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PUBLISHED PROJECT REPORT PPR682

The effect of two novel lighting configurations on the conspicuity of motorcycles

A roadside observation study in New Zealand

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Prepared for: Accident Compensation Corporation

Project Ref: 11112486

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Contents amendment record

This report has been amended and issued as follows:

Version	**Date**	**Description**	**Editor**	**Technical Referee**
0.1	13/11/13	Draft delivered to peer reviewer	SH	CB
0.2	21/11/13	Draft delivered to client (after peer review)	SH	CB
1.0	04/02/14	Final published version	SH/ED	CB

ISBN: 978-1-908855-89-3

ISSN: 0968-4093

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Abstract

Motorcyclists have been shown consistently to be at a high risk of being involved in road collisions (Wulf, Hancock & Rahimi, 1989; Chesham, Rutter & Quine, 1991; Horswill & Helman, 2003), and often such collisions involve another vehicle violating the path of a motorcycle at a junction or intersection. It is known that two key factors contributing to such collisions are the relatively low conspicuity of motorcyclists, and the relative difficulty that other road users have in judging the time it will take a motorcycle to reach their position (time to collision or TTC) (e.g. Wulf et al., 1989; Horswill, Helman, Ardiles, & Wann, 2005). Here we report findings from a roadside observation study in which participants were invited to observe a section of road (60kph limit) in Albany, Auckland, New Zealand, while a trial motorcycle was ridden past their position (average approach speed 55.7kph) displaying either a single headlight, a 'V' lighting configuration with the headlight and LED lighting on the raised mirrors of the motorcycle, or a 'Y' configuration which added LED lighting on the front forks. At night, the motorcycle was detected approximately three-quarters of a second earlier with the 'V' lighting and approximately one and a quarter seconds earlier with the 'Y' lighting than with the headlight alone, but only when the participants were instructed to search the scene for motorcycles (as opposed to reporting the things in the scene that grabbed their attention). At night the 'V' and 'Y' lighting also led participants to report longer 'smallest acceptable gaps' (by approximately half a second and three quarters of a second respectively) in front of the oncoming motorcycle than they did in the 'headlight only' condition. Daytime detection was much earlier than night time detection, and detection was much earlier when participants were asked specifically to search for motorcycles.

Executive summary

Motorcyclists have been shown consistently to be at a higher risk of involvement in road collisions, and of sustaining serious or fatal injuries in road collisions, than any other road user group (Wulf, Hancock & Rahimi, 1989; Chesham, Rutter & Quine, 1991; Horswill & Helman, 2003).

A common cause of motorcycle collisions is the violation of the path of a motorcycle by another vehicle (e.g. Hurt, Ouellet, & Thom, 1981; Wulf et al., 1989; ACEM, 2004). Such events are typically referred to as 'looked but failed to see' (LBFTS) collisions, on account of the fact that often in post-collision interviews drivers claim either not to have seen the motorcycle at all, or not to have seen the motorcycle until it was too late to take avoiding action (Hurt et al., 1981). Not surprisingly in light of such findings there have been numerous calls for improvements to be made to the conspicuity of motorcycles in order that they might be detected more readily by other road users (e.g. Williams & Hoffman, 1979; Olson, Halstead-Nussloch & Sivak, 1981; Hole, Tyrrell, & Langham, 1996; Rößger, Hagen, Krzywinski & Schlag, 2011).

Helman, Weare, Palmer & Fernandez-Medina (2012) reviewed the literature on motorcycle conspicuity and concluded that a number of interventions associated with changes to motorcyclist clothing (for example high-visibility jackets) and motorcycle lighting (for example daytime running lights) have been shown to have potential benefits to motorcyclist safety in laboratory tests, and in some roadside observation studies. However much of the research on interventions has tended to focus exclusively on how easy motorcycles are to detect, and has ignored another factor that is believed to be important in LBFTS collisions; it is known that because motorcycles are smaller than cars, road users tend to overestimate how long it will take for an oncoming motorcycle to reach their position, relative to their judgement for cars (Horswill, Helman, Ardiles & Wann, 2005), and it is believed that this can lead to drivers accepting gaps in front of motorcyclists that they would not accept in front of cars.

The perceptual problems involved in making such judgements about oncoming motorcycles are even more relevant at night, as often motorbikes have only a single headlamp which alone provides almost no information about arrival time or speed of approach. Gould Poulter, Helman & Wann (2012a, b) showed in laboratory judgement tasks that additional lighting designed to provide more information about the size of an oncoming motorcycle had the potential to support more accurate perceptual judgements about its approach speed.

In this study, we present the findings from a roadside observation study in which we tested lighting configurations similar to those used by Gould et al. (2012a, b) for their effect on how easily a motorcycle could be detected in a real road scene in live traffic, and the size of gap that observers said they would accept in front of an oncoming motorcycle that had been detected.

Two Suzuki Inazuma, 250cc motorcycles were fitted with lighting rigs that permitted one of three lighting configurations to be shown. The first configuration was their standard headlight (used as a control condition for the study). The second was the headlight plus LED lighting on either mirror (approximately eight inches above each handlebar grip) in a 'V' formation. The third was the same as the second, but with the addition of LED lighting on each fork leg to give a 'Y' formation. Professional motorcyclists served as 'stooge' riders in the study, which was run on 50 trialling dates between June and August, 2013, in Albany, Auckland, New Zealand. Members of the public were recruited to take part in the study, and were tested either individually or in pairs, sitting in a car (or cars) in an observation position mimicking a side junction or intersection adjoining a 60kph speed limit road. Some participants were tested during daytime, and others were tested at night.

The road layout around the site permitted the trial motorcycle to be ridden in a 'loop' such that it could approach the observation position nine times within approximately a 20-minute trialling session for each participant (or pair of participants). In each set of three approaches, the trial motorcycle displayed one of the three lighting configurations (order of this was counterbalanced across participants). On the first set of three passes participants were asked to report verbally the things in the traffic scene to their right (i.e. the traffic approaching them as if they were about to join the flow of traffic on their side of the road) that grabbed their attention. For the second set of three passes, participants were asked to actively look for motorcycles (including the ones with the novel lighting configurations) and report verbally any that they detected. For the final set of three passes, participants were asked to verbally report the point at which they would no longer consider pulling out in front of the oncoming motorcycle.

For all participants, a camera recorded the approach of the motorcycle (and other traffic) and recorded audio so that the participant response could be coded from the footage. The amount of time between the trial motorcycle being mentioned (for the first two sets of three passes) or the gap being identified (for the final three passes), and the point at which the motorcycle headlight contacted the edge of the video screen, served as the dependent measure.

The findings showed that when compared with the headlight-only condition, the 'V' and 'Y' lighting configurations led to earlier detection of the motorcycle at night (by approximately three quarters of a second for the 'V' lighting, and one and a quarter seconds for the 'Y' lighting) but only when the participants were told to look for motorcycles. The lighting made no difference to the detection of the motorcycle during the day. The data also showed that daytime detection was much earlier than night time detection, and detection of the motorcycle was much earlier when participants were told to look for it than when they were asked simply to report the things attracting their attention. Finally, the 'V' and 'Y' lighting configurations led to participants reporting that they would accept larger (i.e. safer) gaps in front of the trial motorcycle at night when compared with the headlight only condition (by approximately half a second for the 'V' lighting and approximately three quarters of a second for the 'Y' lighting), but again there was no difference during the day.

The study has several limitations that need to be considered when assessing the potential impact of the lighting configurations as safety interventions. Chief among these is the fact that the observation task used was relatively straightforward (a single direction of traffic on a long straight section of road), and therefore we cannot be certain that the findings in this study will generalise to all road situations. In addition, it is not clear that any benefits would transfer completely to everyday road user behaviour (as opposed to the performance being measured in the current study). Nonetheless, the findings suggest that the lighting configurations have real promise as ways of increasing the ease with which road users can detect motorcycles, and the safety margins they accept in front of motorcycles when pulling into traffic.

It is recommended that any new law for motorcycle lighting in New Zealand allows the use of extra lighting that adds width and height information to the motorcycle. It is also recommended that drivers be educated as to the value of actively looking for motorcycles, and that motorcyclists are educated as to the extent to which they are less visible at night, regardless of their use of additional lighting.

1 Introduction

1.1 Motorcyclist injuries as a public health concern in New Zealand and worldwide

It is accepted around the world that injuries sustained in road collisions are a serious public health concern. The World Health Organisation has noted that road traffic injuries were the ninth leading cause of death overall in 2004, and are expected to become the fifth-leading cause overall by 2030 (WHO, 2009). Reducing the burden of road deaths and injuries has been made an explicit aim of the United Nations, with the period from 2011 to 2020 being declared as a decade of action for road safety.

Motorcyclists have been shown consistently to be at a much higher risk of involvement in an injury accident than other road user groups (Wulf et al., 1989; Chesham et al., 1991; Horswill & Helman, 2003). For example Chesham et al. (1991) used data from the UK and reported that that after controlling for mileage and compared with car drivers, motorcyclists were eight times more likely to be involved in an injury accident. Horswill and Helman (2003) used data from the UK covering the period 1997-1999 and reported a near identical figure (7.9 times more likely).

Helman et al. (2012) examined New Zealand data (New Zealand Ministry of Transport, 2011) and reported that in 2010 motorcyclists represented 13% of deaths on New Zealand roads (50 of 375) and 9% of other injuries (1300 of 14,031), despite representing only 3.5% of registered vehicles. In 2011 (the latest year for which published data are available at the time of writing) the corresponding figures are similar in magnitude (nearly 12% of deaths and around 9% of injuries – see New Zealand Ministry of Transport, 2012).

Because of the high injury rate of motorcyclists, and because they are more likely than car drivers to sustain severe injuries or be killed when involved in a collision (e.g. Wulf et al., 1989; Chesham et al., 1991) measures to reduce the likelihood of motorcyclists being involved in collisions have the potential to have a significant impact on road safety and public health.

1.2 'Looked but failed to see' accidents

A common cause of motorcycle collisions is the violation of the path of a motorcycle by another vehicle (e.g. Hurt et al., 1981; Wulf et al., 1989; ACEM, 2004). A common collision scenario between motorcycles and cars occurs when a car driver violates the motorcyclist's path at a junction or intersection. Such events are typically referred to as 'looked but failed to see' (LBFTS) collisions, on account of the fact that often in post-collision interviews drivers claim either not to have seen the motorcycle at all, or not to have seen the motorcycle until it was too late to take avoiding action (Hurt et al., 1981).

Not surprisingly in light of such findings there have been numerous calls for improvements to be made to the conspicuity of motorcycles in order that they might be detected more readily by other road users (e.g. Williams & Hoffman, 1979; Olson et al., 1981; Hole et al., 1996; Rößger et al., 2011). This idea has intuitive appeal as a way to reduce LBFTS collisions, but is not as simple in its execution as it might first appear.

One issue is that increasing motorcycle conspicuity in everyday traffic conditions is not easy (see Section 1.3). This has been recognised for decades; in an early review for example, Wulf et al. (1989) concluded that "Although a number of factors influencing motorcycle conspicuity have been identified, their interaction under differing driving conditions…remains to be elucidated" (p.173).

Another issue is that the term 'looked but failed to see' may not capture all of the underlying perceptual and behavioural failures that can lead to collisions often described as such. Helman et al. (2012) for example reviewed the literature and concluded that so-called LBFTS collisions should be thought of as potentially arising from a range of different failures, not all of which involve 'looking', and not all of which lead to 'failing to see' an approaching motorcycle. The key distinctions are illustrated in Figure 1.

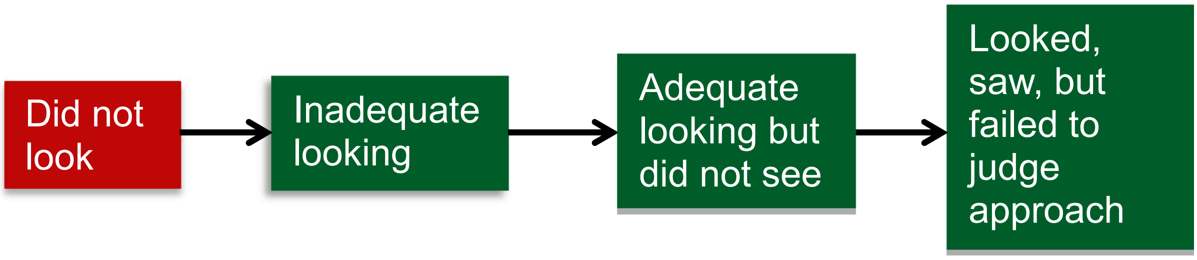

Figure 1: 'Looked but failed to see' accidents have a number of potential underlying perceptual failures, not all of which are fully captured by the term (reproduced with permission from Helman et al., 2012)

The case of someone simply not looking when they execute a manoeuvre that might bring them into conflict with a motorcycle is clearly not a conspicuity or perception issue[1]. There are however at least three levels of failure beyond this that need to be considered by those seeking to design conspicuity interventions to reduce the prevalence of collisions between cars and motorcycles at junctions or intersections.

The first two of these (the two middle boxes in Figure 1) are potentially to do with conspicuity in that they involve drivers looking but failing to detect an oncoming motorcycle. Inadequate looking is one failure that may lead to missing a motorcycle in the scene – for example looking too briefly to cover the area to be searched, or failing to look in the areas of the road scene where motorcycles may be located. If a motorcycle is present but not very conspicuous (for example because it is blending in with its background – see Section 1.3.1), then even adequate looking (i.e. looking for a good amount of time and in the right places) may not be sufficient for detection.

The third failure (the rightmost box in Figure 1) is related to how drivers judge the time they have to execute a manoeuvre in front of a motorcycle that they have detected. Because of the small size of motorcycles, it is potentially difficult for observers to judge how long they have to execute a manoeuvre crossing the motorcycle's path (see Section 1.3.2).

Contributory factors data from injury collisions are consistent with the view that both failures of detection and failures of judgement are important in road collisions generally, and in road collisions between cars and motorcycles specifically. For example in Great Britain the two most frequent contributory factors attributed to car drivers in all collisions are 'failed to look properly' and 'failed to judge other person's path or speed' (Department for Transport, 2012). More importantly for our current purpose,

[1] Also ignored in this description are people who take some aggressive action such as deliberately violating the path of a motorcyclist to communicate frustration or to 'push in' to a line of traffic.

motorcyclists are the most likely vehicle type to be involved in a collision with another vehicle to which the contributory factor 'failed to look properly' was attributed; for example in 2011 in GB 48% of collisions between motorcycles and cars were of this type, while for car-car collisions the rate is 25% (Table RAS50014 in DfT, 2012).

In Section 1.3 we discuss in more detail different ways in which we can think about conspicuity, and the perceptual mechanisms involved in judging vehicle approach. We show that these processes can be mapped onto the different perceptual failures shown in Figure 1, and that they lead to some recommendations regarding ways in which we might attempt to reduce the prevalence of so-called LBFTS collisions between motorcycles and cars. In Section 1.4 we describe briefly the two interventions designed on the basis of these recommendations. The remainder of this report is then devoted to describing the method and results of a roadside study carried out in New Zealand and designed to test the likely effectiveness of these interventions in real traffic conditions.

