DO YOU SEE WHAT I SEE? THE ACCURACY AND RELIABILITY OF OBSERVER ACCOUNTS OF VEHICLE MANOEUVRES

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ABSTRACT

It is intuitive that the overall safety of a road network (and indeed, other transport systems) is highly reliant upon its users making sound assessments of the speed, orientation and direction of travel of fellow users, for example when crossing the road as a pedestrian or when negotiating an intersection as a car driver.

Additionally, how accurately and reliably people estimate the speed of moving vehicles when viewed from different angles, and at what angles estimates of speed are typically most accurate are of considerable interest when considering the role and implications of eye witness (lay) evidence in the conduct of police investigations in criminal and civil legal cases.

Considerable research and experiment have been conducted into both of the aforementioned areas, with specific interest tending to be in the sex, age and experience of observers, and the specification of vehicles used, although it appears that much of it has been undertaken outside of Australia. This paper details research conducted as part of the test track day of the 3rd International Road Surface Friction Conference, which was held in Australia in May 2011.

INTRODUCTION

The 3rd International Road Surface Friction Conference was hosted by ARRB Group on the Gold Coast, Australia, from 15 to 18 May 2011. Day 3 of the conference saw the hosting of a test track / technical demonstration day at the Queensland Department of Transport and Main Roads' (TMR) Mount Cotton facility.

During the day delegates witnessed a demonstration of crash investigation techniques, the undertaking of a number of 'skid to stop' (friction) tests in various conditions and vehicle configurations, and the display of mobile and static skid resistance test devices. A record of the day's activities and findings can be found at the ARRB Group website (www.arrb.com.au) or on www.saferroads.org.au.

Within the same general time frame as the 'skid to stop' testing, delegates were also invited to participate in an observation and recollection exercise, designed by the authors, the details and results of which are the subject of this paper.

The objectives of the exercise were to gain:

- further awareness of the factors in the accuracy and reliability of eye witness observations
- specific data as to the accuracy of the assessment of the speed of a vehicle from various viewpoints
- further awareness of the recollection of 'secondary' parameters in a vehicular scenario, i.e. the clothing being worn by a driver, how many passengers were in the vehicle etc.

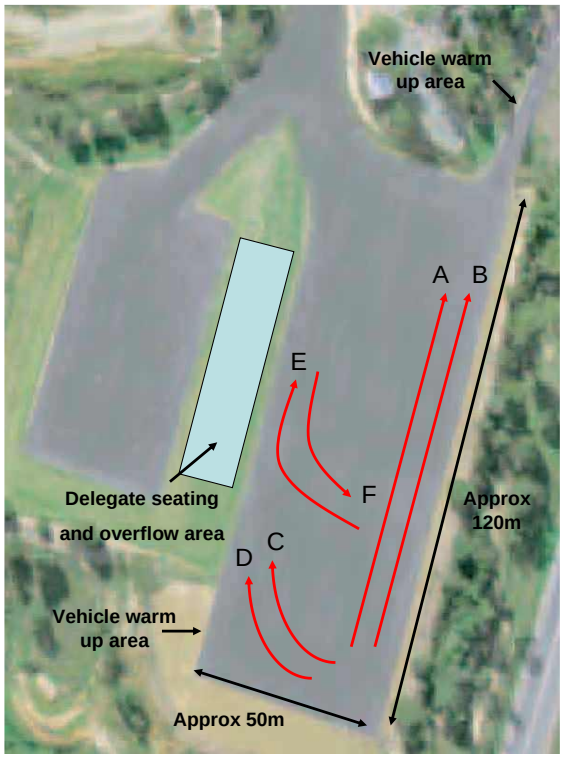
A total of six test runs were undertaken as part of this exercise. Further details are provided later in the paper. Seventy-four delegates participated, with each providing a return on a

dedicated results sheet with the format as shown in Appendix A. This constituted a very high percentage of the total number of delegates attending the test track day[1], even though it was explained that participation was optional.

Delegates were provided with no advanced warning of the first test run and only minimal briefing ahead of each of the remaining five test runs; sufficient to ensure that delegates were ready to record data by having the dedicated form and a writing instrument readily available. No advance briefing (either verbally, or as could be derived from information on the dedicated results sheet) was provided as to what manoeuvre was going to occur in each of the test runs, or what additional questions were going to be posed.

THE TEST AREA LAYOUT

The test runs were undertaken on a controlled test area, known as the Vehicle Manoeuvring Area (VMA) at the Mount Cotton test facility, which has the approximate dimensions of 120 metres (length) by 50 metres (width). Delegate seating was provided to the west of the VMA. This area and the orientations / directions of the six test runs (reference A to F) are shown in plan in Figure 1. Electronic speed measurement devices were used for each test run. The maximum viewing distance for delegates was approximately 50 metres (test runs A and B). Test runs E and F saw the test vehicle travel to within 20 metres of the delegates.



(source of underlying map: Google Earth)

Figure 1: Test area layout

Figures 2, 3 and 4 provide photographs of the test area.

[1] Although the exact number of delegates attending the Mount Cotton day was not determined, the attendance was estimated at 100 people. If this estimate is accepted, a participation rate in excess of 70% resulted, a highly pleasing result that far exceeded the authors' original expectations.

Figures 2, 3 and 4 (top to bottom): Photographs showing views of the test area and delegate observation position

THE VEHICLE

The vehicle used for this research was a new (2011) Holden Commodore sports sedan, and is shown in Figure 5. It was colloquially referred to during the testing as 'the bandit vehicle'. The vehicle, which was driven by one of the authors, Mr Grant Johnston, was of automatic transmission and fitted with anti-lock brakes.

