieve these aims a representative sample of all road accidents to which an ambulance was called in the Adelaide metropolitan area was studied in the 12 months from March 1976. Two teams, each comprising a medical officer, an engineer and a psychologist attended 304 randomly selected accidents and collected medical, engineering and sociological data.

The findings are presented in a series of reports, each covering a specific topic. Part 1 provides an overview, and is followed by reports dealing with pedestrians, pedal cyclists, motorcyclists, commercial vehicles, passenger cars and road and traffic factors. The final report in the series provides a summary of the findings and recommendations.

Basic data from the study are held on computer by both the Road Accident Research Unit, University of Adelaide and the Australian Road Research Board. Access to these data can be arranged for bona fide research workers on application to the Australian Road Research Board. Further copies of this report and copies of other reports in the series are available from the Office of Road Safety, Commonwealth Department of Transport.

ACKNOWLEDGEMENTS

The collection of data at the scene of the accident and in the follow-up investigations was performed by:

H.S. Aust and C.T. Hall
(Engineers)

N.D. Brewer and B.L. Sandow
(Psychologists)

J.R. Lipert and P.J. Tamblyn
(Medical Officers)

The completion of this study was due mainly to the willingness of these team members to work exceptionally long hours under difficult and often hazardous conditions.

Much of the road and traffic data was collected by W.J. Offler, who also attended the scenes of the accidents during the final three months.

The recorded information was processed by the above personnel, assisted by J.K. Darwin, G.M. Haymes, O.T. Holubowycz and C.A. Latta.

The Steering Committee for the study provided valuable assistance and advice. Its members were: Professor R.E. Luxton (Chairman), Professors: I.D. John, R.B. Potts, J.S. Robertson, A.T. Welford, Drs.: B.L. Cornish (representing the Director-General of Medical Services), I.R. Johnston (D.O.T.), J.B. Metcalf (A.R.R.B.), G. Sved, A.P. Vulcan (D.O.T.), and Messrs J.F.M. Bryant (A.R.R.B.), R. Culver, H.E. Roeger (later R.W. Scriven and then M. Knight) (representing the Commissioner for Highways), R. Ungers (D.O.T.), and F.E. Yeend (D.O.T.). The first Chairman was the late Professor N.T. Flentje.

The St. John Ambulance Transport Division played an essential role in the conduct of this study by notifying the Road Accident Research Unit when an ambulance was called to attend a road accident. The South Australian Highways Department, the Road Traffic Board, and the Police Department cooperated in many ways in the execution of this study, as did the Hospitals Department. The proprietors and operators of towing services and crash repair shops facilitated inspections of the damaged vehicles.

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1. INTRODUCTION

A sample of road accidents to which an ambulance was called in the Adelaide metropolitan area was investigated at the scene by multi-disciplinary teams from the Road Accident Research Unit of the University of Adelaide. This survey,which ran for twelve months from 23 March, 1976, was sponsored by the Office of Road Safety of the Commonwealth Department of Transport and the Australian Road Research Board. Each accident was studied by an engineer, a psychologist and a medical officer. Their observations at the scene started an average of ten minutes after the ambulance was called and were supplemented by further investigations including interviews with the drivers and other active participants (pedestrians and cyclists), detailed observation of traffic behaviour at the accident site and examination of the injured persons in hospital and of the vehicles in towing service depots and elsewhere.

An eight per cent sample, totalling 304 accidents, was obtained of all road accidents as defined above. The sample was representative of this accident population by time of day and day of week. The purpose of this survey, the sampling technique and the method of investigation are described in detail in another report in this series together with a review of the types of accidents investigated and an outline of the general conclusions.

There were 22 accidents in which a pedal cycle was involved in this sample of 304 accidents. This report contains a general review of these 22 accidents, followed by a detailed presentation of information obtained from interviewing each cyclist. The characteristics of the drivers whose vehicles collided with a pedal cycle are dealt with briefly. The injuries sustained by the cyclists are described, and specific injuries are related to the objects which caused them. A discussion of the possibilities for preventing accidents involving pedal cyclists, and for minimizing the severity of the injuries sustained in those accidents which do occur,precedes the final sections of this report which list the general conclusions and recommendations.

2. THE ACCIDENTS

Half of these accidents occurred between 3 p.m. and 5 p.m. on a week day (Figure 1). Children riding home from school, or just riding around after school, accounted for most of the pedal cycle accidents in this two-hour period. In two of the three accidents which happened at night there were no lights fitted to the bicycle. The third of these night-time accidents occurred when it was raining. None of these cyclists,or any of the drivers of the striking cars, was found to have a blood alcohol level above .04, and only three had been drinking at all.

ACCIDENT LOCATION

The types of locations at which these 22 accidents occurred, and the associated vehicle movements, are shown in Table 1. The categories shown in this Table are not necessarily mutually exclusive, and so some accidents could have been listed under either of two 'locations'. The most common type of pedal cycle accident in this survey was a midblock collision with a motor vehicle.

2.1 MIDBLOCK ACCIDENTS

CYCLIST TURNED RIGHT, STRUCK BY OVERTAKING VEHICLE

Four of the five cyclists involved in this type of collision did not look to check that the road was clear before they started to turn. They were all children, aged from nine to 13 years, and the careless way in which they turned across the road was similar to the manner in which most of the child pedestrians in this sample of accidents ran onto the road without looking.

In Accident 177 a ten year old cyclist rode out from behind a telephone call box on the left hand side of the road. He swerved left around a parked car, and then suddenly turned right, just as a car was about to overtake (Figure 2). This accident occurred at a T-junction as can be seen in Figure 2, but it is classified here as a midblock collision because the presence of the intersection had no discernible influence on the actions of either the driver or the cyclist (who was not intending to turn into the intersecting road). The driver of the car had been drinking. His blood alcohol level was .03, which is unlikely to have been an important factor, particularly since a completely sober driver probably could not have avoided colliding with the cyclist.

In a somewhat similar accident (298) a 13 year old girl cyclist veered to her right to pass a car parked in a residential street. A motorcyclist who was about to overtake thought that she was turning right, but as she then appeared to be continuing on past the parked car he moved to the centre of the road to allow plenty of room to pass both the cyclist and the car. At this moment the cyclist turned right, heading for the driveway of her parent's house. The motorcyclist was unable to avoid her, and fell from his machine following the collision.

The second of the two accidents in this study which involved a collision between a pedal cyclist and a motorcyclist happened when a 12 year old boy, riding in a group of three cyclists, decided to take a short cut home by riding through the forecourt of a service station on the right hand side of the road (Accident 297). He broke away from his two companions and turned right, to cross the road, having glanced back over his shoulder. He vaguely recalled having seen the motorcycle, but had not thought that it was close enough to bother him (he even thought, after the accident, that he may have mistakenly believed that it was travelling in the other direction). The motorcyclist had noticed the group of cyclists, but he did not expect one to turn across in front of him. When he realized that one was doing so, he swerved to his right and tried to stop. He, too, fell from his motorcycle following the collision.

The remaining pedal cycle accident in this category (Accident 276) happened when a nine year old boy, who was riding a cycle which he had had for two months, suddenly turned right from the far left side of the road. Like the girl in Accident 298, this cyclist also was heading for his home on the opposite side of the road. He was hit by a car as he turned. The driver had seen the cyclist as the boy rode across a four-way intersection, travelling in the same direction as the car. As he caught up with the bicycle, just past the intersection, the driver decided that the rider showed no sign of doing anything other than continuing straight ahead, and so he proceeded to overtake him. By the time that he realized that the cyclist was turning across his path it was too late to avoid a collision. This driver said that cyclists should be allowed to ride on the footpath. Had the cyclist in this accident been doing so, it is possible that the driver would have had enough warning of the cyclist's change in direction to have been able to have avoided hitting the child.

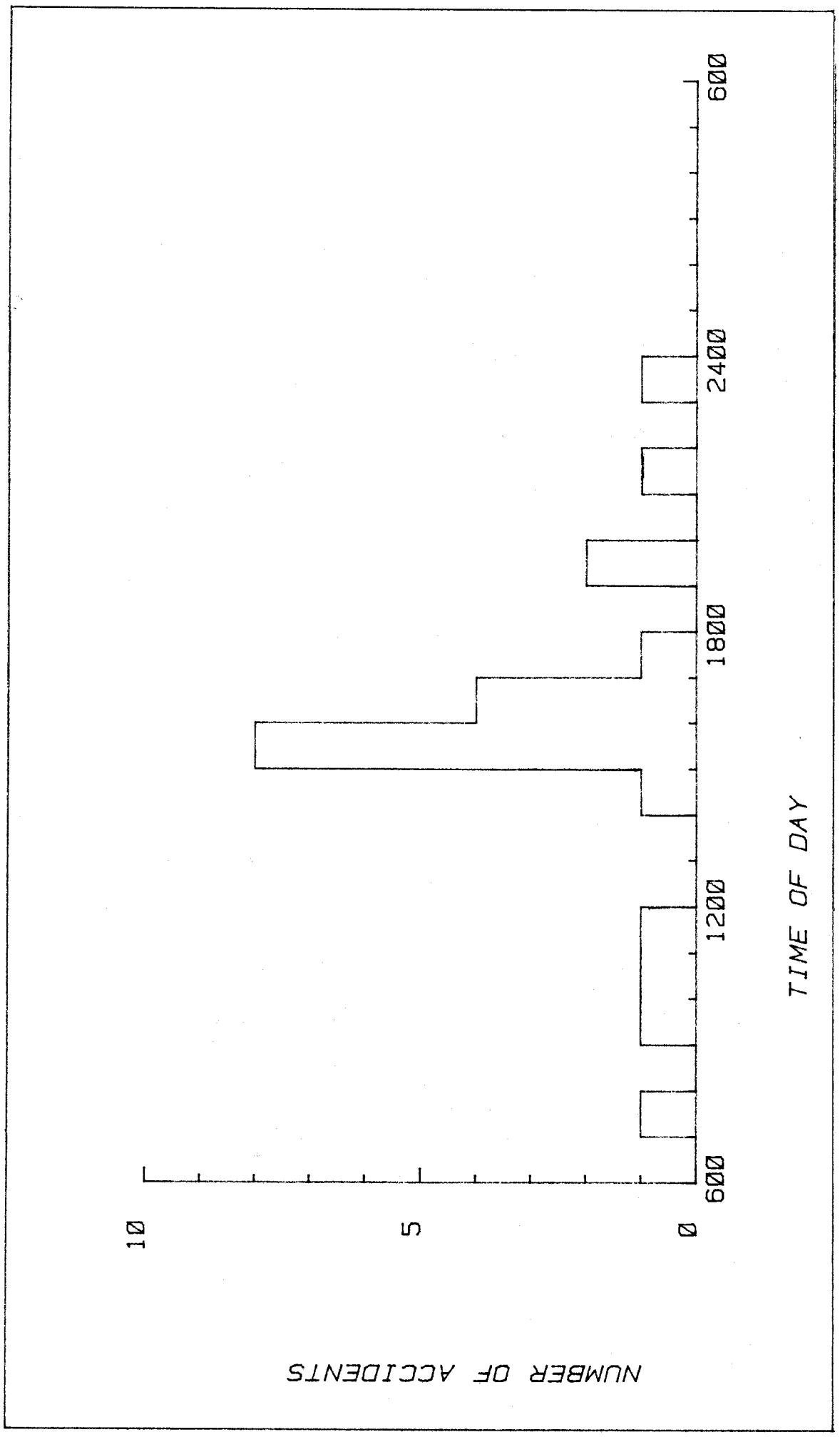


FIGURE 1: Pedal cycle accidents by time of day.