1.3 Conspicuity and judging time to contact

1.3.1 Conspicuity

A widely-cited definition of conspicuity comes from Lesley (1995, cited in Langham & Moberly, 2003); it is suggested that conspicuity is the extent to which an object stands out from its surroundings. That is, conspicuity is reliant not only on the features of the object in question, but also on the surroundings and background against which the object is viewed. Generally it is accepted that the key determinant of an object's conspicuity is the contrast between it and its surroundings, although other features such as movement relative to background are important (e.g. Rushton, Bradshaw & Warren, 2007)[2].

An important additional distinction can be made (see Cole & Hughes, 1984) between *search* and *attention* conspicuity. In short, search conspicuity is the extent to which an object stands out from its surroundings (operationally, its ease of detection) when an observer is actively searching the scene for the object[3]. Attention conspicuity is subtly different, in that it is the ease with which an object 'grabs attention' even when an observer is not actively searching for it.

Another important concept is *cognitive* conspicuity. This can be thought of as referring to the extent to which an object is expected by an observer. In practical terms motorcycles often have low cognitive conspicuity as they tend in most jurisdictions to make up a very small proportion of road traffic (Hancock et al., 1990; see also Most & Astur, 2007, and Hole & Tyrrell, 1995, who discuss the related concept of 'attentional set'). If drivers do not expect to see motorcycles very often this seems likely to lead to low levels of active search ('inadequate looking' in Figure 1). This makes it important that motorcycles possess the ability to 'grab' attention, as well as being conspicuous when drivers are being vigilant with their visual search.

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[2] When a motorcycle is approaching head-on, its movement relative to the background is minimised due to its small size and low rate of expansion; thus not only does the small size of motorcycles have implications for judging time to collision (see Section 1.3.2) but it may also have implications for the movement component of their conspicuity.

[3] This is not the same as, but is related to 'visibility', which Langham and Moberly (2003) define as the ease with which an object can be detected when an observer is aware of its location. Often in road scenes although drivers have defined areas to observe (for example an oncoming road at a junction) some visual search of this area is still required.

Helman et al. (2012) reviewed the research literature on motorcycle conspicuity and concluded that a number of interventions (mainly related to brighter clothing and lighting) have been shown to have promise in increasing both search and attention conspicuity of motorcycles. Helman et al. also concluded that as well as having the potential to make motorcycles more conspicuous, some interventions also show promise in helping drivers more accurately judge the approach speed and time to contact of motorcycles. We now turn our attention to this issue in Section 1.3.2.

1.3.2 Judging time to contact (TTC)

Object size influences time to contact (TTC) judgements, with small objects being judged as arriving relatively later than large objects, even when the actual arrival time for both is the same (DeLucia, 1991; DeLucia, Kaiser, Bush, Meyer & Sweet, 2003). This 'size-arrival' effect has been shown in laboratory studies using vehicles of different sizes (Caird & Hancock, 1994; Horswill et al., 2005); such findings suggest a plausible role for the effect in contributing to some LBFTS collisions. In essence, small objects provide less perceptual expansion information than large objects, and since this is an important component of judging TTC (see Lee, 1976) car drivers may estimate that they have longer than they really do before motorcyclists reach their location.

Helman et al. (2012) and Gould et al. (2012a, b) have pointed out that the perceptual information available for making TTC judgements for motorcycles is reduced to an even greater degree at night, given that most motorcycles only have a single headlight; a small point of light provides almost no expansion information on approach at the distances and speeds involved in most junction interactions between traffic.

Gould et al. (2012a, b) have shown that judgements of speed differences for single headlights (when speed comparison is being made with a two-headlight car stimulus) are much less accurate than for another two-headlight stimulus. When people are given two cars to judge, they are able to reliably tell the difference in speed when it is around 5mph. In night conditions, a speed difference of around 55mph between a single headlight motorbike and a car was required (i.e. a car travelling at 30mph being compared with a bike travelling at 85mph) before people could reliably tell the difference; even in daytime a difference of 20mph was required for reliable detection.

Of interest to the study here, Gould et al. (2012a, b) also tested a 'tri-headlight' formation on motorcycles. This formation has two smaller lights flanking and below the main headlight, which introduces extra width (and height) information, as in Figure 2.

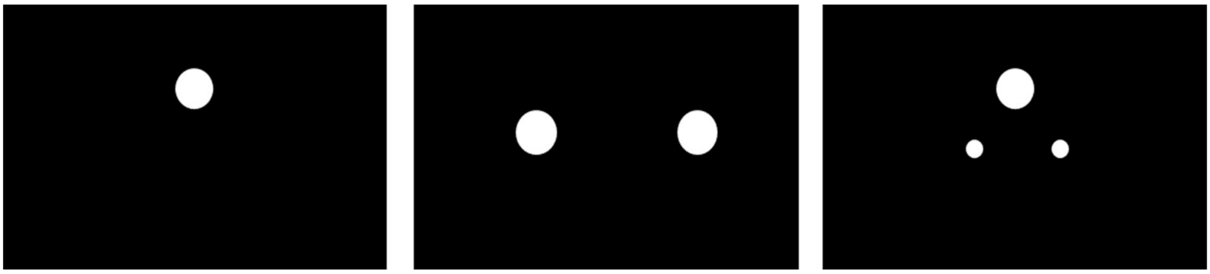

Figure 2: Single motorbike headlight, car (dual) headlight, and motorbike tri-headlight formations similar to those tested in Gould et al. (2012a, b)

Gould et al. found that the tri-headlight formation demonstrated considerable benefits in accuracy of speed judgement over the single headlight formation. Even at night, participants were able to accurately judge when the bike was travelling faster than the car with a speed difference of around 15mph; during daytime a speed difference of just over 10mph was enough.

1.4 Using frontal lighting on motorcycles to increase conspicuity and aid time to contact judgements

Helman et al. (2012) point out that novel lighting configurations on the front of motorbikes have a potential double advantage as interventions to assist in preventing LBFTS crashes. Firstly they introduce more light to the front of the bike, which may increase their search and attention conspicuity when approaching other road users at junctions. Secondly, these configurations introduce more width and height information which can be used to judge oncoming speed more accurately.

Such configurations have been shown to have an impact on conspicuity in laboratory studies, including very recent studies as part of the collaborative 2BeSafe (2-Wheeler Behaviour and Safety) project (see http://www.2besafe.eu/). The Gould et al. (2012a, b) studies provide laboratory evidence of increased accuracy of speed perception using such lighting configurations. What is missing however is work that takes the potential promise shown by these lighting configurations in laboratory studies, and asks whether this promise is evident in real traffic.

This is the starting point for this research. The current study aimed to establish if using novel lighting configurations that introduce more light and more width and height information to the front of motorcycles could improve the attention conspicuity and search conspicuity of motorcycles in a realistic roadside observation setting (mimicking waiting at a junction to pull out into a flow of traffic). The impact of the lighting configurations on pull-out judgements in this realistic observation setting was also examined.

On the basis of the previous work reviewed in this introduction, and assuming that such findings transfer to roadside observation, the following findings can be predicted:

1. The new lighting configurations should result in earlier detection of the motorcycle under both attention and search conspicuity instructions.
2. The new lighting configurations should encourage observers to indicate a larger gap when judging the last point at which they believe it would be safe to pull out in front of the motorcycle.

The study examined these questions separately for night time and daytime observation. In addition, because the study was carried out in live traffic (with only minimal control over placement of the bike in the scene possible) statistical techniques were used to assess the impact of other variables (such as the number of other vehicles in the scene) on detection distances and pull-out judgements, so that the independent effect of the lighting configurations could be established.

2 Method

2.1 Participants

2.1.1 General breakdown of sample

Six hundred and ten participants who reported having a full car licence for New Zealand were recruited from a number of sources in and around Takapuna in Auckland, New Zealand. First, adverts were placed in The North Shore times, in the 'public notices' and 'part time work' sections, throughout the period 10th June to 29th June 2013. Adverts were then placed on 'Trade Me Jobs' weekly from 30th June until 18th August 2013. Contact was also made with a number of organisations in the local area including Hospice North Shore, and Northcote Baptist Church; these organisations advertised the study to their members. Each participant was paid 35 New Zealand dollars in cash for their participation, to cover their travel costs and compensate them for their time.

Two participants who did not have any survey data or video data recorded (due to equipment failure) are excluded from the analyses. Five participants reported not having a full New Zealand car licence in the survey. However since licence status was checked thoroughly during recruitment we have assumed that this represents data entry error on behalf of the participants, and have included data from these participants where we have it.

The age and sex breakdown in Table 1 shows a good spread of ages for both sexes. The table shows observed and expected proportions of age group for each sex (and of sex for total sample size); expected proportions are based on New Zealand licence data for 2012. For both sexes the 25-39 age group is underrepresented. For females the 40-49 age group is overrepresented, as is the 16-24 group (but only slightly). For males the 16-24 age group is overrepresented, and the 40-49 age group is slightly underrepresented. For males and females the proportions of other age groups are approximately as would be expected based on New Zealand licence data. The sample as a whole is slightly biased towards females.

Overall the sample is broadly representative of New Zealand licence holders, albeit with some slight deviations as described above.

Table 2 shows the breakdown of the sample by the length of time they have held their New Zealand driving licence, and Table 3 shows km driven each year. Again both of these variables show a good spread, as would be expected in a range of drivers from the population.

Table 1: Age and gender breakdown of participants[4]

Age group	Female	Male	Total
16-24	58 Actual (16%) Expected (13%)	64 Actual (25%) Expected (14%)	122
25-39	66 Actual (19%) Expected (28%)	54 Actual (21%) Expected (27%)	120
40-49	89 Actual (25%) Expected (20%)	41 Actual (16%) Expected (20%)	130
50-59	68 Actual (19%) Expected (18%)	39 Actual (15%) Expected (17%)	107
60-69	45 Actual (13%) Expected (12%)	33 Actual (13%) Expected (13%)	78
70+	26 Actual (7%) Expected (9%)	25 Actual (10%) Expected (9%)	51
Total	**352** **Actual (58%)** **Expected (49%)**	**256** **Actual (42%)** **Expected (51%)**	**608**

Table 2: Breakdown of length of time with a full New Zealand car licence

Length of time holding car licence	Number of participants
0-2 years	56
3-9 years	108
10-19 years	91
20-29 years	102
30-39 years	104
40-49 years	72
50+ years	70
Unknown	5
Total	**608**

[4] First number in parentheses in each age band gives percentage of females and males separately, and second gives expected percentage based on breakdown of NZ licence data. Corresponding numbers in parentheses in 'Total' row give actual and expected percentages of female and male participants as a percentage of the total number.

Table 3: km driven each year

	Total
0-4,999	154
5,000-9,999	133
10,000-14,999	133
15,000-24,999	106
25,000-49,999	49
50,000-99,999	17
100,000+	11
Unknown	5
Total	**608**

2.1.2 Experience of motorcycles and cycles

Sixty-four participants in the sample had a New Zealand motorcycle licence with a very wide range of values for the number of years this had been held (six participants in the '0-2 years' category, and 16 in the '50+ years' category). Annual km travelled by motorcycle was typically no more than 5000km, with all but 11 of the participants with bike licences falling into this category, and eight of the remaining 11 entering '5000-9999' in the survey.

In response to the question "Does anyone in your immediate family ride a motorcycle?" 150 participants responded 'yes', and in response to the question "Do any of your close friends or colleagues ride a motorcycle?" 309 responded 'yes'. Finally in response to the question "Do you regularly ride a bicycle on the road?" 89 responded 'yes'.

Combining the responses to the motorcycle/bicycle[5] questions gives the number of participants who are 'more bike aware' (i.e. those participants who own a motorcycle licence, or whose friends/relatives ride a motorbike or those who regularly ride a bicycle) as 396 and the number who have 'no connection with bikes' as 212.

2.2 Design

The daytime and night time data were treated separately, as were data from the three different parts of the study. Within the daytime and night time studies, the three parts of the study differed according to the instructions given to the participants (see Section 2.4). The dependent variable was always 'time to contact' in the roadside observation study, which was measured from the video footage recorded (see Section 2.5). One additional dependent variable was a rating of visibility of the three lighting conditions in a static picture, in the survey (see Section 2.3.4).

[5] The 'bicycle' question was asked as we did not anticipate having large numbers of participants with experience of motorcycles, and asking about bicycles maximised the chances that we could split our sample according to their experience with vulnerable modes of transport characterised as being especially likely to be involved in accidents involving conspicuity as a contributory factor.

In each of the daytime and night time studies, and in each part within these, a one-way related-samples design (and therefore a one-way repeated measures ANOVA) was used. This was also true for the visibility ratings for the survey pictures.

In each part, participants viewed the road from the observation position (see Section 2.3.1) and watched the trial motorcycle ride past three times in live traffic. On each of the three passes within parts 1, 2 and 3, the trial motorcycle displayed one of the lighting configurations ('C – control', 'V – intervention 1' and 'Y – intervention 2' – see Figure 9).

Order of lighting condition (as presented to participants) was counterbalanced using a full Latin Square (i.e. each of the six possible orders was used in sequence) although in practice because not all participants provided useable data it was also necessary to check and control for order effects in the analyses.

Lighting configuration served as the key related-samples independent variable in each part of the daytime and night time studies (three levels – C, V and Y). Analyses also examined the number of other vehicles in the road scene when the trial motorcycle rode past the observation location, in an attempt to account for the effect of scene complexity. The effect of having experience as a motorcyclist, and of having friends or family who ride a motorcycle, was also considered where possible.

In all cases where the assumptions for parametric analyses were not met, appropriate transformations were applied to the data, and analyses were carried out on these transformed scores.

2.3 Materials and apparatus

2.3.1 Trial location and observation vehicle(s)

Figure 3, Figure 4, Figure 5 and Figure 6 provide an overview of the trial location showing the observation vehicle, and views of the road from various positions. The observation vehicle (in these figures a 2013 Toyota Camry) was parked on each day of trialling in approximately the same position on a grass bank beside the road. The grass bank was set back from the road, but mimicked as closely as was practical a junction or intersection position from which one might view the road when waiting to pull out into the line of approaching traffic.

The view from the rear quarter-light window was obscured using cardboard and duct tape to help minimise the chances of participants spotting the motorcycle as it descended the hill to the right of the site, to join the road approaching the viewing position. Figure 7 shows a two-car observation set-up (using a 2013 Camry and a Daihatsu Sirion) that was used later in the trialling period to boost participant numbers after technical and environmental challenges resulted in data from some early participants being incomplete or unusable for the main video analysis.

