Exploring different feedback styles of performance in a self-assessment application for older adult drivers[1]

Surya S Neti[1], James Ren Hou Lee[1] and Jennifer Boger[2]

[1] Systems Design Engineering, University of Waterloo, Waterloo, ON, Canada
[2] Research Institute of Aging, Waterloo, ON, Canada

Abstract. As we age our ability to perform day-to-day activities can change. One such activity that is complex and cognitively challenging is driving. Research has shown that older adult drivers have the high- est crashes per mile driven and are more vulnerable to injuries due to frailty. Driving cessation however has been known to cause social isola- tion and depression among older adults. This study aims to better engage the older adult in the discussion and decision about when to stop driv- ing. SmartDrive, a self-assessment application intended to promote safe driving decisions by providing feedback and recommendations based on user performance in driving-related cognitive tasks, has been evaluated in this study. The researchers specifically explore the reactions elicited by different styles of feedback presented to the user (text-only, score map and visuals) to identify the most appropriate style that would persuade them to consider their driving ability and the recommendation shown. Thematic analysis of interviews and cognitive walkthroughs conducted with six actively driving older adults has been performed and emergent themes are discussed in the context of feedback design.

Keywords: Olde adults, Driving, Self-assessment, Feedback.

1 Introduction

Cognitive abilities can change as we age and such changes can affect our performance in day-to-day activities. Driving, often regarded as synonymous to autonomy, is one such daily activity with significant cognitive demand. Studies have found that older drivers have higher crashes per kilometre driven and are more vulnerable to injuries due to frailty [1]. For an older adult, the decision to stop driving is a difficult one, with research showing that driving cessation can cause social isolation, depression, and morbidity [2][3][4], enforcing the idea that this decision requires considerable thought and discussion with family and physicians [5][6]. This research aims to empower the older adult in that discussion by providing them with information about their driving ability. We propose SmartDrive, a digital application that implements clinically validated cognitive tasks that have been correlated with on-road driving performance to help seniors explore their driving health at home using a tablet, without assistance. Studies suggest that different feedback presentation styles can cause varied perceptions amongst users

[1] Supported by University of Waterloo

Persuasive 2020, Adjunct proceedings of the 15th International conference on Persuasive Technology.

even with the same core information [10], therefore this study aimed to identify an appropriate style with the intent to persuade older adult drivers to explore their driving with the objective of promoting safe driving decisions to potentially reduce accident occurrence in this demographic.

2 Design & Methods

For our pilot study, we employed a digitised version of Trail Making Test Part B (TMTb), a cognitive task that has shown to have correlations with on-road driving performance [7][8][9]. Feedback and recommendations based on user performance in this task were designed. Table 1 shows the three performance labels used in the study, devised using the completion times recorded in previous studies. Each label was presented in three different summary styles (see Table. 2).

Table 1. Feedback presented to the user based on their task completion time.

TMTb time threshold	Performance label	Recommendation
< 57 seconds	Average	Repeat the task in two months
> 57 & < 255 seconds	Below Average	Visit physician for further assessment
> 255 seconds	Deficient	Visit physician for further assessment

Table 2. Feedback presented to the user based on their task completion time.

Summary Style	Design Element (DE) 1	DE 2	DE 3
Text-only	Text	Labels	Recommendation
Visual score map	User score & Score map	Labels	Recommendation
Text & Images	User & Average scores	Driving images	Recommendation

2.1 Study Design

Six senior drivers with a mean age of 73.83 years, all of whom possessed valid full G driver's licenses and are actively driving were recruited. After informed consent was obtained, a demographics questionnaire was administered. This was followed by a cognitive walk-through of SmartDrive to allow the participants to express their views on the summary style presented after completion of the task. The interviews were audio recorded and transcribed verbatim. Participants' reactions to the styles presented and their responses in the interviews were thematically analysed by two researchers to identify factors that would persuade use of the application.

3 Results

Theme-based segregation of emergent codes after implementing an inductive and deductive approach are presented in Table 3 in the chronological order of user-reactions that the styles elicited. Firstly, participants found the design flow coherent and generally agreed with the language and layout used. After performing the task, they were quick to compare their scores with the thresholds provided and discussed different aspects of the design that would cause or prevent building trust in the application. Finally, several recommendations that users could po- tentially follow to increase safety while driving were suggested. All these themes were identified as persuading factors for continued use of SmartDrive.

Table 3. Four overarching themes and sub-themes influencing persuasiveness of Smart- Drive, numbers in brackets indicate # of participants who mentioned the sub-theme; n total = 6.

