In-Car Messages to Promote Safer Driving for Older Adults

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***Abstract*— The aim of this work is to provide a clearer picture of the effect of in-car messages on the driving skills of older adults. It is part of a project investigating whether in-car speech messages, generated from geographically positioned data, warning of upcoming hazards, traffic regulations etc linked to a specific location, can make driving safer for older adults. The paper addresses the special properties of older adults related to driving skills and speech systems, and describes experiments and results aimed at determining first of all whether speech messages improve driving, if they are well received and which type of voice would be the most effective for the speech messages. Using questionnaires and a driving simulator, results showed a significant improvement in driving performance with an in-car system when a younger voice presented the messages and also a clear preference for a younger voice for the messages.**

I. INTRODUCTION

Many people find as they get older that driving becomes more difficult and they worry about their safety in the car and the safety of others, as their awareness of potential dangers such as upcoming hazards is reduced with age. Global Positioning Systems (GPS) enable information about hazards such as road works, traffic jams etc at particular locations to be logged by organisations such as the police and be made available to anyone driving with GPS in their car. Systems that provide GPS based information are currently available but require considerable know how to set them up, with many different options available. The driver must also have a clear expectation of the form of information they require, for example roads blocked by snow, in order to use them, which is not always the case with older adults. The work described in this paper is part of a larger project which seeks to understand how in-car speech systems can be used in the service of older people to enhance their driving experience and performance and to help them to stay independent for longer.

This paper reports experiments carried out with a driving simulator fitted with an in-car speech system which provided messages concerning upcoming hazards. The focus of experiments was to determine whether older drivers drove better with a voice system within the car and whether they exhibited preference for one voice over another.

We describe the experimental work carried out to investigate whether speech messages help or hinder driving performance, and whether the age of the voice is significant, and the results of the experiments.

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II. SPEECH SUPPORT FOR DRIVING

It seems possible that a hazard warning messages could instil confidence and help with difficulties associated with age related impairments such as memory loss. By giving older adult drivers relevant information, and thereby providing extra time and distance for them to evaluate the driving situation, it was hoped to improve their ability to react to events that occur on the roadways. The aim of experimentation therefore was to establish whether a speech based in-car information system will help or hinder the driving task for older adults.

The users' perception of the person behind the voice can also influence their feelings of satisfaction with the voice messages. This is a complex area in which many different aspects of the voice can provoke emotional response. Age was selected as a first discriminator, to thus establish whether the age of the voice influenced the perception of the in-car system and driving performance.

A selection of psychological tests were used to measure self-perception, perception of the in-car system and emotive response, and a driving simulator pre-programmed with speech based messages was used to measure drivers' performance.

III. THE EXPERIMENT

The experiment was carried out using eighteen older adult participants, nine male and nine female, who were volunteers aged 55 – 73 years, average age 63 years, living in the United Kingdom. They were currently driving and belonged to the higher socio economic groups most likely to consider buying an in-car information system. The tests were completed as follows:

Participants completed two pre-driving questionnaires before they completed their drive. The first was used to find out their attitudes towards age and the aging process, and to self-report, perceived driving abilities. The second was a standard fifteen term DES (Differential Emotional Scale, [1]) test used to record their current emotional status. The different attitudinal and emotional measures used in the questionnaires are described in Section V

Participants then performed a test run on the driving simulator to familiarize themselves with its workings. [2] found that older adults require about three minutes of driving to adapt and get the feel of the driving simulator [2]). For this experiment a five-minute training course was used to enable participants to have a normal driving experience. It was particularly important that they experience for themselves feedback from the steering wheel on corners, the effects of the acceleration and brake

pedals and that they knew how it felt to have a crash.

Participants were placed in three gender-balanced and age balanced groups of six.

Group 1: drove with no in car information system.

Group 2: drove with voice prompts provided by a 20-year-old female voice.

Group 3: drove with the same voice prompts provided by a 73-year-old female voice.

