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Abstract

Both perceptual errors (failing to perceive) and appraisal errors (failing to make a correct judgment about safety) could explain the relatively high number of pulling out at the junctions involving approaching motorcycles in relation to cars. Two experiments were conducted to investigate the effect of exposure to motorcycles on these types of errors by comparing drivers from Malaysia where motorcycles are very common with drivers from the UK where motorcycles are rare. Experiment 1 investigated drivers' ability to perceive approaching vehicles (car or motorcycle) located at different distances (near, intermediate and far) on UK and Malaysian roads. There was no difference between Malaysian and UK drivers in overall ability to perceive the approaching vehicles but Malaysian drivers were relatively good at perceiving motorcycles at further distances. Experiment 2 investigated drivers' judgments about whether or not it was safe to pull out on the same roads and found that Malaysian drivers were more likely to judge it was safe to pull out as compared to UK drivers. Findings suggest that high exposure to motorcycles may reduce vehicle effects on perception for Malaysian drivers. However they may more risky appraisals about safety of pulling out, which might contribute to the high accident and fatality rates in Malaysia.

Keywords Perception, Appraisal, T-junctions, cross-cultural, Malaysian, UK

1. Introduction

One of the most common types of accidents which involve motorcycles is the failure of another road user to give way to an approaching motorcycle on the main carriageway when emerging from a side road (Clark, Ward, Bartle and Truman, 2004). This mistake has been attributed to the 'Look But Fail to See' error (Brown, 2002) whereby the driver reports having looked into the road but not having seen the motorcycle, and has been documented in several countries previously (Hurt, Ouellet and Thom, 1981; Haworth, Mulvihill, Wallace, Symmons, Regan, 2005; de Lapparent, 2006). Crundall, Humphrey, Clarke (2008) propose that at least three key behaviours are required for a driver to avoid collision with an approaching motorcycle at a junction. First, drivers have to correctly look in the direction of the approaching vehicle before pulling out. Second, drivers must be able to process and recognize the oncoming vehicle. Successful execution of these first two behaviours would result in perception of the oncoming vehicle and should avert the 'Look but fail to see' accident. However, having perceived the approaching vehicle, drivers must also appraise, that is, make a judgment about the safety of pulling out in front of it (Crundall et al., 2008). Failure in any of these three behaviours could lead to a collision.

Crundall et al. (2008) conducted two experiments to investigate the contribution of failures to perceive (to look at and process oncoming vehicles) and failures to appraise (make an appropriate judgment about safety of pulling out) to give-way collisions involving motorcycles with other road users. In the first experiment, a series of images of T-junctions were shown to participants for 250ms each. The photographs were taken from the point of view of a UK driver (left-side driving) who had reached a junction with the intention to turn right across the contraflow lane, and was looking to the right in anticipation of oncoming traffic. Participants were required to respond whether they saw an approaching vehicle, which could be either a car or a motorcycle, located at either a near, intermediate or far distance from the viewer. These target vehicles occurred on 50% of the trials with the remaining trials presenting empty carriageways. It was found that approaching cars were spotted more often than motorcycles and this effect was primarily due to poor performance for motorcycles presented at the far distance and to some extent at the intermediate distance. Despite the acknowledged caveats regarding the use of brief, static stimuli, the difference observed between cars and motorcycles suggests that perceptual failures may indeed contribute to the relatively large number of give-way accidents involving motorcycles as opposed to cars. Crundall et al. (2008) went on to conduct a second experiment which aimed to determine whether there were differences in drivers' judgments about whether it was safe to pull out in front of cars and motorcycles. The same images as used in the previous experiment were this time shown for 5000ms and participants were required to judge whether it was safe to pull out. There were no differences in participants' judgments of safety of pulling out in front of different types of approaching vehicle suggesting that given enough time to perceive the vehicle, drivers' judgments were consistent across vehicle types. Taken together, Crundall et al.'s (2008) experiments suggest that failures in perception may be more important than failures of appraisal in explaining these give-way collisions.

One factor which may mediate these perceptual failures is expectations. In the UK, where Crundall et al.'s study was conducted, motorcycles make up less than 1% of all traffic (DETR, 2000) which may result in a low expectation of their presence. In an experimental study it may however quickly become apparent to participants that motorcycles may occur frequently. Despite this conscious overriding of expectation, the lack of exposure to motorcycles may prevent perceptual learning and discrimination of their front profiles. Crundall et al. (2008) speculate that drivers who have greater exposure to motorcycles in daily driving may accordingly have a lower threshold for motorcycle detection. Consistent with this, it has been found that dual drivers are less likely to be responsible for motorcycle crashes (Magazzù, Comelli, & Marinoni, 2006). Brooks and Guppy (1990) also found that drivers who have family members or close friends who ride motorcycles, and had ridden pillion themselves, are less likely to be involved in accidents with motorcycles, and showed better observation of motorcycles than drivers who did not. Therefore drivers who are frequently exposed to motorcycles in their daily driving may be less impaired in perceiving motorcycles in comparison to cars.

To investigate this possibility we used the methodology developed by Crundall et al. (2008) to directly compare perceptual performance of drivers from the UK, a country with a very low frequency of motorcycles, with drivers from Malaysia, where motorcycles constitute the highest number of registered vehicles. There are over 9 million registered motorcycles on the road in Malaysia (Roslan, Sarani, Hashim and Saniran, 2011) compared with around 1.2 million in the UK (DfT, 2014). Despite these differences both Malaysia and the UK have a left-lane driving system, allowing a direct translation of Crundall et al.'s methodology between the countries. Drivers viewed the same images of UK roads used in Crundall et al.'s (2008) study along with a second set of images taken on Malaysian roads. If Malaysian drivers have a lower threshold for detection of motorcycles we might expect them to show less discrepancy in their ability to detect motorcycles compared with cars than their UK counterparts, and possibly even enhanced motorcycle detection performance. As both groups of drivers viewed roads from both countries the experiment also enabled us to determine whether environmental familiarity plays a role in perceptual performance i.e. whether drivers are better at detecting motorcycles when they appear in a familiar context (their own country) compared to an unfamiliar context (the other country). This would be indicated by an interaction between the driver nationality and the road origin.