Figure 5: The 'bandit vehicle' (Holden Commodore sports sedan)

SCHEDULE OF TEST RUNS

Six test runs (referenced A to F) were conducted. The details of the test runs and questions put to the delegates are set out in Table 1:

Table 1: Schedule of test runs

Run Ref.	Manoeuvre	View of delegate	Measured speed (km/h)	Comment	Question 1	Question 2	Question 3
A	Straight line	Side on (R to L)	80	-	Speed estimate at cones	Colour of vehicle	Attention level (1, low to 5, high)
B	Straight line	Side on (R to L)	60	high revs / low gear	Speed estimate at cones	Make & model of vehicle	How many people in the vehicle
C	Right turn	Rear/side	28	'sedate' driving / low revs	Speed estimate at cones	Colour of driver's jacket	Speed excessive (Yes or No)
D	Right turn	Rear/side	47	'aggressive' / squeal tyres	Speed estimate at cones	Driver wearing seat belt	Speed excessive (Yes or No)
E	Straight line then 'hook'	Towards	45	headlights illuminated	Speed estimate at cones	Registration of vehicle	Any difference to vehicle
F	Straight line then 'hook'	Away	66	-	Speed estimate at cones	Did driver indicate	Which direction did vehicle hook

RESULTS AND ANALYSIS

The delegate returns were analysed following the completion of the conference, with the detailed results provided in Appendix B.

DISCUSSION OF THE RESULTS

Over 70 of the delegates took part in this exercise by completing and submitting a results sheet (which it is estimated relates to a participation rate of around 70%). This participation rate far exceeded the original expectations of the authors, even when considering the interests of the conference and its delegates, and provides an excellent statistical base.

Additionally, an answer rate of 70% was exceeded for all of the questions asked, with this rate exceeding 90% for the majority of questions asked, i.e. there were few blank returns or non-answers such as don't know. This also exceeded the authors' expectations. There was no cause for the authors to conclude that delegates were providing answers for the sake of providing them or randomly guessing the answer. Notwithstanding, it should be remembered that eye witnesses will often provide (or want to provide) a non-conclusive answer such as 'I don't know', 'I am not sure' or 'I couldn't say' when interviewed by police etc. and are quite within their rights to do so.

Eye witness estimates of vehicle speed, recollections regarding vehicle type (and features) and its occupants are important components of any incident investigation, and are hence given considerable credence by the police and the courts. Estimates help the police to decide whether to seek a prosecution against a driver (e.g. for exceeding the posted speed limit) and a court to reach a decision on a balance of probabilities as to who was at-fault in an incident. Notwithstanding, in such cases there is often discussion and debate regarding the reliability of eye witness recollections, which may or may not be supported by, or be consistent with, physical evidence that might be collected from the scene by the police or a third-party incident investigator. This is not a criticism of eye witnesses per se, as it is important to remember that in the vast majority of cases eye witnesses are not aware that an incident is about to occur and may well be focusing on other things, being distracted, or looking in a slightly different direction. On top of this, the eye witness may well be asked to provide a recollection on a range of aspects / parameters in the incident.

Estimates of vehicle speed, approach angle, whether the vehicle was accelerating or braking etc. are also used alongside physical evidence by incident reconstructionists to determine a most likely incident scenario and identify its causation and contributory factors.

Runs A and B (straight line manoeuvre, vehicle viewed from side)

The authors had an expectation that delegates would more accurately / reliably estimate the speed of the moving vehicle in these two test runs given that the direction of travel of the vehicle was parallel to the delegate seating area (i.e. delegates had a side-on view of the vehicle). It is widely held among practitioners that this is the easiest orientation for eye witnesses to reliably estimate a vehicle's speed. It could be argued that this belief was confirmed by a response rate of 92% and 96% for the speed estimate of runs A and B respectively

The bandit vehicle was recorded at 80 km/h by the speed measurement device for Run A; 41% of delegates correctly estimated this speed within ± 5 km/h of the correct speed.

The average speed estimate recorded for Run A was 78 km/h (2 km/h less than the measured speed) although the overall range of results was considered quite significant with an 80 km/h variability in the stated range of responses (40 km/h to 120 km/h). This result supports past research that the average of eye witness recollections tends to be accurate, but individual values are often unreliable.

Overall, 70% of respondents' estimates were within one standard deviation of the measured speed; 58% of respondents estimated a value equal to or above the measured speed, leaving 42% estimating a value below the measured speed.

For Run A, delegates were asked to estimate their level of attention to the bandit vehicle, using a scale of 1 to 5, with 1 being the lowest level of attention and 5 being the highest; 11% of

delegates estimated their level of attention as 5; 65% of delegates estimated their level of attention as either 3 or 4. This result was not unexpected, as it is known that where a range of responses is provided to a respondent, it is typical for returns to favour the middle of the range.

Only 14% of those delegates who estimated the highest level of attention also estimated the speed within 80 km/h ± 5 km/h, whereas 60% of those delegates who estimated the lowest level of attention also estimated the speed to be within this 10 km/h range. The authors do not offer any explanation of this seemingly paradoxical result based on this single data point. Unfortunately, each time a series of experiments is conducted there is usually only one opportunity for a completely un-alerted response.

Delegates were not asked to estimate their level of attention for subsequent runs (Runs B-F inclusive).

The bandit vehicle was recorded at 60 km/h by the speed measurement device for Run B; 48% of delegates correctly estimated this speed within ± 5 km/h.

The percentage of delegates returning an estimate that was correct or within ±5 km/h is slightly higher than for Run B than Run A (48% compared to 41%). In this test (Run B) a speed range of 80 km/h was also found (30-110 km/h), i.e. identical to Run A. However, the overall standard deviation decreased from around 18 km/h in Run A to around 13 km/h in Run B. It is suspected that these findings are due to the lower test speed for Run B and also the fact that delegates had already seen a previous test and therefore, had established a benchmark in their minds (either consciously or sub-consciously).

The average reported speed for Run B was 57 km/h (3 km/h less than the measured speed), which is once again considered to be consistent with the accuracy of the average found in past experiments and research.

Overall almost 80% of respondents' estimates were within one standard deviation of the measured speed which is above the typical frequency in a normal distribution. Overall, 55% of respondents estimated a value equal to or above the measured speed, leaving 45% estimating a test speed below the measured speed.

For Run A delegates were asked to record the colour of the bandit vehicle; 97% of delegates correctly identified that the vehicle was green (or mentioned a shade of that colour, e.g. bright green). Only 1 delegate (1.5% of responses) recorded the colour of the vehicle as red. It is speculated that this return could have come from a female delegate suffering from colour blindness, which it is understood affects approximately 8% of Australian males and only about 0.4 % of Australian females.