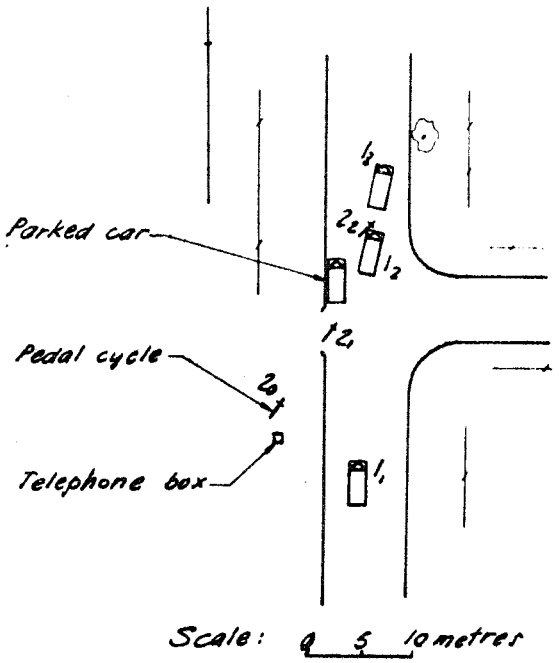


FIGURE 2:
Accident 177.

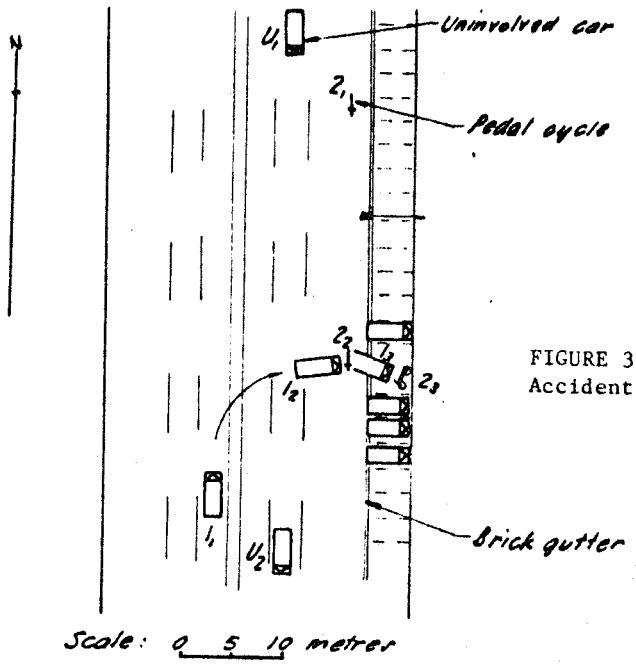
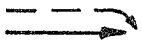
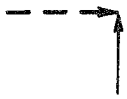


FIGURE 3:
Accident 069.

TABLE 1: PEDAL CYCLE ACCIDENTS BY LOCATION, VEHICLE MOVEMENT AND ACCIDENT NUMBER

Vehicle Movements (Cycle: — — ➤)	Accident Location				Total Accidents
	Signalised	Sign Controlled Intersection	Uncontrolled Intersection	Midblock	
	-	-	-	023 177 276 297 298	5
	030 [1]	005	028	069 284	5
	087 [2]	238	031 226 296	-	5
	-	-	-	154 214 271	3
	-	250	254 [3]	-	2
	107	-	-	-	1
 (car door)	-	-	-	157	1
Total Accidents	3	3	5	11	22

Notes: [1] Turning vehicle not physically involved.

[2] Inactive School Crossing, cyclist walking alongside bicycle.

[3] Roundabout.

The one adult cyclist who was involved in this type of collision was merging across to the centre of the road in order to turn right at the next intersection. He was on his way home from work, and followed this route every day. On this occasion he misjudged the approach speed of an overtaking car which, based on the braking skid marks, was travelling at about 90 km/h in a 60 km/h speed limit area (Accident 023).

CAR TURNED RIGHT, COLLISION WITH ONCOMING CYCLIST

A 17 year old youth (Accident 284) stopped his car in the centre lane of a four lane road to allow another car to pass from the opposite direction. He then turned right to enter a shopping centre parking area. As his car reached the driveway entrance it was hit on the left side by a pedal cycle. The driver had never driven this particular car before, and had not driven at all for the previous two months. The 15 year old cyclist was riding near the concrete gutter, and as he approached the entrance to the shopping centre he veered across to his right onto the bitumen pavement. He was concentrating on doing this, because there was a rough edge between the gutter and the road surface, and he noticed the car only as it suddenly turned across his path. He braked, but could not stop in time. The driver did not see the cyclist at all before the impact, possibly because the rider was in the shade of overhanging trees and also wearing relatively inconspicuous clothing. The accident occurred in daylight during the afternoon peak traffic period.

The other collision of this type involving a cyclist occurred in heavy rain at night (Accident 069). The car driver turned right, after waiting for an oncoming car to pass, to cross the road and enter a parking space (Figure 3). He slowed down to cross a brick-paved gutter, and was about to accelerate into the parking space when the left front corner of the car hit a cyclist, who was thrown over the bonnet. The driver had not seen the cyclist at all before the impact. The street lighting on the approach path of the cyclist was good, with a sodium vapour lamp directly above, but the rider was hard to see because of the heavy rain. The 21 year old cyclist had seen the car waiting in the centre of the road, and had anticipated the possibility that it might turn across in front of him, but when it did so he found that he could not stop because the rims of the wheels on his bicycle were wet and the brakes were not effective.

CAR DOOR OPENED IN THE PATH OF A CYCLIST

The one accident of this type in the survey happened late at night (Accident 157). The 18 year old cyclist said that he was riding quite fast through a signalised intersection, keeping well to the left on a left hand curve. On leaving the intersection he saw a car parked at the kerb ahead of him. It did not have its parking lights on, and appeared to be empty. As he was about to pass the car the driver's door was opened and he crashed into it, breaking the door off its hinges.

The driver of the car had stopped at the kerb intending to go to a nearby shop. He had stayed in the car for a short time, talking with his passenger, before opening the car door to get out. He had not noticed the cyclist approaching.

The car had high-backed front seats, which both restricted the driver's rear vision a little and may have concealed the occupants from the view of the cyclist. The bicycle was not equipped with either lights or fittings for lights, and the cyclist was wearing dark, inconspicuous clothing.

SINGLE VEHICLE ACCIDENTS

One of these three accidents was the direct result of the cyclist, a 69 year old man, suffering a stroke while riding his bicycle along a footpath (Accident 271). The other two cases each involved 16 year old girls who lost control of their bicycles when descending a steep slope. In the first of these two accidents (Accident 154), the bicycle was intended for use by a child of about ten years of age. The rider, although she owned the bicycle, had not ridden it for more than two years and she was trying to carry another girl as a pillion passenger. The girl in the other accident was on a friend's bicycle which she had not ridden before (Accident 214). She was descending a steep slope into a subway when the cycle began to wobble from side to side and she eventually fell off, striking the retaining wall at the side of the roadway. This bicycle had a heavy bag of books strapped to the rear carrier.

2.2 COLLISIONS AT UNCONTROLLED INTERSECTIONS

In three of the five accidents at uncontrolled intersections a child cyclist turned right from the stem of a T-junction without allowing for the possibility that a car might be approaching on the intersecting road (Accidents 031, 226 and 296). The fourth accident was at an intersection at which a roundabout had been installed, but with no 'Give Way' lines painted on the road (Accident 254). A child on a bicycle was about to turn right at the roundabout when he was hit on his left side by the front of a car which had approached on the intersecting road (Figure 4). The rider and his bicycle were trapped under the front of the car, which continued on for 60 metres past the

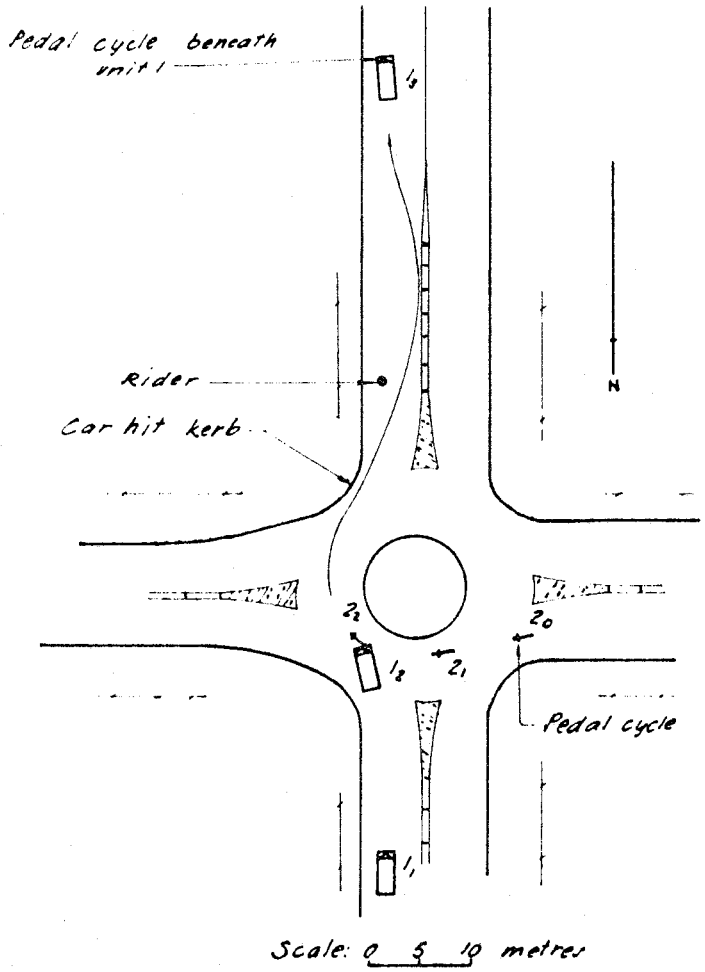


FIGURE 4:
Accident 254.