Figure 3: 'Participant' (MP) seated in rear of trials car, with video camera attached to driver's side window and experimenter (SH) in front passenger seat. Note 'view obstructer' attached to rear quarter-light window

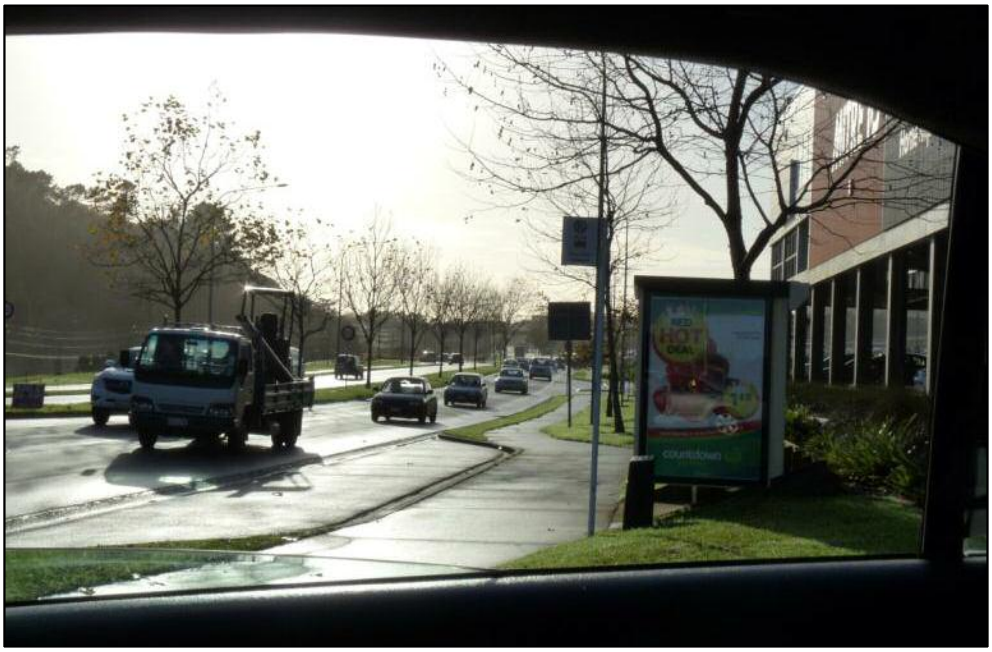

Figure 4: Participant view of approach

Figure 5: Camera view of approach

The camera view of the road was standardised as closely as possible between participants by anchoring the right hand edge of the camera screen to a fixed landmark within the scene (in most cases the bus stop on the right of the wide sidewalk). The camera direction was not moved once set up for a testing session.

Figure 6: Trials location, with trials motorcycle ('Y' lighting) approaching in upper right of image

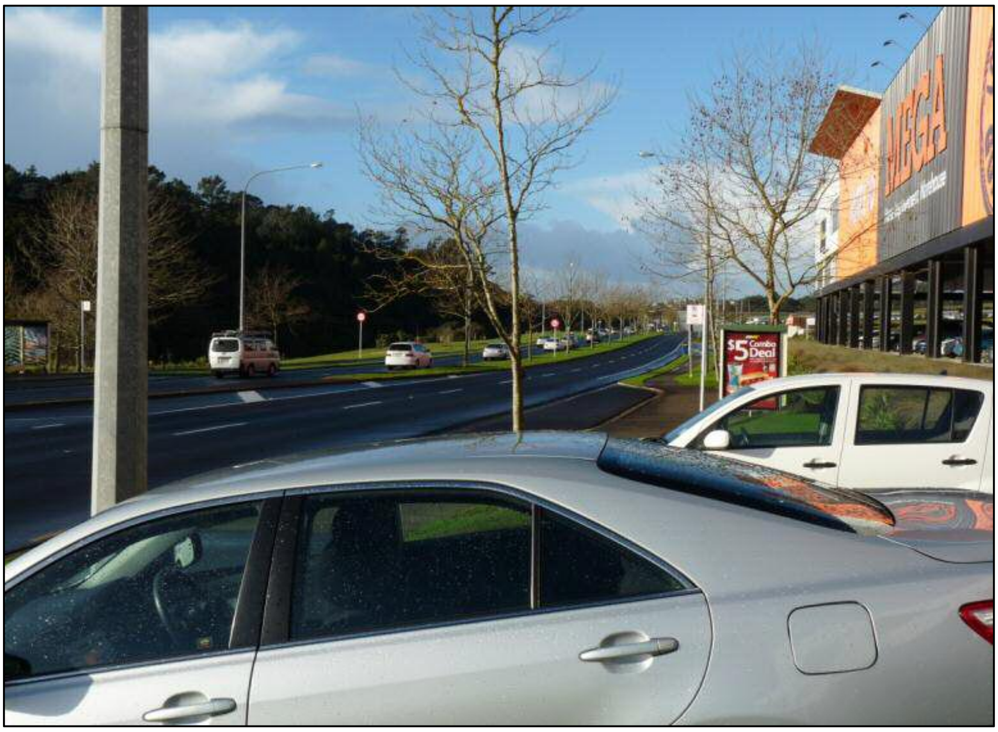

Figure 7: Two-car testing set-up used later in the trial

Figure 11 and Figure 12 in Section 2.4 show plan views of the trial site alongside a description of the procedure used for testing participants, and the way in which the trial motorcycle was used.

2.3.2 Bikes and lighting

The motorcycles selected for the trials were two Suzuki Inazuma, 250cc twin cylinder standard motorcycles (see Figure 8). The Inazuma was considered suitable to represent the types of motorcycle that New Zealand's drivers were likely to encounter during daily driving. Two identical bikes were used to ensure continuity in the event of any technical failure.

Figure 8: Trial motorcycle, displaying both pairs of Daytime Running Lights (DRLs, in this case the Y' configuration)

Location of lighting on the motorcycles was guided by the findings of the earlier literature review (Helman et al., 2012), the work on the 2BeSafe project, and the Gould et al. (2012a, b) studies. Figure 9 shows the three lighting configurations used. The control (C) configuration comprised only the motorcycle headlight. The 'V' configuration comprised the headlight, plus two round DRLs mounted in front of the mirrors. The 'Y' configuration added two fork-mounted rectangular LED strips to the 'V' configuration.

Figure 9: Three lighting configurations; 'C' control, interventions 'V' and 'Y'

Previous suggestions in the literature (for example in the 2BeSafe project) for the location of upper LED lights have included the use of strip lighting on handlebars. However in this study the upper lights were positioned high, in front of the rear-view mirrors. This was for two reasons. Firstly it was anticipated that 'higher and wider' would maximise any benefits for improved assessment of approach speed. Secondly, the additional lights were at the maximum practical distance away from the standard front indicators on the bike, which reduced the likelihood of any glare preventing the indicators being seen by other road users during the trials.

The additional lighting was installed using fittings constructed specifically by Hella for the Inazuma trial motorcycles, with switches easily accessed by the rider to allow changes in configuration displayed throughout trial sessions. The lighting used for the upper lights was circular (Hella Type 1006) and the lower lighting on the fork legs was rectangular (Hella Type 5617).

It was considered essential that the motorcycles and riders used for the trials should be relatively neutral. Therefore, the motorcycles selected for use were obtained in plain black colour, fitted as standard with automatic headlamp on (AHO) which means that the motorcycle's dipped beam is displayed while the machine's ignition switch is 'on'. Riders were provided with plain black over-suits, and those without plain black helmets were provided with removable plain, dark, helmet covers (note the photos in Figure 9 were taken before trialling so the rider is not wearing his helmet cover). As discussed in the previous literature (for a summary see Helman et al., 2012), there may be conspicuity benefits from maintaining (through the use of a black motorcycle and rider equipment) a 'solid', potentially recognisable, outline of 'motorcycle and rider' against a lighter background. However the approach used was felt to provide the most neutral appearance possible for the observation location used, especially during night time testing.

Figure 10: Trials motorcycle, displaying upper DRLs (‘V’ configuration) with rider wearing black clothing and helmet cover

Current New Zealand motorcycle lighting legislation (New Zealand MoT, 2005) requires that motorcycles display dipped headlamps during daytime riding (although it permits that daytime running lamps may be used):

> *8.3 Use of motor vehicle lighting equipment on road*
>
> *(5) This subclause applies to the driver of a moped or motorcycle manufactured on or after 1 January 1980. The driver other than during the hours of darkness must use the moped's or motorcycle's headlamps or, if fitted, the moped's or motorcycle's daytime running lamps.*

This regulation prohibits the lighting configurations combining dipped headlamp displayed with DRLs as used during the trials, so an exemption was applied for and granted by the New Zealand Transport Authority, permitting the trials motorcycle to display both dipped headlamp and DRLs together during the trials.

2.3.3 Cameras and tablets

Video footage was captured using Panasonic HDC-SD90 cameras, set to the widest angle zoom. Figure 5 shows one of the cameras mounted on the inside of the car window, using a suction mount.

Survey data were captured using Samsung Galaxy Note 10.1 tablets, running a survey designed and hosted using the droidSURVEY software (www.droidsurvey.com).

2.3.4 Survey

The survey was used to collect informed consent from participants, to provide instructions as they undertook the three parts of the study, and then to collect some demographic data (age and gender), licence status (car and motorbike), mileage (car and motorbike), ratings of visibility in the three lighting configurations, and some additional questions regarding experience with motorcycles (for example whether participants have family or friends who ride, and whether or not participants saw the trial motorcycle before taking part in the study). Screenshots showing the entire questionnaire can be seen in Appendix A.

2.4 Procedure

2.4.1 Arrival

Participants were asked to attend for a specific 25 minute time slot. During the daytime sessions, and at the beginning of the night time sessions, the trial site had access to a café in the Mitre 10 store just off the road, and this was used for meeting participants as they arrived. For remaining night time participants a people carrier was used for this purpose with participants meeting the experimenters outside the Mitre 10 store on a piece of private road adjacent to the car park.

On arrival, participants were asked to complete the initial section of the survey on a tablet; they read some general information and then completed the consent form. Participants were told as part of the consent process that they were welcome to withdraw their participation at any time if they wished, without giving a reason. All participants signed the consent form, and none withdrew.

After participants had provided consent, the first experimenter walked them to their observation vehicle, and passed control of them to a second experimenter. Each tablet stayed with its participant throughout the study; when participants reached their observation vehicle the second experimenter guided them through the three parts of the roadside observation section of the study.

2.4.2 Part 1

In part 1, each participant was instructed to observe the road scene to their right as if waiting to turn into the flow of traffic, and was asked to describe anything that grabbed their attention in the scene. A short video (around 20 seconds long) was played to each participant demonstrating one of the experimenters undertaking the task; a different (urban) road was used for this video so as not to prime the participants as to what things to comment on in the scene they were observing. The instructions and commentary in the example video clearly prioritised oncoming vehicles, but care was taken to explain (and demonstrate in the commentary) that anything that grabbed attention (near or far, moving or static) should be vocalised as soon as it did so.

After the participant indicated that they were ready to begin, the experimenter started the video (stating participant number and part number to assist later video coding – see Section 2.5) and then stated to the participant that they would warn the staff who were 'meeting and greeting' that the study was going to begin, by using the call button on the radio, so that the participant would not be disturbed while commentating; the experimenter then pressed the call button (which emitted an audible tone) and invited the participant to begin their commentary[6]. Unbeknownst to participants, the call signal

[6] In the two-car setup, two experimenters were used (one in each car with each participant). One of these took responsibility for pressing the call button, after establishing that both participants were ready to commence.

was to alert the motorcyclist that they could begin their circuit of the trial location. A plan view of the circuit ridden is shown in Figure 11, and more detail of the approach in Figure 12.

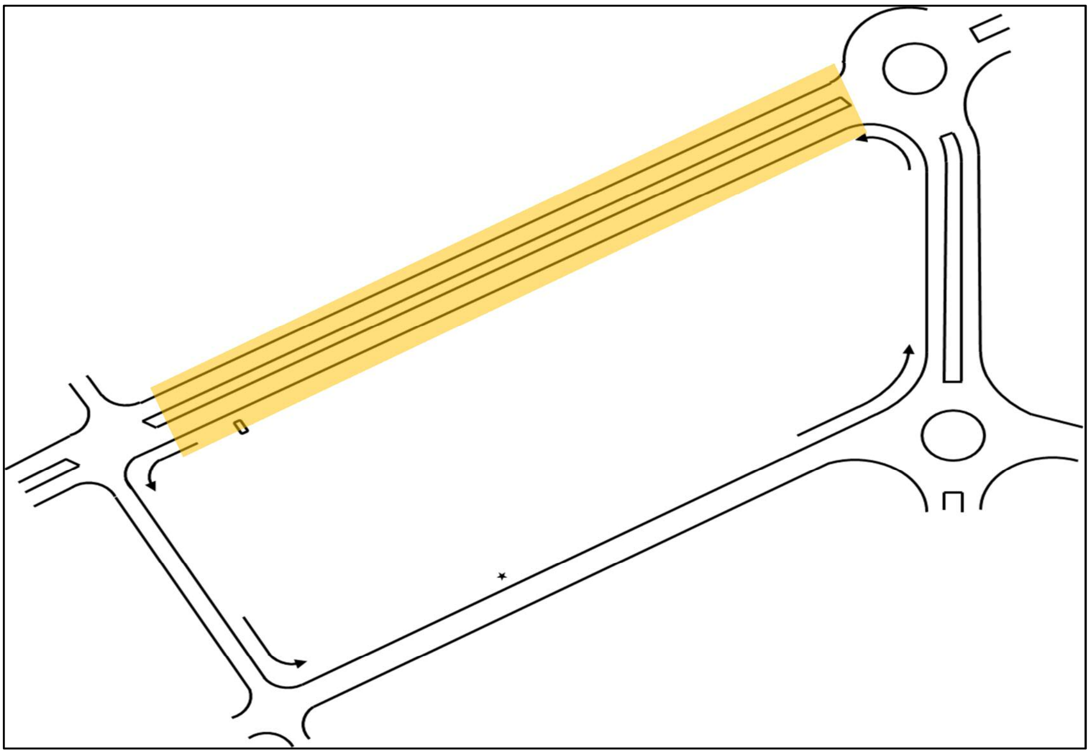

Figure 11: Plan view of trial circuit (not to scale). Small rectangle to left is approximate observation vehicle location. Arrows indicate direction of travel around circuit for motorcycle. Asterisk marks waiting position for motorcycle. Shaded section expanded in Figure 12

