Mobility scooter user behaviour and hazard perception at road crossings

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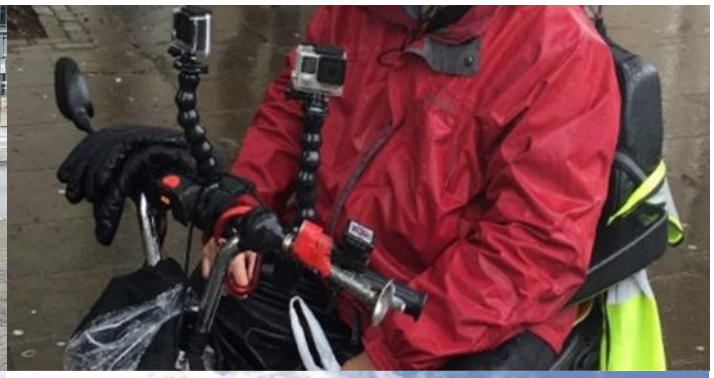

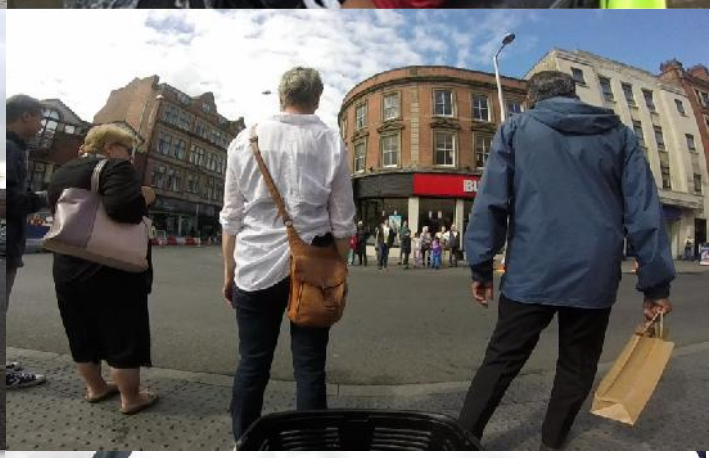


See & Scoot
A Mobility Scooter Training Resource
Road Safety Trust
Supporting Road Safety
NOTTINGHAM TRENT UNIVERSITY
This training resource has been put together by TRiP, the Transport Research Group in Psychology at Nottingham Trent University

Mobility scooter user behaviour and hazard perception at road crossings

Executive Summary

Motorised mobility scooter (MMS) numbers In the UK have increased from an estimated 90,000 in 2005 to 300,000-350,000 in 2014 with this number estimated to continue increasing at a rate of 5-10% per year. They have become one of the most popular methods of assisting mobility and short distance travel due to their easy operation, compact design and because they can be used indoors and outdoors. Not much is known about MMS accidents due to the way they are reported (or not). However, in 2014 there were 209 reported mobility scooter related collisions within England and Wales, including nine fatal road accidents (Department for Transport, 2015). In a study of 43 MMS users, Hoenig, Pieper, Branch and Cohen (2007) found that 18% of users reported collisions during a three-month period, suggesting the number of minor accidents is quite high.

In relation to enhancing MMS driving safety, there is a patchwork of approaches across the country, with some advice tools or training DVDs, and other training days or training centres. However, much of the training available has focused on vehicular control and research into the effectiveness of training programs is limited and of variable quality. Importantly, no research has been conducted to try and understand the types of hazards MMS users might face and what strategies they use to deal with these. Whilst vehicle handling is of central importance, it is also important to train users about the situations they might face and how to handle them. This Road Safety Trust grant on *Mobility scooter user behaviour and hazard perception at road crossings* issued to Dr Duncan Guest (Nottingham Trent University) was designed to do this, and in particular to focus on road crossings, which are the most hazardous situation for MMS users.

The two-year project had multiple phases. The first phase was a large-scale questionnaire to assess the types of hazards users faced and how they dealt with these alongside also getting an understanding of training received, MMS experience and views on MMS use (benefits and disadvantages). Out of 268 users who responded, only 38% reported that they had received any training. Of the types of training users reported the most frequent was training with vehicular controls (39%). Training users about the hazards they might encounter in a real-world environment, and strategies that can be used to increase safety whilst out on the road was rarely reported. Our analysis revealed a number of key categories of hazards for MMS users; Pedestrians, Traffic/other drivers, Structural design of road crossings, Visibility at crossings, Space at crossings, Structural design of roads/pavements, Crossing time, Scooter design, Weather and Priority issues.