2. Experiment 1: How do Malaysian and UK drivers perceive approaching vehicles at junctions?

2.1. Methods

2.1.1. Participants

In total 33 participants were recruited who were all students studying for degrees at either the University of Nottingham UK or Malaysian campuses. This comprised 17 Malaysian (9 males and 8 females) and 16 British (8 males and 8 females) drivers. The average age of Malaysian drivers was 20.12 years (s.d.=1.58) ranging from 18 to 23 years old and they reported an average of 1.97 years of active driving experience since getting their driving license in Malaysia (s.d.=1.59 years). The average age of British drivers was 21.00 years (s.d.=1.10 years) ranging from 19 to 23 years old and they reported an average of 2.75 years of active driving experience since getting their driving license in the UK (s.d.=1.34 years). Independent-samples t-tests revealed that there was no difference in the years of active driving experience, $t(31)=1.53$, $p>0.05$, and no difference in terms of age between Malaysian and British drivers, $t(31)=1.86$, $p>0.05$. All reported normal or corrected-to-normal vision and were not colour blind. All participants reported no experience of riding a motorcycle.

2.1.2. Design

A 2x3x2x2 mixed design was used. There were three within-subjects independent variables: type of approaching vehicle used in the picture stimuli (car or motorcycle; ‘no vehicle’ trials were used as controls but do not contribute to the analysis); distance of approaching vehicle (near, intermediate or far); and the country where the T-junction photographs were taken, “country of road” (UK or Malaysia). The fourth independent variable was a between subjects factor which was the country of origin of the drivers (UK or Malaysia). The dependent variable was the accuracy in perceiving whether or not there was an approaching vehicle. Four hundred trials were presented across two identical blocks. Each 200 trial block included 60 trials without an approaching vehicle (30 UK roads and 30 Malaysian roads), 60 trials with an approaching motorcycle (30 UK and 30 Malaysian) and 60 trials with an approaching car (30 UK and 30 Malaysian). The car and motorcycle trials were further divided into ‘near’, ‘intermediate and ‘far’ distances for the approaching vehicles. The remaining 20 trials were ‘catch trials’: in order to ensure that the starting location for participants’ eyes was as realistic as possible for the situation, the fixation cross was located at the far left edge of the screen (though vertically central to the screen). This ensured that participants had to move their eyes to the right, or at least use rightward peripheral vision to detect the approaching vehicle. On catch trials the fixation cross changed from a ‘+’ symbol to an ‘x’ symbol. This change required participants to abort the trial, demonstrating that they were fixating the cross prior to the onset of the pictures. Data of three participants who scored lower than 40% in the catch trials were excluded.

2.1.3. Stimuli

The same 70 photograph stimuli developed in Crundall et al. (2008) were used. Ten pictures of T-junctions were taken in the UK (Nottinghamshire and Derbyshire roads) which were then edited to include either one of a range of motorcycles or cars at a near, intermediate or far distance (10 roadways x 2 vehicle types x 3 distances + 10 empty versions of each road as control pictures). A further 70 stimuli were created by taking photographs from the viewpoint of a driver who was looking towards the right while approaching T-junctions in Malaysia (University of Nottingham roads, Broga roads and Serdang roads). The same cars and motorcycles used in Crundall et al. (2008) were edited onto these roads at locations of near, intermediate and far, to avoid the vehicle types and colour of the vehicles being confound variables. One might suggests that UK vehicles onto Malaysian roads might look out of place and distract drivers' performance - however the number plates of vehicles, which would be the main distinguishing feature, were not clearly visible from the screen. As in Crundall et al. (2008), the vehicle height was controlled whereby the far vehicles measured 1cm, intermediate vehicles measured 2cm and the near vehicles measured 3cm. This enabled the actual size of the target vehicles to remain constant across trials while varying the related time-to-contact, as the same vehicle varied in where it was placed in each photograph depending on the features of the road depicted. This resulted in seven versions of each road including six with approaching traffic (car and motorcycle at three different distances) and one without approaching traffic. All stimuli were 720 x 540 pixels. Figure 1a and 1b show some of the examples of images used in the experiment.

Figure 1a. Six sample stimuli displaying a car and motorcycle at far, intermediate and near distances at Malaysia junctions.

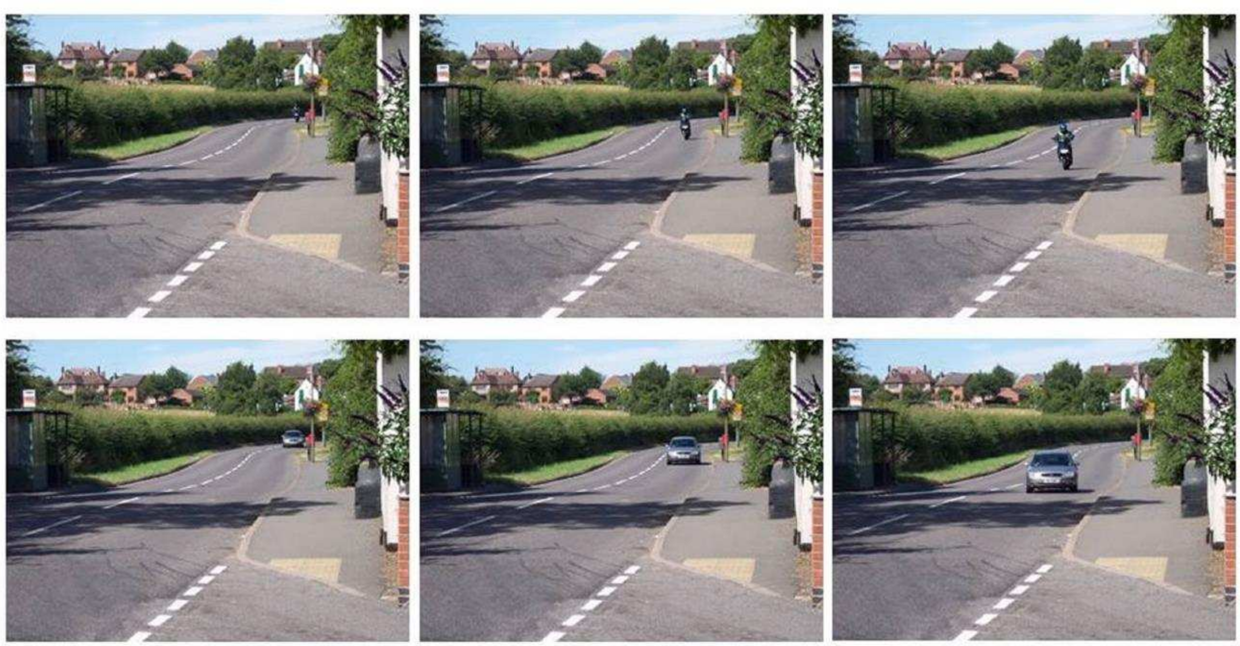

Figure 1b. Six sample stimuli displaying a car and motorcycle at far, intermediate and near distances at UK junctions.