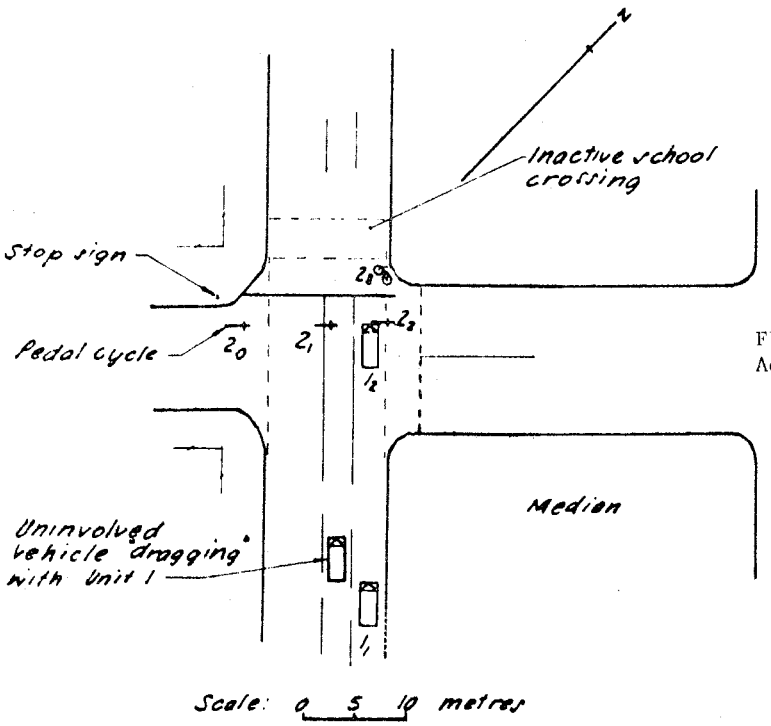


FIGURE 5:
Accident 238.

impact point. The cyclist came to rest 35 metres behind the car, which still had the bicycle wedged under the front bumper. The driver claimed that his brakes had failed. We were not able to get access to the car to check on this claim, but the fact that the driver continued on his way in the same car after the accident suggested that it may not have been correct.

The remaining collision at an uncontrolled intersection occurred at night (Accident 028). A car turned right, across the path of a cyclist who was riding a bicycle which was not equipped with lights. The sole street lighting at the scene was provided by one tubular fluorescent lamp.

2.3 COLLISIONS AT SIGN-CONTROLLED INTERSECTIONS

In two of the three accidents in this category there was evidence that the striking car had been travelling well in excess of the 60 km/h speed limit. In Accident 250 the cyclist turned right, past a Give Way sign, from the stem of a T-junction without looking to his left. A car which was approaching from the cyclist's left, at a speed of about 95 km/h, was unable to avoid him. Even though the cyclist should have given way, had the car been travelling at the legal speed limit of 60 km/h it could have been stopped at least 10 metres before the actual collision point.

The other speeding vehicle had been racing another car. An elderly cyclist had moved off from a Stop sign at the left of the three-lane one-way road when the two cars were still some distance away. He was hidden from the view of the driver of the striking car by the second car until just before the impact (Accident 238, Figure 5). As in the previous accident, this collision may have been avoided had the striking car been travelling at the legal speed limit rather than at about 85 km/h.

The third accident at a sign-controlled intersection had no relevance to the traffic control sign. It involved a car which turned right into the stem of a T-junction, only to be hit by an oncoming cyclist who had passed a stationary bus on its left by riding between it and the kerb (Accident 005). The bus driver had been held up by a queue of vehicles banked up from pedestrian-actuated traffic signals. He had stopped his bus clear of the entrance to the side-street to allow vehicles waiting to turn right to clear the intersection.

2.4 COLLISIONS AT SIGNALISED LOCATIONS

There were three pedal cycle accidents at signalised locations, but the presence of the signals was directly relevant in only one case, Accident 107. In this accident the cyclist, although turning right with a green arrow (or possibly at the start of the yellow phase), failed to clear the intersection during the intergreen period and was hit by an oncoming car which had entered the intersection from the kerb lane (Figure 6). The car had moved across into this lane to pass vehicles which were stationary in the other three lanes, and continued on into the intersection, without slowing down, as the signal turned to green. The cyclist had covered 37 metres from the STOP line, and still had another eight metres to go to clear the intersection completely, when she was struck by the car.

The intergreen period for right-turning traffic was four seconds, including a three second yellow. This meant that a vehicle which commenced a right turn when the signal changed from green to yellow had to average 40 km/h to clear the intersection before oncoming traffic got a green signal. This is obviously an unrealistic requirement for a pedal cyclist.

An all-red period of one second may have been selected for this turning movement on the assumption that the oncoming vehicles have a clear view of any turning vehicles, but this is not necessarily so, as this accident demonstrates. Increasing the all-red period to four seconds would make the intersection safer, but even then a cyclist would have to average 23 km/h to be clear of the intersection before oncoming traffic entered. This topic is discussed at greater length in the companion report on road and traffic factors.

The cyclist in Accident 030 appeared to have been approaching a four-way signalised intersection too fast to have been able to take safe avoiding action when a car began to turn right, across his path. Although the car stopped before completing the turn the cyclist, who had swerved to his left, could not stop and fell from his bicycle when it hit the kerb.

The traffic signals were not operating at a School Crossing which was being used by a cyclist who was walking alongside her bicycle across a four-lane priority road (Accident 087). Despite the fact that the crossing was not activated, and therefore had no legal significance, this accident is included in this category because the cyclist chose to cross at this point on her way home from work each day; possibly being encouraged to do so by the presence of the pavement markings and a raised median refuge. The driver of the striking car said that he did not see the 'cyclist' until she was almost directly in front of him, because he had just pulled out to pass the car ahead of him.

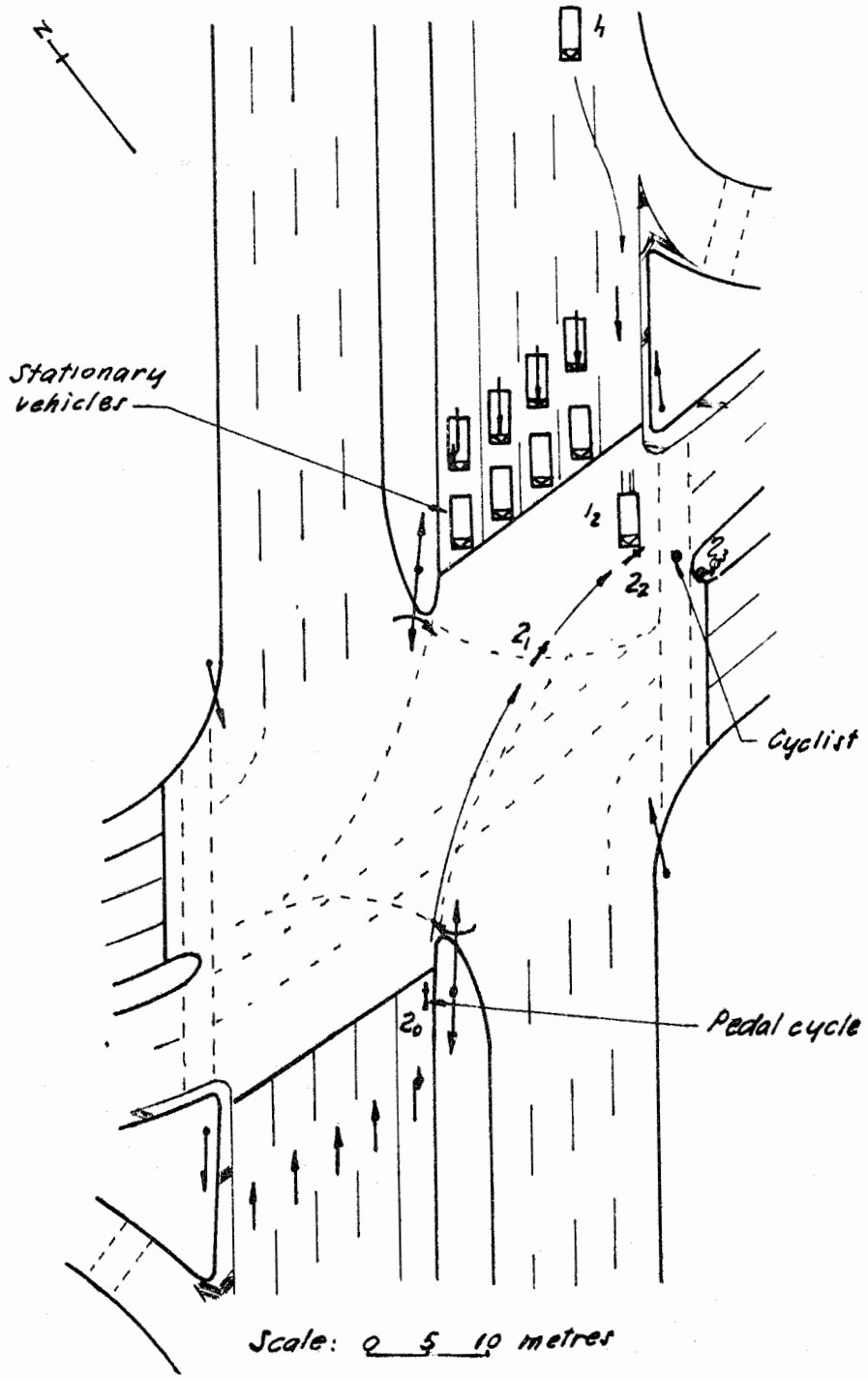


FIGURE 6: Accident 107.

3. CHARACTERISTICS OF THE PEDAL CYCLISTS

There were 22 pedal cyclists among the 537 active participants in this survey, and each of these cyclists was interviewed some time after the accident. One other person, a girl aged 15, was a passenger on a bicycle. She is not included in this section.