The second phase of the work comprised a naturalistic driving study in which we attached three GoPro HD cameras to a mobility scooter and the MMS user wore mobile eye tracking glasses and negotiated a route around Nottingham City Centre which included 42 crossings. Twenty -seven MMS users took part and data was analysed to see the type of hazardous situations users were presented with and assess how they dealt with these. Thirteen MMS users then re-watched footage from their drive, explaining why they were behaving in particular ways. These studies confirmed the different themes of hazard identified in the questionnaire and provided real life footage of some of these hazards being encountered and negotiated. The project then used this footage to create the training DVD *See and Scoot* which is now hosted for free on https://www.testmydriving.com/see-scoot. This training is unique because it is evidence based using data provided by MMS users, is shot from the users perspective showing potential MMS users what it feels like to be in an MMS and because it contains live footage which is more meaningful and powerful.

The final part of the project evaluated whether this training DVD worked. Forty-five older adults with no MMS experience were trained to handle an MMS and then either shown *See or Scoot* or a video not related to MMS training. They then completed a course through Nottingham, which was recorded using GoPro HD cameras and eye tracking glasses. This footage was then assessed. Analysis showed that watching *See and Scoot* led to statistically significant improvements in the way hazards were negotiated and led to participants using more behaviours known to be advantageous and using better strategies to negotiate hazards. Those who watched *See and Scoot* also were more aware of strategies to negotiate hazards, but counterintuitively felt less able to deal with hazards, possibly because by being more aware of hazards they were more aware of their inability to effectively deal with them.

Overall the project led to the creation of *See and Scoot*, which we have shown to be an effective, evidenced based, training tool. *See and Scoot* is available free online, and a number of organisations around the UK are already using it including TGA Mobility, one of the largest MMS manufacturers in the UK.

Given that the population in the UK is ageing, and that MMS are becoming much more popular, this project represents an important step in understanding how to improve safety for MMS users. Our data also show the positive impact MMS use has on users lives, which further demonstrates the need for better training for MMS users.

Extended Summary

This 2 year Road Safety Trust grant on *Mobility scooter user behaviour and hazard perception at road crossings* aimed to better understand the hazards that motorised mobility scooter (MMS) users faced at road crossings and understand the strategies they used to negotiate these crossings. There were four phases to the project.

Phase 1. Large scale questionnaire

Phase 2. Naturalistic Driving Study

Phase 3. Developing a training intervention (DVD)

Phase 4. Naturalistic evaluation of the training DVD

Phase 1 comprised a large survey (Study 1) of 268 participants that asked questions on past MMS use, views on MMS safety, views on MMS use and its benefits, MMS training that had been received and asked users about the hazards they faced at road crossings and the strategies they used to mitigate these. The questionnaire was extensive and, as far as we are aware, comprises the largest study to date on MMs users. The data was analysed using both quantitative and qualitative techniques. Importantly, this survey produced the first comprehensive assessment of the hazards that MMS users face and the strategies they use to negotiate these. It also provides very useful contextual information about MMS users more generally, their experience and their views on MMS use. Analysis was broken down by experienced/less experienced groups, which provided some useful insights.

Some significant findings were as follows. In relation to MMS training only 38% reported that they had received training. Of the types of training users reported the most frequent was training with vehicular controls (39%). Much of the training occurred either at point of sale or when users rented a MMS (41%). A very small proportion of users had received training on an inside (4%) or outside (4%) course (e.g., where the user has to negotiate a predefined course). Some users reported reading safety manuals or handbooks written for MMSs (4%), and others reported their own experience of using a MMS was adequate enough training. Importantly, training users about the hazards they might encounter in a real-world environment, and strategies that can be used to increase safety whilst out on the road was rarely reported. This demonstrates the extent to which this important element of preparation and training has been neglected across the various patchwork of training programs that exists for these users, and thus the importance of the approach adopted here in terms of trying to identify the types of hazards MMS users face.

An example of the taxonomy of the hazards users phase taken from the results of the questionnaire is shown below in Table 1. Similarly a taxonomy of strategies used at road crossings is shown in Table 2. These tables demonstrate the value of this study in terms of being able to break down and understand hazards MMS users face and how they deal with them.

Table 1. Emergent themes of hazards faced by MMS users at road crossings. Percentages refer to the percentage of the total amount of hazards identified and are broken down by an overall percentage and then a percentage for less experienced users (L) and more experienced users (M).