2.1.4. Procedure

Participants were seated approximately 70cm from the computer screen with images presented at a visual angle of approximately 28x21°. Instructions were presented on the screen which explained to participants that they were about to see a series of pictures depicting the view from a side-road, looking right along the main carriageway, with the intention to turn right and cross the contraflow lane. Due to both the UK and Malaysia having a left-lane driving system, this task description translates well between countries. Participants were first asked to fixate on a fixation cross of variable duration (500ms, 100ms, 1500ms) that appeared to the left of the screen prior to the presentation of each picture. Upon picture onset participants were asked to identify whether there was an oncoming vehicle approaching them from the right, and to respond as quickly as possible by pressing 0 on the numerical keypad of a computer keyboard if the road was empty, or 2 on the keypad if a vehicle was approaching. Participants were allowed to move their eyes from the fixation cross once the picture appeared, however to ensure that the participants' eyes focused on the fixation cross prior to the presentation of the picture, they were also required to abort catch trials where the fixation cross changed shape prior to picture presentation (from a "+" to a "x"). Catch trials were correctly aborted by pressing the space bar on the keyboard.

The picture stimuli were each presented for 250 ms, following the variable-duration fixation cross, to simulate a single fixation on the picture. Following offset of each picture, participants were presented with a prompt screen detailing the appropriate buttons to press in order to make correct responses. Finally they were presented with visual feedback of the response accuracy before the fixation cross appeared signaling the start of the next trial.

Participants were given a practice block of 10 trials before the 2 blocks of the experiment started, and a self-paced break was allowed between the two experimental blocks.

2.2. Results

The data for all 33 participants were subjected to a 2x3x2x2 mixed Analysis of Variance (ANOVA) comparing percentage accuracy for spotting an approaching vehicle for vehicle type (car or motorcycle) at different distances (near, intermediate or far), for different drivers (UK or Malaysian) on different roads (UK roads or Malaysian roads). Mean percentage accuracy and standard deviations are shown in Table 1.

Percentage accuracy (%)	Distances	Vehicles	UK Drivers		Malaysian Drivers	
			UK Roads	MY Roads	UK Roads	MY Roads
	Near	Car	99.38 (1.71)	99.38 (1.71)	99.12 (2.64)	99.41 (2.43)
		Motorcycle	99.06 (2.02)	99.69 (1.26)	99.41 (1.66)	97.65 (4.00)
	Intermediate	Car	99.37 (1.71)	95.63 (3.87)	98.82 (2.81)	95.35 (4.57)
		Motorcycle	99.06 (2.02)	97.81 (3.15)	97.94 (3.98)	97.94 (3.98)
	Far	Car	91.56 (9.08)	93.25 (5.85)	99.37 (1.71)	86.71 (12.25)
		Motorcycle	66.25 (13.48)	80.31 (11.47)	69.12 (13.37)	82.94 (9.36)

Table 1. Mean and standard deviation of accuracy (percentage) of perceiving an approaching vehicle at different distances.

The ANOVA identified three main effects. First, there was a main effect of distance, $F(2, 62)=172.15$, $p<0.001$. Bonferroni pairwise comparisons showed that it was easier to perceive vehicles at a near distance (99.14%) than intermediate (97.74%), $p<0.001$; near (99.14%) than far (82.44%), $p<0.001$; and intermediate (97.74%) than far distances (82.44%), $p<0.001$. The second main effect revealed that cars (95.62%) were easier to perceive than motorcycles (90.6%), $F(1,31)=65.69, p<0.001$. A third main effect suggested that approaching vehicles on Malaysian roads (93.84%) were easier to perceive than on UK roads (92.38%), $F(1,31)=7.72$, $p<0.01$. There was no main effect of country of origin of drivers.

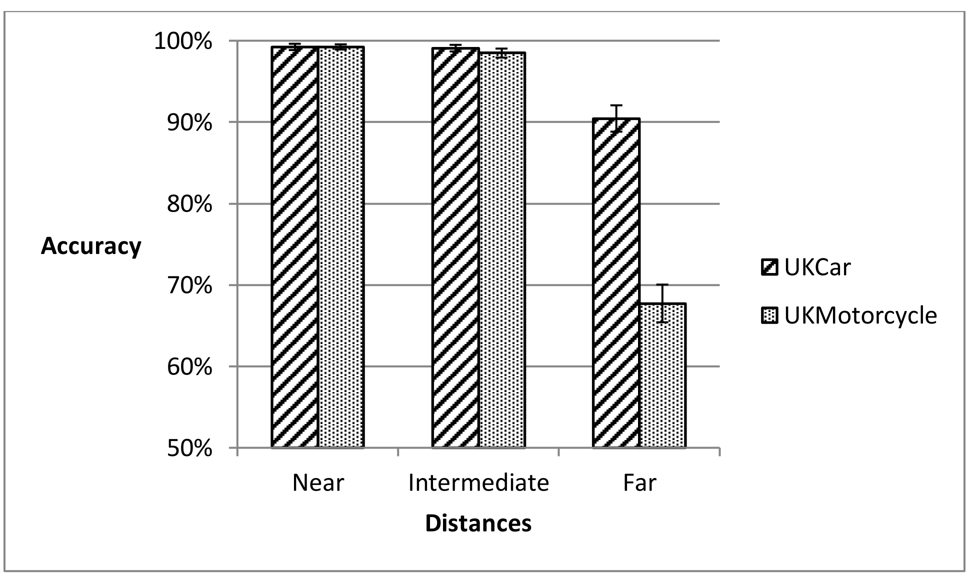

Figure 2A. Drivers' ability to perceive cars and motorcycles at different distances on UK roads.

