Introduction

Ego-motion perception is a crucial ability of humans, particularly with regard to control of posture. Therefore the role of multisensory integration, which handles the information from multiple senses, seems to be a basic necessity. Currently, most experimental work on visual-vestibular interaction is based on modification of one or more sensory signals. Cognitive variables like previous knowledge, expectancy or attention are largely disregarded in this research area. A few recent research, however, suggests that especially attention has a significant impact on the way information from different senses is combined [1,2].

Methods

11 Helicopter Pilots
12 Naive Subjects

Instruction-related Distractions

Task-irrelevant Disturbances

Attentional Focus

Pilots Use Different Strategies than Nonpilots

Different Patterns of Response

Fig. 1: The cognitive sensor hypothesis: multisensory processes are thought to require cognitive processes [3]

To investigate the influence of attention in an ego-motion perception task, we employed a realistic, physics-based helicopter simulation on a Stewart motion platform.

12 Naive Subjects
11 Helicopter Pilots

Fig. 2: The somasturopic illusion leads to confusion because of ambiguous information. Translational displacement is mistaken for tilt around the roll axis. Under regular conditions, the ambiguity can be dissolved by using multiple information from multiple modalities.

Fig. 3: The electric Stewart motion platform allows a realistic flight simulation in six degrees-of-freedom. The projection screen is used for visualizing the virtual environment.

Fig. 4: The realistic 3d-model “Virtual Tübingen” served as an experimental environment for the hover task. The task consisted in obtaining and maintaining the orientation towards a virtual TV-tower.

Fig. 5: The input devices (a) Cyclic (roll and pitch adjustment) (b) Pedals (yaw adjustment) (c) Collective (height adjustment)

Subjects had to use all three devices at the same time.

Results

The results did not reveal any systematic influence of the mode of instruction on the control behavior. Further analysis showed that pilots and non-pilots exhibited different patterns of responses under the different conditions. Non-pilots were distracted only by visual disturbances. In contrast the pilots responded only to the combined offset (visual together with vestibular).

Fig. 6: Pedal deflection - nonpilots

The figure shows the pedal deflection during the disturbance time slice. The visual condition differs significantly from the baseline (p<0.002*) and represents the subject’s compensatory behaviour during the disturbance.

Fig. 7: Pedal deflection - pilots

The figure shows the pedal deflection during the disturbance time slice. The combined condition is nominally different to the baseline (p=0.052).

Fig. 8: Platform roll - pilots

The figure shows the platform roll angle during the disturbance time slice. The combined condition got significantly compared to the visual condition (p<0.005**).

Furthermore, female subjects benefited from the vestibular whereas the male subjects profited by the visual focus of attention, resulting in a better hover performance.

Fig. 9: General hover performance - nonpilots

The figure shows the interaction between instruction and gender in the time slice without disturbances. The standard deviation was taken as a measurement for hover accuracy (p<0.01**).

Conclusions

The findings indicate that lateral disturbances are in part erroneously interpreted as rotational movements during helicopter flying. The specific response patterns suggest that non-pilots were using a rather visually based control strategy, whereas pilots relied on the integrated, visual and vestibular information - the latter finding possibly reflecting the pilots’ previous knowledge of helicopter dynamics.

CONCLUSIONS: The findings indicate that lateral disturbances are in part erroneously interpreted as rotational movements during helicopter flying. The specific response patterns suggest that non-pilots were using a rather visually based control strategy, whereas pilots relied on the integrated, visual and vestibular information - the latter finding possibly reflecting the pilots’ previous knowledge of helicopter dynamics.

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References