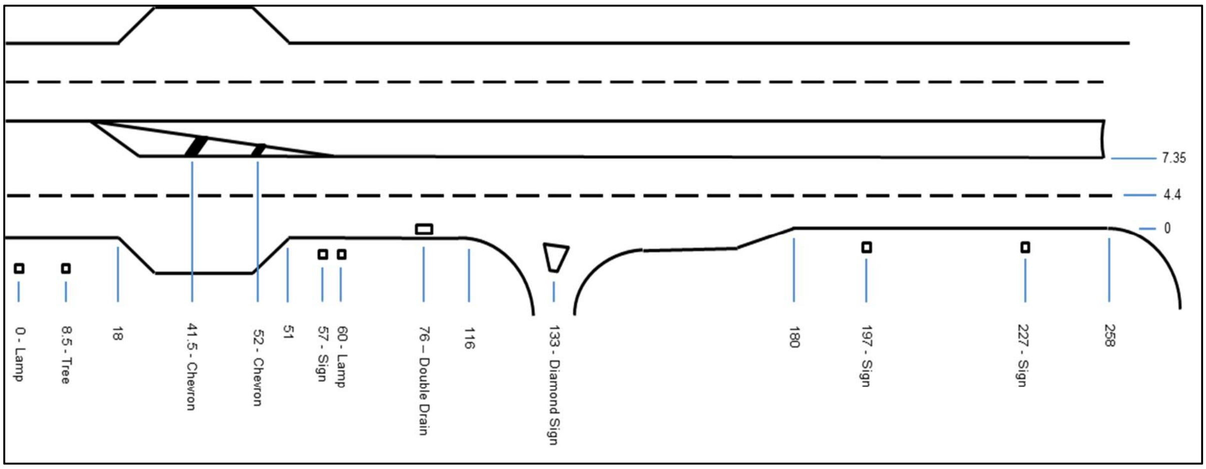

Figure 12: Close up detail of approach road with distances from lamp on left (0) in metres (not to scale). Observation vehicle was parked roughly half way between lamp (0) and tree on left in single-car setup. Second car was parked just to left of lamp (0) in two-car setup

Riders wore a radio with ear-piece, so that they could hear the call signal and all of the communication between experimenters at the site[7]. Riders were briefed that on hearing the call signal they should ride three passes of the observation position, using the three different lighting conditions in the order specified for that participant (or pair of participants in the two-car setup). To control order of lighting condition, riders were instructed which order to use for the first participant (or pair of participants) in any given testing session, and they then moved through the six possible orders in sequence with each new participant or participant pair. Riders were given several other specific instructions to follow on each pass (these instructions applied to all parts of the study):

- Ride approximately in the centre of the lane[8] on approach to the observation vehicle(s), maintaining a constant speed up to or just below the speed limit[9] when possible and safe
- Maintain a good following distance (ideally at least six seconds) from any vehicle ahead to help ensure maintenance of unobstructed view from the observation vehicle(s)
- Try not to follow directly after any vehicle which obstructs view completely (for example HGVs)[10]
- As far as possible, keep riding consistent between all riding sessions (e.g. riding line, approach speed, following distance)
- Avoid making turn signals for the left turns into the approach road and past the observation position while in view of the observation position; there was sufficient room before being in view and after riding past the observation position to use turn signals to alert other road users to manoeuvres but without drawing the attention of the participant(s) (flashing lights would draw attention independently of lighting configuration)

After three passes, the rider waited at the holding position (see Figure 11) until the next call signal was given.

After the third pass of the motorcycle for part 1, the participant(s) in the observation vehicle(s) were instructed to cease their commentary, the camera was stopped, and the instructions for part 2 commenced.

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[7] Note however that the motorcyclist was never referred to or spoken to directly (so as to avoid giving away the topic under investigation to participants); if it was necessary that a message be passed to the motorcyclist (for example for them to begin another circuit, or if they had missed the call signal) they were referred to as 'experimenter 4' (e.g. "Can someone let experimenter 4 know that their radio may need checking?")

[8] At the trials site, recent road works had created a well-defined dark longitudinal mark on the road surface within the left lane, which riders followed; see Figure 6 and Figure 10.

[9] The speed limit on the road was 60kph. Informal observations by the trial team suggested that the speed obtained by the bike was extremely consistent. A GPS tracker on the main trial bike confirmed this, indicating that the mean speed obtained within a region approximately 20m either side of the Mitre 10 entrance ('133 Diamond Sign' in Figure 12) was 55.7kph (stdev 3.06, 1209 data points taken from the entire course of the study, day and night combined). Approach speed did not vary with lighting condition.

[10] The traffic on the road approaching roundabout where the motorcycle joined the run-up to the observation position tended to come in 'waves' as there were traffic lights around a quarter of a mile further down the road at the entrance and exit points to a highway. Therefore there were almost no examples in the trial where the trial motorcyclist was unable to ensure that they met the requirements for following distance and remaining unobstructed. In the handful of examples where an obstruction or some other event ruined a pass, data for that participant were not used in the analysis – this is one of the reasons why there are different numbers of participants contributing data to the different parts of the study (see Section 3), and why the number of people contributing usable video data is typically lower than the total number tested.

2.4.3 Part 2

In part 2, participants were instructed to again observe the road scene to their right as if waiting to turn into the flow of traffic. They were instructed to look specifically for motorcyclists on the approach road, including any with the novel lighting configurations being used in the study, and to say ‘bike’ when they detected one. Photos of the trial motorcycle with the three lighting configurations were shown as part of these instructions, and participants were informed that they were looking for any motorcycle, including ones with these types of lights. Participants were also invited to describe the differences between the three lighting configurations, so as to familiarise themselves with what they would be looking for.

After participants indicated that they were ready, the experimenter started the camera, read out the participant number and part number for use in later video coding, and pressed the call button to alert the motorcyclist to do the second set of three passes. The participant was then invited to begin looking for motorcycles on the approach road, and to say ‘bike’ whenever they detected one.

The same order of lighting configurations was used during part 2 as in part 1, with the rider again waiting at the holding position after three passes. After the third pass of the motorcycle for part 2, participants were instructed to cease looking for motorcycles, the camera was stopped, and the instructions for part 3 commenced.

2.4.4 Part 3

In part 3, participants were told that they would be asked to indicate to the experimenter the minimum size of gap they would accept in front of motorcycles coming from the right, as if they were making a left turn onto the road on which the motorcyclist was travelling. Participants were told that the experimenter would point out the motorcycle to them as it came onto the road (to ensure that they had seen it) and that they should say ‘no’ at the point at which they would no longer pull out. After a short practice of the task using other vehicles, the experimenter started the camera (again reading out the participant number and part number for use in later video coding) and pressed the call button to alert the motorcyclist to do the third and final set of three passes.

The same order of lighting configurations was used during part 3 as in parts 1 and 2. After the third pass of the motorcycle for part 3, the participants were instructed that the roadside observation part of the study was over. They were then invited to begin completing the short survey (see Section 2.3.4) on their tablet; some participants completed this in the observation vehicle while the next participant was walked down by one of the other experimenters, while some completed it back at the meeting area; this depended on various factors such as the times at which new participants arrived, and the speed with which they could walk down to the observation vehicle. In all cases, after a participant had completed the survey they were debriefed that they should not mention to anyone what they had done in the study (in case they had friends or family who would be taking part later on). It was made clear to participants that in particular, it was important that they did not mention to anyone that the trial had included a focus on motorcycles. Participants were then thanked for their participation and signed the final page of the survey to acknowledge receipt of their 35 New Zealand dollars.

2.5 Data management and coding from video

2.5.1 Data management

All survey data were uploaded to the secure droidSURVEY website (www.droidsurvey.com), and periodically downloaded in .csv format to TRL's secure servers.

Each participant had been assigned a participant number on the tablet they used to complete the survey, and this participant number was the same as that read out by the experimenter on the camera footage for each part of the roadside observation study. Thus the participant number served as the method by which survey data could be matched with video footage when video coding commenced.

All video files from the camera SD cards were downloaded at the end of each day onto a single 3TB hard disc drive on site in New Zealand that served as the main backup of data throughout the project. Additionally data were copied onto one of three 1TB hard disc drives that were used by the trial team to carry the video data back to TRL's offices throughout the ten-week period of trialling when staff changeovers permitted this. On arrival at TRL, all video files were transferred to TRL's secure servers, and video coding commenced.

2.5.2 Video coding

A team of six video coders worked on the task, with three coders completing around 75% of clips between them. A single coder coded every data point originating from a given participant (i.e. three passes for each of three parts) to ensure that the very slight differences that may exist between coders were not apparent within participants. From early informal checks on inter-coder reliability it was apparent that the almost completely objective nature of the task led to very high agreement between coders.

For each participant, video (with audio) of each pass by the motorcycle in each part of the study was inspected to establish the point at which participants had given their indication of having seen or made their decision about the trial motorcycle. For parts 2 and 3, this was the point at which the participant had said 'bike' or 'no' respectively (as per the instruction for those parts). For part 1 the open and free-choice nature of the commentary resulted in a range of language being used to describe the trial motorcycle, meaning that there was not a single 'target word' that defined the point of detection. In addition, presumably because participants had no prior experience of the novel lighting configurations in part 1, they were often observed to be unsure, or hesitate when describing the trial motorbike in these conditions. While some participants described the motorcycle unambiguously and immediately on detection (e.g. "Motorbike coming towards us…") others were less immediate in their confirmation (e.g. "What on earth is that…a motorbike").

In order to ensure that the data coding was carried out in as objective a manner as possible for part 1, the point of detection was defined as the beginning of the utterance which unambiguously related to the trial motorcycle. Thus in the examples above the points would be defined as the [m] sound of "Motorbike…" for the first example, and the [w] sound of "What on earth…" in the second. Other examples include the [ð] sound at the beginning of "Three lights on a bike coming towards us…" and the [g] sound at the beginning of "Got a funny looking thing with three lights on it…"

Once the point of detection (or for part 3 the 'no' decision) had been established, the number of seconds from that point, to the point at which the motorcycle headlight touched or passed the edge of the screen was entered on the spread sheet. This value was used as a proxy for the time to contact when the response was given[11]; because different participants sat in slightly different positions, and because the camera was also in a slightly different position on each trial day, we cannot assume that this value is an exact, absolute, time to contact. However the camera was in the same position for each participant throughout all three parts so we can be confident that any differences observed between the time to contact values of different lighting conditions for a given participant reflect genuine differences, and are not simply artefacts of the testing process.

Table 4 lists this and the other variables coded from the video so that they could be taken into account during the analysis in the current report.

Table 4: Variables coded from video (for each participant, for each pass of each part) for the analyses in the current report

Variable	Rationale
Lighting configuration on bike	The main variable under investigation
Time to contact at detection (parts 1 and 2) or 'no' decision (part 3)	The main outcome variable of interest
Number of oncoming vehicles in the scene during the time that the bike first pulled onto the road (and therefore became potentially visible) and when it was detected (parts 1 and 2) or 'no' decision was made (part 3):	It was important to take traffic into account as an indicator of how complex the scene was while the motorcycle was in view; with more traffic in view it would be more difficult to detect the motorcycle, and additional objects moving towards the observer are also known to change time-to-collision judgements (for example see Oberfeld & Hecht, 2008).

Order effects were also examined and controlled for if necessary in the analysis, since order was not completely counterbalanced in the participants who contributed usable video data. This was done (when needed) by checking that the pattern of results found in a given part of the study was the same when participants were removed randomly from the analysis to permit complete counterbalancing.

[11] A longer TTC indicates earlier detection. If the trial motorcycle was not mentioned at all, a value of zero was entered in the spread sheet, although participants who did not mention the bike were not included in the analysis.

3 Results

This section discusses the key findings from the study. First we present the ratings of visibility from the roadside survey, including analysis of whether this rating was affected by being in the 'more bike aware' group. Then the findings from the three parts of the roadside observation study are presented. (No analysis of the effect of being 'more bike aware' is made for the roadside observation study, since we do not believe there is sufficient statistical power in the design to do this.)

Note that for the roadside observation parts of the study data were not available for all participants. This was anticipated, as in such studies there are often technical and environmental difficulties that present themselves when data collection is taking place. For each part of the roadside study (attention conspicuity, search conspicuity, gap acceptance), the numbers of people with usable data vary slightly due to these factors.

3.1 Ratings of visibility in survey

Table 5 shows ratings of visibility for the three lighting conditions in the pictures used in the tablet-based survey.

Table 5: Ratings of visibility (from 0 to 100) for the three lighting configurations in the survey (pictures can be seen in Appendix A)

Lighting condition	Mean	Standard deviation	N
C	38.66	25.91	608
V	40.33	23.98	608
Y	41.78	24.95	608

A repeated measures ANOVA showed that mean visibility rating differed significantly between the three lighting conditions, (p<.001)[12] and post-hoc t-tests showed that all three conditions differed significantly from all other conditions (p<.001, <.001 and <.05 for the CV, CY and VY comparisons respectively).

When the variable 'awareness of motorcycles/bicycles' was added into the analysis as a between-participants factor, a main effect of group was found (p<.001) but the interaction was non-significant, indicating that the 'more bike aware' group rated the motorcycle as less visible in all three pictures than did the 'no connection with bikes' group.

3.2 Attention conspicuity

The mean number of vehicles coming towards the camera in each lighting condition did not differ, and thus this variable was left uncontrolled in the analysis.

[12] As is standard in such research, we report p-values which represent the probability that such differences in the data would have been observed through random variability in the data alone. It is customary to accept any p-value of below 5% (p<.05) as 'statistically significant'; we also report whether significance was obtained at the 1% (p<.01) or 0.1% (p<.001) levels.

Usable video data was provided by 378 participants for the attention conspicuity part of the study. Of these, 28 did not report the motorbike in their commentaries during the day (C=6, V=11, Y=11) and 19 did not report the motorbike in their commentaries during the night (C=10, V=3, Y=6). Analysis of data from the remaining 343 participants (the ones who did report the bike in their commentaries) showed that during the daytime and at night there was no significant effect of lighting configuration on the time to contact when participants mentioned the motorbike. This was true even after order effects were controlled for in the analysis. The mean values can be seen in Table 6.

There is a clear disparity between the mean time to contact values observed at night and those observed during the day for the attention conspicuity instructions, as would be expected, and this is confirmed by the statistical analysis ($p<.001$). During the day, those people who mentioned the motorcycle in their commentaries (irrespective of lighting configuration) did so at around a seven and a half second time to contact, while at night this drops to around five seconds.

Table 6: Time to contact for daytime and night time attention conspicuity instructions (part 1)

Time of day	Lighting configuration	Mean	Standard deviation	N
Day	C	7.77	4.56	201
	V	7.46	4.37	201
	Y	7.66	4.12	201
Night	C	5.14	3.37	142
	V	4.82	3.32	142
	Y	4.57	3.33	142

3.3 Search conspicuity

The mean number of vehicles coming towards the camera in each lighting condition did not differ, and thus this variable was left uncontrolled in the analysis.

Usable video data was provided by 377 participants for the search conspicuity part of the study.

Analysis of daytime data showed that there was no significant effect of lighting configuration on time to contact when participants mentioned the motorbike. This was true even after order effects were controlled for in the analysis.

Analysis of the night time data showed a significant effect of lighting condition on time to contact when the bike was seen, even after order effects were controlled for in the analysis ($p<0.05$) and post-hoc t-tests showed that all lighting configurations differed significantly from all others ($p<.01$, $p<.001$, $p<.05$ for the CV, CY and VY comparisons respectively). The mean values can be seen in Table 7.