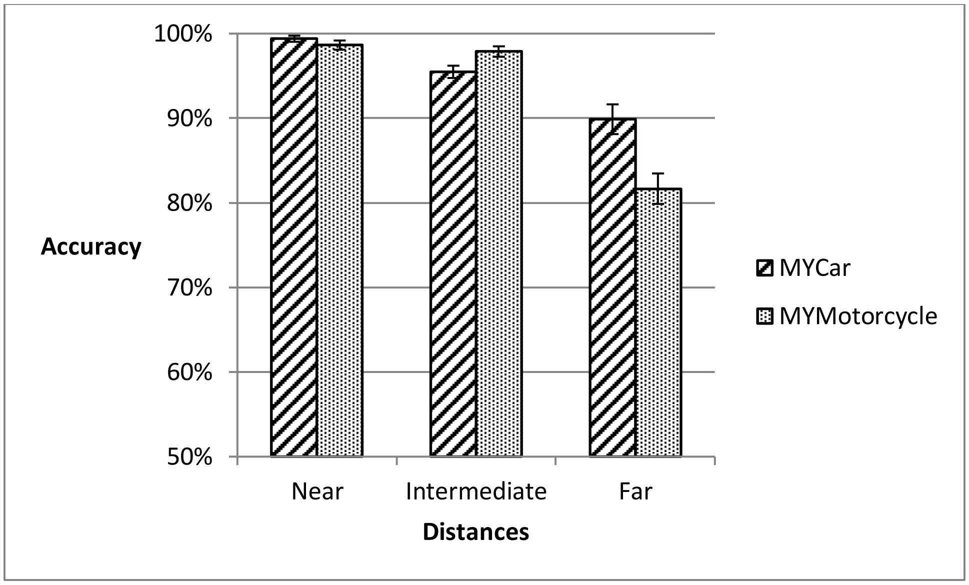

Figure 2B. Drivers' ability to perceive cars and motorcycles at different distances on Malaysian roads.

Three two-way interactions were found (see Figure 2A and 2B). The first interaction between road origin and vehicle type($F(1,31)=28.35$, $p<0.001$) revealed that motorcycles at an intermediate distance were easier to perceive than cars at the same distance on the Malaysian roads ($t(32)=4.05, p<0.001$), but not on the UK roads ($t(32)=1.07, p>0.05$). The second interaction between road origin and vehicle distance $F(2,62)=18.16$, $p<0.001$ demonstrated that near vehicles were easier to perceive than intermediate vehicles on Malaysian roads ($F(2,64)=18.78, p<0.001$; bonferonni pairwise comparisons for near and intermediate, $p<0.001$) but on the UK roads, vehicles at an intermediate distance were spotted just as easily as those at a near distance ($F(2,64)=28.69, p<0.001$; bonferonni pairwise comparisons for near and intermediate, $p>0.05$). A third two-way interaction between vehicle type and vehicle distance, $F(2,62)=68.20$, $p<0.001$ showed cars at a far distance to be more accurately reported than motorcycles at a far distance, $t(32)=8.04$, $p<0.001$, but this was not found at the other two distances (intermediate, $t(32)=-1.85, p>0.05$; near, $t(32)=1.38$, $p>0.05$).

These interactions were subsumed by a three-way interaction between road origin, vehicle type and vehicle distance, $F(2,62)=27.27$, $p<0.001$. As can be seen in figure 1, this appears to be due to intermediate cars on Malaysian roads being harder to perceive than intermediate motorcycles ($t(32)=-2.714$, $p<0.05$) but not on the UK roads ($t(32)=1.071$, $p>0.05$). The vehicle effect (whereby cars were easier to perceive as compared to motorcycles) also seems to be larger for UK roads than Malaysian roads at the far distance.

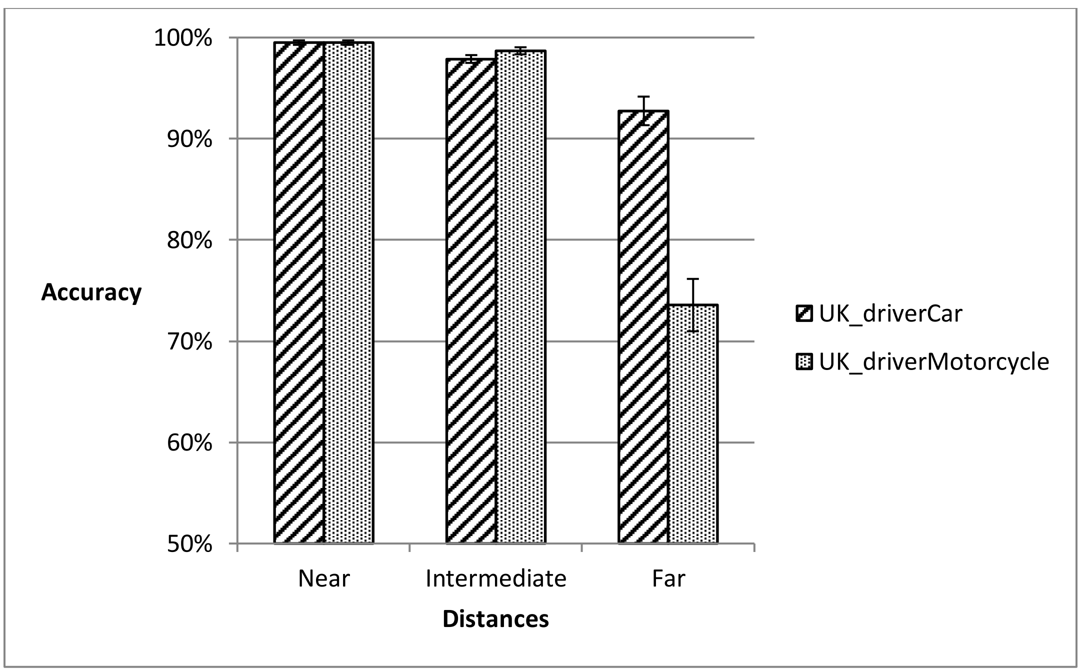

Figure. 3A UK drivers' ability to perceive cars and motorcycles at different distances.