Hazard Type	**Marked Crossings**	**Unmarked Crossings**	**Typical issues**	**Example quote**
Pedestrians	22.68% L 20.63% M 23.48%	3.17% L 2.77% M 2.88%	Pedestrians are unpredictable, they do not notice MMS users	*"Pedestrians do not seem aware of our existence and walk straight in front of the scooter."*
Traffic/other drivers	22.04% L 21.43% M 19.70%	28.53% L 31.06% M 30.22%	Traffic not stopping, traffic going too fast	*"Some drivers don't consider you to be a pedestrian and at times won't stop"*
Structural design of road crossings	21.73% L 20.63% M 23.48%	23.34% L 24.24% M 24.46%	Buttons at crossings are too high and/or difficult to reach.	*"Not always a dropped kerb opposite forcing you to use the road for a short distance"*
Visibility at crossings	7.99% L 8.73% M 6.82%	13.26% L12.88% M 13.67%	Parked cars near crossings, pedestrians waiting in front of scooter at crossing	*"People parked on the zig zag lines and because you are lower down visibility is a real issue. Visibility is an issue as drivers don't look low down for scooters they are thinking walking person"*
Spacing at crossings	7.35% L 7.94% M 6.82%	11.53% L 9.85% 12.23%	Central area not wide enough	*"Central reservation not always wide enough for scooter to be clear of traffic."*
Structural design of roads/pavements	7.35% L 8.73% M 6.82%	7.49% L 6.06% M 5.04%	Pot holes, narrow pavements	*"Some dropped kerbs are inadequate, too narrow, occasionally too steep"*
Crossing time	5.75% L 5.56% M 6.82%	0.58% L 0% M 0%	Not long enough to cross	*"When the crossing is used by lots of pedestrians you may have to wait behind them for clearance and the time limit at some crossing is not long enough."*
Scooter design	2.56% L 3.97% M 2.27%	1.15% L 1.52% M 1.44%	Small scooters feel unsteady	*"Bumps cause problems to steering and traction"*
Weather	2.56% L 2.38% M 3.03%	0.86% L 0.76% M 0.72%	Slippery when raining, breaking time	*"Weather - if raining breaking at crossings can take longer."*
Priority issues	0% L 0% M 0%	10.09% L 11.36% M 9.35%	Who has right of way? Can I go?	*"Being extra cautious as cars do not always stop, especially if turning into road you are crossing."*

Table 2. Emergent themes of strategies used by MMS users at marked road crossings. Percentages refer to the percentage of the total amount of strategies used and are broken down by an overall percentage and then a percentage for less experienced users (L) and more experienced users (M).

Hazard Type		**Typical strategy**	**Example**
Modify speed or wait	25.59% L 26.61% M 28.26%	Slow down / Speed up to avoid hazard or wait for hazardous situation to pass (e.g., number of pedestrians decrease)	*"I do not move until I am confident that I have been seen by approaching road users"* *"Reduce speed when approaching the crossing. Turn up speed when crossing but be very aware of other people also on the crossing."*
Assessing the situation	17.32% L 17,43% M 15.22%	To look at the situation and assess how they might need to behave, for example	*"Asses roads on approach looking for gaps in traffic and always looking out for pedestrians. vehicles not slowing down"*
Vigilance	15.35% L 13.76% M 16.30%	To be aware and vigilant of surroundings at all times	*"Take care from all directions and double check all the time. This is even more so even if it is raining"*
Making oneself visible	12.20% L 13.76% M 11.96%	To increase visibility through clothing (high vis), scooter lights, being audible (e.g., a horn) and making eye contact with others	*"I have a reflective top on the back of seat to help me being seen by other road users"*
Alternate route	11.81% L 12.84% M 11.96%	Find an alternate route so that the hazard does not need to be negotiated	*"I am very cautious at zebra crossings and will often go out of my way to avoid pelican crossings"* *"I tend to use less busy roads when i have to cross them travelling an extra half a mile to be more safe"*
Positioning	9.45% L 11.01% M 7.61%	Thinking about how to position the scooter to minimise risk	*"I may let people cross before I do, or wait until I can be correctly positioned at the front so take the next time for crossing"*
Asking for help	5.91% L 3.67% M 5,43%	Ask someone else for help (e.g., press button)	*"Requesting others to press the pedestrian crossing button"*
Prepare route	1.18% L .92% M 2.17%	Think about and plan the route in advance.	*"Try to stick to areas where I don't need to cross roads"*
Stopped going out completely or at certain times	1.18% L 0% M 1.09%	User stopped going out altogether on their scooter or at certain times	*"I tend to wear bright colours, I only go out in daylight, never in bad weather & only go outside my home by myself when I really have no other option"*

One section of the questionnaire study included a section on views of MMS use. This provided a comprehensive understanding of MMS users views on a range of issues in relation to MMS use. Figure 1 shows the positive impact MMS use can have on users on a range of measures, including participation in activities, independence and self-esteem. This adds to the argument that MMS use is actually very positive for society, and thus there is an important need to ensure better training so

that people with mobility issues use an MMS safely, and in doing so continue to use it for longer and enjoy the benefits from its use that users report.

