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Difficulties experienced by older drivers during their regular driving and their expectations towards Advanced Driving Aid Systems and vehicle automation

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ABSTRACT

The aim of this study was to analyse the difficulties experienced by older drivers during their regular driving, and to identify their needs and their expectations regarding Advanced Driving Aid Systems (ADAS) and vehicle automation. More than 100 items were investigated by using a Focus Group method based on a Collective Questionnaire (named *FoG-CoQS*). Thirty elderly drivers, 15 females and 15 males aged from 70 to 81 years (mean age of 73.3; S.D. = 3.18) were recruited among a representative sample of 76 older drivers living in the Rhône area and having previously participated to an on-road experiment, in order to collect from this Focus Group method further information about the driving difficulties they experienced in their everyday life and their expectations towards driving aids. Seven main topics were more particularly investigated, recovering at last all the main dimensions of the driving task (from navigation to speed control, through intersection crossing).

Regarding driving difficulties, one of the most interesting result collected is the high contrast between the literature review, identifying Left Turn (LT) manoeuvres at crossroads as a risky driving situation for elderly drivers, and the relatively low values of perceived difficulties (i.e. compared to other driving sub-tasks) collected during this Focus Group among our sample of older drivers. Regarding the driving aid functions investigated, 10 of them obtained high scores of "perceived utility" (i.e. overpassing 60% on scales ranging from 0% [no utility] to 100% [high utility]), and they concerned assistances liable to support all the main components of the driving task investigated in this study.

Additional results are related to the differences between the elderly female and male drivers. Several driving situations were assessed as significantly more difficult to perform by the older female than by the older male drivers, like intersection crossing, entering expressways, or implementing a lane change manoeuver. By contrast, this gender effect is more limited regarding driving aids: synthetically, men and women have a positive attitude towards driving aid systems and their expectations for future ADAS are quite similar (for instance, "informative systems" are preferred than driving aids based on "vehicle automation").

Finally, from two transversal items (i.e. "difficulties" to perform a driving sub-task and "perceived utility" of ADAS), it was possible to rank older drivers' difficulties experienced during their everyday life (from lowest difficulties to "navigate on a familiar itinerary" to highest when "interacting with bicyclists") and their expectations towards driving aids (from lowest utility score given to "Automatic Lane Change systems" to highest utility value provided to "Speed Informer systems"). At last, older drivers' acceptance and expectations towards highly automated cars was also investigated: full automation was assessed as an

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interesting solution to ensure the self-mobility of elderly peoples in their circle, but also for themselves in the future, in case of impairments of their own cognitive or physical capacities.

1. Introduction theoretical background and objectives

During the last few decades, increasing attention has been devoted to the issue of elderly drivers. Older drivers are usually experienced and careful drivers (Langford, Methorst, & Hakamies-Blomqvist, 2006) with a high concern for respecting the safety rules when driving their car (Classen et al., 2010). However, although involved in few crashes in terms of absolute numbers, elderly people represent one of the highest risky population of drivers for crashes with serious injury and death per number of drivers and per distance travelled (Koppel, Bohensky, Langford, & Taranto, 2011). This is both related to their greater fragility and with the decline in their physical, sensory, and cognitive capacities (Langford & Koppel, 2006; Li, Braver, & Chen, 2003). Vrkljan and Miller-Polgar (2005) indicated that changes due to age in the visual and cognitive systems may reduce the ability to drive a car safely. Physical abilities, like neck flexibility, can also negatively affect various aspects of driving performance. Effect of age on information processing could be linked to an interaction between cognitive and sensory changes: although all the components of vision are affected by aging, it is the higher order visual processes including dynamic visual acuity and the simultaneous use of central and peripheral vision which have been shown to have some correlation with accident rates (Baldwin, 2002). Audition is also affected by aging, notably pure tone detection and speech comprehension. Koppel, Charlton, and Fildes (2009) also observed that the processing speed of elderly drivers decreases as cognitive load increases. This could be the result of slowed integration of relevant information, limited memory and attentional capacities as well as a decline in executive functions, cognitive processes like action planning, inhibition of irrelevant information, mental flexibility, judgement and self-adaptation. Thus older drivers could be more subject to distraction than other drivers because they have less spare attentional capacity, and multitasking can be more problematic for them due to the reduction of time sharing skills. Another set of studies also showed negative age effects on drivers' Situation Awareness (SA). Situation Awareness was defined by Endsley (1995; p. 36) as "the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future". In the frame of car driving activity, SA corresponds to a mental representation of the road environment, as perceived and understood by the driver (Bellet, Bailly-Asuni, Mayenobe, & Banet, 2009). Using a simulator experiment, Bolstad (2001) showed that, due to age-related declines in perceptive and cognitive functions, older drivers' mental models of road environments are less complete than SA formulated by younger experienced drivers. Similar results were also found by Bailly (2004) under normal driving conditions, and more recently by Kaber, Zhang, Jin, Mosaly, and Garner (2012) for hazardous situations: old age negatively impacts the content and adequacy of SA, especially for complex driving situations with high attentional demands. Faced to the complexity of certain traffic situations, elderly drivers may have greater difficulty in perceiving and integrating all the relevant pieces of information required to make the right decision, resulting in higher involvement in certain types of accidents, typically for situations requiring complex interaction with other road users, like at intersections crossing, merging, or lane changing in dense traffic (Alexander, Barham, & Black, 2002; Clarke, Ward, Bartle, & Truman, 2010; Dukic & Broberg, 2012; Koppel et al., 2011; Langford & Koppel 2006; Larsen & Kines, 2002; Mayhew, Simpson, & Ferguson, 2006; Preusser, Williams, Ferguson, Ulmer, & Weinstein, 1998; Skyving, Berg & Laflamme, 2009). And the more the driver is old, the more the risk is increasing. Braitman, Kirley, Ferguson, and Chaudhary (2007) reported that failure to yield was found in more than half of the crashes involving drivers +80 and older in the US. These crashes occurred more often when drivers were turning left and at stop signs. The authors attributed this fact to misjudgements of the time needed to proceed. They also reported that "look but failed to see" errors were predominant among drivers +80 and older.

In the frame of this general background, this Focus Group (FG) study aimed to address several research questions related to difficulties experienced by older drivers in their everyday life. At this level, the objective was not only to know their personal feelings, but also to investigate their awareness about these difficulties, more specifically by considering traffic situations with a high risk of accident for older drivers (typically for intersection crossing and left turn manoeuvres) and/or how self-confident they are in their abilities to perform these tasks. Indeed, when being aware of the changes in their skills due to the old age, elderly drivers may adapt their driving behaviours accordingly and compensate these declines by self-regulations. Self-regulations are voluntary decisions to avoid driving situations assessed as too challenging or demanding. Some self-regulations, like avoiding driving during the night or in bad weather conditions, are generally well identified by elderly people, and used as a means to keep driving activity safe (Baldock, Mathias, McLean & Berndt, 2006; Hakamies-Blomqvist and Wahlstrom, 1998; Raitanen, Tormakangas, Mollenkopf and Marcellini, 2003). However, to adequately regulate their driving behaviours, they need to be aware of these difficulties and of the dangerousness that some traffic situations present for older drivers. Accident studies previously mentioned seem to indicate that it is not always the case for some situations or manoeuvres, like intersection crossing, merging, or inserting in a traffic flow. Moreover, feeling about driving-related difficulties and self-regulatory practices may be also dependent of the gender. For instance, Kostyniuk and Molnar (2008) indicate that elderly women are more likely to self-regulate by full driving cessation than