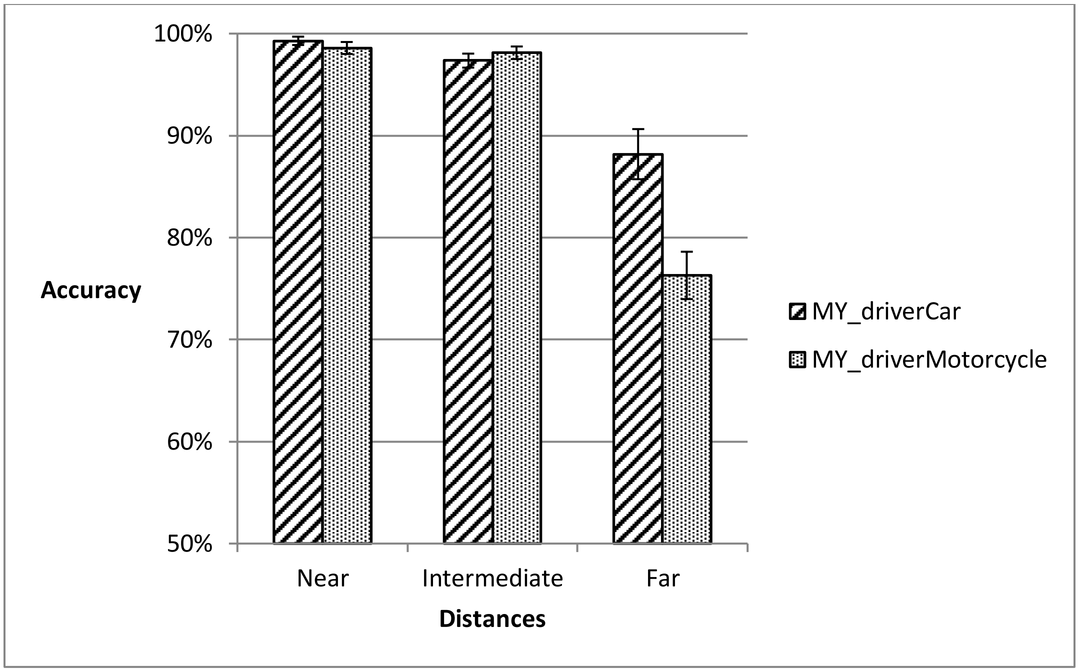

Figure. 3B Malaysian drivers' ability to perceive cars and motorcycles at different distances.

A further three-way interaction was found between driver origin, vehicle and distance (Figure. 3A and 3B), $F(2,62)=3.83$, $p<0.05$. This interaction appears to be driven by performance for photographs with vehicles at the far distance where there was an approaching significant cross-over interaction between vehicle and driver origin, $F(1,31)=3.96$, $p=0.056$ (compared with $F(1,31)=0.003$, $p>0.05$ for near distance and $F(1,31)=1.83$, $p>0.05$ for intermediate distance). Post-hoc t-tests revealed that there was no difference between Malaysian and UK drivers' ability in perceiving far cars ($t(31)=1.587$, $p>0.05$) and far motorcycles ($t(31)=-0.787, p>0.05$). Also both UK drivers ($t(15)=8.44$, $p<0.001$) and Malaysian drivers were better at perceiving far cars than far motorcycles ($t(16)=4.174$, $p<0.005$). Thus the interaction appears to be due to the fact that the difference in performance for cars and motorcycles is greater for UK drivers (19.19%) than Malaysian drivers (11.88%). While both Malaysian and UK drivers found it harder to spot motorcycles than cars at a far distance, the effect was reduced with the Malaysian participants who were more sensitive to spotting the motorcycles, but at a slight expense of spotting the far cars.

2.3. Discussion

Several findings of Crundall et al. (2008) were replicated, whereby cars were found to be easier to perceive as compared to motorcycles (Walton, Buchana and Murray, 2013) and nearer vehicles were easier to perceive as compared to further vehicles. It was also found that approaching vehicles on Malaysian roads were easier to perceive as compared to UK roads and this was true for both Malaysian drivers and UK drivers. In other words, there was no sign of an environmental familiarity effect i.e. participants did not show enhanced perception for stimuli on roads from their own country.

The two three-way interactions extend the previous findings by demonstrating that ability to spot approaching traffic in static images is impacted by the country of origin of the road pictures, and the country of origin of the participants. In regard to the former, the results suggested that cars at an intermediate distance are harder to spot when presented on Malaysian roads. This may be due to a number of factors such as the contrast between the edited vehicles and the brightness of the road images (with Malaysian pictures being inherently brighter than the UK pictures due to the sunnier climate), or the width of the roads influencing detection rates (narrower roads in Malaysia may lead to greater visual clutter and the possibility of lateral masking). If road origin had interacted with participant origin, these potential confounds would have been of less concern, but such an interaction did not occur.

The more interesting interaction demonstrated that the decline in ability to spot motorcycles at far distances is mediated by participants' country of origin, with Malaysian participants suffering a slightly moderated decline in spotting far motorcycles. This beneficial effect was however offset by a slight increase in the decline for spotting far cars compared to UK participants. The effect of participant origin on motorcycle detection is far smaller than the effect of vehicle distance, but nonetheless argues that Malaysian drivers have developed some increased sensitivity to motorcycles, which fits with the suggestion that the increased exposure of Malaysian participants to motorcycles when driving has lowered their detection threshold perhaps through perceptual learning (Crundall et al., 2008; Magazzù et al., 2006; Brooks & Guppy, 1990). This explanation does not however fit with the corresponding decline in sensitivity to cars. One alternative suggestion is that the ratio of exposure to cars and motorcycles in Malaysia changes the relative bias for identifying on-road stimuli, which forms a reciprocal inhibitory relationship for classifying road users from different vehicle categories. Thus instead of lowing thresholds for motorcycles per se, exposure may have created a slight bias to classify stimuli as motorcycles, which in turn slightly reduces the tendency to report cars.