Again a large disparity exists between day and night time detection, as would be expected, and this is confirmed by the analysis ($p<.001$) with an average detection time to contact of around 14.5 seconds in the daytime and around 9 seconds at night. In addition, the difference in time to contact at detection with search instructions versus attention instructions is clear and significant ($p<.001$ for daytime and night time data), by comparing the numbers in Table 7 with those in Table 6.

Table 7: Mean time to contact when bike seen in search conspicuity instruction (part 2)

Time of day	Lighting configuration	Mean	Standard deviation	N
Day	C	14.48	4.70	214
	V	14.49	4.70	214
	Y	14.58	4.70	214
Night	C	8.18	3.79	163
	V	8.88	4.46	163
	Y	9.55	4.74	163

3.4 Gap acceptance

The mean number of vehicles coming towards the camera in each lighting condition did not differ during the day, so this variable was left uncontrolled in the daytime data analysis. For the night time data the number vehicles did differ, being significantly higher for the C lighting condition than for the V and Y conditions. Therefore for this analysis the number of vehicles within the scene was controlled using a linear mixed model with number of vehicles as a covariate.

Usable video data was provided by 374 participants for the gap acceptance part of the study. Analysis of daytime data showed that there was no significant effect of lighting configuration on time to contact when participants mentioned the motorbike. This was true even after order effects were controlled for in the analysis.

Analysis of the night time data showed a significant effect of lighting condition on time to contact when the 'no' decision was given, even after order effects and the number of vehicles in the scene were controlled for in the analysis ($p<.05$). Post-hoc tests showed that the C condition differed from the V and Y conditions ($p<.001$ in both cases) which did not differ significantly from each other. The mean values can be seen in Table 8.

Table 8: Mean time to contact when participant indicated that they would no longer pull out in front of motorcycle (part 3)

Time of day	Lighting configuration	Mean	Standard deviation	N
Day	C	6.50	1.83	217
	V	6.57	2.11	217
	Y	6.53	2.04	217
Night	C	6.21	1.95	157
	V	6.68	1.98	157
	Y	6.91	2.05	157

4 Discussion

4.1 Summary of key findings

The purpose of the current study was to establish if using novel lighting configurations that introduce more light and more width and height information to the front of motorcycles could improve the conspicuity of motorcycles in a realistic roadside observation setting (mimicking waiting at a junction to pull out into a flow of traffic).

Conspicuity was measured as the time to contact when the trial motorcycle was seen. This was measured under 'search' instructions (in which participants were told to look specifically for the bikes) and under 'attention' instructions (in which participants were told to simply report everything in the scene that grabbed their attention). The time to contact when participants indicated that they would no longer pull out in front of the motorcycle was also measured. The study examined these questions separately for night time and daytime observations.

It was predicted that if the novel lighting conditions behave as expected on the basis of previous laboratory-based work (e.g. 2BeSafe, Gould et al. 2012a, b) then they should lead to earlier detection of the motorcycle, and they should encourage observers to indicate a larger gap when judging the last point at which they believe it would be safe to pull out in front of the motorcycle.

The findings can be summarised as follows:

1. Under search conspicuity instructions (i.e. when participants were told specifically to look for the motorcycle) the V and Y lighting configurations led to earlier detection of the trial motorcycle (a longer time to contact at detection) at night, but made no difference to detection during the day. The extra time to contact at detection (compared with the single headlight) at night was in the region of three quarters of a second for the V configuration and over one and a quarter seconds for the Y configuration (at 55.7kph – the mean approach speed observed in the study – this equates to the bike being around 11.5m to 19.5m further away when detected). Thus we can conclude that when people are primed to search for motorcycles at night, the new lighting configurations make this task easier, at least in the observation setting that we used in the current study.
2. When participants were asked to indicate the last moment at which they would pull out in front of the trial motorcycle, the V and Y lighting configurations were associated with a larger time to contact at night, but made no difference during the day. Compared with the single headlight at night, the V and Y lighting led to a gap of approximately an extra half to three quarters of a second in length (at 55.7kph - the mean approach speed observed in the study - this equates to the bike being around 7.5m to 11.5m further away when drivers decide they would no longer pull out in front of it).
3. Under attention conspicuity instructions, we cannot conclude that the V and Y lighting configurations made any difference to detection of the motorcycle. The average time to contact when the trial motorcycle was mentioned by participants who were simply commentating on the things in the road scene that drew their attention did not differ between the three lighting conditions, during daytime or night time testing in the current study.

4. Broadly (and unsurprisingly) detection was a great deal earlier during the day with search and attention instructions, and a great deal earlier under search instructions than under attention instructions.
5. Ratings of visibility of the trial motorcycles in three photos used in the survey showed a small but statistically significant increase in ratings for the V and Y configurations, when compared with the headlight only. In addition, when the sample was split according to whether they were 'more bike aware' or had 'no connection with bikes', the 'more bike aware' group gave significantly lower ratings of visibility for all three lighting configurations (but still rated the V and Y configurations as significantly more visible than the single headlight).

Helman et al. (2012) concluded that all of the physical intervention types (broadly, clothing and lighting) they reviewed had the potential to be beneficial in New Zealand (or indeed in any jurisdiction where motorcycles and other vehicles interact at junctions), but that lighting interventions may be more promising due to their potential benefits both at night and during the day. (They also reviewed previous work that showed that lighting interventions may be more acceptable to motorcyclists than clothing interventions.) The current study arose following these conclusions.

Considering this background literature reviewed by Helman et al. (2012), and the current findings, we can conclude that lighting configurations of the sort tested here are likely to be beneficial in a number of settings (and especially at night). The current work extends previous work by showing that not only do the lighting configurations enhance conspicuity (in this study, search conspicuity performance at night) they also appear to encourage safer gap-judgements by drivers (again at night). Thus the lighting configurations tested in the current study seem to have the potential to affect not only failures associated with visual search at junctions, but also failures associated with judging the time to contact of motorcycles that have been detected (Figure 1).

4.2 Limitations

Taken as a whole the findings from the current study suggest that the novel lighting configurations tested show promise as treatments to increase the conspicuity of motorcycles, and to encourage drivers to accept safer gaps in front of them, at night. As with any study, there are several limitations that need to be considered before drawing firm conclusions from the findings.

The first limitation concerns the specific observation conditions used. The site used presented participants with what might be considered a relatively straightforward visual monitoring task, in that they only needed to observe a stretch of road in a single direction, in moderate traffic flow, with target vehicles generally being visible for around 18 seconds on approach. In addition, the slight downward gradient from the observation position provided participants with a better view of traffic than would necessarily have been the case in more level viewing conditions. The consequence of this limitation is that we do not know whether the novel lighting configurations would have had different effects under different observation conditions. It is possible for example that under conditions that were more challenging, the lighting may have been beneficial even in the daytime (for example with more traffic, or with multiple directions of approach requiring saccades). Future studies should seek to elucidate the boundary conditions for the effectiveness of lighting configurations such as the ones tested here. One specific question that will become relevant as modern cars with daytime running lights populate the vehicle fleet in greater numbers is whether novel lighting configurations such as the ones tested here will become more important, even during the day, at making motorcycles stand out among the lights on other vehicles.

A second important limitation is that when participants were under attention conspicuity instructions, their lack of prior experience of the novel lighting configurations may have led to delays in their commentary mentioning the bike in these conditions; on seeing the bike with the 'V' or 'Y' lighting many participants were observed to hesitate in their commentary, seemingly unsure of what they were looking at. The language used to describe the bike in the 'V' and 'Y' conditions often confirmed this. Again there is a possibility that the findings here represent a conservative estimate of the potential effectiveness of the lighting configurations tested – if participants had prior experience of the novel lighting configurations it is possible that they would have been able to mention the bike unambiguously in their commentaries earlier in these conditions. Future work should examine the impact of prior experience with novel lighting on motorcycles on the ways in which drivers describe them, as this may help to indicate what (and how much) training is required for drivers to ensure that they have sufficient expectations of what they might see on the roads. This will be particularly important in any transition phase where more bikes are being fitted with such technologies.

A third limitation concerns the instructional video used to demonstrate the 'attention conspicuity' instructions to participants. This video was not used to manipulate attentional set; no motorcycles were present in the instructional video (although cyclists and pedestrians, as well as non-vehicle items in the scene were mentioned to ensure that participants knew they could mention literally anything in the scene that grabbed their attention). In future work, it would be interesting to directly test whether participants can be 'primed' to notice motorcycles by using an instructional video with motorcycles present in greater numbers than would be expected in everyday traffic (in New Zealand approximately 3.5% of registered vehicles are motorcycles – New Zealand MoT, 2012).

A fourth limitation concerns the wider extent to which generalisations can be drawn from the findings in this study to actual safety benefits on the road. What the data in this study show is that the novel lighting configurations confer a relative advantage over a single headlight at night, for some measures, when participants are observing a single stretch of road. The extent to which this advantage will transfer to naturalistic driving (when drivers are actively involved in a journey when observing oncoming traffic, likely with their minds on things other than detecting motorcycles), and the absolute benefits if it does, will need to be established with monitoring of effects over the longer term.

5 Recommendations

Based on the findings of the current study, we make the following recommendations:

1. If the law in New Zealand is to be changed regarding the use of extra lighting on motorcycles, then we suggest that the law should be worded to allow the use of a headlight and extra lights that add both height and width to the frontal view of the motorcycle (as on the trial motorcycle used here). On the basis of the results reported here, we would expect such lighting to at least provide some advantages for detection and gap judgements at night.

2. If any new lighting configurations are permitted in law, we suggest that there should be an attempt at some kind of standardisation of approach along the lines of the features outlined in recommendation 1, and widespread publicity should be made available so that drivers can be educated as to what they might expect to see appearing on motorcycles in the New Zealand fleet. Alongside this, drivers should be educated about the importance of actively looking for motorcycles when pulling across or into traffic. Our data suggest that there is a considerable detection advantage (in terms of how early the motorcycle was detected) when participants were prompted to actively search for the motorcycle in the scene.

3. We suggest that motorcyclists should be educated regarding the extent to which their conspicuity drops at night, even when drivers are actively searching for them in the road scene, and even when they have additional lighting. The advantage afforded by daylight for detection is very large compared with the advantage afforded by the novel lighting configurations.

4. Future research should focus on the below points in addition to the validation and application activities above:

    a. In more difficult roadside observation scenarios (for example busier junctions and situations in which drivers need to look in multiple directions to judge when to pull out) it is possible that greater advantages would be found than in the current study, and perhaps that these may be present even when drivers are not actively told to look for motorcycles. Research should attempt to find the boundary conditions for the effectiveness of novel lighting configurations on conspicuity and gap judgements.

    b. Work should also examine the persistence of the advantages on detection when other vehicles (specifically cars) have designs of daytime running lights that may diminish the 'novelty' effect of the lighting configurations tested here on the conspicuity of motorcycles (although we would not expect TTC benefits to be diminished). There may be a case for trying to maintain a difference in design for motorcycle and car lighting.

    c. It is not clear in the current study whether the gap judgements for the novel lighting configurations on motorcycles are of a similar magnitude to those that would have been seen to an oncoming car. Future work could include a trial car as another control condition.

    d. The data in the current study suggest a safety advantage from a realistic roadside observation scenario. However it will be important to evaluate the impact of novel lighting configurations on actual driver behaviour. This can be achieved through various means, but one innovative possibility is the use of front facing cameras on light-equipped and light-unequipped bikes (from volunteer motorcyclists) with basic instrumentation to detect near misses and collisions and save footage for later analysis. This will allow us to understand if the apparent safety effect we have seen in previous laboratory work, and in this study in a realistic roadside observation scenario, transfers all the way through to naturalistic driver behaviour.

References

ACEM (2004), MAIDS: *In-depth Investigation of Accidents Involving Powered Two Wheelers*, Report of the Association of European Motorcycle Manufacturers, Brussels. Retrieved November 21, 2013, http://www.maids-study.eu/pdf/MAIDS2.pdf

Caird J.K., & Hancock P.A. (1994). The perception of arrival time for different oncoming vehicles at an intersection. *Ecological Psychology, 6,* 83–109

Chesham, D.J., Rutter, D.R., & Quine, L. (1991). Mapping the social psychological determinants of safe and unsafe motorcycle riding. In: Grayson, G. B., Lester, J. F. (Eds.), *Behavioural Research in Road Safety*. Transport and Road Research Laboratory, Crowthorne, UK.

Cole, B.L., & Hughes, P.K. (1984). A field trial of attention and search conspicuity. *Human Factors*, *26,* 299–313.

DeLucia, P.R. (1991). Pictorial and motion-based information for depth perception. *Journal of Experimental Psychology: Human Perception and Performance*, *17*, 738–748.

DeLucia P., Kaiser, M., Bush, J., Meyer, L., & Sweet, B. (2003). Information integration in judgements of time to contact. *Quarterly Journal of Experimental Psychology*, *56,* 1165–1189.

Department for Transport (2012). *Reported road casualties Great Britain, 2011*. London, UK. Retrieved July 16th, 2013 from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/9280/rrcgb2011-complete.pdf

Gould, M., Poulter, D.R., Helman, S., & Wann, J.P. (2012a). Judgments of approach speed for motorcycles across different lighting levels and the effect of an improved tri-headlight configuration. *Accident Analysis and Prevention, 48,* 341–345.

Gould, M., Poulter, D.R., Helman, S., & Wann, J.P. (2012b). Errors in judging the approach rate of motorcycles in nighttime conditions and the effect of an improved lighting configuration. *Accident Analysis and Prevention, 45,* 432–437.

Hancock, P.A., Wulf, G., Thom, D., & Fassnacht, P. (1990). Driver workload during differing driving manoeuvres. *Accident Analysis and Prevention*, *22*, 281–290.

Helman, S., Weare, A., Palmer, M., & Fernandez-Medina, K. (2012). *Literature review of interventions to improve the conspicuity of motorcyclists and help avoid 'looked but failed to see' accidents.* Published Project Report PPR638. Crowthorne: Transport Research Laboratory.

Herslund, M., & Jørgensen, N.O. (2003). Looked-but-failed-to-see-errors in traffic. *Accident Analysis and Prevention, 35,* 885–891.

Hole, G.J., & Tyrrell, L. (1995). The influence of perceptual 'set' on the detection of motorcyclists using daytime headlights. *Ergonomics*, *28,* 1326–1341.

Hole, G.J., Tyrrell, L., & Langham, M. (1996). Some factors affecting motorcyclists' conspicuity. *Ergonomics, 39*, 946-965.

Horswill, M.S., & Helman, S. (2003). A behavioural comparison between motorcyclists and a matched group of non-motorcycling car drivers: Factors influencing accident risk. *Accident Analysis and Prevention*, *35,* 589–597.

Horswill, M.S., Helman, S., Ardiles, P., & Wann, J.P. (2005). Motorcycle accident risk could be inflated by a time to arrival illusion. *Optometry and Vision Science*, *82,* 740–746.