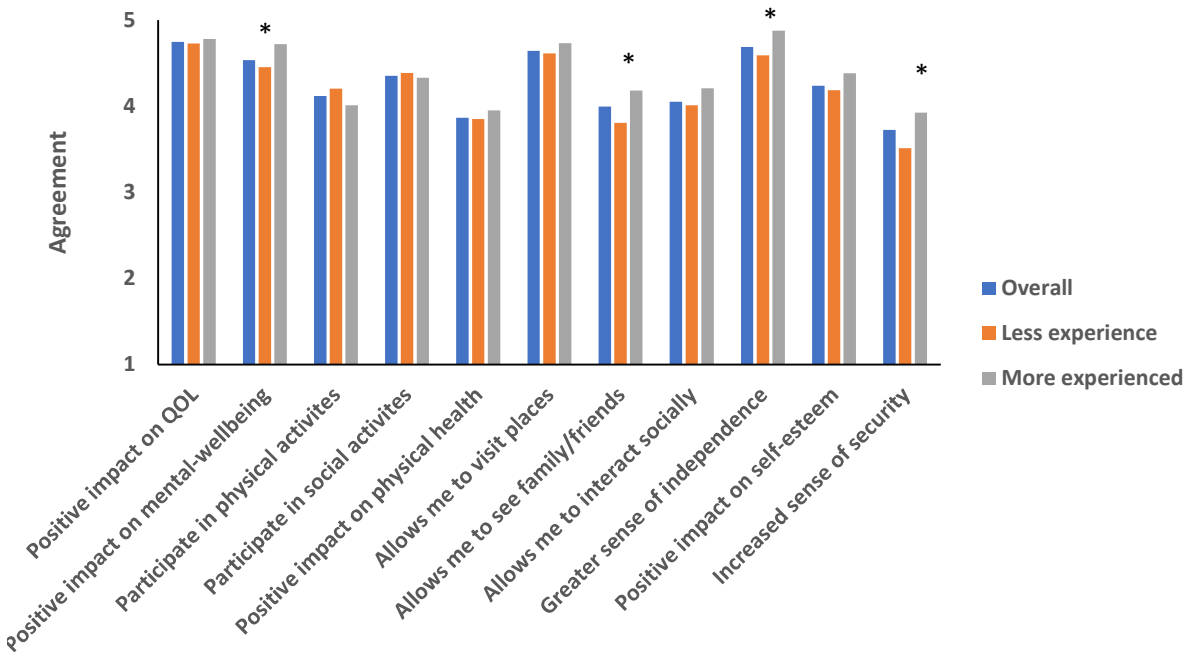

*Figure 1. MMS users views on the impact of mobility scooter use. Scores represent agreement on a 5-point scale ranging from strongly disagree (1) to strongly agree (5). * represents statistically significant differences between the scores of less and more experienced users. QOL refers to quality of life.*

Phase 2 was a naturalistic study of MMS users (Study 2). Three GoPro HD cameras were attached to a mobility scooter and participants wore mobile eye tracking glasses. Participants were MMS users and the focus of the study was to record footage as users negotiated a route around Nottingham The route comprised 42 crossings in total (17 puffin/pelican, 6 zebra, 14 unmarked road crossings, 1 unmarked entrance/exit to a car park, and 4 crossings in pedestrian areas). Overall 27 participants took part in the study and competed this route (which took around 30-45 minutes to complete) yielding approximately 25 hrs of footage, all from the MMS users perspective creating a unique and valuable dataset.

In analysis, the footage from all cameras was combined into a single video (see Figure 2). A proforma for coding the videos was developed and all of the crossings in each video were assessed with the coder noting any hazards that were apparent, whether the user saw them, rated the severity of each of the hazards, rated how well the MMS user negotiated/responded to the hazard, noted any strategies used, noted the number of strategies used, rated how well the strategy used mitigated the risk to the user and finally listed who the hazard was more dangerous for. At a later point in time the strategies used were converted to the categories developed in Study 1.

Figure 2. An example of the video created from the three different HD cameras (bottom) and the eye tracking camera (top) in Study 2.

Table 3. Data from Study 2 comprising; ratings of hazard severity, how well a hazard was negotiated, how effectively the strategy used mitigated the risk as well as the mean number of strategies used.