For Run B delegates were asked to record the vehicle's make and model. Even given that delegates at the conference came from 15 different countries, a very high percentage (87%) correctly used the words Holden and/or Commodore in their response.

For Run B delegates were also asked to record the number of people in the vehicle. For Run A the driver was unaccompanied, but between Runs A and B, two rear-seat passengers were added to the vehicle out of sight of the delegates. Only 34% of delegates correctly identified that a total of 3 persons were in the vehicle. It is not known whether this result is not higher due to incorrect observation or a broad assumption that no passengers would be added to the vehicle while testing was being undertaken.

Runs C and D (turning manoeuvre, vehicle viewed by delegates to their right and turning towards the delegates)

Runs C and D were staged the furthest distance away from the delegate seating and required delegates to recollect a turning manoeuvre, i.e. the aspect of the vehicle was constantly changing, making observation more difficult than with a straight line manoeuvre parallel to vision.

For Run C the vehicle was driven sedately at low engine revs. For Run D the vehicle was driven aggressively, with the tyres allowed to squeal on cornering.

The bandit vehicle was recorded at 28 km/h by the speed measurement device for Run C. The speed estimate of 40% of delegates was within ± 5 km/h of the measured speed. An overall speed range of 35 km/h was found (15-50 km/h) for Run C, a lesser range than found for Runs A and B and subsequently found for the following tests.

The average speed recorded by delegates for Run C was 31 km/h (3 km/h higher than the measured speed).

Overall 62% of respondents' estimates were within one standard deviation of the measured speed; 64% of respondents estimated a speed equal to or above the measured value, leaving 36% estimating a value at or below the measured value.

Delegates were asked whether the speed travelled in Run C was excessive for the manoeuvre being attempted. A resounding 85% of delegates believed that the speed was not excessive. It is considered possible that the driving style on this run (described earlier as sedate, with no harsh acceleration or braking) contributed to the acceptance of the speed by so many delegates.

The bandit vehicle was recorded at 47 km/h by the speed measurement device for Run D; 36% of delegates' estimates fell within ± 5 km/h of the measured speed.

An overall speed range of 40 km/h was found (30-70 km/h) for Run D.

The average reported speed for Run D was 49 km/h (2 km/h higher than the measured speed).

Overall 68% of respondent's' estimates were within one standard deviation of the measured value; 57% of respondents estimated the speed as equal to or above the measured speed, leaving 43% of estimates below the measured speed.

Delegates were asked whether the speed travelled in Run D was excessive for the manoeuvre being attempted. 86% of delegates believed that the speed was excessive. This is considered largely consistent with the aggressive driving style adopted on Run D, which would have also led to greater operating noise (past research refers to such factors as an extra stimulus to delegates), although it is interesting to note that the speed difference between the two runs was only 18 km/h.

For Run C, delegates were asked to recollect the colour of clothing worn by the driver on the top half of his body. The driver was wearing a dark blue racing jacket with red and yellow sleeve logos; 62% of delegates correctly identified that the driver was wearing predominantly dark clothing (dark blue or black); 21% of delegates included the colour yellow in their response.

The recollection of the colour yellow is possibly significant as for Runs A and B the driver had been wearing a yellow retro-reflective vest, but changed into the dark blue racing jacket between Runs B and C out of view of the delegates. This must therefore suggest an answer based on a previous recollection, as opposed to an actual observation at the time of this test.

In Run D, delegates were asked to recollect whether the driver was wearing a seat belt. 78% of delegates correctly responded that the driver was not wearing his seat belt for this particular run. The authors consider this to be a slightly high and surprising result given that the driver had undertaken the previous runs (Runs A, B and C) with his seat belt on. However, it is also considered possible that delegates had an expectation that the driver would be wearing a seat belt at such an event (i.e. as a default) and when asked a question about seat belt usage, this was for a specific reason, i.e. that the test condition had changed and the driver was doing something out of the norm.

Run E (vehicle coming directly towards the delegates)

It is often thought and expressed by practitioners that the hardest scenario for an eye witness to accurately estimate the speed of a vehicle is when that vehicle is heading directly towards them, as in Run E. Past research has speculated that this is largely due to a fear of collision which would tend to lead to an over-estimation of true vehicle speed.

The bandit vehicle was recorded at 45 km/h by the speed measurement device for Run E. The result was therefore surprisingly accurate with 62% of delegates giving a response within ± 5 km/h of the measured speed. Contrary to expectation, this test and the test within the curve actually had the smallest values of standard deviation being 10 and 11 km/h respectively as compared to 17 km/h for the unexpected crossing test and 13 km/h for the expected crossing test.

An overall speed range of 50 km/h was found (20-70 km/h) for Run E. This appears to be largely consistent with the results of the previous four (4) test runs undertaken (Runs A to D inclusive).

The average reported speed for Run E was 44 km/h (1 km/h lower than the measured speed). Contrary to expectation, this was therefore the most accurate test result when directly comparing the average response to the measured value and was very close to the lowest standard deviation.

Overall the estimates of 64% of the respondents were within one standard deviation of the measured value. Interestingly, despite the average being the most accurate result, the overall percentage within one standard deviation of the mean was towards the lowest of the test results. This may however also reflect the lower value for the standard deviation and therefore a much narrower range.

A speed equal to or above the measured speed was estimated by 49% of the delegates, leaving 51% estimating a value below the correct value. It is noted that this was the first occasion where there has been a general under-estimation of speed by the majority of delegates (albeit only by 1%).

Delegates were asked to recall the registration number of the vehicle. 23% of delegates correctly recorded the entire registration number in the correct order of digits and letters. A further 27% had some part (at least one digit or one letter) of the registration correct. While the authors had no evidence or indications of contrary conduct by delegates, it is of course possible that a delegate not certain of the registration after Run E might have focused on that detail during a later run (Run F) and made a late entry on their results sheet. The bandit vehicle was also used for Runs A to D inclusive, meaning that delegates also had four (4) opportunities prior to Run E to view and absorb the registration of the bandit vehicle.

Additionally, on Run E, delegates were asked to recollect whether anything was different about the front of the vehicle when compared to previous runs; 55% correctly identified that the headlights of the vehicle were illuminated for Run E. The authors were somewhat surprised that this percentage was not higher.