Hurt, H.H., Ouellet, J.V., & Thom, D.R. (1981). *Motorcycle accident cause factors and identification of countermeasures (Tech. Rep. Vol. 1).* Los Angeles: Traffic Safety Centre, University of Southern California.

Langham, M., & Moberly, N. (2003). Pedestrian conspicuity research: a review. *Ergonomics*, *46,* 345–363.

Lee, D. (1976). A theory of visual control of braking based on information about time-to-collision. *Perception, 5,* 437–459.

Most, S. B., & Astur, R. S. (2007). Feature-based attentional set as a cause of traffic accidents. *Visual Cognition*, *15*, 125–132.

New Zealand Ministry of Transport (2005). *Land Transport Rule: Vehicle Lighting 2004 and Land Transport (Road User) Rule*. Available at: http://www.nzta.govt.nz/resources/rules/vehicle-lighting-2004.html

New Zealand Ministry of Transport (2009). *Clause 30 of the Land Transport (Road User) Amendment Rule 2009 (SR 2009/253).* Available at: http://www.legislation.govt.nz/regulation/public/2009/0253/latest/DLM2257001.html

New Zealand Ministry of Transport (2011). *Motor vehicle crashes in New Zealand 2010. Retrieved October 3rd, 2012.* Available at: http://www.transport.govt.nz/research/Documents/Motor-Vehicle-Crashes-in-New-Zealand-2010.pdf

New Zealand Ministry of Transport (2012). *Motor vehicle crashes in New Zealand 2011.* Retrieved July 16th, 2013 from: http://www.transport.govt.nz/research/Documents/Motor-Vehicle-Crashes-in-New-Zealand-2011.pdf

Oberfeld, D., & Hecht, H. (2008). Effects of a moving distractor object on time-to-contact judgements. *Journal of Experimental Psychology: Human Perception and Performance*, *34*, 605–623.

Olson, P.L., Halstead-Nussloch, R., & Sivak, M. (1981). The effect of improvements in motorcycle/motorcyclist conspicuity on driver behavior. *Human Factors, 23,* 237-248.

Rößger, L., Hagen, K., Krzywinski, J., & Schlag, B. (2011). Recognisability of different configurations of front lights on motorcycles. *Accident Analysis and Prevention, 44*, 82–87.

Rushton, S.B., Bradshaw, M.F., & Warren, P.A. (2007). The pop out of scene-relative object movement against retinal motion due to self-movement. *Cognition*, *105,* 237–245.

Williams, M.J., & Hoffman, E.R. (1979). Conspicuity of motorcycles. *Human Factors, 21,* 619-626.

World Health Organisation (2009). *Global status report on road safety*. *Time for action.* Retrieved November 21st 2013 from http://whqlibdoc.who.int/publications/2009/9789241563840_eng.pdf

Wulf G., Hancock P. A., & Rahimi, M. (1989). Motorcycle conspicuity: an evaluation and synthesis of influential factors. *Journal of Safety Research*, *20,* 153–176.

Acknowledgements

This work was funded by the motorcycle safety levy, which is overseen by the Motorcycle Safety Advisory Council and administered by the Accident Compensation Corporation.

The project required the assistance of a number of people in addition to the report authors, especially in support of the extensive fieldwork phase which was run between June and August in 2013.

Firstly, we are grateful to the wider trial team. Ronald Francois and David Wakenshaw from RTI, Simon Tong and Emma Delmonte from TRL, Kimberley Moser from Albany Senior High School, Denise Haines and Lesley Pain all provided invaluable support with the recruitment of participants and the collection of data during the fieldwork phase. Thanks also to Nicolas and Stacie for help both with logistics and 'meals-on-wheels' especially during evening trial sessions. Special thanks also to Emma Delmonte for final checks on the consistency and wording of this final report.

Special thanks must also go to the four riders who served as our 'stooge motorcyclist' during trial sessions. Hylton Pause, Gary Johnston, Anita Horsley, and particularly Chris Power, the trial could not have been run without your focus and your consistent riding of the circuit used during testing; presumably your skill levels at making left turns are now as high as they will ever be.

We are also extremely grateful to Luke Stock, the manager at the Mitre 10 store on Oteha Valley Road in Auckland, for allowing us the use of the car park and café facilities when trials were taking place, Clive Kemp of GPS Logboook for the GPS logger used on the main trial motorcycle, and to Martin Reinbach from Hella Marine for providing and fitting the LED lighting to the trial motorcycles.

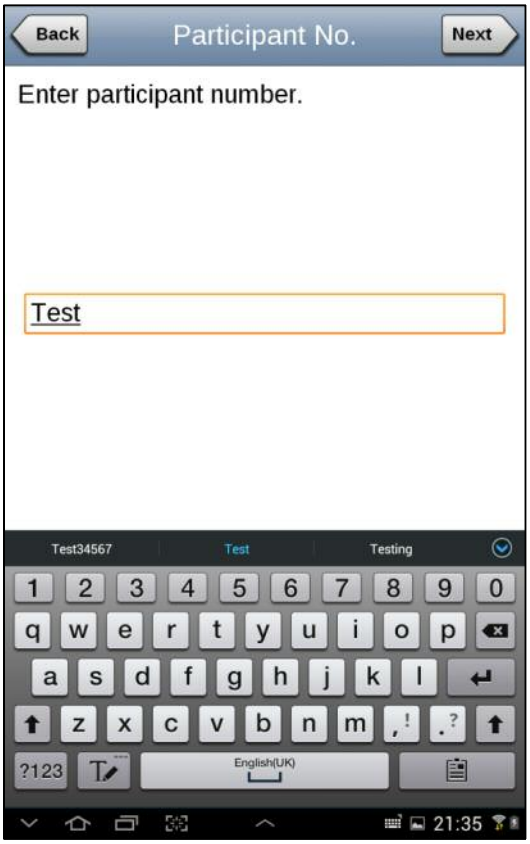
Thanks to the New Zealand Transport Authority for granting the exemption that made it possible for the trial motorcycles to be ridden on-road with the 'V' and 'Y' lighting configurations during the trial period.

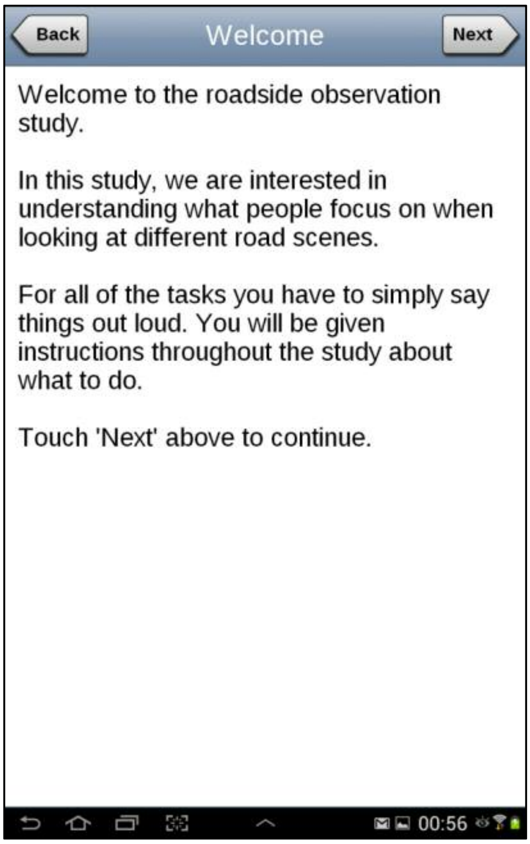
Cris Burgess peer-reviewed this report and we are grateful for his insightful comments and the resultant improvements to its quality.

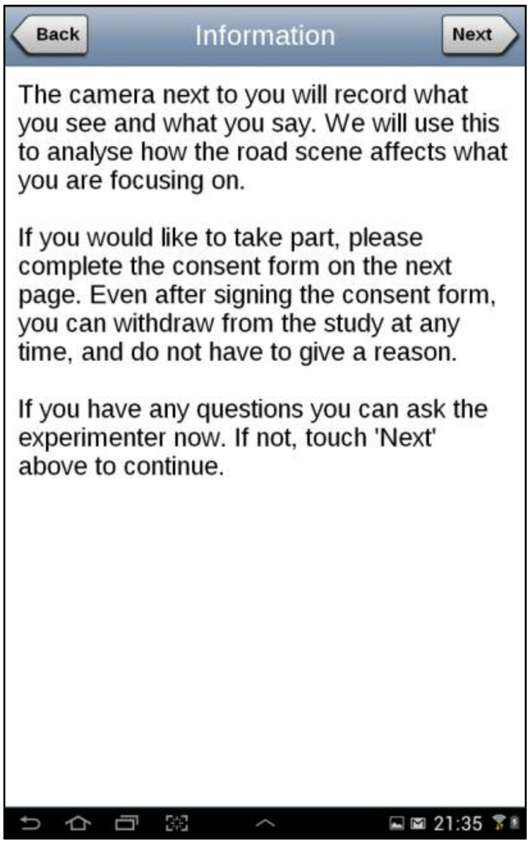
Finally our thanks go to the two anonymous motorists in the centre picture, on the front cover of this report. This picture was taken by the second author from the hotel room which served as the base for the TRL team during the trialling, in a (rare) idle moment between sessions in June 2013. It shows a car driver pulling out in front of a motorcyclist, who has just managed to take action to avoid a collision. This picture reminds us why we do this work.

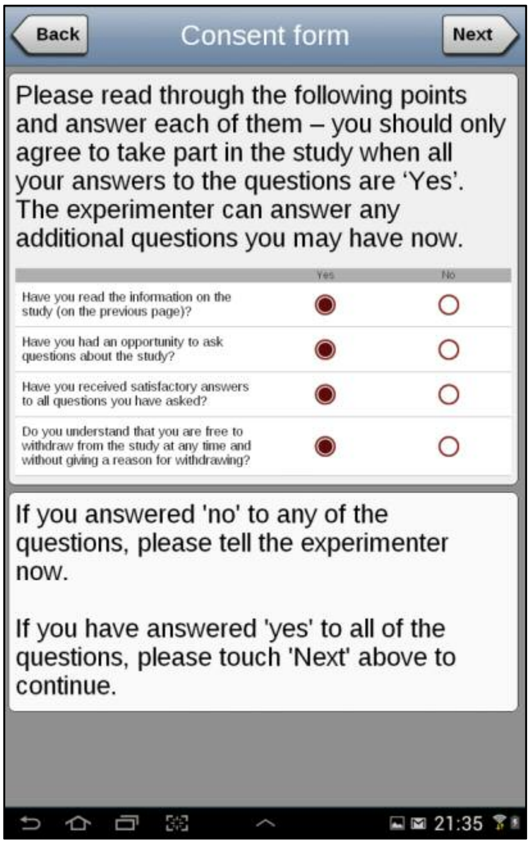
Appendix A

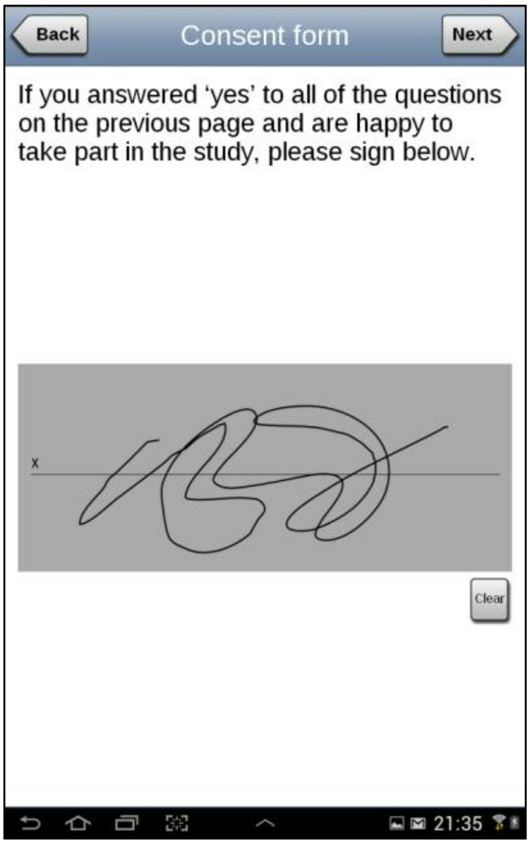

Welcome to the roadside observation study.
Touch 'Start' to continue.
Start
21:34


Back
Participant No.
Next
Enter participant number.
Test
Test34567
Test
Testing
English(UK)
21:35

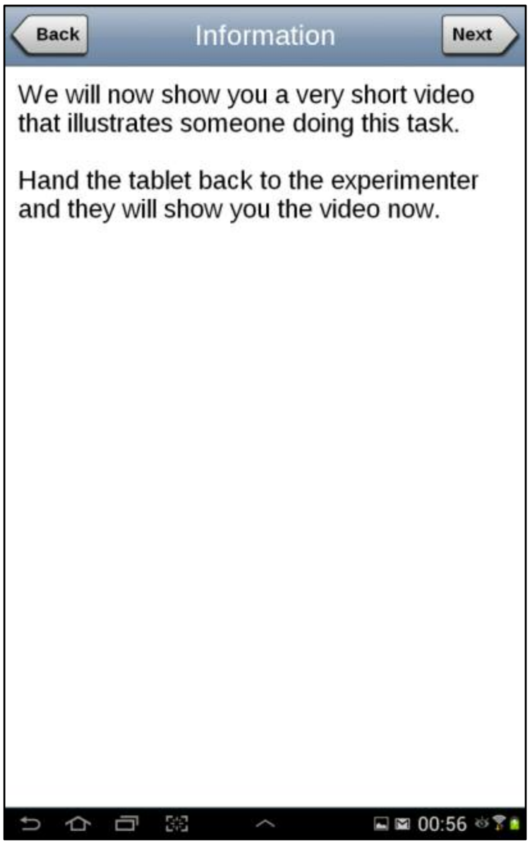

Back
Welcome
Next
Welcome to the roadside observation study.
In this study, we are interested in understanding what people focus on when looking at different road scenes.
For all of the tasks you have to simply say things out loud. You will be given instructions throughout the study about what to do.
Touch 'Next' above to continue.
00:56

