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BETTER VEHICLE DESIGN FOR ALL

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Abstract: With increases in life expectancy, there is a growing population of older people around the world. As a result, the population of older drivers is showing a similar increase. Many cars have not been designed to meet the needs of people with age-related disabilities. A questionnaire survey of older and younger drivers (paper/online version $n=903$) and supplementary interviews with drivers aged ≥ 65 years ($n=15$) were conducted June-August 2012. Younger drivers were identified as <65 years (53.5%) and older drivers were ≥ 65 years (46.5%). 7.1% of participants were aged ≥ 80 . Older males and females reported more difficulties with parallel parking and driving on a foggy day than younger drivers. Significantly more discomfort was reported by older drivers in the hips, thighs, buttocks and knees compared to younger drivers.

Introduction

Vehicle design and performance are constantly being developed with vehicles becoming smarter and more sophisticated. Contemporary vehicles are now equipped with many characteristics formerly constrained to the luxury market: for example, technologies to assist the user with specific driving tasks such as intelligent automated parking systems (Bradley et al., 2008). There is a growing population of older people around the world, mainly in developed countries (Meyer, 2009). According to 2012 figures of DVLA there are more than 15 million people aged over 60 with a driving license; more than 1 million of those are over 80 (IAM, 2012). However, the automotive industry has not focused on the needs and expectations of this population and many cars do not meet the needs of people with age-related disabilities (Herriotts, 2005). On the other hand, all vehicle manufacturers claim to provide a positive driving experience, but do they really meet the requirements of users of all ages?

Methodology

A comprehensive questionnaire survey was conducted within the UK with a large sample of car drivers. In total 903 people took part; 53.5% were younger drivers ($n= 483$, <65) and 46.5% were older drivers ($n= 420$, ≥ 65). Drivers over 80 years represented 7.1% ($n= 64$) of the whole sample. 59% of participants were male and 41% were female (Table 1). The aim was to understand the experiences of car drivers of different ages and identify some of the key challenges for car design. The questionnaire was available as both paper and online versions and included: musculoskeletal symptoms, the vehicle seat, access to specific vehicle features, driving performance and driving behavior.

Age category	Age	Male		Female		Total	
		n	%	n	%	n	%
Younger drivers (<65 years) 53.5%	20-34	70	7.8	66	7.3	136	15.1
	35-49	62	6.9	53	5.9	115	12.7
	50-64	144	15.9	88	9.7	232	25.7
Older drivers (≥ 65 years) 46.5%	65-79	216	23.9	140	15.5	356	39.4
	≥ 80	43	4.8	21	2.3	64	7.1
Total		535	59.2	368	40.8	903	100

Table 1: Age and gender distribution (whole sample)

Many factors were considered during the design and development of the survey, for example, questions had to be to be specific, short and easy to read/understand for older people. Questions from a survey conducted by Sang et al. (2009) were included in this survey with slight modifications. Where appropriate, Likert scales were incorporated with specific statements and tick boxes.

A stratified sampling technique was used, whereby the population is divided into various subgroups/strata (Robson 2012). Once the strata are determined, a simple random sample was taken from each stratum individually. For the questionnaire survey, the sample was arranged in a number of sub-groups focusing on age and gender.

Major organisations within the UK were consulted for distribution of the questionnaire to the target audience. These are well known institutes, voluntary action groups, and charity and motoring organisations. Agreement was obtained for the distribution of questionnaire (data collection from e-mails, interviews and personal contacts). For the on-line survey several techniques were used to increase the number of responses such as; snowballing technique. Initially, the target sample size for the survey was 600; this was thought to be a reasonable number in order gain a robust data set for statistical analysis; however, the survey achieved 50% more ($n=903$). Supplementary interviews ($n=15$) were

conducted with a further sample of drivers aged 65 years and over by using the questionnaire in a structured interview format.