	Unmarked	Marked (Puffin)	Marked (Zebra)	Pedestrian Area (Crossing)	Pedestrian Area (Entrance/ Exit)	All Marked	All Pedestrian Area
Severity of hazard	4.75	4.12	4.28	3.31	4.50	4.17	3.54
Hazard negotiation?	4.86	4.36	5.17	4.68	3.92	4.74	4.49
Mean number of strategies used	1.63	1.02	1.73	1.19	0.95	1.32	1.11
How effectively did the strategy mitigate the risk?	6.01	5.60	5.89	5.94	5.82	5.76	5.98

The central findings from Study 2 are shown in Tables 3 and 4. First, that hazards were encountered frequently (1048 hazards across 27 participants) and across all types of road crossing. This clearly indicates the need for any training to focus on a range of different types of crossing. Second, crossing types differed in the severity of hazard encountered, with most severe hazards at unmarked crossings, followed by marked crossings then crossings in pedestrian areas. This indicates a particular need for training to incorporate how to deal with hazards at unmarked road crossings. Third, that participants used a greater number of strategies at unmarked crossings. Fourth that participants tailored the strategy they used to the type of crossing. Key examples being the

importance of positioning and asking for help at marked crossings, the importance of vigilance at crossings in pedestrian areas, and more generally the central importance of continual assessment of the situation and in tailoring speed to the situation.

Table 4. Percentage that each strategy was used across different crossing types in Study 2a and 2b for All users and More experienced and Less experienced users.

	Vigilance	Modifying Speed/ waiting	Asking or Help	Assessing Situation	Making oneself visible	Positioning
All Unmarked - All	15%	43%	5%	52%	91%	19%
All Unmarked - More	14%	49%	8%	56%	100%	13%
All Unmarked - Less	4%	38%	0%	46%	100%	23%
All Marked – All	52%	44%	95%	41%	9%	71%
All Marked - More	54%	42%	92%	37%	0%	77%
All Marked - Less	65%	47%	100%	48%	0%	69%
All Pedestrian Area - All	33%	13%	0%	7%	0%	9%
All Pedestrian Area - More	32%	9%	0%	8%	0%	10%
All Pedestrian Area – Less	30%	14%	0%	7%	0%	8%

The second part of Phase 2 was Study 3 in which participants from Study 2 were invited back to watch the footage from their drive and complete a retrospective think-aloud protocol, talking about why they were doing what they were doing. Only 13/27 returned to complete this interview. This data was sufficient to provide a good contextualised understanding of the reasons why MMS users acted in certain ways. The data from Study 3 were coded using the categories of hazards developed in Study 1-2 as a way of triangulating from a variety of perspectives whether the classification of hazards we had developed was robust. Table 5 shows that this categorisation system was useful with the hazards identified aligning well with these categories. An example quote from a participant is shown below. This refers to issues around the positions of the green light at a crossing (many users reported it was difficult to see).

> *"You've got the green man, but you can't see that until you're actually away from there. It's not directly…. when you press that button, you know you press the button and it lights up, but you can't see that green man from…. Unless you come away (reverse) like we were there, but if you're right next to that post."*

Table 5. Phase 2. Hazards identified by participants in in depth interviews (Study 3)

Hazard Type	Marked Crossings %	Unmarked Crossings %	Typical Issues
Structural design of crossings	92%	69%	Can't reach to press button, pedestrian crossing positioning of signal lights (green man) on near or opposite side, the need for some unmarked crossings to be marked pedestrian crossings, crossings close to a junction/roundabout
Pedestrians	62%	54%	Lack of awareness of MMS by pedestrians, pedestrians standing in front of scooters
Traffic/other drivers	54%	31%	Driving too fast, blocking crossings, not giving way
Visibility issues	38%	46%	Difficulties seeing round corners to check if it is safe to cross. Difficulties seeing over vehicles near crossings
Spacing issues	54%	15%	Reservation areas not wide enough, railings can make reservation areas narrower, some roads are very wide to cross
Crossing time	38%	8%	Not long enough to cross
Priority issues	0%	8%	Unclear who has priority.

Phase 3 involved the development of a training intervention. The findings from Studies 1-3 were used to create a DVD training tool for scooter users – *See and Scoot.* The tool is evidenced based, as the hazards it discusses correspond to those identified in three empirical studies with MMS users. Importantly, these studies used very different approaches and so the understanding about the hazards MMS users face was triangulated from a large questionnaire study (Study 1), a scooter route study in which video footage was rated (Study 2) and interviews with MMS users who had completed the scooter route study (Study 3). Importantly, a large amount of this data was MMS users themselves and as such the video has been developed based on their perspectives. A steering group was held during the DVD creation to gain advice about what would be useful. Participants included representatives from the local shop-mobility scheme, a scooter user and a representative from a manufacturer of scooters. This focus group advised on the types of things that might be included, but also on the length and the type of structure that might work. The research team presented various ideas to the group for comment and gained some useful feedback that informed the DVD production.

Live footage from Study 2 was used in the DVD because it was felt to be much more powerful than staged footage, and the richness of the data meant there was ample footage from which to choose. Moreover, the fact that all the videos in the training are live footage from the users' perspective means that it is a very unique training tool compared to those in existence. As the grant focused on improving safety at crossings, the training DVD focuses on road crossings. However, as there was substantial footage of traversing pedestrian areas, the DVD also includes a section on this. Table 6 shows the correspondence with between the categories of hazard we identified in Studies 1-3 and the training DVD sections. Scooter design and Weather did not have sections as the footage did not really feature much about Scooter Design, and the Weather was always dry because this was a requirement of using the study equipment.