3.1 DEMOGRAPHIC CHARACTERISTICS

AGE AND SEX

Seventeen of the pedal cyclists were males and five were females. Their ages ranged from nine to 70 years, with half of them being less than 17 years of age (Table 2).

MARITAL, EDUCATIONAL AND OCCUPATIONAL STATUS

Neither the marital nor the educational status of these pedal cyclists appeared to be a relevant factor in any of these accidents. More than half the cyclists were students, as would be expected from the age distribution shown in Table 2.

Unskilled workers were the second most numerous occupational group, after the students noted above. Two other cyclists were pensioners, and a further two were unemployed (Table 3). This may reflect a relatively high dependence upon pedal cycles as a mode of transport by persons who are among the lower socio-economic groups in the community.

3.2 PHYSIOLOGICAL CONDITION

ALCOHOL INTOXICATION

The consumption of alcohol in the 12 hour period prior to the accident was reported by two cyclists. In each case the cyclist said that he had consumed only one glass of an alcoholic beverage at the house of a friend or relative less than two hours before being involved in the accident.

Although 21 of the cyclists were admitted to hospital as a consequence of the accident, blood samples were not obtained from eight of them. Seven of these eight cyclists were less than 14 years old and thus were not legally required to submit to this procedure. The remaining cyclist was categorized on admission to hospital as a cerebrovascular accident case rather than as being from a vehicle accident (Accident 271) and so a blood sample was not taken. However, there was no evidence to suggest that any of these eight cyclists had been consuming alcohol prior to their accident.

Of the 13 cyclists from whom a blood sample was taken in hospital, 12 recorded blood alcohol concentrations (BACs) of zero and one a BAC of 0.01. The only pedal cyclist who was not taken to hospital recorded a BAC of zero in a breath test administered at the accident site by a member of the research team.

Alcohol intoxication of the pedal cyclist was not a factor in the causation of these 22 accidents.

PRESCRIPTION AND NON-PRESCRIPTION DRUGS

Two cyclists reported that they were taking prescribed drugs: antibiotics as treatment for a minor infection (Accident 157) and bronchodilators for a minor chest condition (Accident 271). Neither treatment would be expected to produce any impairment of performance.

None of these cyclists reported taking non-prescription legal or illegal drugs prior to their accidents.

MEDICAL CONDITION AND FATIGUE

For 19 of the pedal cyclists there was no evidence of a disabling medical condition at the time of the accident. While another two participants were suffering from minor ailments, a minor infection and a minor diabetic condition respectively, no apparent disability derived from either condition. However, as noted above, one cyclist (Accident 271) suffered a cerebro-vascular accident when riding along a footpath, with the resulting left hemiplegia and associated impairment of function of the right side of the body causing him to fall from his cycle. In this case the medical condition of the pedal cyclist clearly constituted a significant disability. The medical history of this participant indicated a transient right hand weakness several weeks prior to the accident. No other evidence of relevant past illness emerged from these participants.

The state of fatigue of the cyclist was necessarily a subjective judgement, and was identified crudely by a comparison of recent sleep patterns with the normal sleeping habits of the individual. Assessed on this basis, fatigue did not appear to be a significant factor underlying the performance of these pedal cyclists.

TABLE 2: PEDAL CYCLISTS: AGE AND SEX

Age (years)	Sex		Total
	Male	Female	
Less than 9	-	-	-
9	1	-	1
10 - 14	6	1	7
15 - 19	3	2	5
20 - 24	2	-	2
25 - 34	1	2	3
35 - 44	1	-	1
45 - 54	1	-	1
55 - 64	-	-	-
65 - 74	2	-	2
Over 74	-	-	-
Total	17	5	22

TABLE 3: PEDAL CYCLISTS: OCCUPATIONAL STATUS

Occupational Status	Number of Cyclists
Student	13
Unskilled	6
Semi-skilled	1
Office or sales	1
Unknown	1
Total	22

3.3 PHYSICAL CHARACTERISTICS

VISION AND HEARING

None of the cyclists had any significant hearing loss. Snellen tests of visual acuity and Ishihara Tests for colour blindness also did not reveal any relevant deficits as far as the cyclist's accident involvement was concerned nor was the wearing, or non-wearing, of corrective lenses a significant factor.

CONSPICUITY OF THE CYCLIST

In eight of the 19 collision accidents the lack of conspicuity of the cyclist was a factor in the failure of the driver to have seen the cyclist in time to have taken more effective avoiding action. These eight accidents include the three which occurred at night. One of the night accidents happened in heavy rain, but in the other two the pedal cycle was not fitted with lights.

3.4 PSYCHOLOGICAL CONDITION

EFFECT OF THE JOURNEY SCHEDULE

Twenty of these 22 cyclists reported that there were no rigid schedules associated with their journeys. The other two cyclists reported that prior to the accident they had been running late and so they had been riding less cautiously than usual. One of them, a male aged 54 years (Accident 250), was travelling to work. The other, a boy of nine years (Accident 296), having realised he was late returning home, was cycling hurriedly in pursuit of a friend in order to retrieve the pedal cycle that the friend had borrowed.

SOCIAL INTERACTIONS AND EMOTIONAL STATE BEFORE THE JOURNEY

Only one cyclist reported having had social interactions that were other than routine in nature before starting out on the journey that resulted in the accident. Yet even for this individual, as for the others, there was no evidence to suggest that his performance prior to the accident might have been influenced by the nature of these social interactions.

All but three of the pedal cyclists described their emotional state prior to starting their journey as being unemotional or contented. The performance of two of the remaining three pedal cyclists may have been, at least to some extent, a reflection of their emotional state prior to the journey. For example, one 16 year old cyclist (Accident 214) suggested that one of the factors underlying her inappropriately rapid descent into a subway may have been her continued pre-occupation with forthcoming examinations. The events preceding the accident of the other person (Accident 296) have been described above in connection with his journey schedule.

EMOTIONAL REACTIONS AND PREOCCUPATIONS BEFORE THE ACCIDENT

These cyclists' recollections of their emotional reactions immediately prior to the accident again suggested that their pre-accident performance was rarely affected by some transient emotional state. However, two instances which may have been of some significance were reported. The circumstances of one accident (296) already have been presented. In the other accident another young male cyclist (Accident 297) who turned into the path of an overtaking motorcycle reported that he had been excited by the prospect of his forthcoming school camp.

Six cyclists reported some mental preoccupation prior to the accident, and this preoccupation may have had a significant influence on the performance of four of them. The relevant circumstances of these accidents (214, 250, 296 and 297) have been discussed previously in this section.

INCIDENTS DURING THE JOURNEY

None of these cyclists could recall any unexpected incidents during the journey which could have affected their likelihood of being involved in an accident.

SUMMARY: PSYCHOLOGICAL CONDITION

Four of these 22 cyclists may have been influenced to some degree by their psychological condition before the accident. But even in these four cases it was not possible to assess realistically the importance of these psychological factors in relation to that of the other causal factors which were present in these accidents.

3.5 EXPERIENCE

CYCLING EXPERIENCE

Nineteen of the 22 pedal cycles were owned by the rider, one was owned by a parent of the rider, and two belonged to the rider's friends. Of the 20 cycles owned by the rider or the rider's family, 18 were being used regularly by the accident-involved cyclist. Thus, regardless of pedal cycle ownership, four of the cycles were not being ridden regularly by the cyclist who was involved in the accident.

In two of the four accidents in which the rider was not familiar with the bicycle it seemed unlikely that this had any significant effect on the rider's ability to operate it safely. Although

one of these two cyclists had purchased his bicycle only a few days before the accident (Accident 254), the cycle was very similar to his previous model and the other cyclist (Accident 296) was riding a friend's bicycle, that was the same model as his own, which he rode regularly.

However, for the remaining two of these four cases a lack of recent experience with the pedal cycle did appear to have been an important factor. In Accident 154 the cyclist was a 16 year old girl who had owned the bicycle for six years but had ridden it very infrequently during the two years preceding the accident. This pedal cycle was of the so-called 'hi-riser' design and was intended for use by a much younger and therefore smaller, rider. This physical incompatibility between the rider and the bicycle was compounded by the presence of a pillion passenger, similar in stature to the rider, who was being carried on the same seat. As the speed of the cycle increased when descending a hill the cycle began to wobble and the rider lost control. The pillion passenger jumped off at this stage, possibly accentuating the rider's difficulty in controlling the bicycle. Soon afterwards the rider fell off.

In the other accident in which the rider's inexperience was an important factor (Accident 214) another 16 year old girl, who seldom rode a pedal cycle, lost control and subsequently fell from a friend's bicycle while travelling very rapidly down into a subway. A heavy load attached to the rear carrier of the cycle may have made her task more difficult.

ACCIDENT HISTORY

Seventeen of the 22 pedal cyclists reported that this was the first time that they had been involved in a road accident. Four of the remaining five riders had each been involved in one previous accident, but only one of these was a pedal cycle accident and that was a very minor one. The remaining person, a middle-aged male, recalled being involved in at least three minor accidents as a cyclist. By virtue of his age and his reliance on cycling as a mode of transport his exposure to the risk of being involved in an accident would have been greater than that of many of the other cyclists in this survey, but there was also some evidence that he had been involved in at least one non-vehicular accident. His general background history suggested that he was at least mildly mentally retarded and so it is possible that his accident history may have reflected the less efficient accumulation and processing of information that often characterises the performance of even mildly retarded individuals.

FAMILIARITY WITH THE ACCIDENT ENVIRONMENT

Apart from one person for whom this information was not obtained, only one cyclist could not recall any previous exposure to the accident environment. The accident in which this cyclist was involved (Accident 214) has been discussed under 'Cycling Experience'. Table 4 lists the frequency with which the other cyclists had been exposed to the accident site.

SUMMARY: EXPERIENCE

A lack of familiarity with the pedal cycle, and with the conditions under which it was being used at the time of the accident, was an important causal factor in two of the accidents. Neither of these two cyclists had been riding a bicycle regularly, and both were involved in single vehicle accidents. The accident site itself was not familiar to one of these two riders. Only one of the 22 cyclists had a history of more than one pedal cycle accident.

3.6 ERRORS MADE BY PEDAL CYCLISTS

FAILURE TO ACCOMMODATE TO A VISUAL RESTRICTION

The field of view of 12 cyclists was restricted by some temporary or permanent obstruction. The types of these obstructions are listed in Table 5, together with an indication of their relevance to the causation of the accident.