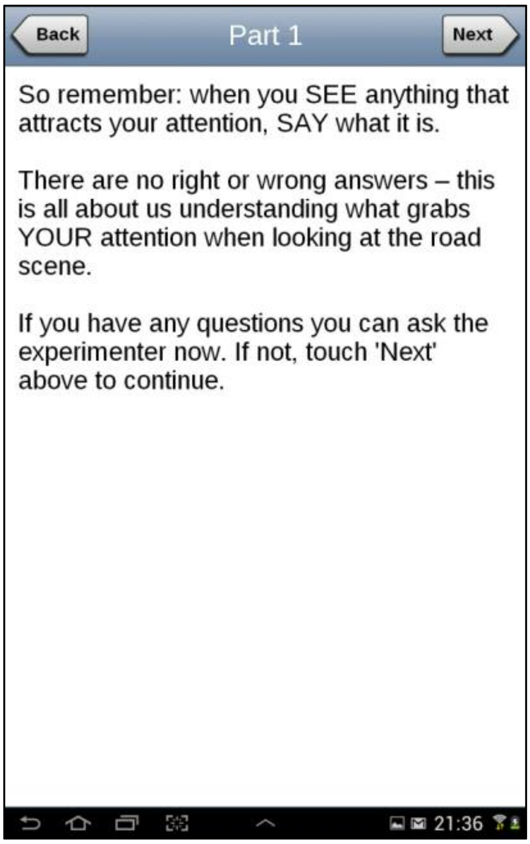

Back
Information
Next
The camera next to you will record what you see and what you say. We will use this to analyse how the road scene affects what you are focusing on.
If you would like to take part, please complete the consent form on the next page. Even after signing the consent form, you can withdraw from the study at any time, and do not have to give a reason.
If you have any questions you can ask the experimenter now. If not, touch 'Next' above to continue.
21:35


Back
Consent form
Next
Please read through the following points and answer each of them – you should only agree to take part in the study when all your answers to the questions are 'Yes'. The experimenter can answer any additional questions you may have now.
Yes
No
Have you read the information on the study (on the previous page)?
Have you had an opportunity to ask questions about the study?
Have you received satisfactory answers to all questions you have asked?
Do you understand that you are free to withdraw from the study at any time and without giving a reason for withdrawing?
If you answered 'no' to any of the questions, please tell the experimenter now.
If you have answered 'yes' to all of the questions, please touch 'Next' above to continue.
21:35

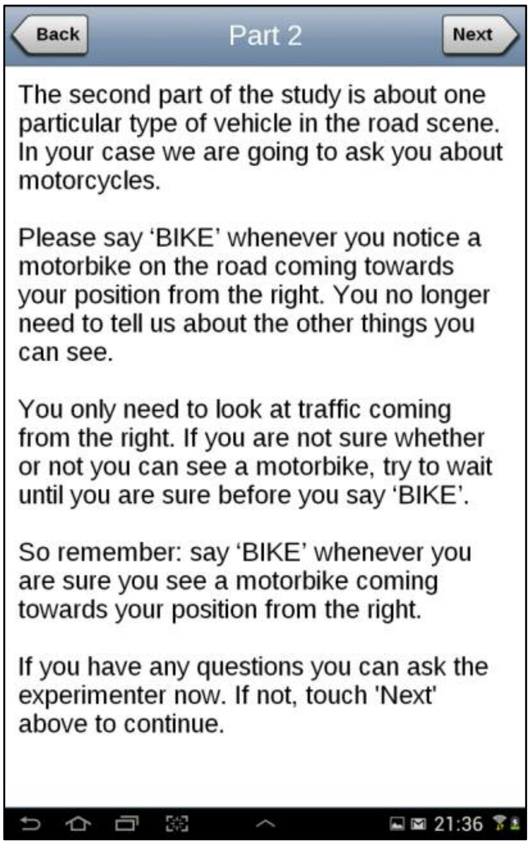

Back
Consent form
Next
If you answered 'yes' to all of the questions on the previous page and are happy to take part in the study, please sign below.
x
Clear
21:35

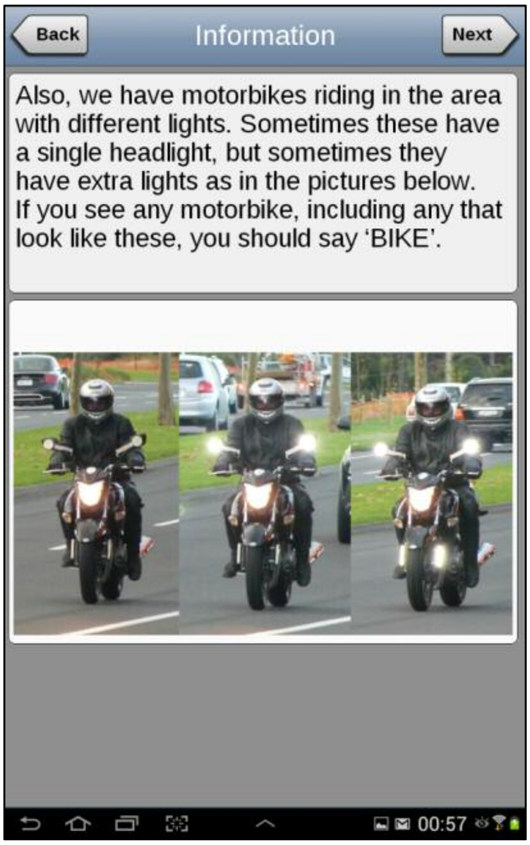

Back
Part 1
Next
You are now going to begin the study.
For the first part, say out loud what you see on the road scene to your right. You will do this for about five minutes.
Every time something attracts your attention, please say out loud what it is, using very simple commentary.
You can comment on anything that attracts your attention, even if it seems irrelevant.
Touch 'Next' above to continue.
00:56


Back
Information
Next
We will now show you a very short video that illustrates someone doing this task.
Hand the tablet back to the experimenter and they will show you the video now.
00:56


Back
Part 1
Next
So remember: when you SEE anything that attracts your attention, SAY what it is.
There are no right or wrong answers – this is all about us understanding what grabs YOUR attention when looking at the road scene.
If you have any questions you can ask the experimenter now. If not, touch 'Next' above to continue.
21:36

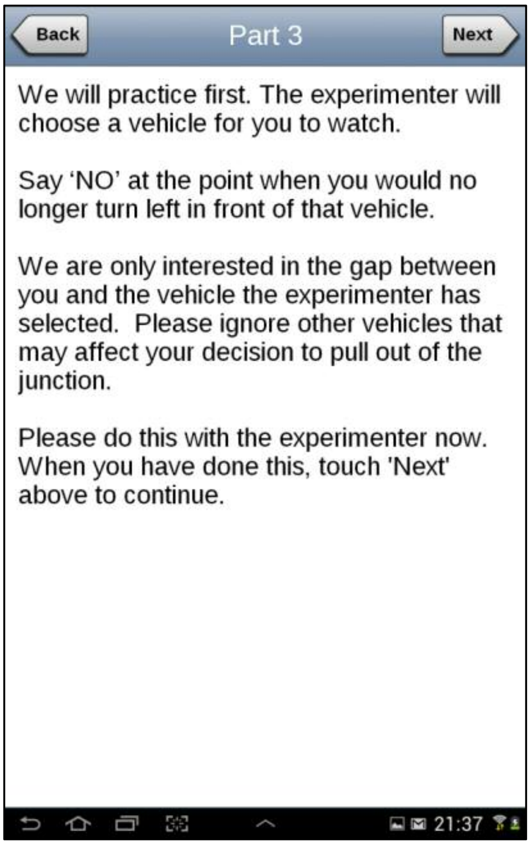

Back
Part 1
Next
Hand the tablet back to the experimenter, who will now start the camera and tell you when to begin.
(Code required to continue.)
Your Answer
You must enter a whole number.
21:36

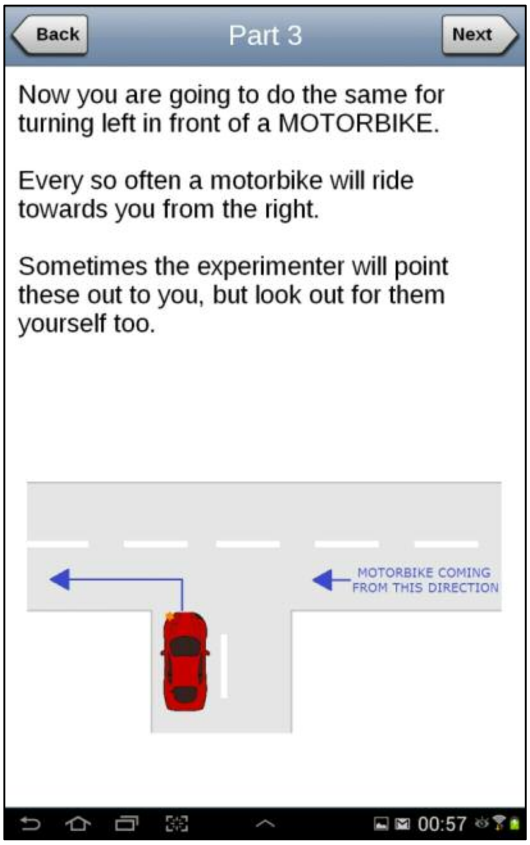

Back
Part 2
Next
The second part of the study is about one particular type of vehicle in the road scene. In your case we are going to ask you about motorcycles.
Please say 'BIKE' whenever you notice a motorbike on the road coming towards your position from the right. You no longer need to tell us about the other things you can see.
You only need to look at traffic coming from the right. If you are not sure whether or not you can see a motorbike, try to wait until you are sure before you say 'BIKE'.
So remember: say 'BIKE' whenever you are sure you see a motorbike coming towards your position from the right.
If you have any questions you can ask the experimenter now. If not, touch 'Next' above to continue.
21:36

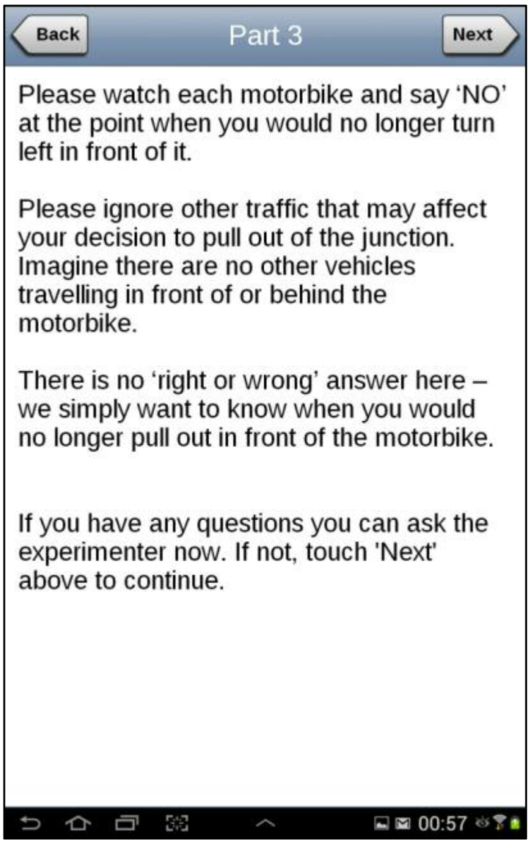

Back
Information
Next
Also, we have motorbikes riding in the area with different lights. Sometimes these have a single headlight, but sometimes they have extra lights as in the pictures below. If you see any motorbike, including any that look like these, you should say 'BIKE'.
00:57


Back
Part 2
Next
Hand the tablet back to the experimenter, who will now start the camera and tell you when to begin.
(Code required to continue.)
Your Answer
You must enter a whole number.
00:57

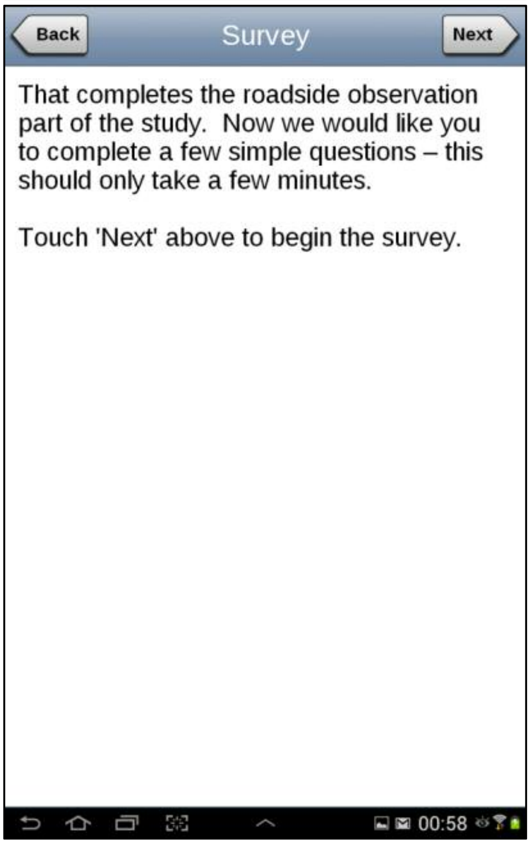

Back
Part 3
Next
The final part of the study is about turning left.
Imagine that where we are parked now is a junction and you are waiting to turn left. You are going to be asked about your decision to turn left in front of an approaching vehicle.
VEHICLE COMING FROM THIS DIRECTION
21:37


Back
Part 3
Next
We will practice first. The experimenter will choose a vehicle for you to watch.
Say 'NO' at the point when you would no longer turn left in front of that vehicle.
We are only interested in the gap between you and the vehicle the experimenter has selected. Please ignore other vehicles that may affect your decision to pull out of the junction.
Please do this with the experimenter now. When you have done this, touch 'Next' above to continue.
21:37


Back
Part 3
Next
Now you are going to do the same for turning left in front of a MOTORBIKE.
Every so often a motorbike will ride towards you from the right.
Sometimes the experimenter will point these out to you, but look out for them yourself too.
MOTORBIKE COMING FROM THIS DIRECTION
00:57

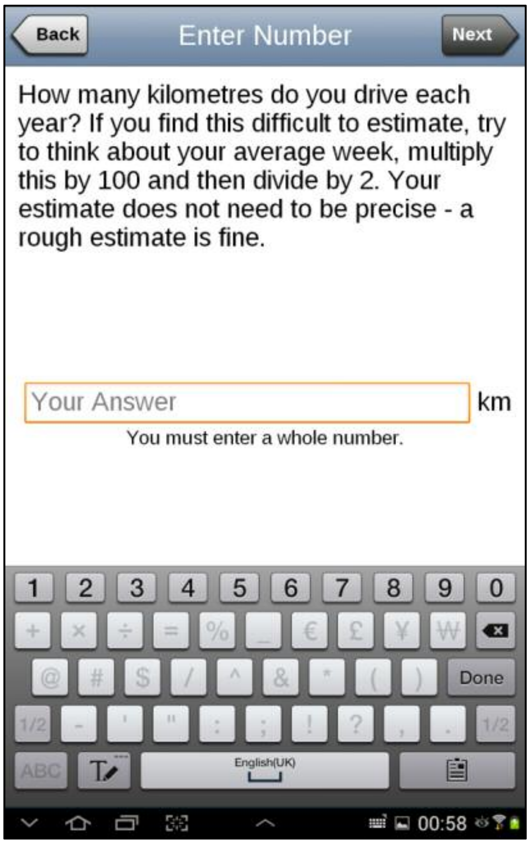

Back
Part 3
Next
Please watch each motorbike and say 'NO' at the point when you would no longer turn left in front of it.
Please ignore other traffic that may affect your decision to pull out of the junction. Imagine there are no other vehicles travelling in front of or behind the motorbike.
There is no 'right or wrong' answer here – we simply want to know when you would no longer pull out in front of the motorbike.
If you have any questions you can ask the experimenter now. If not, touch 'Next' above to continue.
00:57