Run F (vehicle going away from delegates)

Run F involved the vehicle aggressively accelerating away from the delegates' viewing position, which as with Run E (the vehicle heading towards an eye witness) is stated as one of the most difficult scenarios to reliably assess vehicle speed.

The bandit vehicle was recorded at 66 km/h by the speed measurement device for Run F. In this instance only 23% of delegates returned estimates within ± 5 km/h of the measured speed, which is consistent with the authors' prior expectations.

An overall speed range of 70 km/h was found (20-90 km/h) for Run F. This is considered to be broadly consistent with the findings from Runs A and B, i.e. with the highest driving speeds.

The average reported speed for Run F was 58 km/h (8 km/h lower than the measured speed). This is the largest variation between the average of the delegate responses and the measured speed, probably attributable to the difficulty in assessing the speed of a vehicle that is going away from the observer.

Overall, 73% of respondents' estimates were within one standard deviation of the measured value. Interestingly, despite the average being the least accurate, the overall percentage within one standard deviation of the mean was towards the upper end of the test results.

A speed equal to or above the measured speed was estimated by 30% of respondents; leaving 70% estimating a speed below the measured speed. It is noted that this is the only test where there has been a significant underestimation of speed by the majority of delegates. Interestingly though, the other test involving a vehicle travelling towards the delegates displayed the same trend of an under-estimation of the speed.

In Run F, the driver ultimately conducted a turning manoeuvre to the right after deploying the vehicle's left-hand indicators. However, delegates were only asked to recollect whether the driver deployed the vehicle's indicators (not the direction) and the turning direction of the vehicle.

Somewhat surprisingly to the authors, only around half of the returns (55%) recalled the driver deploying the indicators (right or left). The authors expected this result to be a lot higher, as per the final question associated with this test run, where 89% of delegates correctly recalled that the vehicle made a right-hand (rather than left-hand) turning manoeuvre.

Figure 6 shows a graphical representation of the frequency distribution of all six test runs including a representation of the measured test value. It is noted that all tests display a normal type distribution spread largely symmetrically about a mean which is at or very close to the actual measured value in all instances. Figure 7 also demonstrates the overall cumulative distribution of all tests.