Participants then spent approximately 30 minutes driving the simulator, driving freely and choosing whichever route they preferred. Those in Groups 2 and 3 with speech prompts were free to either act upon the advice of the voice prompts or not as they wished.

After driving, each participant completed two post-driving questionnaires. The first was exactly the same standard fifteen term DES test used before driving and the second asked users how they felt about the source credibility of the speech based in car information system.

IV. THE DRIVING SIMULATOR

The driving simulator used in the experiment was STISIM from Systems Technology Inc. Users sat in a real car seat and 'drove' using a Microsoft Sidewinder steering wheel and pedals consisting of accelerator and brake. The simulated journey was projected on a wall in front of participants and was set to daylight and cloudy but no rain, avoiding bright light which might be distracting. The simulator was also able to record driving performance in terms of many parameters, including the number of accidents and time to finish the course.

A specially designed driving scenario was built involving several hazards and a varied and realistic road layout. Speech prompts were inserted in the drive at various points where additional information might be useful. All speech prompts were recorded in a young female voice and an older female voice. The information provided in the prompts was of an ephemeral type that could feasibly be supplied by police reports or weather reports, together with more permanent information such as the location of school zones and speed limits.

Prompts provided road information concerning hazards such as a tree on the road or fog and informed drivers of the current speed limit, or made suggestions such as diversions due to slow moving traffic or accidents ahead. They are listed below under two headings.

Prompts that provided information about road conditions and traffic events:

- There is thick fog ahead
- You are approaching an intersection
- Warning there is a fallen tree in the road ahead
- Beware of cyclists ahead.
- The current sped limit is 60 miles an hour
- There are crosswinds in this area
- Stop sign ahead.

Prompts providing suggestions:

- The police use radar here, you might need to slow down
- There is heavy traffic ahead, turn left to avoid it.
- There is an accident ahead, turn right to avoid it.

V. MEASURES USED IN QUESTIONNAIRES

A. Emotional status

The emotional status of participants before driving was measured to see if there were any initial differences within the group and then measured after driving to see if it varied according to which voice group the users had been placed in

A positive emotion index was created based on the DES questionnaire, using the terms calm, relaxed, at-ease, happy and excited in a 10-point Likert scale ranging from Describes very oorly to Describes very well. The index for the pre-driving questionnaire was very reliable (*alpha* = .76).

The emotional status of each participant was also measured after the driving session with the same positive emotion index based on the DES questionnaire. The index was very reliable (*alpha* = .84).

B. Source credibility of voice system

The credibility of the voice system was measured after the driving session and it was based on combining McCroskey's and Berlo's source credibility scales [3]. We created five indices, authoritative, character, safety, qualification and dynamism using a 10-point Liker scale ranging from Describes very poorly to Describes very well.

C. Influence of voice system

The influence of the voice system on attitudes and perceived driving performance was measured after the driving session. The measures are based on the questions "How well do the following statements describe how you feel about the voice system" and "The voice made me:" each followed by a list of statements in a 10-point Liker scale ranging from Describes very poorly to Describes very well.

D. Perceived value of the voice system

This was an index created and based on the statements "Fun to use", "High in quality", "I would use again", "I want to have it" and "I would discourage family and friends from using it" and "I would not buy it or pay for it" reverse coded. The index was very reliable (*alpha -= .85)*

E. Positive influence of the voice system

This was created and based on the statements "Watch more carefully at intersections", "React faster to dangerous driving situations", "More comfortable driving at faster speeds" and "A better driver in low visibility conditions". The index was very reliable (*alpha .93*)

F. Measured driving performance

The driving simulator software was setup to automatically save driving performance parameters for each participant. An index was created for Bad Driving

based on *Accidents while driving* (collisions, off-road accidents and accidents involving pedestrians) and *Time to conclude the driving session*. The index was very reliable (*alpha .82*).

VI. RESULTS OF EXPERIMENTS

The effects of the in car information system on drivers attitude and driving performance were evaluated by a one-way ANOVA with the variant of the in car information system as the between-participants factor.

