Haptic Signals for Communication under Workload

SENSORY PERCEPTION AND INTERACTION RESEARCH GROUP

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Motivation

•Visually oriented tasks, such as driving are often accompanied by both perceptual and cognitive distractions

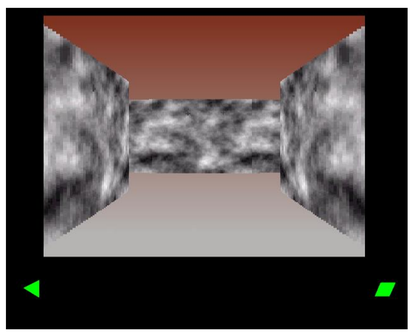
•As technology advances, the driver interface is complicated by the addition of secondary functions and enhanced driver information systems

•Haptic (tactile) signals might be useful as a more effective and less distracting means of communicating this additional information

Hypothesis

In a primarily visual task, haptic signals can be more resistant to large cognitive workloads than visual signals

Setup



•Participants navigated a virtual maze, turning left or right at each intersection

•To keep their attention on the maze, participants were asked to watch for and identify occasional visual targets on the maze walls

•Participants placed each hand on a tactile display box

•A button on the box could be pressed to trigger a turn in either direction

The Experiment

Task

Navigate a maze where the correct direction to turn at each intersection is indicated by different types of signals: **Visual signals**, **Haptic signals**, **Haptic + Visual signals** or **Mixed signals** (Haptic or Visual)

•Each condition was repeated with and without an additional cognitive workload task of counting the number of sentences being read from a document

•A **haptic signal** was a short vibration presented to the index finger

•A **visual signal** was a triangle that appeared on the screen below the maze

Measures Collected

•Number of correct turns

•Participants' estimates of correct turns

•Number of visual targets correctly identified

•Reaction times between signal presentation and turning

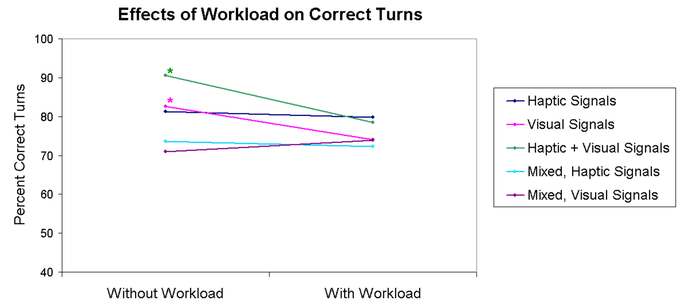
Calibration of Task Difficulty

Task difficulty was adjusted for each participant using an adaptive procedure to obtain 80% correct turns for both visual and haptic conditions (without workload)

•Haptic noise was presented through the tactile display boxes, and the amplitude of the target haptic signal was adjusted

•Visual signals were presented serially with a variety of shapes in a rapid sequence; the duration of target presentation was adjusted

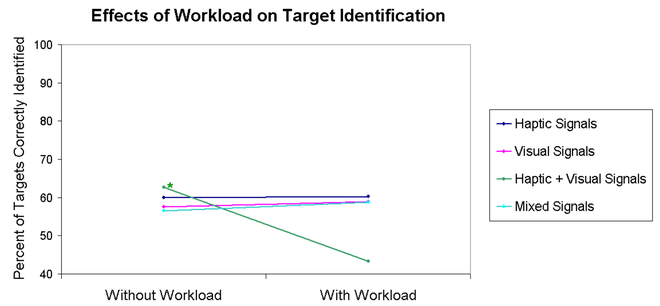
Results



➢Workload had no significant effect on the number of correct responses to haptic signals

➢Correct responses to visual and haptic + visual signals were affected by workload

(p = 0.026 and p = 0.022)



➢Visual target identification was affected by workload when both haptic and visual signals were presented simultaneously

(p = 0.007)

➢Workload had no effect in any other condition

•Results for Reaction Times were not significant, but suggested an increase in RT with workload

•Confidence was lower for visual signals than for haptic signals, but this difference was not statistically significant

Conclusions

•In a visual navigation task, haptic signals are more resistant to the effects of cognitive workload than visual signals

•Presenting both visual signals and haptic signals at the same time increases cognitive demand more than presenting either signal alone – the addition of non-visual workload raises cognitive demands and impairs identification of visual targets

•Confidence was a more accurate reflection of performance for haptic signals compared to visual signals