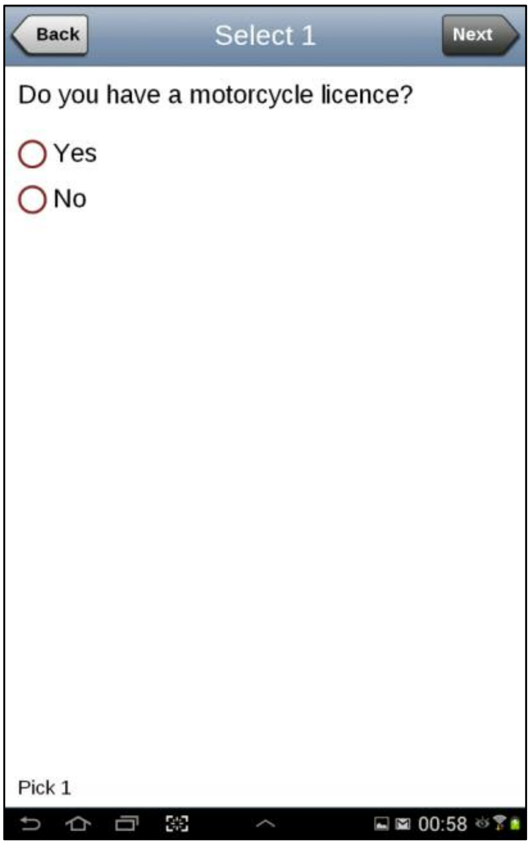

Back
Part 3
Next
Hand the tablet back to the experimenter, who will now start the camera and tell you when to begin.
00:57


Back
Survey
Next
That completes the roadside observation part of the study. Now we would like you to complete a few simple questions – this should only take a few minutes.
Touch 'Next' above to begin the survey.
00:58

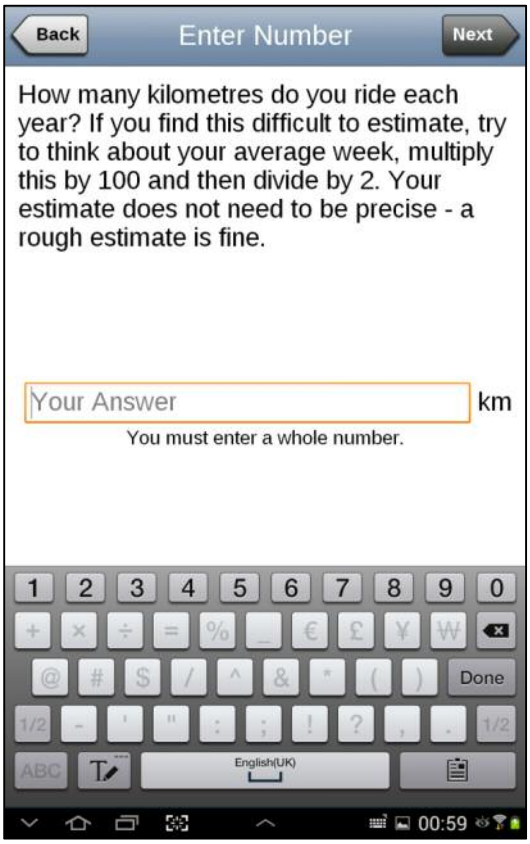

Back
Enter number
Next
What is your age in years?
Your Answer
Years
You must enter a whole number.
What is your gender?
Male
Female
Pick 1
Do you have a car licence for New Zealand?
Yes
No
1 2 3 4 5 6 7 8 9 0
Next
English(UK)
00:58

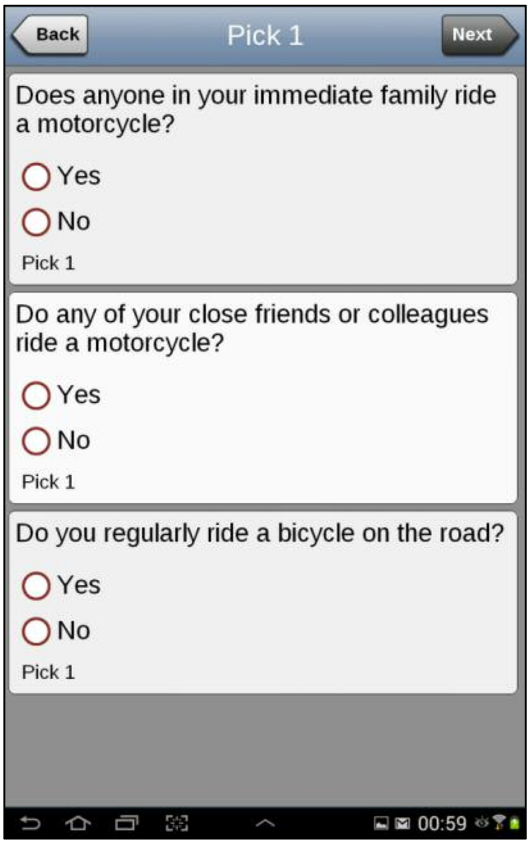

Back
Enter number
Next
For how long have you had your car licence in years? (Please round up to the nearest year)
Your Answer
Years
You must enter a whole number.
Done


Back
Enter Number
Next
How many kilometres do you drive each year? If you find this difficult to estimate, try to think about your average week, multiply this by 100 and then divide by 2. Your estimate does not need to be precise - a rough estimate is fine.
Your Answer
km
You must enter a whole number.
Done


Back
Select 1
Next
Do you have a motorcycle licence?
Yes
No
Pick 1


Back
Enter Number
Next
For how long have you had it in years? (Please round up to the nearest year)
Your Answer
Years
You must enter a whole number.
Done

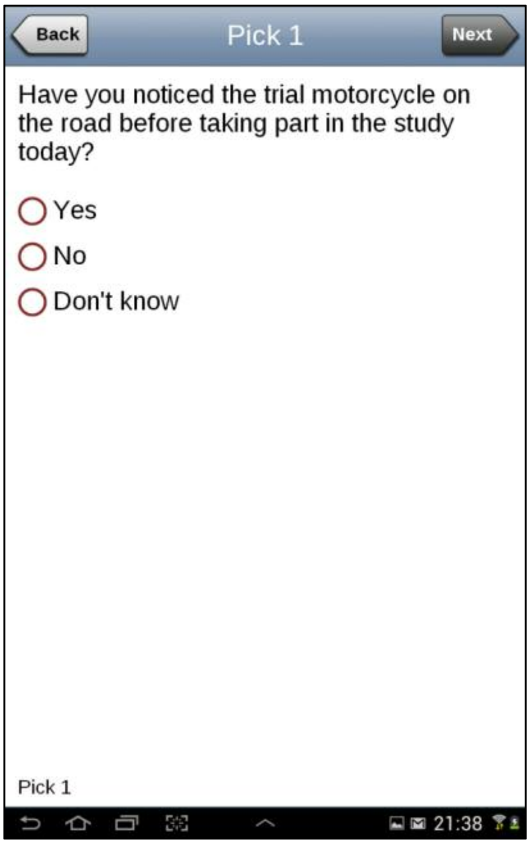

Back
Enter Number
Next
How many kilometres do you ride each year? If you find this difficult to estimate, try to think about your average week, multiply this by 100 and then divide by 2. Your estimate does not need to be precise - a rough estimate is fine.
Your Answer
km
You must enter a whole number.
Done
00:59

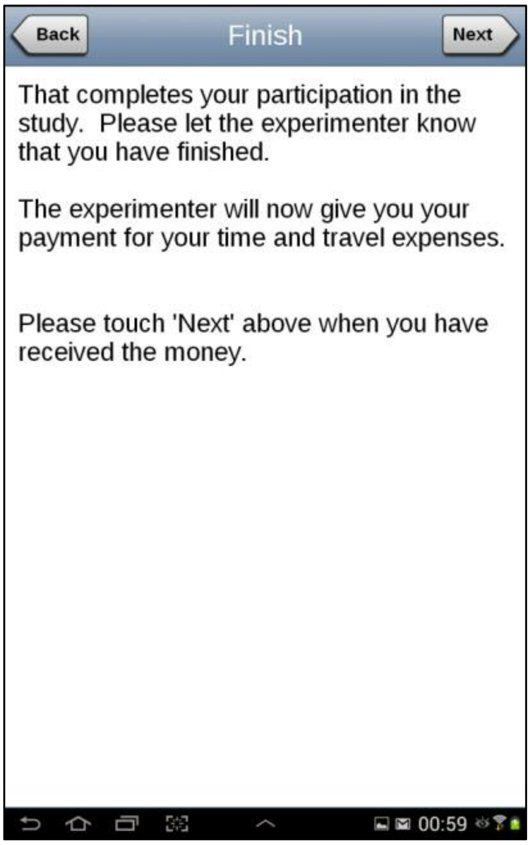

Back
Pick 1
Next
Does anyone in your immediate family ride a motorcycle?
Yes
No
Pick 1
Do any of your close friends or colleagues ride a motorcycle?
Yes
No
Pick 1
Do you regularly ride a bicycle on the road?
Yes
No
Pick 1
00:59

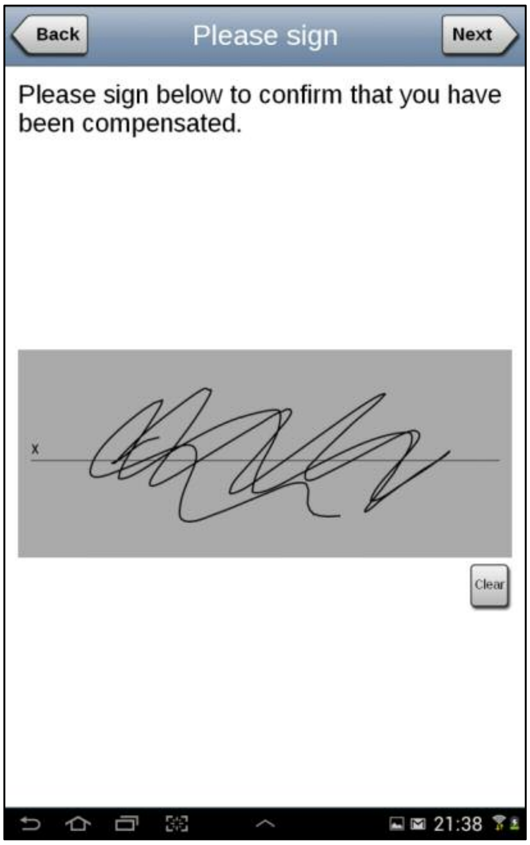

Back
Use slider
Next
In your opinion, how visible is the motorcycle in the above picture?
Not at all visible
Extremely visible
21:38

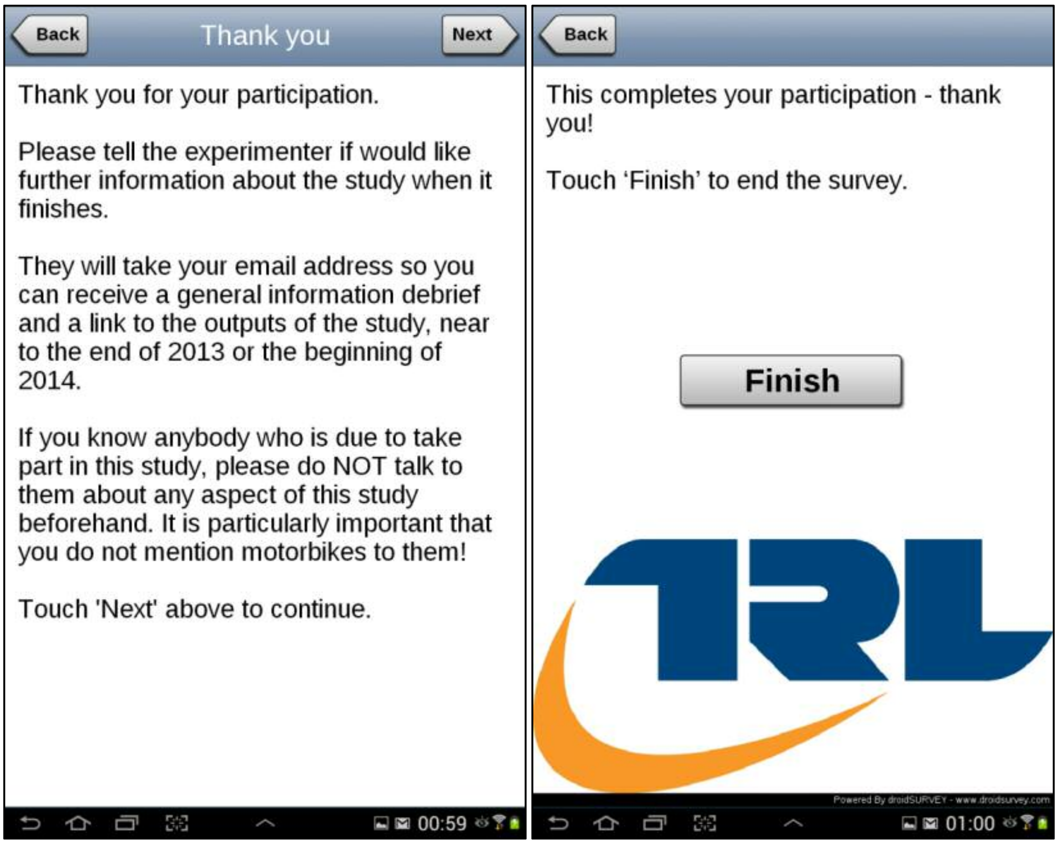

Back
Use slider
Next
In your opinion, how visible is the motorcycle in the above picture?
Not at all visible
Extremely visible
21:38


Back
Use slider
Next
In your opinion, how visible is the motorcycle in the above picture?
Not at all visible
Extremely visible
00:59


Back
Pick 1
Next
Have you noticed the trial motorcycle on the road before taking part in the study today?
Yes
No
Don't know
Pick 1
21:38


Back
Finish
Next
That completes your participation in the study. Please let the experimenter know that you have finished.
The experimenter will now give you your payment for your time and travel expenses.
Please touch 'Next' above when you have received the money.
00:59


Back
Please sign
Next
Please sign below to confirm that you have been compensated.
x
Clear
21:38


Back
Thank you
Next
Thank you for your participation.
Please tell the experimenter if would like further information about the study when it finishes.
They will take your email address so you can receive a general information debrief and a link to the outputs of the study, near to the end of 2013 or the beginning of 2014.
If you know anybody who is due to take part in this study, please do NOT talk to them about any aspect of this study beforehand. It is particularly important that you do not mention motorbikes to them!
Touch 'Next' above to continue.
00:59
Back
This completes your participation - thank you!
Touch ‘Finish’ to end the survey.
Finish
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01:00