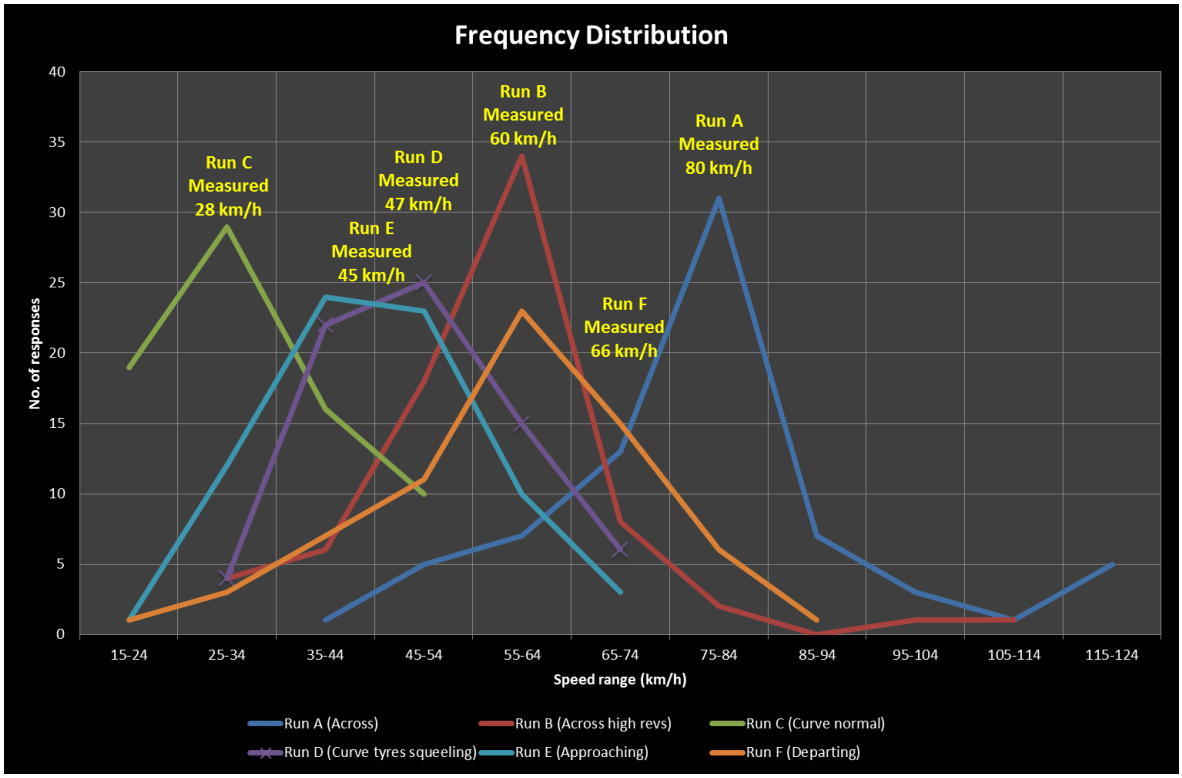


Figure 6: Frequency distribution of test results

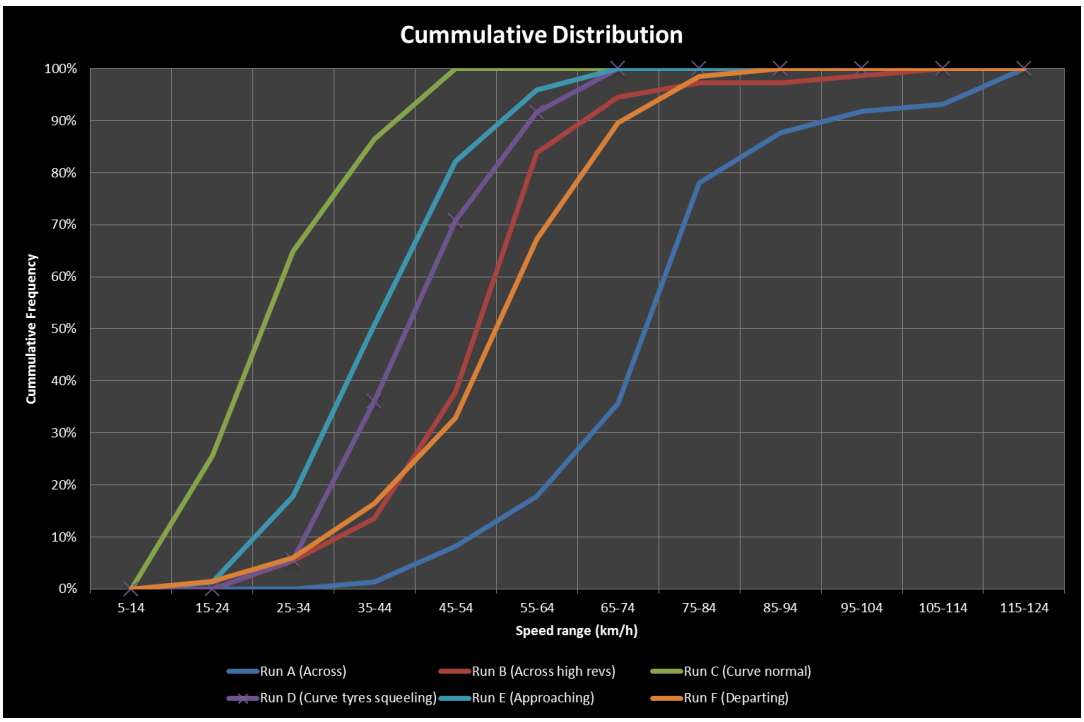


Figure 7: Cumulative distribution of test results

PREVIOUS SIMILAR SITE EXPERIMENTS

Since the date of the test runs undertaken in May 2011, the authors have become aware of two previous, and largely similar, experiments conducted in the USA (at the World Reconstruction Exposition in Texas in September 2000) and in the United Kingdom [at the Institute of Traffic Accident Investigators (ITAI) biennial conference in September 2007]. Both experiments were reported in the ITAI journal Impact (Bartlett 2002, Croft 2007).

Although the authors had no prior knowledge of these previous international experiments when devising their local experiment in Australia, the objectives and testing scenarios have much synergy.

In the US experiment (2000), delegates attending a scheduled crash-test of a car into a pole were asked to estimate the speed of a passing car (side-on view), as well as recollecting its colour and the number of doors. Delegates were given no prior warning of the vehicle or what was required of them. Additionally, delegates were asked to note whether they had ever used a speed (radar) gun before to measure the speed of vehicles. Further test runs were then made using a white panel van, with the delegates being given an advanced warning prior to each test run. The main results / findings for the test involving the car were as follows:

- The actual speed of the car was measured at 37 mph (59 km/h).
- A range of speed estimates was reported between 20 mph (32.6 km/h) and 60 mph (97.7 km/h).
- The average reported speed was 36.5 mph (59.5 km/h).
- The standard deviation of reported speeds was 10.2 mph (16.7 km/h).
- 26% of respondents thought the speed of the car was ‘slow’, 65% thought it was ‘medium’ and 9% thought it was ‘fast’.

The experiment concluded that:

- *'though individual speed estimates were highly variable, the average values for the group were very close to the actual value'*

- *'regardless of warning status, individual stationary witnesses without accurate means of evaluating a vehicle's speed should not be relied upon to provide accurate speed estimates for analytical purposes'*

- the standard deviation of speed estimates when delegates were not given prior warning (i.e the car test) was almost twice that found when delegates were warned that a test was about to commence (i.e the van tests).

- there was no differentiation between the delegates that had used a speed (radar) gun and those that had not.

The UK experiment (2007) comprised six test runs, the first of which involved the side-on view of a police car traveling at 45 mph (72 km/h). The vehicle also momentarily activated its two-tone horns to initially attract delegate attention. The five tests where prior warning was provided comprised two tests involving a car [at 30 mph (48 km/h) and 48 mph (77 km/h)], two tests involving a motorcycle [30 mph (48 km/h) in top gear and 32 mph (51 km/h) in 2nd gear] and a single test involving a panel van at 38 mph (61 km/h). It appears that approximately 40 delegates provided speed estimates.

The conclusions of the UK experiment were as follows:

- as with the US experiment (2000) the UK results '*indicate that individual estimates are unreliable although, where the speed of the vehicle is about 30 mph, the average speed estimate is seen to be in good agreement. However, as the vehicle speed increases the accuracy of the average estimate worsens'* (and tends to be an under estimate)

- the estimates of speed for the motorcycle were unaffected by the gear selection

- the size of the vehicle / machine did not appear to adversely influence the ability to estimate speed.

A SELECTION OF PREVIOUS RESEARCH

The summary provided in Appendix C represents only a small part of the total extent of research in this subject matter. Notwithstanding, the summary enables a comparison of the generic principles and trends identified by previous research with the results obtained from the Mount Cotton test day.

It apparent that past research in this field has two distinct interests:

- Road safety / road design (e.g. as it affects judgement of gaps in traffic, decision making by drivers and pedestrians, how older and young pedestrians compare etc.).

- Incident investigation / reconstruction / legal proceedings (e.g. establishing a most likely incident scenario, which includes vehicle speeds and orientations, and helps decide causation and contributory factors and fault etc.).

The past research has also tended to consider the following viewpoints:

- The driver – i.e. judging their own travelling speed and the speed of other vehicles, e.g. when negotiating an intersection or overtaking.

- The pedestrian – i.e. judging gaps in traffic and the closing speed of vehicles in reaching a decision as to whether to cross the road at a given time.

- The eye witness – the credibility of eye witness evidence and recollections in legal proceedings.

CONCLUSIONS

The authors hope that the outcomes of this research will be of use to practitioners with an interest in the accuracy and reliability of eye witness recollections, especially where eye witnesses are asked to provide their best estimate of the speed of a vehicle. The six (6) test runs conducted during this experiment allowed consideration of a number of viewing positions / orientations of a vehicle.

The authors believe that the results obtained from this research are consistent with the majority of past research identified in these areas, namely:

- Eye witness estimates of vehicle speed are not grossly inaccurate per se and tend to spread reasonably precisely around a mean (average) value that is close to the measured speed.