1.Comperensibility	**2. Performance Comparison**
Information density (2)	Performance relative to others (6)
Feedback tone (6)	Performance relative to self (over time) (2)
Numeric/Word format (3)	
Feedback style & colours (6)	

1. Trustworthiness	**2. Action Plan**
Applicability to driving (5)	Changes in driving habits (5)
Reliability (6)	Self-Improvement (6)
Score explainability (3)	Seek medical assessment (3)
Appropriate suggestions (5)	Alternative Transportation (3)

4 Discussion

All six participants favoured the scoring map that presented the distance of their scores from the two thresholds on a horizontal axis. This quantification of rela- tive performance was cited as informative and influential in intent to use. High colour contrast and low text density were also stated as reasons for its positive reception. Two participants preferred both text-only and visual score-map styles and sug- gested displaying them sequentially to avoid clutter and promote layered mes- saging to prevent the user from feeling overwhelmed. The driving images selected elicited varied responses, as four participants found that this brought forward relevance to driving while two considered them judgemental and unnecessary. Different images will be explored in the next iteration. While the style of feed- back had some impact, analysis revealed that the

feedback tone used, task appli- cability, and reliability of the scoring method were significantly more important in developing sufficient trust in the application to prompt the user in following the suggestions presented. All six participants were willing to use SmartDrive again to track changes in driving-related cognitive status, and five of the six participants were keen on pursuing a follow-up plan that ranged from minor changes in their driving habits to an appointment with the doctor for further assessment.

5 Conclusions & Future Work

The first two themes identified are consistent with usability frameworks previ- ously proposed for designing digital applications for older adults [11]. Need for 'Trustworthiness' and an 'Action plan' through the sub-themes mentioned are new and emergent concepts that have been recognised in this study as signif- icant factors affecting the willingness of application-use. The research team is presently translating the sub-themes into practical design features to incorpo- rate in the next version, which will be further tested by a larger participant cohort. Follow-up interviews will be conducted to explore any changes in driving behaviour and data will be analysed using the Outcome/Change design matrix using the Behaviour Change Support System framework [12] to determine the persuasiveness of the application.

References

1. Qin, Weidi, Xiaoling Xiang, and Harry Taylor. "Driving Cessation and Social Iso- lation in Older Adults." Journal of aging and health (2019): 0898264319870400.
2. Choi, Namkee G., and Diana M. DiNitto. "Depressive symptoms among older adults who do not drive: association with mobility resources and perceived transportation barriers." The Gerontologist 56.3 (2016): 432-443.
3. Taylor, Brian D., and Sophia Tripodes. "The effects of driving cessation on the elderly with dementia and their caregivers." Accident Analysis & Prevention 33.4 (2001): 519-528.
4. AZAD, NAHID. "A survey of the impact of driving cessation on older drivers." Geriatrics Today 5 (2002): 170-174.
5. Kendall-Wilson T Depelteau A Whalen K Culp J. Hamdy RC, Kinser A. Driving and patients with dementia. Gerontology and geriatric medicine.., 2018
6. Eberhard, John. "Older drivers'"high per-mile crash involvement": The implications for licensing authorities." Traffic injury prevention 9.4 (2008): 284-290
7. Haley Duncanson, Ann M Hollis, and Margaret G O'Connor. Errors versus speed on the trail making test: Relevance to driving performance. Accident Analysis Pre- vention, 113:125–130, 2018.
8. Jane C Stutts, J Richard Stewart, and Carol Martell. Cognitive test performance and crash risk in an older driver population. Accident Analysis Prevention, 30(3):337–346, 1998.
9. Papandonatos, George D., et al., "Clinical utility of the Trail-Making test as a predictor of driving performance in older adults." Journal of the American Geriatrics Society 63.11 (2015): 2358-2364.

10. Choe, Eun Kyoung, et al. ”Persuasive performance feedback: The effect of fram- ing on self-efficacy.” AMIA annual symposium proceedings. Vol. 2013. American Medical Informatics Association, 2013.(10)
11. Becker SA, Webbe FM. Designing for older adult users of handheld technology. In2006 International Conference of the IEEE Engineering in Medicine and Biology Society 2006 Aug (pp. 3297-3300). IEEE.
12. Oinas-Kukkonen, Harri. ”Behavior change support systems: A research model and agenda.” International Conference on persuasive technology. Springer, Berlin, Hei- delberg, 2010.