A. Status before Driving

All participants were in the same age range, and there was no significant difference between the groups on self reported driving style, emotional status and perceived driving ability, before they drove the simulator.

B. Emotional Status after Driving

The participants felt less calm and at ease after driving than before driving. However, the reduction in positive emotional status was less for the drivers that interacted with the in-car information system with the young voice than the other two conditions. *F(1, 15) = 4.73, p<.03* (See Figure 1).

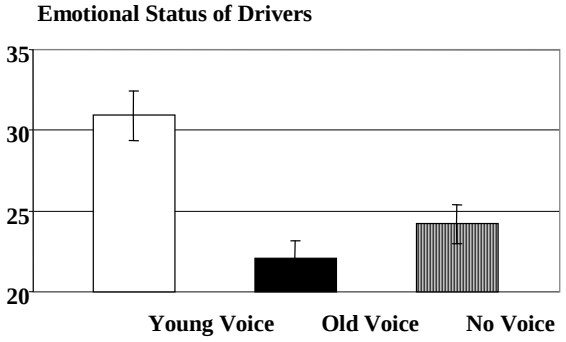

Figure 1: Emotional Status of Drivers after the Driving Session

Drivers in the young voice condition tended to be relatively more at ease and relaxed than the other drivers.

C. Source Credibility of Voice System

There was a significant difference in how the credibility of the two different voices was perceived. The young voice was seen as much more authoritative, had more character and was safer than the old voice. *F(1,10) = 45.65, P < .001* (see Figure 2)

The other properties of source credibility, qualification and dynamism did not by themselves show significant difference between the young voice and the old voice.

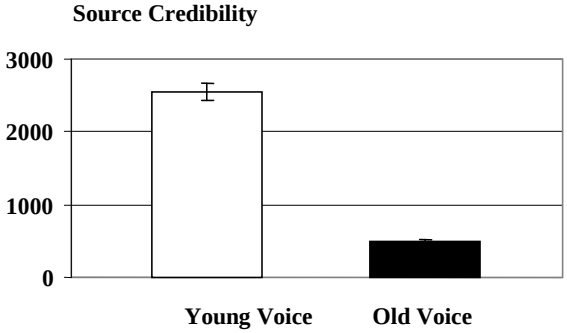

Figure 2: Source Credibility of In Car Information System

D Influence of Voice System

Perceived Value of Voice System - There was a significant difference in the perceived value of the in-car information system based on the voice that was used to present the information. F(1,10) = 28.61, p< 0.001.(see Figure 3)

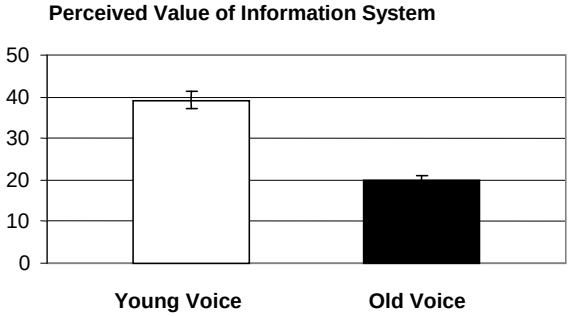

Figure 3: Perceived Value of In-Car Information System

Drivers that interacted with the young voice perceived the in-car information system to be more fun to use, higher in quality, they would have the system, pay for it and also recommend it to family and friends.