Table 6. Alignment of the sections in See and Scoot with the hazards identified in Studies 1-3.

Hazards identified in Studies 1-3	Training DVD sections
Pedestrians	1. Pedestrians
Traffic/other drivers	2. Traffic
Structural design of road crossings	3. Crossing design
Structural design of roads/pavements	3. Crossing design
Crossing time	3. Crossing design
Visibility at crossings	4. Visibility at crossings
Spacing at crossings	5. Spacing at crossings
Priority issues	6. Priority at crossings
Scooter design	Not included in DVD
Weather	Not included in DVD
Pedestrian Hazards identified from Studies 1-3.	7. Negotiating pedestrian areas

The DVD was created by selecting footage that we felt spoke to a particular hazard. A mix of examples were used in which MMS users either successfully negotiated a hazard or made some mistakes negotiating a hazard. Several clips used a "what happens next" format to vary the ways in which to engage the audience. Unlike Study 3, footage from all 4 cameras was not shown. Rather a full screen was used (see Figure 3) using either footage from the eye tracking camera or footage from the central GoPro HD camera, depending on which contained the most relevant information for that hazard. The DVD was professionally created with a professional voice over. The footage and script went through numerous edits, which included input from an MMS user. The Road Safety Trust is acknowledged in the title screen and accompanying information.

Phase 4 involved a naturalistic evaluation of the training video. This Phase comprised the final study of the project, a randomised control trial in which healthy older adults (sampled from the Trent Aging Panel – all age 60+) without any MMS experience were all given training for handling a scooter (provided by Nottingham city council Shopmobility, who kindly set aside a scooter for the sole purpose of using it in the evaluation). Half of the participants then received the training DVD (20 minutes) and half received a control (watching countdown for 20 minutes). Participants then drove the scooter around a pre-defined route around Nottingham city centre which comprised 23 crossings. Forty five participants took part, and also completed a pre and post-drive questionnaire. Their drive was also recorded using the same method as Study 2 (HD GoPro cameras fitted to the scooter and mobile eye tracking glasses). The questionnaire yielded quantitative and qualitative data. The quantitative data showed that those who received the training video were more aware of strategies to negotiate hazards but felt less able to deal with them. The latter finding is potentially because by alerting drivers to a range of hazards, they noticed them more than those without any training. Qualitative data on the training yielded positive views of the training DVD. Video footage was also rated by a researcher who was blind to which condition the participant was in. The coding system required the rater to note whether there was a hazard (666 were noted in total), and then rate the severity of it, how well it was negotiated, the number of strategies used, the number of good behaviours (pre-defined) used, how good the strategy was and the number of relevant good behaviours (pre-defined) that were not used. The results are shown in Figure 4. Those who watched *See and Scoot* better negotiated hazards, produced more good behaviours and used better strategies to negotiate hazards at road crossings (all these differences were statistically significant). The same pattern was observed for hazards encountered in pedestrian areas. The project has therefore developed a training tool that not only increases awareness of hazards but has a positive impact on behaviour when negotiating hazards. This is impressive, particularly given that the

evaluation was naturalistic, and therefore we could not control what happened at any point on the pre-defined route.

The qualitative data from the study was also supportive of the training tool. It also showed that for participants in both groups, experience of using an MMS changed their perceptions about MMS use, suggesting that educational training tools aimed at MMS users may also be useful for other road users.