In two of the six cases in which there was a relevant obstruction to vision there was some doubt as to whether the cyclist even bothered to look in the appropriate direction. Three of the other four cyclists were children who failed to give way to a car at a T-junction. Their view of the car was obstructed by trees, shrubs and/or a garden fence.

SECONDARY ACTIVITIES

Three cyclists could not remember whether they had been trying to pay attention to something other than riding along the road immediately before the accident, but 17 other cyclists were sure that they had not been engaged in any secondary activity. The two remaining cyclists could recall some activity of this type: one was aware of the presence of a vehicle close behind her (Accident 214) and the other was concentrating on a parked vehicle which he had veered to his right to pass (Accident 177). However, neither of these two cyclists appeared to have been involved in their accident because they had not been concentrating fully on riding their bicycles.

TABLE 4: PEDAL CYCLISTS: FREQUENCY OF EXPOSURE TO THE ACCIDENT SITE

Frequency of Exposure	Number of Cyclists
Daily	12
Weekly (1 to 4 times per week)	4
Monthly (1 to 3 times per month)	2
Annually (1 to 3 times per year)	1
Never before	1
Not relevant (Accident 271)	1
Unknown	1
Total	22

TABLE 5: VISUAL RESTRICTIONS: FREQUENCY AND RELEVANCE FOR PEDAL CYCLISTS

Type of Object Restricting Vision	Number of Cyclists	
	All Restrictions	Relevant Restrictions
None	10	16
Moving traffic	4	1
Stationary traffic	1(1)*	1
Roadside objects (man-made)	2	-
Roadside objects (trees, etc.)	2(2)	2(2)
Objects on or beyond property boundaries	3(3)	2(2)
Total	22	22

* number in parentheses indicates a second visual restriction.

INADEQUATE MONITORING OF THE RELEVANT ENVIRONMENT

Six cyclists failed to look carefully enough for approaching traffic, if they looked at all, before they started the manoeuvre that preceded the accident. None of the six were hindered by an obstruction to their view of the other vehicle, or were engaged in any secondary activity.

Five of these six cyclists were attempting to cross to the right hand side of the road from a position close to the left hand kerb when they were hit by a car or a motorcycle. Four of the five were children, aged from nine to 13 years. The fifth was a middle-aged man whose inspection task was made more difficult by the unusually high (90 km/h) approach speed of the striking car. It may be that the frequency of this type of error could be reduced by requiring that pedal cycles be fitted with a rear vision mirror.

The sixth cyclist in this group rode into the side of a car which turned across his path (Accident 284). This rider, a 15 year old boy, was concentrating on moving away from a concrete gutter to avoid a rough section of pavement adjoining the edge of the gutter. It is possible that he could have avoided the turning car had he been watching it when it began to turn.

RIDING WITHOUT LIGHTS AT NIGHT

Two of the three cyclists who were involved in accidents at night were riding pedal cycles which were not fitted with lights. These accidents have been described earlier in this report, where it was noted that the absence of lights on the bicycles was an important factor in the causation of these two accidents. In this context it is interesting to note that only eight of the 22 pedal cycles in this survey were fitted with lights.

FAILURE TO SIGNAL INTENTION TO TURN RIGHT

Ten cyclists should have signalled their intention to make a right turn immediately before they were hit by another vehicle. In five of these accidents any failure to signal would not have made any difference to the eventual outcome. One of these five cyclists said that he did not signal, but we could not be sure whether or not the other four had done so.

The failure of the remaining five pedal cyclists to provide the appropriate hand signal to indicate the intended manoeuvre was a significant error that contributed to their accident involvement. These five accidents, all of which have been discussed in earlier sections, involved pedal cyclists turning right and into the path of an overtaking vehicle. In each of these accidents the driver or motorcyclist said that he had been aware of the presence of the pedal cyclist, but had not received any prior indication of the cyclist's intended manoeuvre. As has been pointed out, four of the five cyclists were children. They were aged from nine to 13 years.

NO APPARENT ERROR

Four, or possibly five, of these 22 cyclists did not appear to have committed any error which was significant in the causation of their accident. One of these accidents was the direct result of an unexpected and disabling medical condition, and in three others the errors of the other party were such that, from the viewpoint of the pedal cyclist, the accident was unavoidable. In the fifth case, the phasing of the traffic signals did not ensure that a cyclist could complete a right turn in safety.

LEGAL RESPONSIBILITY: PEDAL CYCLIST

The frequency and nature of the offences committed by these cyclists against the Road Traffic Act are shown in Table 6. Eight cyclists were thought, by the research team, not to have committed any offence of this type in the accident which was studied. Riding without due care and failure to give way were the two most common offences (allocating no more than one offence to each cyclist). Of the 14 cyclists who were thought to have committed an offence, nine were juveniles, and they are not often prosecuted (although one was; for riding a cycle without a light at night). Three of the five adults in this group of 14 cyclists were involved in accidents in which the other vehicle was exceeding the speed limit by a wide margin. This could have been considered to have been a mitigating factor when deciding whether to charge the cyclist with an offence, but the fact that these cars had been speeding was not recorded by the police officers who attended these accidents. In the two remaining cases involving offending cyclists the driver of the car was charged with an offence, and the cyclist was not. In summary, none of the five adult cyclists who could be shown to have committed an offence against the Road Traffic Act was charged with having done so.

During the follow-up interviews it was learnt that all but one of the 22 cyclists understood correctly those sections of the Road Traffic Act which were relevant to their actions immediately before the accident. This information was not relevant in the remaining accident.

TABLE 6: PEDAL CYCLISTS: OFFENCES AGAINST THE ROAD TRAFFIC ACT

Nature of Offence	Number of Cyclists
Riding without due care	5(4)*
Failure to give way	5(3)
Unlit cycle at night	2(1)
Carrying a passenger on a cycle	1
Overtaking on the left	1
No offence	8
Total	22

*numbers in parentheses are for juvenile offenders.

TABLE 7: DRIVERS AND MOTORCYCLE RIDERS INVOLVED IN PEDAL CYCLE ACCIDENTS: AGE AND SEX

	Sex		
Age (years)	Male	Female	Total
16 - 19	6	-	6
20 - 24	4	-	4
25 - 34	2	1	3
35 - 44	1	-	1
45 - 54	2	1	3
Over 54	-	-	-
Total	15	2	17

4. CHARACTERISTICS OF THE DRIVERS

This section contains a brief review of the relevant characteristics of the drivers and riders whose vehicles collided with a pedal cycle. As noted earlier in this report, four of the pedal cycle accidents involved only the cyclist, and so there were 18 collisions with other vehicles. In one accident (157) the collision was with an opening door of a stationary car.

AGE AND SEX

There were 15 males among the 17 drivers or riders whose vehicles collided with a pedal cyclist (Table 7). The driver who opened a car door in the path of a cyclist was also a male. Ten of the 15 male drivers of a moving motor vehicle were under 23 years of age.

ALCOHOL INTOXICATION

Blood alcohol levels were obtained for 14 of these 17 drivers or motorcycle riders. The other three drivers all appeared to have been sober at the time of the accident. Two drivers had positive BACs: one at 0.03 and the other at 0.04. In each of these two cases the driver's moderate level of intoxication was unlikely to have contributed significantly to the causation of the accident.

LEGAL RESPONSIBILITY: DRIVER

As noted earlier in this report, the cyclist who rode into an opened door was operating a bicycle without lights at night. He was not charged with this offence, but the driver of the car was charged with opening a door to endanger another road user.

Seven of the other seventeen drivers or riders were considered by the research team to have committed an offence against the Road Traffic Act. Three of these offences were 'fail to stand' and one was 'fail to give way' and all four drivers were charged with the appropriate offence. Three other drivers were exceeding the urban area speed limit by a wide margin, but the relevant physical evidence (skid marks due to braking) was not recorded by the investigating police officer and so no charges were laid. The estimated speed before braking for these three cars ranged from 85 to 95 km/h.

TABLE 8: OVERALL INJURY SEVERITY FOR EACH TYPE OF ROAD USER

Type of Road User	Overall Injury Severity (Per Cent)*							Total Number of Cases
	Nil	Minor	Moderate	Severe	Serious	Critical	Fatal	
Pedestrian	2.3	25.0	20.5	29.5	11.4	4.5	6.8	44
Pedal Cyclist	4.3	21.7	39.1	21.7	8.7	4.3	-	23
Motorcyclist	3.7	37.5	30.0	16.2	7.5	-	5.0	80
Car Occupant	52.0	32.9	11.0	2.1	1.1	0.8	0.1	727
Occupant of Light Commercial Vehicle	53.3	20.0	26.7	-	-	-	-	15
Occupant of Heavier Commercial Vehicle	81.0	14.3	4.8	-	-	-	-	21
Bus Occupant	18.2	72.7	9.1	-	-	-	-	11
All Road Users	44.5	32.5	13.9	5.0	2.3	1.0	0.9	921

*Note: The figures for bus occupants show a higher average severity of injury than was actually the case. This is because in one accident the bus was carrying a large number of passengers, possibly as many as sixty, and when the bus stopped after the collision almost all of these passengers transferred to a following bus within a minute or so. Ten car occupants are also not represented in this Table because we were unable to examine them after the accident. One of them probably was injured, the others almost certainly were not.

TABLE 9: PEDAL CYCLISTS: FREQUENCY AND SEVERITY OF INJURY BY BODY REGION

Body Region	All Injuries		Severe* Injuries	
	Per Cent	No. of Persons	Per Cent	No. of Persons
Head	21.2	15	23.5	3
Face	14.9	12	11.8	2
Neck	2.1	2	5.9	1
Shoulder	6.4	6	-	-
Upper Arm	-	-	-	-
Elbow	4.3	4	-	-
Forearm	3.2	3	-	-
Wrist/hand	8.5	5	-	-
Back	2.1	2	-	-
Chest	3.2	3	5.9	1
Abdomen	3.2	1	17.6	1
Pelvis	3.2	3	-	-
Thigh	9.6	7	23.5	4
Knee	6.4	5	-	-
Lower leg	6.4	5	11.8	2
Ankle/foot	5.3	5	-	-
Total Injuries: %	100.0	-	100.0	-
: No.	94	-	17	-

* AIS $\geq$ 3.