If Malaysian drivers have expertise in perceiving motorcycles, or even a bias towards identifying them, this should presumably result in lower rates of collisions involving motorcycles in Malaysia. However, data suggest that fatality rates involving motorcycles are actually higher in Malaysia than in the UK even when the total number of registered motorcycles is taken into account. In Malaysia in 2011, it is reported that there were 3,614 rider fatalities (1 in every 2,613 registered motorcycles), around 10% of which occurred at T-junctions (Sarani, Roslan & Saniran, 2011). In contrast in the UK in 2012, there were 328 rider fatalities (1 in every 3,300 registered motorcycles; DfT, 2012). The higher fatality rate in Malaysia does not appear to be accounted for by distance travelled: in the UK in 2008 the fatality rate was reported to be 94 per billion vehicle kilometers travelled (VKT; DfT, 2012) while in the same year in Malaysia, the rate was estimated at 289 per billion VKT (Sharifah Allyana, Zarir, Abdul Rahmat, Siti Atiqah, Noor Faradila, Wong & Jamilah, 2010). This suggests that any advantage in perception conferred by increased exposure to motorcycles in Malaysia is not sufficient to result in fewer fatal accidents taking place. As mentioned previously, after perceiving an approaching vehicle it is necessary to make a judgment about whether or not it is safe to pull out. It is possible that the high fatality rate in Malaysia at junctions may in part be related to failures in the appraisal process i.e. Malaysians may have a greater tendency to judge it was safe to pull in front of vehicles as compared to UK drivers.

In order to investigate this suggestion, we replicated the methodology of Crundall et al.'s second experiment to compare Malaysian and UK drivers' judgments about whether it was safe to pull out at the same junctions (from both the UK and Malaysia). In addition to predicting that drivers would judge it is safer to pull out in front of further approaching vehicles than nearer vehicles (in line with Crundall et al., 2008), it was also hypothesized that Malaysian drivers would have a greater tendency to say it was safe to pull out than UK drivers. The use images of both UK and Malaysian roads in this experiment again allowed us to determine whether environmental familiarity impacts on drivers' judgments.

3. Experiment 2: How do Malaysian and UK drivers appraise approaching vehicles at junctions?

3.1. Methods

3.1.1. Participants

In total 35 university students from the University of Nottingham (UK and Malaysia campuses) took part, all of whom did not take part in the experiment 1. This resulted in 18 drivers who were Malaysian (9 males and 9 females) and 17 who were British (9 males and 8 females). The average age of Malaysian drivers was 21.42 years (s.d.=3.89) ranging from 18 to 33 years old and they reported an average of 3.21 years of active driving experience since getting their driving license in Malaysia (s.d.=2.56 years). The average age of British drivers was 21.78 years (s.d.=1.80 years) ranging from 19 to 25 years old and they reported an average of 2.79 years of active driving experience since getting their driving license in the UK (s.d.=1.67 years). Independent-samples t-tests revealed that there was no difference in the years of active driving experience, $t(33)=0.57, p>0.05$, and no difference in terms of age between Malaysian and British drivers, $t(33)=-0.35, p>0.05$. All reported normal or corrected-to-normal vision and were not colour blind. They also claimed that they do not have any experience of riding a motorcycle.

3.1.2. Design

The design of this experiment was similar to Experiment 1. A 2x3x2x2 mixed design was used. There were three within-subjects independent variables: type of approaching vehicle (car or motorcycle); distance of approaching vehicle (near, intermediate or far); and the country where the T-junction photographs were taken, country of road (UK roads or Malaysian roads). The fourth independent variable was a between-subjects factor which was the country of origin of the driver (UK or Malaysia). The dependent variable was the participants' judgment about whether it was safe to pull out from the junction.

For this experiment, a total of 160 trials were presented. 120 trials were presented with an approaching vehicle included and 40 trials were presented without any approaching vehicles, with a repetition twice for each image (10 UK roads and 10 Malaysian roads). Unlike in Experiment 1, the fixation cross was located in the middle of the screen as participants had a much longer period of inspection rendering little benefit of simulating the first saccade in the scene (Crundall et al., 2008).

3.1.3. Stimuli and Procedure

The same stimuli from Experiment 1 were presented in random sequence but without catch trials. Participants were asked to press 0 for "safe" to pull out and 2 for "not safe" to pull out. All picture stimuli were presented in random sequence for 5000ms and all participants made a response within the time frame. After making a response, participants were presented with visual feedback of the decision they made for each trial, for example "you said pull out" or "you said don't pull out". Since that there is no right or wrong answer in this experiment, the visual feedback was used to make sure that they made the appropriate key press which is congruent with their decision. The fixation cross appeared again in the middle of the screen before the next trial began. All stimuli were presented in random sequence using E-prime program and the experiment took approximately 15 mins to complete.

3.2. Results

The data for all 35 participants were subjected to a 2x3x2x2 mixed Analysis of Variance (ANOVA) comparing percentage of judgments it was safe to pull out in front of an approaching vehicle for vehicle type (car or motorcycle) at different distances (near, intermediate or far), for different drivers (UK or Malaysian) on different roads (UK roads or Malaysian roads). Mean percentage of judgments that it was safe to pull out in front of an approaching vehicle and standard deviations are shown in Table 2.

Percentage of judgments of safe to pull out (%)	Distances	Vehicles	UK Drivers		Malaysian Drivers	
			UK Roads	MY Roads	UK Roads	MY Roads
	Near	Car	0.59 (0.59)	1.18 (0.81)	5.00 (1.67)	4.44 (1.45)
		Motorcycle	0.00 (0.00)	0.59 (0.59)	3.33 (1.40)	2.78 (1.35)
	Intermediate	Car	6.47 (2.09)	9.41 (3.78)	15.00 (4.80)	23.33 (6.47)
		Motorcycle	4.71 (1.51)	4.71 (1.94)	16.11 (4.29)	26.11 (6.48)
	Far	Car	54.71 (7.87)	75.88 (5.43)	69.44 (7.16)	80.56 (4.68)
		Motorcycle	60.59 (5.97)	74.71 (6.19)	73.89 (4.99)	78.33 (5.26)

Table 2. Mean and standard deviation of the percentage of judgments it was safe to pull out in front of an approaching vehicle at different distances.