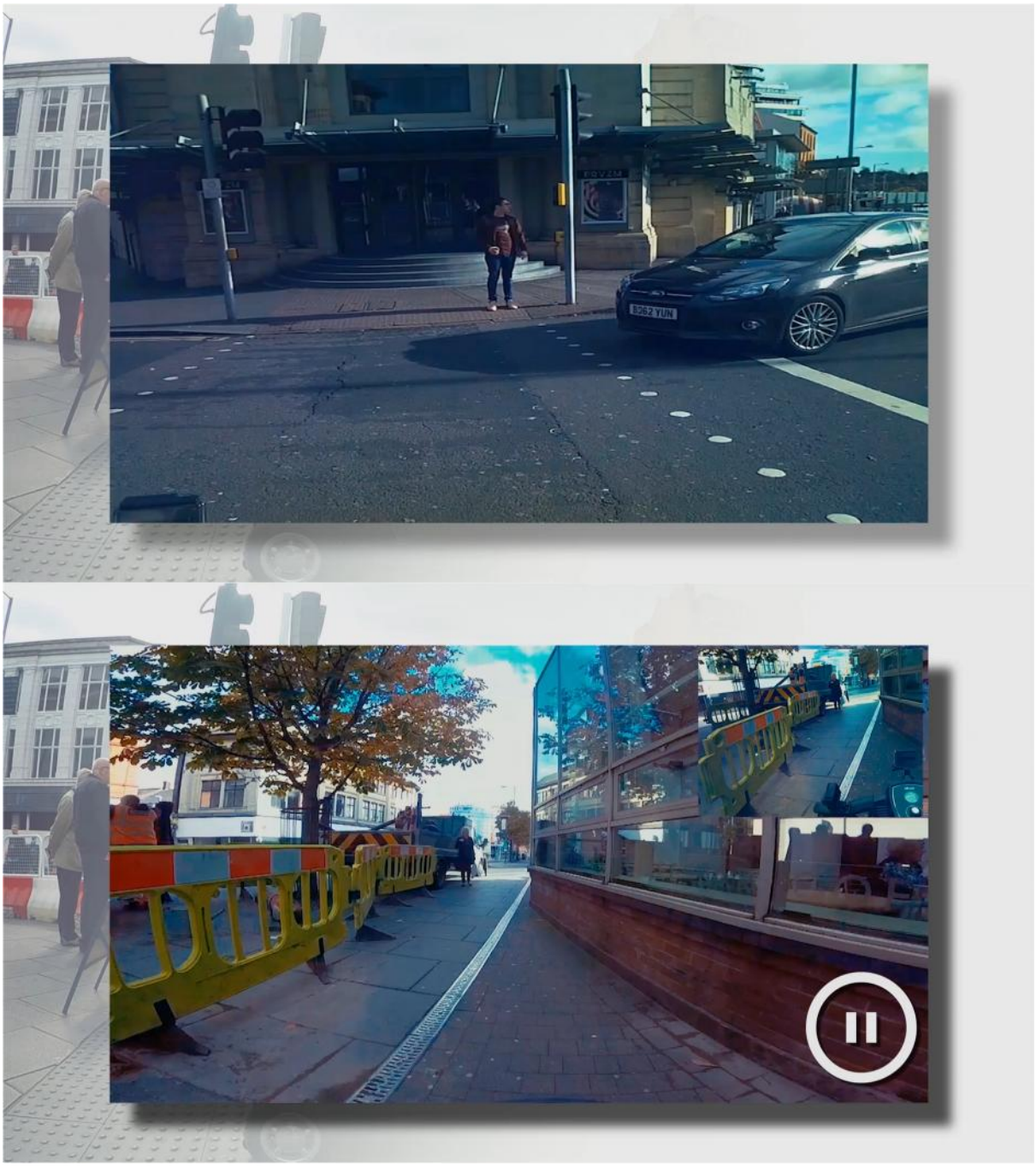

Figure 3. Example frames from See and Scoot

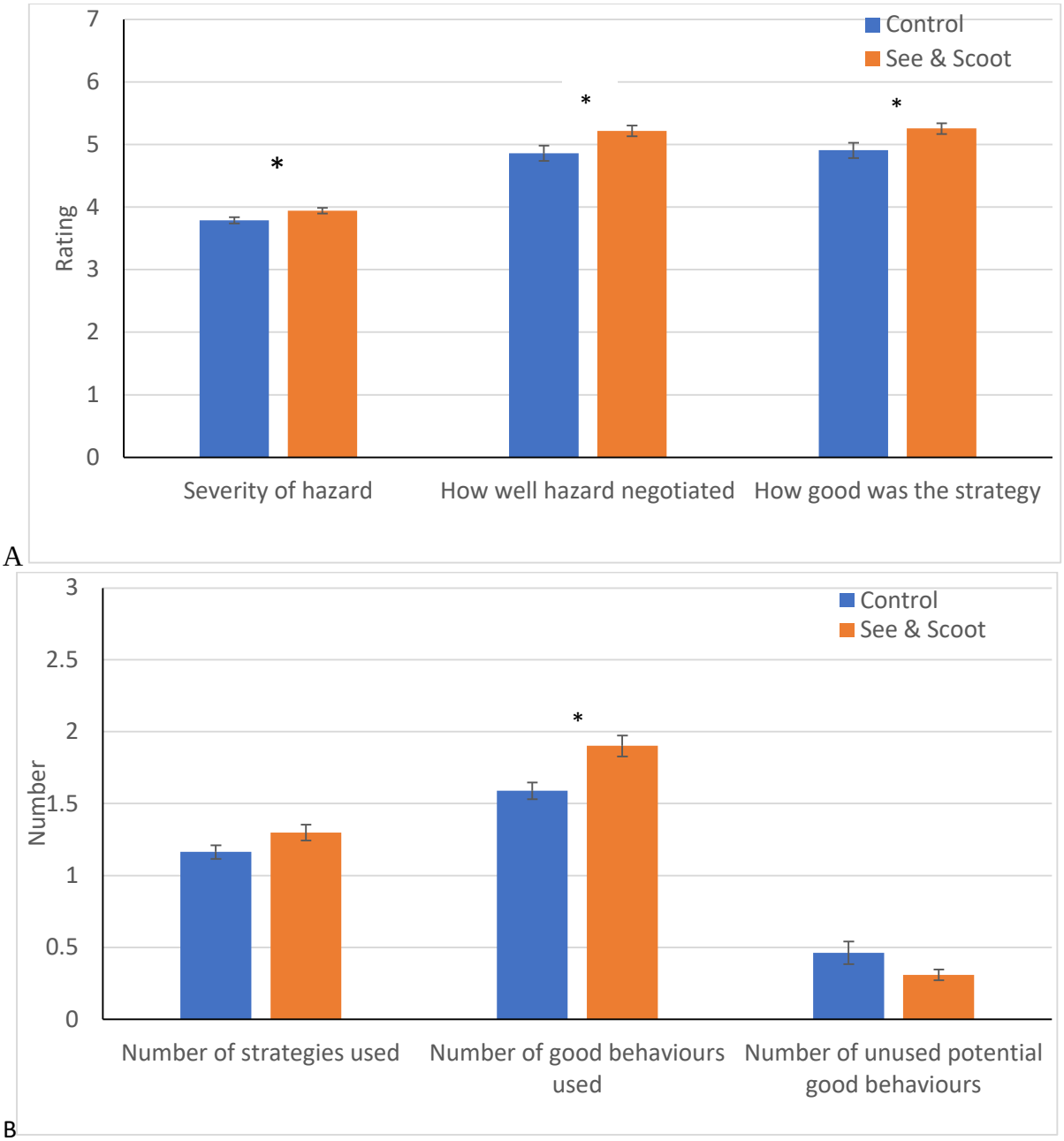

*Figure 4. Mean ratings in Study 4 for hazards encountered at road crossings (A) and number of strategies, good behaviours and potential good behaviours (B). * indicates significant differences (p<.05). Error bars refer to standard errors.*

Phase 5 involved dissemination of the training intervention. The final DVD was completed in Autumn 2018. In February 2019 it was uploaded on the website www.testmydriving.com which is owned by the Nottingham Trent University Transport Research in Psychology group (of which the research team is part) and contains a range of training tools for different road users. *See and Scoot* can be accessed for free at https://www.testmydriving.com/see-scoot. The training tool was soft launched in March 2019 in time for promotion at NAIDEX 2019 – Europe's largest independent living sector event. A stall for the full two days of the show enabled the promotion of *See and Scoot*, handing out free copies of the training DVD and networking with charities, retailers, manufacturers and other agencies. *See and Sc*oot was also publicised through the network developed during the project, with online publicity by MASIS, Independent Living, Road Safety GB, Disabled Motoring and Stay Safe, an

article in THIIS and an advert in the Enable magazine. The PI also presented *See and Scoot* at the Older Adult Road User conference in September 2019. A further press release is planned on publication of the first journal article.