TABLE 10: PEDAL CYCLISTS: FREQUENCY AND SEVERITY OF INJURY BY OBJECT CONTACTED

Object Contacted	All Injuries			Severe* Injuries		
	Contacts		Persons	Contacts		Persons
	No.	%	No.	No.	%	No.
Bonnet, upper surface	8 [1#]	8.5	3	1	5.9	1
Bonnet, leading edge	7 [1]	7.4	6	2	11.8	2
Front bumper	3	3.2	3	2	11.8	2
Front mudguard, leading edge	1	1.1	1	1	5.9	1
Windscreen glass	2 [1]	2.1	1	-	-	-
Front corner post (A pillar)	1 [1]	1.1	1	-	-	-
Side doors (exterior)	3	3.2	1	-	-	-
Side door (open, interior)	1 [1]	1.1	1	-	-	-
Front wheel/tyre	4	4.3	1	4	23.5	1
Other front of car	1 [1]	1.1	1	-	-	-
Pedal cycle	6 [1]	6.4	5	1 [1]	5.9	1
Motorcycle chain guide	1	1.1	1	-	-	-
Road surface	54 [3]	57.4	20	6	35.3	3
Object not known	2	2.1	2	-	-	-
Total contacts:	94 [10]	100.1	-	17 [1]	100.1	-

* AIS ⩾ 3.

\# Superscript indicates number of listed contacts rated as 'possible'.

5. THE CONSEQUENCES OF PEDAL CYCLE ACCIDENTS

5.1 THE INJURIES

The overall severity of the injuries sustained by cyclists is reviewed in this section, together with the nature of the injuries and the objects which were contacted by each cyclist.

OVERALL INJURY SEVERITY

The distribution of overall injury severity for each category of road user in this survey is listed in Table 8. It can be seen in this Table that, apart from fatal cases, pedal cyclists tended to receive more severe injuries than any category of road user other than pedestrians. Over 34 per cent of the pedal cyclists sustained severe injuries, compared to 52 per cent for pedestrians, 29 per cent for motorcyclists and four per cent for car occupants. One pedal cyclist, a pillion passenger, was not injured.

INJURY SEVERITY SCORE

Whereas 61 per cent of pedal cyclists in this survey had an Injury Severity Score (ISS) which was greater than 4, the corresponding percentage for pedestrians was 61, with 53 for motorcyclists and 13 per cent for car occupants.

BODY REGIONS INJURED

The average number of injuries for the 22 pedal cyclists who were injured was between four and five. One cyclist sustained more than the nine separate injuries which can be coded in the crash injury computer file used in this study. The severely injured cyclists, as would be expected, had a higher mean number of injuries per person (between five and six) of which, on average, two were rated as being severe or even more serious.

The frequency of injury to each body region is shown in Table 9. As was the case with the pedestrians in this survey, 80 per cent of the injuries sustained by these cyclists were to the extremities (arms and legs) or to the head or face. The head was the most frequently injured body region, with concussion accounting for 70 per cent of these injuries. Although the face was the second most frequently injured body region, the injuries were mostly minor, two thirds of them being abrasions.

Almost half of the severe, or worse, injuries were sustained by one cyclist, the 13 year old boy in Accident 254. His injuries comprised brain damage, a flail chest and a ruptured diaphragm (all rated 4 on the AIS severity scale), a ruptured spleen, a fracture of the cervical spine, a compound fracture of the skull, a lacerated mesocolon, and damage to the facial nerve (all AIS = 3), fractures of the maxilla, clavicle and scapula, and abrasions over the trunk, upper arms, face and head. As noted above, the computer data file from which Table 9 has been constructed allows for the recording of only the nine most severe injuries. Consequently several significant injuries to this cyclist do not appear in that Table.

The most common severe injuries were severe concussion or brain damage (four cases) and fractures of the femur (also four cases).

5.2 OBJECTS CAUSING INJURY

In the companion report on pedestrian accidents the difficulties inherent in determining what object caused a specific injury were discussed in some detail. Once again, the association of a given object with a particular injury has been rated as 'certain', 'probable' or 'possible'. We have found it necessary to assign a 'possible' rating in ten instances and 'unknown' in two others (Table 10).

ROAD SURFACE

Contacts with the road surface were the direct cause of more than half of all injuries, and of more than one third of the severe (AIS $\geq$ 3) injuries. The most common injury from this cause was abrasions, which were often extensive, but the six severe injuries were all to the head, face or neck. Four of these six severe injuries were to one person, the 13 year old cyclist in Accident 254. The exact kinematics of that collision are not certain, but it appeared as though his cycle, which was hit on the left side by the front of the car (Frontispiece), became trapped under the front bumper and was pushed along for 60 metres. At about 15 metres from the collision point the left front wheel of the car ran up over the concrete kerb at the corner. The child's head and facial injuries were probably caused by his being shunted into this kerb while still entangled with the bicycle which was under the front of the car. He came to rest some ten metres further on but the car, still dragging the bicycle, did not stop until it had travelled a further 35 metres. The cyclist's internal injuries, comprising a flail chest, ruptured diaph-

ragm, ruptured spleen and torn mesocolon, may also have been caused during this kerb impact but were probably a more direct result of being run over by the left front wheel of the car. These internal injuries, the first two of which made breathing extremely difficult, could well have been fatal in the absence of readily available emergency care. The multiplicity and severity of the injuries inflicted on this cyclist were almost entirely attributable to the unexplained failure of the driver of the car to stop as soon as possible (which should have been within about 10 metres) after the collision.

The other two severe injuries attributable to contact with the road surface were a fractured mandible and broken teeth (in Accident 154) and severe concussion in Accident 276.

UPPER SURFACE OF BONNET

The three cyclists who had injuries which were due to contact with the upper surface of the bonnet were all concussed as a consequence of this impact. In two cases the cyclists were of similar age and stature and were hit by the same make and model of car (a Ford Falcon). The head impact in each accident was located on the grille covering the plenum chamber, just to the rear of the bonnet itself. In Accident 023 one or two hairs were stuck to the deformed panel (Figure 7), whereas in Accident 250 a small blood stain matched up with a small laceration on the cyclist's scalp (Figure 8). The impact speed, as estimated from the location of debris and from the statement of a witness in relating the collision point to the end of the braking skid marks, was about 50 km/h in Accident 023, and about 60 km/h in Accident 250. These speed estimates may be in error by as much as 10 to 15 km/h, but it seems to be probable that the impact speed in the latter case was the higher of the two because the head impact point was slightly further back and part of the force of the impact was taken by the base of the windscreen. This may account for the more severe concussion sustained by this cyclist, compared to the one in Accident 023, since the base of the screen is a far more rigid structure than the grille over the plenum chamber.

The windscreen was shattered in Accident 250, but not in Accident 023. This difference was reflected in extensive, though minor, scalp lacerations which were attributed to the shattered glass in Accident 250, and the absence of such lacerations in Accident 023. But both cars had minor damage to the leading edge of the roof, above the windscreen (Figure 8, arrowed) which suggests that some part of the cyclist contacted that area of the exterior of the car in each accident.

The forward part of the bonnet of the car was more severely damaged in Accident 023 than in Accident 250. This damage was likely to have been associated with bruising of the cyclist's lower back and hip.

LEADING EDGE OF BONNET

Two of the injuries resulting from impacts with the leading edge of the bonnet were rated as being severe; they were both fractures of the femur. In Accident 031 the ten year old cyclist failed to yield to a car at a T-junction. His right thigh was struck by the leading edge of the bonnet, which fractured his femur. The bonnet of the car, a 1965 XP model Ford Falcon, was virtually undamaged. In Accident 226, the bonnet of a 1963 EH Holden was deformed, but the 14 year old cyclist, who had also failed to yield at a T-junction, sustained a fracture of the right femur.

LEADING EDGE OF THE FRONT MUDGUARD

This section of a car is often similar in shape to the leading edge of the bonnet, but may have a more rigid underlying structure. The injury potentials of these two parts of the car are similar, however, as is illustrated by the preceding examples and Accident 276, in which a nine year old boy turned across in front of an overtaking car. The slightly-protruding left front corner of the car (Figure 9), a 1972 Toyota Corona, struck the child high on his right hip. The resulting superficial injury was slight (Figure 10) but his femur was fractured at the top of the shaft.

FRONT BUMPER BAR

The two severe injuries caused by the front bumper bar were both fractures of the lower leg. In Accident 023, which was discussed in connection with the upper surface of the bonnet, the rider sustained a compound fracture of the tibia and fibula. In Accident 226, also noted above, the young cyclist received a simple fracture of the tibia in addition to a fractured femur.

PEDAL CYCLE

Most of the injuries caused by some component of the pedal cycle were minor, and were a result of the bicycle being impacted by the striking car and, in turn, impacting the rider's leg which was not trapped between the bicycle and the car. In Accident 177 the ten year old cyclist's left femur was fractured, even though his bicycle was struck on the right hand side. The most likely cause of this injury was the long seat on his 'hi-riser' bicycle, although there may have been a subsequent impact with the front corner post of the car.

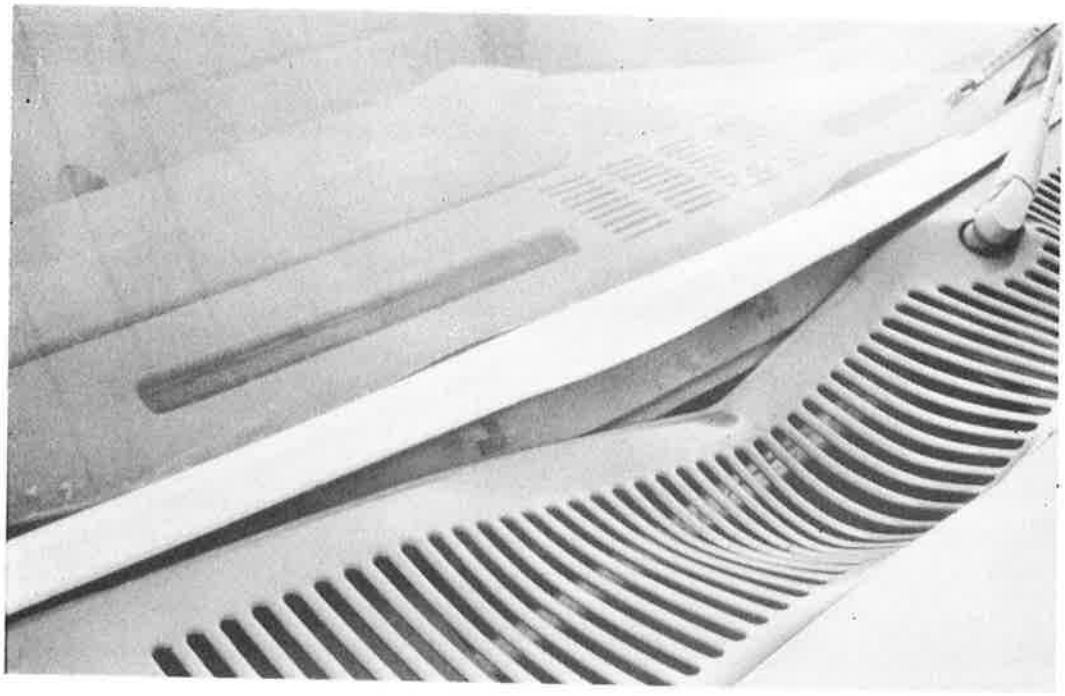


FIGURE 7: Damage resulting from impact by cyclist's head. Accident 023.