The ANOVA identified three main effects. First, there was a main effect of distance, $F(2, 66)=277.50$, $p<0.001$. Bonferroni pairwise comparisons showed that it was judged safer to pull out in front of intermediate (13.2%) as compared to near (2.2%) approaching vehicles, $p<0.001$; it was judged safer to pull out in front of far (71%) as compared to near (2.3%) approaching vehicles, $p<0.001$; and it was judged safer to pull out in front of far (71%) as compared to intermediate (13.2%) approaching vehicles, $p<0.001$. Secondly, it was judged safer to pull out in front of an approaching vehicle on Malaysian roads (27.74%) than UK roads (21.18%), $F(1,33)=34.76$, $p<0.001$. Thirdly, there was a main effect of country of origin of drivers whereby Malaysians (33.2%) were more likely to judge it was safe to pull out than British drivers (24.46%), $F(1,33)=4.86$, $p<0.05$.

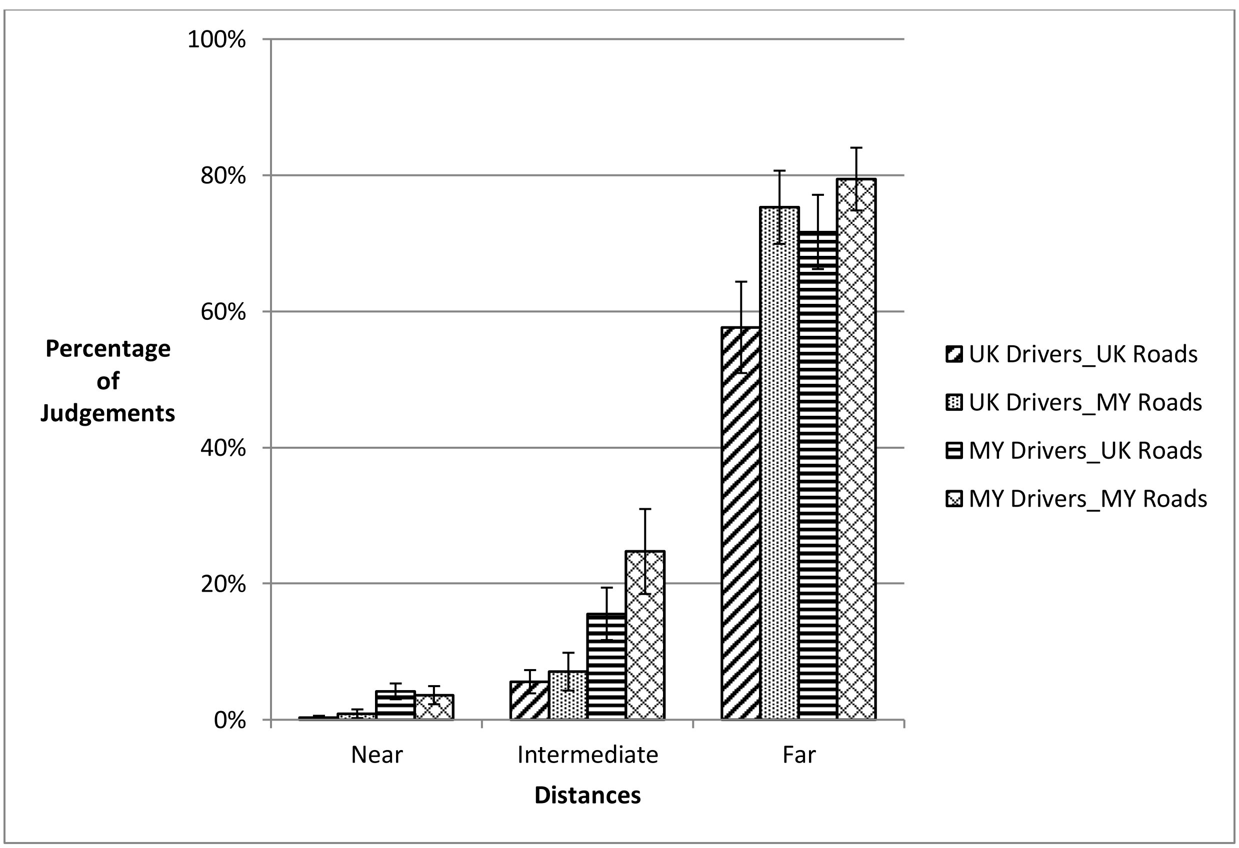

Figure 4. Percentage of judgments it was safe to pull out at junctions on UK and Malaysian roads at near, intermediate and far distances

There was a significant two-way interaction between road origin and distance, $F(2, 66)=10.48$, $p<0.005$ (Figure 4). Drivers were more likely to judge it was safe to pull out on Malaysian roads than UK roads at the far distance, $t(34)=-5.61$, $p<0.001$; and also at the intermediate distance, $t(34)=-2.19$, $p<0.05$; but not at the near distance. There was also a significant three-way interaction between road origin, vehicle distance and driver origin, $F(2,66)=4.97, p<0.05$. An interaction between road origin and vehicle distance was found for UK drivers ($F(2,32)=16.84$, $p<0.001$) but not for Malaysian drivers ($F(2,34)=2.834$, $p>0.05$). Paired-samples t-tests showed that UK drivers were more likely to judge it was safe to pull out on Malaysian roads than UK roads at a far distance, $t(16)=-4.95$, $p<0.001$, but there was no difference in judgments for UK and Malaysian roads for intermediate and near distances. All other main effects and interactions were non-significant.

3.3. Discussion

Crundall et al.'s (2008) results were successfully replicated. Firstly, there was no difference in making judgements about whether it was safe to pull out in front of different types of vehicle. When enough time was given to process all the available information there were no differences in making judgments for different types of vehicles located at the same distance (Crundall et al., 2008). Secondly, just like Crundall et al. (2008) it was found that drivers were more likely to judge it was safe to pull out when the approaching vehicles were located at the further distances compared to the nearer distances.