This soft launch has led to the tool being used by a variety of organisations. The set-up of the tool means that the website logs user details upon the first view of the resource, it then issues users with a password and the link from which to access the video. By March 2020, 221 users had accessed the resource, including individual users and organisations. Organisations include county councils, road safety teams, disability groups, shopmobility groups, Fire and Rescue services, government agencies and mobility scooter manufacturers and retailers. In addition, TGA mobility, one of the largest scooter manufacturers in the UK, are hosting the training video on their social media and recommend it use to their retailers and to customers who buy direct from them that they watch the video before using their scooter. Other agreements have been set up with the Disability Resource Centre in North Wales and Oxfordshire Fire and Rescue who will use the DVD in training.

More broadly, as part of the project evidence was submitted to the Road Safety Inquiry – Transport Committee as well as evidence to D2N2 (The Local Enterprise Partnership for Derby, Derbyshire, Nottingham and Nottinghamshire) in response to a D2N2 call for evidence about the ageing population and impact on the locality. The project has also been filmed and reported on BBC national news and the PI has completed 8 radio interviews and the work presented at 7 conferences.

Conclusions

This project has significantly advanced our understanding of a subsection of road users that until this point have had little attention paid to them, MMS users. The in depth studies supported as part of this grant have produced a clear understanding of the hazards users face, and has used studies working directly with MMS users to develop a training intervention that has been shown to improve ability to negotiate live hazards encountered at road crossings and in pedestrian areas of a city centre location This training is available online, and free of charge and we hope that it will be widely used. Our thanks to the Road Safety Trust for funding this worthwhile work.