FIGURE 8: Damage resulting from collision with cyclist. Note small dent in trim above windscreen (arrowed). Accident 250.

FIGURE 9: Damage to car in Accident 276. Note buckling of panel above wheel arch. Impact point corresponding to mark on cyclist's thigh (Figure 10) is arrowed.

FIGURE 10: Cyclist injured in Accident 276. Note abrasions to back from the road surface and mark on thigh, over site of fracture of femur, due to the leading edge of the front mudguard. (See also Figure 9.)

5.3 KINEMATICS OF THE CAR-PEDAL CYCLE COLLISION

The motions of a cyclist when hit by a car were described in the report on the first Adelaide in-depth study (Robertson et al., 1966). The accidents reported here were consistent with this earlier description. The pedal cyclist experiences a similar sequence of impacts to that of the pedestrian, with the exception that the cyclist, being slightly higher off the ground, tends to receive fractures of the femur rather than of the pelvis. The risk of injury to the cyclist's lower leg is determined largely by the position of the pedal when the rider is hit by the front of the car. If the pedal is high, the rider's foot will be at or above bumper height in the case of a full-size bicycle.

5.4 CONSEQUENCES OF INJURIES TO PEDAL CYCLISTS

LENGTH OF HOSPITAL STAY

Sixty-one per cent of these cyclists were admitted to hospital as a result of being involved in the accident. One third of those who were admitted were there for less than one week, but half of them were still hospitalized one month after their accident.

PERIOD OF RESTRICTION OF NORMAL ACTIVITIES

One cyclist was not injured, and four others were not incapacitated in any way by their injuries. Three others were restricted from carrying out their normal activities for less than one week, six for up to three weeks, and seven for more than three months. One of the two cyclists for whom this information was not obtained would be expected to have been incapacitated for more than three months.

EXTENT OF RESIDUAL DISABILITY

Two-thirds of these cyclists had no residual disability as a consequence of the accident. Seven riders were left with a minor permanent disability and one, a child, was severely disabled.

5.5 CRASH HELMETS FOR CYCLISTS

Most of the head injuries sustained in these accidents could have been prevented, and the severity of the remainder lessened, had the cyclist been wearing a suitable crash helmet. Consequently there is a need to encourage cyclists to wear a crash helmet and to make available the information necessary for them to be able to select a helmet which will provide an adequate level of protection. The current Australian Standard for General Purpose Protective Helmets (AS 2063) was developed to meet the needs of the pedal cyclist, among other users, and helmets advertised as being for use by cyclists should be required to comply with this Standard and, accordingly, to carry the Standards Association of Australia seal.

Such helmets are not readily available for adults and the situation is even worse for children. Furthermore, the retail prices of apparently suitable helmets is often exceptionally high when compared to that for the more substantial helmet designed for use by motorcyclists. If the availability of helmets for cyclists can be improved, schools would appear to have a useful role to play in encouraging children to wear a crash helmet when cycling to and from school. They may even be able to institute rental schemes whereby the school owns the helmets which are then rented to the children. A scheme of this type could overcome the difficulties inherent in providing a well-fitting helmet for a rapidly-growing child over a period of several years by ensuring that the 'pool' of helmets contains a suitable range of sizes.

6. THE PEDAL CYCLE

6.1 PRIMARY SAFETY

CONSPICUITY OF THE CYCLE

Measures which increase the conspicuity of the pedal cycle itself are likely to be more effective than those which are intended to make the cyclist more conspicuous, if only because the latter rely primarily on the cyclist being willing to, or remembering to, wear brightly-coloured clothing or a special garment such as a fluorescent orange vest. The characteristics of the bicycle,by comparison, are less subject to change from day to day.

Two of the three bicycles involved in accidents at night in this survey did not have lights, nor did almost two-thirds of the total sample of 22 cycles. These observations tend to support the provision, as original equipment, of reflectors on the pedals and on the wheels, as specified in the Australian Standard for pedal cycles (AS 1927).

Conspicuity by day can be increased by the fitting of fluorescent orange safety flags mounted on flexible rods. In addition to attracting a driver's attention to the presence of the cyclist, these flags can be seen over the top of a car, which can warn a driver that a cyclist may be about to cross his path from behind a stationary car at an intersection. This can be of particular value in the case of the small child cyclist, who may not be able to see over the top of the stationary car.

BRAKING PERFORMANCE

One of the cyclists in this survey was aware of the possibility of an impending collision, but when he tried to stop he was unable to do so because the calliper brakes on his bicycle were adversely affected by water on the wheel rims (Accident 069). This indicates a need to amend the relevant Australian Standard (AS 1927) to incorporate a required level of braking performance in wet weather, as recommended in the report on motorcycle and bicycle safety by the House of Representatives Standing Committee on Road Safety.

HANDLEBAR TYPE AND WIDTH

With one exception, none of the cyclists in this survey was involved in their accident because of any characteristics of the handlebars fitted to their bicycle. The exception was an accident (154) in which two teenage girls fell from a child's bicycle while travelling down a steep hill. This bicycle was fitted with both 'hi-riser' handlebars and a 'sissy bar' at the rear of the seat. It is likely that the 'sissy bar' made it very difficult for the passenger to jump off the bicycle, which she did when she thought the rider had lost control, and the handlebar type may have accentuated the rider's difficulties. The major factor in this accident, however, was the attempt by two girls to ride fast on a bicycle which was too small for either one of them riding alone.

TABLE 11: TYPES OF HANDLEBARS ON PEDAL CYCLES BY TYPE OF ACCIDENT

Type of Handlebar	Type of Accident		Total
	Single Cycle	Collision with Motor Vehicle	
Dropped, or racing	2	6	8
Touring	1	3	4
Straight	1	3	4
Straight (wide)	-	2	2
Hi-riser	1	3	4
Total	5	17	22

The types of handlebars on these 22 pedal cycles are listed in Table 11 together with the type of accident. There was no obvious association between handlebar type and accident type, although the number of accidents is very low in most of the cells in this Table.

REAR VISION MIRROR

The cyclists who were involved in an accident because they turned across the path of an overtaking vehicle may not have acted in this way had they had available, and made use of, an effective rear vision mirror on their bicycle.

EFFECT OF LOAD ON STABILITY

A heavy school bag strapped to a rear carrier may have been a factor in a school girl losing control of a bicycle on a fast down hill run in one of the accidents in this survey (Accident 214). The effects of such loads on the stability of a bicycle are worthy of further investigation.

6.2 SECONDARY SAFETY

The role of the pedal cycle in injury causation appears, on the basis of the information available in these accidents, to be of relatively minor importance when compared to the characteristics of the striking vehicle and to the consequences of the cyclist being thrown to the road surface. The one severe injury that may, possibly, have been due to the bicycle being accelerated sideways by the striking car has been noted in Section 5.2 of this report (Accident 177).

7. ROAD AND TRAFFIC FACTORS

About two-thirds of these accidents occurred on arterial roads or on central-city traffic routes. Six accidents happened on local-access streets in residential areas and the remaining two accidents were on residential streets which were used as collector roads.

All of the accidents on residential streets or collector roads involved cyclists who were under 18 years of age and who were legally at fault. The accidents on arterial roads or city traffic routes were more likely to have been a consequence of errors made by both the cyclist and the driver or rider of the other vehicle. The three cars which were travelling well in excess of the speed limit were on arterial roads.

BICYCLE PATHS, FOOTPATHS AND RIDING AGAINST THE TRAFFIC

Separation of the cyclist from motorized traffic would obviously reduce the frequency of many of the collisions of the types observed in this survey. Bicycle paths perform this function of separation but it is not always, or even often, practicable to provide such paths.

Making it legal for cyclists to ride on the footpath rather than on the road itself, and encouraging them to do so, can be regarded as a partial substitute for separate bicycle paths. There are at least two potential safety problems associated with the use of the footpath by a cyclist: the risk of a collision with a pedestrian and with a vehicle entering or leaving private property, but neither of these two types of collision is likely to be as severe as those which now occur on the road itself. Furthermore, not all footpaths are suitable for cycling, for reasons such as non-mountable kerbing at intersections. Even so, the child cyclist might well be required to ride on the footpath wherever it is practicable for them to do so, if only because by so doing following drivers would be given considerably more warning that the young cyclist is turning across their path than is now the case.

Unexpected turning manoeuvres by child cyclists might be reduced in frequency if it were legal for the cyclist to ride on the right-hand side of the road, against the traffic flow. The natural initial reaction to such a suggestion is one of alarm or incredulity but, if adopted, it would not have much effect on the severity of any collision which did occur and it would make it much more likely that the cyclist would be looking at the approaching vehicles and thereby less prone to turn suddenly across their path.

QUALITY OF THE ROAD SURFACE

The road surface appeared to play only a minor role in the causation of these pedal cycle accidents (see Accident 284). Nevertheless the pedal cycle is affected more by irregularities in the road surface than is any other vehicle. Consequently there is good reason to pay particular attention to the quality of the surface at the sides of the carriageway, thereby enabling the cyclist to keep well to the left and at the same time not to be distracted by having to watch for irregularities in the road surface.

PHASING OF TRAFFIC SIGNALS

A major factor in one of the accidents (107) in this survey was the inability of a cyclist when turning right to clear a signalised intersection before oncoming traffic was free to move. The difficulties which slowly-moving vehicles may have at some signalised intersections are well-known, but are not always adequately provided for. The pedal cyclist is at a particular disadvantage because, unlike a heavy vehicle such as a truck, it is not easy for other drivers to see that the cyclist is still in the intersection.

CONTROL OF TRAFFIC SPEEDS

It is obvious that many of these accidents were a consequence, in part, of the considerable difference in travelling speeds between the pedal cycle and a car or motorcycle. A reduction in the urban area speed limit of 10 km/h, from 60 to 50 km/h, may be accompanied by a reduction of perhaps one-seventh in the frequency of pedal cycle accidents, based on the accidents investigated in this survey. The impact speeds in those collisions which still happen are also likely to be reduced and this would result in less severe injuries being inflicted on the cyclists.

