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## Eye-movement in the dark for the exploration of virtual scenes encoded by sounds

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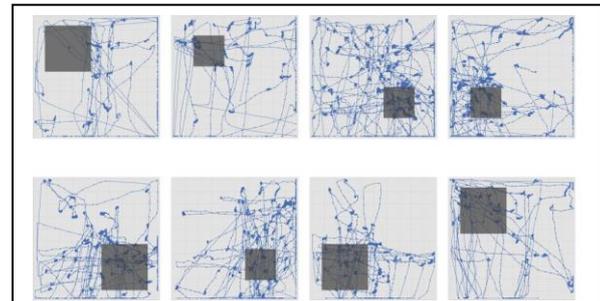
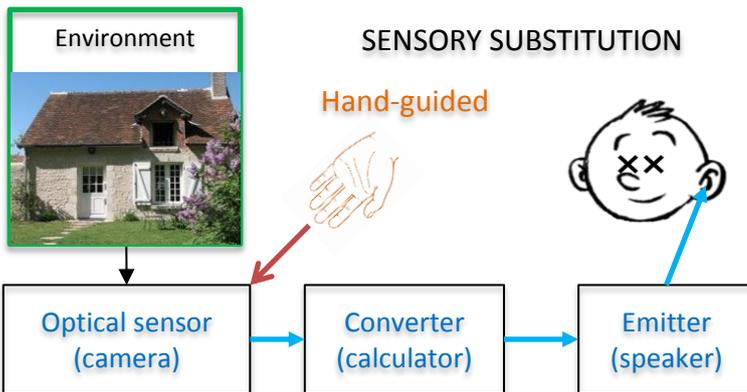
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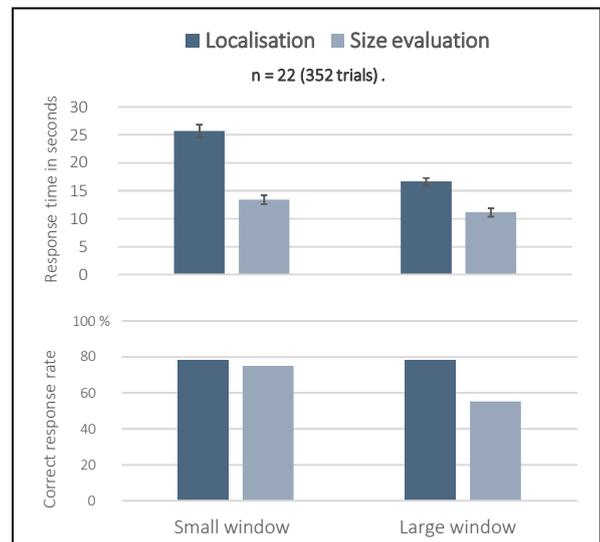
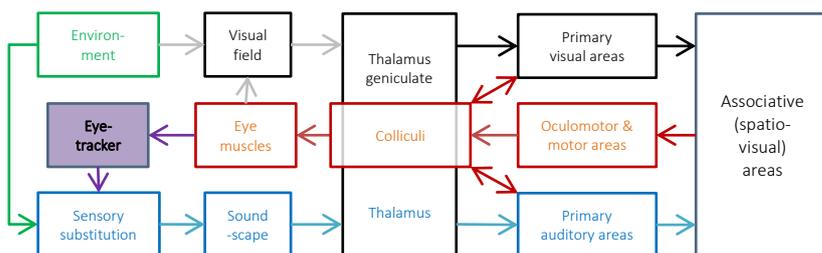
**Introduction:** Sensory substitution consists in artificially replacing an impaired sensory channel (e.g. vision) by another intact one (e.g. hearing). We use a depth camera to catch distance and convert it into pitch

**Method:** A focal region within a virtual depth scene is guided by the user's eye movements captured with a fixed eye tracker. The focus position come across depth levels within the scene, which defines the audio feedback (the closer the distance, the higher the pitch).



Normal participants had to direct their gaze (in blue) in the dark, in order to locate one open window (four possible positions, in black) and identify its size (small or large) by hearing alone. Sample tracks above.

Normal vision of the environment (green) involves an afferent pathway (black) from the visual field to visual cortex areas, but also feedback and feedforward loops closed by eye movements (red). Basic auditory substitution (blue) linearly brings spatial information from the environment (green) to the same spatio-visual areas. It may benefit from restituting some action-perception loops between the environment and the spatial cortex by connection with an eye-tracker.



**Concept:** Explore an invisible depth scene using the eye movements that normally constitutes the natural action-perception loops. A proof of such *Auditory Night Sight (ANS)* has already been provided by Twardon et al (2013) testing participants on a real canvas with four closable windows.

**Results:** Participants succeeded in the dark in locating an open square window among four different places and in evaluating between two possible sizes.

**Conclusion and perspective:** Participants efficaciously guided the visuo-auditory substitution focus point by blind gaze to explore a virtual scene. Window localization and size estimation were >70% correct, a successful partial replication of Twardon et al.'s original results in a real-scene set-up. We carry on tests in 3-D virtual environments. Sensory substitution may also help for biofeedback reeducation of eyeball position of blind people.

Lukas Twardon, Hendrik Koesling, Andrea Finke and Helge Ritter. Gaze-contingent audio-visual substitution for the blind and visually impaired. - 7th International Conference on Pervasive Computing Technologies for Healthcare (Pervasive Health) 2013, Venice, Italy.)