In addition to these findings, it was found that Malaysian drivers were more likely to judge it was safe to pull out as compared to UK drivers and drivers from both countries judged it as safer to pull out on Malaysian than UK roads. Possible reasons for these findings and their relationship with the findings in Experiment 1 are discussed below.

4. General Discussion

As in Crundall et al. (2008), drivers were more likely to judge it was safe to pull out when the approaching vehicles were located at the further distances compared to the nearer distances. Also consistent with Crundall et al., there was no difference in drivers' judgments about whether or not it was safe to pull out in front of cars and motorcycles. Crundall et al. (2008) argue that when enough time is provided for all the available information to be fully processed our decisions do not differentiate between types of vehicle positioned at the same distance. They go on to point out that this contradicts the size-arrival effect, which is a tendency to assume that smaller vehicles are moving more slowly and will therefore take longer to reach the junction, though they acknowledged that static stimuli did not provide a realistic test of the size-arrival illusion. Our findings here suggest that this lack of vehicle effect in static imagery is robust and extends to drivers who have learned to drive in differing environments.

More importantly, although Experiment 1 showed that Malaysian drivers were just as capable of perceiving approaching vehicles, even slightly favouring the relative classification of motorcycles over cars, Malaysian drivers were still more likely to judge that it was safe to pull out in front of such vehicles as compared to UK drivers. This is consistent with the possibility that Malaysian drivers are more like to engage in risk taking when driving than UK drivers, or at least they leave narrower margins for error when making manoeuvres. This could contribute to the higher fatality rate of road users in Malaysia compared to the UK. When all vehicles are taken into consideration, the fatality rate is some eight times greater in Malaysia than in the UK (IRTAD, 2011) and it is notable that the greater tendency to judge it was safe to pull out was observed for approaching cars as well as approaching motorcycles.

However, there are some alternative explanations for these results which must be considered. It is possible that vehicles in Malaysia generally travel at lower speeds than vehicles in the UK, which would potentially result in Malaysian drivers assuming that the vehicles in the photographs were travelling at lower speeds than UK drivers do, leaving more time available for performing the manoeuvre. As only static stimuli were used in the current study, the speed of the vehicle may be inferred by participants as they make the judgements and it is possible that the drivers from the two countries differ systematically in the speed they infer for the vehicles. Such an explanation appears plausible for motorcycles given that the engine capacity for motorcycles is smaller in the Malaysia than in the UK. In the UK, around 31% of motorcycles have an engine size of less than 150cc (DfT, 2014) while in Malaysia it has been reported that 99% of motorcycles have an engine size in this range (Hussain, Ahmad Farhan, Radin Umar & Dadang, 2005). However this does not explain why there is a difference in judgments of drivers from the two countries of the same magnitude for cars. Furthermore, if Malaysians expect motorcycles to be driving slowly due to their engine size, we would expect to see an effect of vehicle type for the Malaysian drivers, which we do not. The default speed limit for state roads in Malaysia such as those where the photographs were taken is 60 km/hr (equivalent to 37mph) which is slightly higher than the 30mph default speed limit for the type of roads photographed in the UK. This also appears inconsistent with the suggestion that vehicles generally drive slower in Malaysia than in the UK, although we do not know for certain whether vehicles in Malaysia do typically travel at the speed limits established for the roads. Another possible explanation for the increased tendency for Malaysian drivers to say that they would pull out is that they may be more likely to believe that other approaching motorists would decelerate and/or give way in order for them to make a successful manoeuvre.

People judged it as being safer to pull out in front of vehicles on Malaysian roads than on UK roads, at least for vehicles appearing at the intermediate and far locations and this tendency was particularly pronounced for UK drivers with vehicles at far locations. However, as in Experiment 1 where differences were observed in relation to country of road, these findings are difficult to interpret as vehicles were positioned within the stimuli according to where they looked correct (i.e. were placed within the scene such that their edited size was commensurate with the perceived distance) and this could have resulted in the vehicles being positioned at a slightly further distance from the junction in the Malaysian stimuli at those distances.

As in the previous experiment there was no interaction between driver origin and the country of the road, which implies no effects of environmental familiarity on judgments about them. This contrasts with the findings of Lim, Sheppard and Crundall (2013) who observed that Malaysian drivers and UK drivers were able to detect more pre-defined hazards from their own country in a hazard perception task. It was suggested that this could be due to both familiarity with the general environment and familiarity with particular hazards which tend to be context-specific, which facilitate and improve drivers' detection ability. In the current research, the lack of influence of environmental familiarity suggests a high level of transferability of perceptual and decision-making processes across contexts.

Finally, it is worth bearing in mind that a limitation of the current study is that dual drivers (i.e. those who can drive both a car and a motorcycle) were excluded. This was done to ensure comparability between the samples from the two countries, as well as homogeneity within the samples, as previous research has found that dual drivers may have enhanced motorcycle detection skills (Magazzù et al., 2006). However, given that there are similar numbers of registered cars and motorcycles in Malaysia (47% and 42% respectively, Manan & Várhelyi, 2012), we might expect a greater number of dual drivers than in the UK (although data on this is not available, to our knowledge). If this is the case, it may mean that we have underestimated the actual differences in motorcycle perception ability between drivers from the two countries, a possibility which could be addressed by focussing future research on perception and decision making of Malaysian dual drivers.

In summary, the results suggest that driving in an environment with high exposure to motorcycles may lead to a relative enhancement in perception of motorcycles. However, whether this translates to a lesser propensity to be involved in accidents with motorcycles is likely to depend on a range of other factors, such as the front light configuration (Pinto, Cavallo and Saint-Pierre, 2014), colour, motion and spatial frequency (Crundall, Crundall, Clarke and Shahar, 2012), traffic volume and speed limit (Manan, 2014). Our research suggests that Malaysian drivers are more inclined to think it is safe to pull out in front of approaching vehicles than drivers from the UK. This indicates they might adopt a less cautious appraisal process about oncoming traffic in general which may partly contribute to the high driver fatality rate in Malaysia.

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