Perceived Influence of Voice System on Driving Performance - There was also a significant difference in how drivers felt influenced by the in-car information system depending on the voice used by the system. Drivers that interacted with the young voice felt more positively influenced by the system with respect to their driving performance than drivers that interacted with the old voice. *F(1,10) = 31.38, p < 0.001*.(see Figure 4)

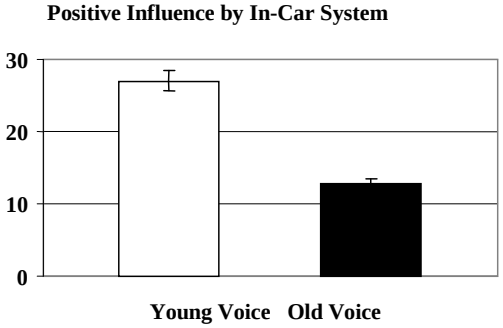

Figure 4: Positive Influence of the In-car Information system on Driving Performance

Driving Performance - Drivers that were driving with

the in-car information system with the young voice had significantly better driving performance than the other two groups, i.e. the drivers driving with the in-car information system with the old voice and the drivers that were driving without the in-car information system. $F(1,15) = 22.29, p < 0.001$.(see Figure 5)

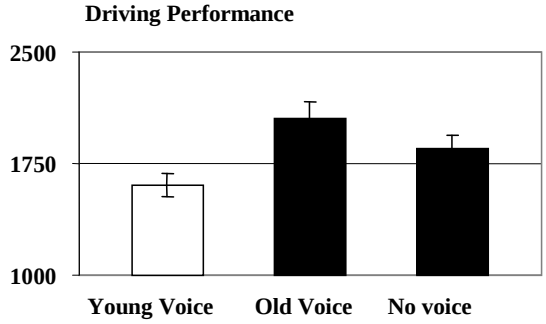

Figure 5: Driving Performance – Accidents and time to finish course

There was a significant difference in the number of accidents between the three groups of drivers, favoring the young voice for the in-car system for safe driving. However, the most striking effect of the in-car system was the time to finish the driving course. Drivers interacting with the in-car information system with the young voice finished the course much faster than the other groups. $F(1,15) = 8.65, p < 0.003$. M= 1600, SD = 98 for young voice, M = 2030, SD = 257 for old voice, and M = 1810, SD = 144 for no voice, based on a two-tailed t-test for t-test t(16) = 3.8, p< .003. This speedup was done without exceeding the speed limit, and signifies that drivers in this condition felt more comfortable driving at a higher speed (without exceeding the speed limit).

VII. CONCLUSIONS

The aim of experimentation was to establish whether a speech based in-car information system can help or will hinder the driving task for older adults and to find out whether the age of the voice influenced the perception of the in-car system and driving performance.

The results are interesting and complex. In Figure 1. and Figure 5., we see that those older adults who experienced the younger voice messages had a significantly more positive emotional status i.e were happier than those with an older voice or no voice and similarly those with a younger in-car voice drove more safely than those with an older voice or no voice. The answer here must be that yes if the voice is a younger voice then it certainly does improve driving performance and emotional status of the driver.

The results reported in Figure 2. for source credibility, Figure 3. for perceived value and Figure 4. perceived influence, all showed that when the two voices were compared the younger voice scored higher on all three measures. The answer then must be that the age of the voice makes a considerable difference and a younger voice for the messages is preferred.

The most significant result is that those with the younger voice message drove the simulated journey in less time but more safely than the other two conditions thus providing a strong indicator that the voice was promoting confidence in the driver to drive faster, and not dawdle, but was also promoting safer driving.

In will be noted in Figure 1 and Figure 5 that those older people driving with an older person's voice were less happy and drove less safely than those with no voice. These results correspond to those found in unpublished work by the authors where younger people (20 – 35 yrs) driving with an younger person's voice were less happy and drove less safely than those with no voice but were happier and drove more safely and were happier with an old person's voice. It seems therefore that young people and old people are not happy and do not gain confidence or safety from a same age voice.

One can hypothesise that older people know their own deficiencies and associate them with their age group. They feel less confident in their driving abilities and attribute less authority to a similarly aged person. A young person with excellent vision, good reflexes and high cognitive capacity advising on upcoming road hazards definitely inspires more confidence.

These results confirm that in-car speech messages can make older people drive more safely and more happily but that the choice of voice has a great impact on the level of safety achieved.

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