- Although the majority of observations were found to be within one standard deviation of the measured value, individual outlier estimates can however vary by up to nearly 100% of the measured value, and can be either an under, or over-estimate.

- The range of speed estimates found for a particular test run tends to be largest at the highest vehicle speeds.

- There appears to be a general tendency for eye witnesses to under-estimate the highest vehicle speeds and over-estimate the lowest vehicle speeds, but this was not found to be a uniform (consistent) and reliable rule.

- Accurately estimating the speed of a vehicle is most difficult to achieve when the vehicle is travelling perpendicular to the viewing positions (i.e. directly towards or away from the delegate's viewing position).

- Extra stimulus factors (such as driving aggressively and/or using high revs) do appear to lead to delegates slightly over-estimating the vehicle speed, all other things being equal.

ACKNOWLEDGEMENTS

The authors would like to acknowledge:

- The support of the Transport and Main Roads Queensland (TMR) in the staging of the Mount Cotton test track day.

- The assistance of Mr David Tulloch (TMR) and Sgt David Stocker (Queensland Police Forensic Crash Unit) in the conduct of the test track day.

- Preliminary data processing, analysis and presentation undertaken by Mr Guy Brown, then of the ARRB Group's Sydney office.

- Document searches conducted by Linda Cox of ARRB Group's MG Lay Library.

CONFERENCE PROCEEDINGS

The proceedings of the 1st, 2nd and 3rd International Road Surface Friction Conferences can be found from www.saferroads.org.uk.

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AUTHOR BIOGRAPHIES

Paul Hillier is ARRB Group's National Technical Leader in Incident Investigation and Strategic Reviews. He has some 22 years' experience in road safety and highway management and maintenance fields. He has been with ARRB for 6 years, and prior to that gained experience with the Transport Research Laboratory (TRL) (in both Australia and UK) and a large UK road authority. He is experienced in investigating and reporting upon highway provision and maintenance-related legal cases, and has led or been part of a number of recent Austroads projects on skid resistance. He has assisted a number of road authorities in Australia and overseas with the development of strategy and practice in this technical area. Paul has presented, and had papers published, on highway management, skid resistance and risk-related (legal liability) issues throughout the world and regularly provides training in these fields.

Grant Johnston is the Principal of Grant Johnston Consulting Engineers and is the current President of ASPACI (an office he has held since 2006). Grant is one of Australia's most experienced and respected crash investigators and reconstructionists, having undertaken over 5000 investigations during his 25-year road safety career. He has also undertaken a range of projects and training activities with the ARRB Group and TRL. He has extensive experience in investigating and reporting upon the human factors and road-related aspects of motor vehicle incidents, workplace incidents and public liability incidents. Grant has presented, and had papers published, on human factors and biomechanical investigations, highway management, skid resistance and risk-related (legal liability) issues throughout the world and has often provided training to other practitioners in these fields.

APPENDIX A – DELEGATE RECORD SHEET CONTENT

Mount Cotton test track day

Tuesday 17 May 2011

Additional results sheet

Name:

Organisation:

Contact e-mail:

Reference	Parameter 1	Parameter 2	Paramater 3

Full instructions on the completion and submission of this sheet will be provided on the day

Please note that in completing and submitting this sheet you will be assisting valuable research being undertaken by:

APPENDIX B – ANALYSIS OF DELEGATE RESPONSES

Run A

What was the colour of the vehicle?

Correct answer = metallic green

74 of 74 delegates (100%) answered this question

72 of 74 delegates (97%) included the word green (metallic green, bright green etc.)

1 of 74 delegates (1.5%) included the word black

1 of 74 delegates (1.5%) included the word red

What was your level of attention towards the vehicle (on a scale of 1 to 5, where 1 = lowest, 5 = highest)?

74 of 74 delegates (100%) answered this question

Scale 1 = 5 of 74 delegates (7%)

Scale 2 = 13 of 74 delegates (17%)

Scale 3 = 29 of 74 delegates (39%)

Scale 4 = 19 of 74 delegates (26%)

Scale 5 = 8 of 74 delegates (11%)

What was the speed of the vehicle at the recording point?

Measured speed = 80 km/h

68 of 74 delegates (92%) provided an estimate of speed

All returns fell within a range 50-120 km/h

Average of estimated speeds = 77.9 km/h (standard deviation = 17.7 km/h)

25 of 68 delegates (37%) correctly estimated the speed at 80 km/h

3 of 68 delegates (4%) were within ± 5 km/h of the speed of the vehicle

14 of 68 delegates (21%) over-estimated the speed of the vehicle

26 of 68 delegates (38%) under-estimated the speed of the vehicle

Run B

What was the make and model of the vehicle?

Correct answer = Holden Commodore SV6 sports sedan

71 of 74 delegates (96%) provided an answer

62 of 71 delegates (87%) included the word or combination of words: Holden, Commodore, SV6, HSV in their return

5 of 71 delegates (7%) included the word Ford in their return

59 delegates correctly identified both the colour and the make/model of the vehicle

How many people in total were in the vehicle?

Correct answer = 3 (i.e. driver + 2 passengers)

73 of 74 delegates (99%) provided an answer

25 of 73 delegates (34%) stated that a total of 3 people were in the vehicle

41 of 73 delegates (56%) stated that a total of 2 people were in the vehicle

NB. Run A was done with driver only with additional passengers being loaded for Run B out of sight of the delegates

What was the speed of the vehicle at the recording point?

Measured speed = 60 km/h

71 of 74 delegates (96%) estimated the speed

All returns fell within the range 30-80 km/h

Average estimated speed = 56.5 km/h (standard deviation 13.5 km/h)

28 of 71 delegates (39%) correctly estimated the speed at 60 km/h

The estimates of 6 of 71 delegates (9%) were within ± 5 km/h of the speed of the vehicle

9 of 71 delegates (13%) over-estimated the speed of the vehicle

28 of 71 delegates (39%) under-estimated the speed of the vehicle

Run C

What colour clothing was the driver wearing on the top half of his body?