Results

Musculoskeletal symptoms: high levels of musculoskeletal symptoms were reported in the lower back, knees, neck, shoulders and elbows. Younger drivers reported higher levels of musculoskeletal symptoms in the neck ($p<0.01$), shoulders ($p<0.05$) and middle back ($p<0.001$), than older drivers. These symptoms are likely to be related to their level of activity (e.g. work) compared to older drivers. Significantly more discomfort was reported by older drivers in the hips/thighs/buttocks and knees ($p<0.05$) compared to younger drivers.

Driving behaviour: half of all respondents (46.7%) reported that other drivers' lights restricted their vision when driving at night; more females (53.3%) than males (42.5%) reported this ($p<0.001$; Table 2). Older drivers (31.7%) reported more difficulties than younger drivers (18.4%) with turning their head and body around during reversing ($p<0.001$). Similarly, older drivers reported their reactions were slower than they used to be (e.g. braking in an emergency situations) compared to younger drivers.

Answer options	Agree (%)	Neither agree or Disagree (%)	Disagree (%)
Other drivers' lights restrict my vision when driving at night	46.7	19	34.2
I have difficulty turning my hand and body around when reversing	24.5	14.2	61.4
Operating entertainment systems distract me from driving (e.g. playing radio)	23.7	38	38.3
Operating navigation systems distract me from driving (e.g. looking at sat-navigation)	22.9	29.5	47.6
My reactions are slower than they used to be (e.g. braking in an emergency situation)	22.8	20.3	56.9

Table 2: Driving behaviour (whole sample)

Driving performance: older males and females (16.8%) reported more difficulties with parallel parking and driving on a foggy day than younger (12.2%) drivers ($p<0.01$). Compared to younger drivers (25.5%), older drivers (19.5%) reported having less distraction when using navigation systems but no significance was found. Reasons for this may include that older drivers are more experienced and they know the routes. They also tend to travel shorter distances and therefore they are less likely to use these technologies compared to younger drivers.

Adjusting the seat features: 10.5% of respondents reported that they were dissatisfied with adjusting specific seat features, namely the head rest height, head rest distance from the head and setting the seat belt height. Females reported more difficulty than males. Reasons given for this difficulty may include reaching, accessing and operating the controls while seated.

Supplementary interviews: the main findings are summarized as follows:

- Females (specifically older females) reported more difficulty than males with adjusting seat features, namely the head rest height/distance and seat belt height. Reasons given for this include reaching, accessing and operating the controls while seated.
- When reaching and pulling the boot door down to close, older females reported having less mobility and reduced reach. A reason may be that older females are shorter in stature.
- Older drivers are less likely to drive at night.
- Older drivers generally avoid using navigation systems due to their short travelling distances.
- The most commonly used entertainment system is the radio among older drivers.

Conclusion

This study has provided data to understand the key issues experienced by drivers of all ages. Some issues are common for all ages, and some are age related. The future direction of this research will focus on understanding how design of the vehicle cab impacts on posture, comfort, health and wellbeing in older drivers.

References

- BRADLEY, M., KEITH, S., KOLAR, I., WICKS, C., GOODWIN, R., 2008. *What do older drivers want from new technologies?* [online]. SPARC, Reading. [viewed 12/01/2012]. Available from: <http://www.sparc.ac.uk/media/downloads/executivesummaries/execsummarybradley.pdf>
- HERRIOTTS, P., 2005. Identification of vehicle design requirements for older drivers. *Applied Ergonomics*, **36**(3), pp. 255-262.
- IAM, 2012. *More than a million drivers now aged over 80*. [online]. Institute of Advanced Motorists, London. [viewed 22/05/2012]. Available from: <http://www.iam.org.uk/news/latest-news/983-more-than-a-million-drivers-now-aged-over-80>

- MEYER, J., 2009. *Designing in-vehicle technologies for older drivers*. [online]. National Academy of Engineering, Washington. [viewed 20/01/2012]. Available from <http://www.nae.edu/About/19687.aspx>
- SANG, K., GYI, D. and HASLAM, C., 2009. Musculoskeletal symptoms in pharmaceutical sales representatives. *Occupational Medicine*, **60**(2), pp.108-114.