The three accidents in which a car was exceeding the 60 km/h speed limit by a wide margin (25 to 35 km/h) are not included in the above estimated reduction in accident frequency since such behaviour is unlikely to be affected significantly by a 10 km/h reduction in the speed limit. There is a strong case for attempting to reduce the frequency of driving offences of this type, because the speeding driver may well be as great a hazard to other road users as the one who is intoxicated.

8. CONCLUSIONS

Many of these accidents were the result of a careless, impulsive manoeuvre by a child cyclist. Their accidents were very similar, in this respect, to those involving child pedestrians, except that the young cyclists were involved in accidents on residential streets, whereas the corresponding pedestrian accidents were all on arterial roads.

The adult cyclists were involved in accidents on arterial roads or on traffic routes in the central city. While most of them made some error which contributed to, or was the major cause of, their accident-involvement, the driver of the car also was likely to have been driving in an unsafe manner.

Three-fifths of the drivers or motorcyclists whose vehicles collided with a pedal cycle were males under 23 years of age. Drivers who committed an offence against the Road Traffic Act were much more likely to be charged than were the cyclists, even allowing for the fact that most of the offending cyclists were juveniles.

Neither alcohol intoxication nor the effect of any other drug was a relevant factor in any of these accidents.

Eight cyclists were relatively inconspicuous when viewed from the approach path of the other party in the collision. Most of these eight riders were adults.

Almost all of the cyclists were injured, and those who were sustained an average of four to five separate injuries per person. The head was the most frequently injured body region, with 90 per cent of these injuries being concussion. One fifth of the riders were hospitalized for more than a month; one third were prevented, by their injuries, from carrying out their normal activities for a period of more than three months, and a similar proportion were left with a permanent disability which in one case was severely incapacitating.

One half of the injuries sustained by these cyclists were caused by contact with the road surface, but two-thirds of the severe injuries were caused by the striking vehicle. The front bumper bar and the leading edge of the bonnet and front mudguards were associated with these severe injuries. The upper surface of the bonnet and the area immediately to the rear, at the base of the windscreen, were contacted by some cyclists, and these impacts were likely to be to the cyclist's head.

The style of the handlebars fitted to the pedal cycle did not appear to be an important factor, with one possible exception. The poor braking performance of calliper brakes in wet weather was the direct cause of one cyclist's inability to avoid a collision which he had anticipated was likely to occur. Another accident may have resulted largely from the unstabilising effect on the cycle of a heavy load on the rear carrier.

The customary road and street layout which makes no provision for separating the cyclist from other vehicular traffic was an underlying factor in many of these accidents. In one accident an irregularity in the road surface near the kerb distracted the cyclist just as a car turned across his path, and the phasing of the traffic signals did not allow enough time for a cyclist to clear a major intersection. Drivers who were exceeding the speed limit by a wide margin contributed to the occurrence of three collisions and the excessive speeds of their cars probably increased the severity of the cyclists' injuries.

9. RECOMMENDATIONS

Child cyclists are often involved in accidents because they turn, without signalling or looking, across the path of an overtaking car. Even though this essentially impulsive behaviour may be difficult to modify, it is recommended that:

> *Road safety programmes for child cyclists emphasise the need to look for overtaking traffic and then to signal before starting to turn across a road when the way appears to be clear.*

Although the cyclists involved in these accidents were aware of the relevant sections of the Road Traffic Act, only one of the 15 who committed an offence against this Act was prosecuted. On the assumption that this failure to lay charges is likely to encourage continuing disregard of the road traffic laws by these cyclists, we endorse the recommendation of the House of Representatives Standing Committee on Road Safety that:

> *Stricter enforcement of road rules applying to cyclists be implemented.*

Physical separation of the cyclist from other vehicular traffic would eliminate the possibility of the occurrence of many of the collisions observed in this survey. For this reason it is recommended that:

> *The provision of bicycle paths be encouraged in established areas, and be required in new developments.*

Because of the obvious difficulties in providing bicycle paths in established areas, it is recommended that:

> *It be made legal for a cyclist to ride on the footpath and that, subject to adequate warning of the risk of collisions with pedestrians and with vehicles entering and leaving private driveways, cyclists be encouraged to use the footpath rather than the roadway whenever it is convenient for them to do so.*

Child cyclists, as noted above, are often involved in accidents because they turn, without looking, across the path of an overtaking car. Consequently it is recommended that:

> *Consideration be given to an evaluation of the safety implications of allowing cyclists to ride on the right hand side of the road, adjacent to the kerb, so that they are looking towards, rather than away from, approaching motor vehicles.*

The inability of a cyclist, who was turning right, to clear a signalised intersection before oncoming traffic was free to move was an important factor in one of the accidents in this survey. The need to allow for slow-moving vehicles when setting the phasing of traffic signals is well-known, but this accident indicates that:

> *There is a need to ensure that the phasing of traffic signals allows sufficient time for a slow-moving vehicle such as a pedal cycle to clear the intersection safely.*

Many of these accidents were, in part, a consequence of the difference in travelling speeds of the pedal cycle and the other vehicle. If this speed differential were reduced, some of these accidents may have been avoided and the severity of the cyclist's injuries would have been reduced in those accidents which still occurred. Therefore it is recommended that:

> *Consideration be given to a reduction of the urban area speed limit from 60 to 50 km/h.*

Three drivers were unable to avoid a pedal cyclist partly because they were travelling at a speed far in excess of the speed limit. The speeding driver may be as great a hazard to other road users as the one who is intoxicated. Therefore it is recommended that:

> *Measures that can be shown to be effective in reducing the frequency with which drivers travel at a speed far in excess of the speed limit be strongly supported.*

The quality of the road surface was not a major factor in the causation of any of these accidents, but it did play a role in one case. Nevertheless it appears to be reasonable to expect that the cyclist will be more likely to keep well to the left, and less likely to be distracted by the need to watch for irregularities in the road surface, if that part of the roadway is well maintained, and so it is recommended that:

> *An assessment be made of the extent to which the quality of the road surface adjacent to the kerb has safety implications for the pedal cyclist.*

The cyclist was relatively inconspicuous in eight of these collisions, and most of these eight riders were adults. While some measures can be taken by the cyclist to improve his conspicuity, such

as by wearing an orange vest, it is likely that improvements to the conspicuity of the bicycle will be more effective, if only because they are present regardless of any action on the part of the rider. The Australian Standard for Pedal Cycles (AS 1927) includes specifications for the placement of reflectors on cycles, and so it is recommended that:

> *Compliance with AS 1927 be required under Section 62 of the Trade Practices Act.*

This recommendation was also made by the House of Representatives Standing Committee on Road Safety. (Section 62 prohibits the supply of goods which the Minister has declared to be unsafe.)

In these accidents more cyclists were inconspicuous in the daytime than at night. The daytime conspicuity of a bicycle is enhanced by the fitting of a fluorescent orange pennant mounted on a 1.5 metre high flexible wand, and so it is recommended that:

> *The fitting of fluorescent orange safety flags to pedal cycles be encouraged by appropriate publicity campaigns.*

One cyclist was unable to avoid a collision because his calliper-type brakes were not effective when wet. This case reinforces the recommendation of the House of Representatives Standing Committee that:

> *The Standards Association of Australia give serious consideration to amending Australian Standard 1927 (1978) to provide for appropriate levels of wet weather braking performance.*

Because child cyclists often turn without first looking for following traffic, it is recommended that:

> *An evaluation be made of the value of a rear vision mirror on a bicycle.*

A heavy load on a rear-mounted carrier may have contributed to the loss of stability of a bicycle on a steep downhill slope. It is therefore recommended that:

> *The effects of the location and method of attachment of a heavy load on the stability of a bicycle be investigated with a view to the development of recommendations for safe load-carrying practices.*

Head injuries were the most common type of injury sustained by these cyclists, and most of the severe head injuries were caused by striking the head on the road. This emphasises the need for adequate head protection, and so it is recommended that:

> *Compliance with the Australian Standard for General Purpose Protective Helmets (AS 2063) be required for any helmet advertised or sold for use by cyclists, and that cyclists be encouraged to wear such a helmet.*

At least three factors act to limit the use of crash helmets by cyclists. These are: cost, availability and, for children, a need for periodic changes in the size of the helmet to ensure a satisfactory fit. Consequently it is recommended that:

> *An investigation be conducted into ways to reduce the price and increase the availability, particularly for children, of crash helmets which comply with AS 2063, and that, when suitable helmets become available, schools consider instituting rental schemes for cyclists' crash helmets for use by their students who cycle to and from school.*

The front of the striking car caused most of the severe injuries sustained by the cyclists in these accidents. The leading edge of the bonnet and front mudguards fracture the cyclist's femur and the area at the base of the windscreen is struck by the cyclist's head. Consequently,as in the companion report on pedestrian accidents, it is recommended that:

> *At the initial design stage, account be taken of the need to reduce greatly the injury potential of the front of the car, extending back as far as the windscreen.*

REFERENCES

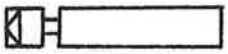
House of Representatives (1978), *Motorcycle and Bicycle Safety*, Report of the Standing Committee on Road Safety, Australian Government Publishing Service, Canberra.

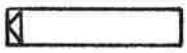
Robertson, J.S., McLean, A.J. and Ryan, G.A. (1966), *Traffic Accidents in Adelaide, South Australia*, Australian Road Research Board, Vermont, Victoria.

Standards Association of Australia (1978), *AS 1927: Pedal Cycles*, Standards Association of Australia, North Sydney.

Standards Association of Australia (1977), *AS 2063: General Purpose Protective Helmets (For Use in Pedal Cycling, Horse Riding and Other Activities Requiring Similar Protection)*, Standards Association of Australia, North Sydney.

APPENDIX: Legend for Scale Plans.


Semi-trailer


Bus


Car


Small car

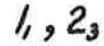
Motor cycle/
Pedal cycle


Motor cycle on side


Pedal cycle on side

Subscripts denote
accident sequence

Person



Unit number with
subscript indicating
time sequence

Uninvolved vehicle

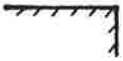
Separation line

Kerb/Stop line

Unkerbed pavement edge

Lane markings

Boundary/Fence


Building

Traffic signals

Type of street lamp:

fluorescent


mercury vapour

sodium vapour

incandescent

Utility pole


Tree