Correct answer = blue motor racing team jacket, with Red Bull name and yellow and red patches (logos) on sleeves

71 of 74 delegates (96%) provided an answer

A large range of returns was fielded:

25 of 71 delegates (35%) stated black or had the word black in their return

19 of 71 delegates (27%) stated blue or had the word blue in their return

15 of 71 delegates (21%) stated yellow or had the word yellow in their return

9 of 71 delegates (13%) used the word motifs in their return (4% stated blue with motifs)

2 of 71 delegates (2%) used the specific word jacket in their return

NB. Prior to, and during, Runs A and B, the driver was wearing reflective clothing. The driver changed his clothing for this run out of view of delegates

What was the speed of the vehicle at the recording point?

Measured speed = 28 km/h

70 of 74 delegates (95%) estimated the speed

All results were within a range 15-50 km/h

Average estimated speed = 31.1 km/h (standard deviation = 9.8 km/h)

1 of 70 delegates (1%) estimated the exact vehicle speed correctly

27 of 70 delegates (39%) were within ± 5 km/h of the speed of the vehicle

24 of 70 delegates (34%) overestimated the speed of the vehicle

18 of 70 delegates (26%) under-estimated the speed of the vehicle

Do you consider that the vehicle speed was excessive for the manoeuvre being attempted? (Yes or No)

73 of 74 delegates (99%) answered this question

62 of 73 delegates (85%) replied No

11 of 73 delegates (15%) replied Yes

Run D

Was the driver wearing his seat belt? (Yes or No)

Correct answer = No

65 of 74 delegates (88%) answered this question

51 of 65 delegates (78%) replied No

14 of 65 delegates (22%) replied Yes

NB. The driver had been wearing a seat belt during Runs A, B and C (and also returned to wearing his seat belt in subsequent runs E and F)

What was the speed of the vehicle at the recording point?

Measured speed = 47 km/h

70 of 74 delegates (94%) estimated the speed

All of the returns fell within the range 40-70 km/h

Average estimated speed = 48.3 km/h (standard deviation = 10.2 km/h)

0 of 70 delegates (0%) estimated the exact vehicle speed

25 of 70 delegates (36%) were within ± 5 km/h of the speed of the vehicle

19 of 70 delegates (27%) over-estimated the speed of the vehicle

26 of 70 delegates (37%) under-estimated the speed of the vehicle

Do you consider that the vehicle speed was excessive for the manoeuvre being attempted? (Yes or No)

72 of 74 delegates (97%) answered this question

62 of 72 delegates (86%) replied Yes

10 of 72 delegates (14%) replied No

Run E

What was the speed of the vehicle at the recording point?

Measured speed = 45 km/h

72 of 74 delegates (97%) estimated the speed

All of the results were within the range 25–70 km/h

Average estimated speed = 44.4 km/h (standard deviation = 11.3 km/h)

4 of 72 delegates (6%) estimated the vehicle speed as 45 km/h

40 of 72 delegates (56%) were within ± 5 km/h of the speed of the vehicle

13 of 72 delegates (18%) over-estimated the speed of the vehicle

15 of 72 delegates (21%) under-estimated the speed of the vehicle

What was the registration of the vehicle?

52 of 74 delegates (70%) answered this question

12 of 52 delegates (23%) of delegates gave the correct answer (i.e. digits and letters correctly identified and in the correct order)

14 of 52 delegates (27%) of delegates had part (some) of the letters and/or digits correct

NB. The test vehicle did one more run following this question

Was there any difference in the front of the vehicle when comparing previous runs?

Correct answer = headlights illuminated

58 of 74 delegates (78%) answered this question

32 of 58 delegates (55%) of delegates correctly stated that the vehicle headlights were illuminated

1 of 58 delegates (1.7%) stated that the headlights had been turned off for this test run (i.e. they were turned on during previous test runs)

20 of 58 delegates (34%) thought there was no change to the vehicle

Run F

What was the speed of the vehicle at the recording point?

Measured speed = 66 km/h

66 of 74 delegates (89%) estimated the speed

All returns fell within the range 30-80 km/h

Average estimated speed = 58.5 km/h (standard deviation = 13.9)

0 of 66 delegates (0%) estimated the exact speed correctly

15 of 66 delegates (23%) were within ± 5 km/h of the speed of the vehicle

7 of 66 delegates (11%) over-estimated the speed of the vehicle

44 of 66 delegates (66%) under-estimated the speed of the vehicle

Did the driver indicate before turning following his straight line manoeuvre? (Yes or No)

Correct answer = Yes (to the left)

60 of 74 delegates (81%) replied to this question

Of these 60 remaining returns, 33 delegates (55%) referred to an indicator being illuminated (14 of these 33 delegates also got the direction correct)

27 of 60 delegates (45%) did not think that the driver indicated

Which direction did the vehicle turn?

Correct answer = to the right

66 of 74 delegates (89%) answered this question

53 of 66 delegates (80%) correctly stated that the vehicle turned to the right

APPENDIX C – A SELECTION OF PREVIOUS RESEARCH

Estimating the speed of vehicles: the influence of stereotypes, Davies (2009) – as published in Psychology, Crime and Law Journal

The following is a brief summary of Davies paper:

- The introduction to the paper refers to the Lady Diana crash in Paris – citing differences in eye witness accounts of the vehicle speed of between 75-80 mph (120-128 km/h) and > 100 mph (161 km/h) and a general perception of that the involved vehicle (a powerful black Mercedes) would be / was travelling quickly.
- Research in estimating the speed of vehicles within the field of psychology goes back as far as Richardson (1916).
- The preliminary to the paper refers to past research which has *'….generally concluded that estimates of vehicle speed are not grossly error-prone'* (Evans 1970, Sciafa et al, 1991).
- Davies mentions that some researchers (Hills 1980, Scialfa et al, 1991, Triggs and Berenyi 1982) have reported a general tendency for speed to be underestimated at lower speeds [i.e. less than 20 mph (32 km/h)] and over-estimated at higher speeds [> 50 mph (80.5 km/h)].
- Some past research has found that more older women showed a general tendency to over-estimate speed than younger men and women, and that groups of older men provided the most accurate estimate of speed.
- Depriving observers of auditory information (e.g. engine noise etc.) has little appreciable effect on accuracy, but relying on noise only leads to a general over-estimation of speed.
- It is reported that Karas (1959) asserts *'anything which gives the impression of speed results in a higher guess of actual velocity'* (e.g. low convertible car, bright colour, roaring exhaust) and provides an example of a car being driven at 15 mph (24 km/h) being estimated within range of 10-50 mph (16-80 km/h).
- Davies used observations of video (shown to approximately 40 to 60 drivers), from which he concluded *'the accuracy of estimation from the videos at all three speeds was high'*, and did not find *'gross inaccuracy'*. He goes on to state: *'there may be errors: slower speeds being overestimated and higher speeds underestimated, but little to justify the claim that people are not very good at judging how fast a vehicle was actually travelling'* .[Davies opines that this is consistent with previous research by Loftus and Palmer. 1974]
- Davies concludes that there is nothing to support the theory that driving experience leads to more accurate estimates of speed or that involvement of a stereotypically fast car will inevitably lead to gross exaggeration of its speed.
- Davies does recognise that the circumstances of the observation (pre-warning etc.) and 'attentional set' adopted by the witness are important, i.e. when did they make the judgement, at the time of the incident, sometime after, or when knowing the gravity of the

outcome and proceedings etc. He calls these 'extra stimulus' factors in the estimate of vehicle speed.

Observed Vehicle Speed and Drivers' Perceived Speed of Others (Aberg et al. 1997) – from Applied Psychology Review

The paper includes the following:

- Connolly and Aberg (1993) suggested that a driver's adjustment of their own speed is affected by comparison of their own speed and that of other, nearby drivers, which may also account for why speeding appears 'contagious'.
- The research found that drivers generally over-estimate the speed of other drivers by 8 to 10 km/h.
- This research is more about understanding why people speed and examines the scenario if drivers were given the speeds of others on the road would this lead to less people driving above the speed limit.

The perception of vehicle speeds by pedestrians (Goodwin et al. 1975)

This paper examines how accurately pedestrians judge the speed of on-coming vehicles. However, it is acknowledged that those taking part in the research received advanced warning and time to observe the on-coming car. The paper includes that:

- Any error in estimating speed would be down to:
    - bias – the person may habitually tend to over or under-estimate the speed of vehicles, or
    - averaging – where individual estimates will be scattered about an average.
- This research involved 50 vehicles, a number of different viewing positions and angles and 50 different vehicle speeds, which gives 1,100 possible observations of speed. Cars, lorries and buses were used.
- The viewing angle did not affect the spread of results.
- The spread of estimates was found to be similar for all speeds.
- There were no notable differences between the spread of estimates for cars, lorries or buses.
- Some evidence was found that true speeds above 35 mph (56 km/h) tend to be under-estimated.
- Different observers have different 'scales of measurement', but all of the observers are equally competent at using these when estimating speed.

Speed Estimation (Triggs, not dated) – in Automotive Engineering & Litigation Journal

This paper tends is a summary of previous research in this field, i.e. it is a highly technical, heavily referenced paper (it contains 134 references). The paper considers the assessment of speed from highway design, incident / crashes and litigation perspectives. Triggs concludes:

- Human eye witnesses process what is called 'environmental information' to estimate speed, rather than using a speedometer as per the driver of a car.
- Speeds appear to be generally under-estimated in driving experiments, but evidence / research can be contradictory.
- Individuals differ greatly in their accuracy of estimates.
- Children are less able than adults to estimate speed correctly – and tend to over-estimate lower speeds and under estimate higher speeds.
- Triggs favours a general under-estimation of speed, but does caveat this by saying that practitioners must gain an understanding of how past research was conducted, including what age groups, sex, vehicles, speeds etc. were involved.
- The judgement of absolute and relative speeds of vehicles is a basic component of many road user behaviour tasks.

Forensic Aspects of Driver Perception and Response (Olson and Farber, 2nd edition, 2003)

This considerable work looks in detail at driver and eye witness estimates of speed and distance as important considerations in the investigation and reconstruction of crashes / incidents. Chapter 4.8 covers eye witness testimony, as follows:

- The authors express some doubt on the value of eye witness evidence, describing it as 'frail', but nonetheless recognises that *'the testimony of eye witnesses can have a powerful influence on the development and outcome of a case, particularly when physical evidence is weak or there is substantial disagreement amongst experts about that evidence'.*
- Poor eye witness evidence is often used if little else is available and/or the evidence is a good fit with one of the arguments being put forward, but it is stressed that eye witness evidence is not always wrong or even wrong much of the time. It should never be forgotten that it comes from *'ordinary people involved in extraordinary events'*.
- Events are described as being of short duration (i.e. seconds) and are largely unexpected. There is often a complex scene, with *'lots going on at the time'*, but importantly, can never discount that the eye witness was there.
- Useful research on eye witness testimony includes Ross et al. (1994), Rubin (1996), Sporer et al. (1996), but it is believed that Haber and Haber (2001) provides excellent discussion of the problems of eye witnesses.

- Proximity to the action (and gravity of the event) have an effect on the eye witness, e.g. they could be very close to a sliding car that then demolishes a wall close by – this must have an effect on the perception of speed or estimate of speed.
- Need to understand all details about the eye witness' position, view, context / reason for being at the scene etc.
- Opinion and hearsay can become part of 'remembered evidence'.
- Haber and Haber also list factors in the accuracy of an estimate:
    - observational view
    - allocation of attention
    - bias in the focus of attention
    - knowledge, familiarity and experience
    - expectation
    - retrieving facts from memory
- The authors conclude: *'people are generally poor judges of speed in many situations and have difficulty expressing distance judgements'* and despite this, legal and insurance cases place credence and often over and above *'measurements taken with a tape and radar gun'* and that if relying on an eye witness testimony, must fully understand the factors and context behind the estimate and first determine how accurate the recollection actually is.

Chapter 6 covers the judgement of speed and distance, but almost exclusively from the perspective of driver judgement when making decisions and effecting manoeuvres:

- Farber (1970) showed that drivers can estimate distance to an accuracy *'within about 20%'*, but tend to over-estimate short distances and under-estimate long distances. Accuracy was similar in both day and night-time (i.e. under car and artificial street lighting).
- Drivers' judgement of speed is less reliable than their judgement of distance, especially when the car being viewed is moving directly toward or away from the driver making the estimate.
- When driving, correctly estimating the closing speed of another vehicle is difficult and errors (i.e. go / no go) occur leading to incidents.