Effects of Multimodal Feedback on the Acquisition of Rowing Skills

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Background

Objective of the study: We explored the importance of enriched augmented feedback for indoor rowing training of healthy young novices.

- Rowing skill is based on a periodic movement, where stroke is a unit cycle. Successful performance requires coordination of several body limbs to make the oars cover the right cyclic trajectory in the right direction as smooth as possible.
- Skill acquisition necessitates multi-session practice and thus can benefit from simulator environment empowered by virtual reality technologies that allow enrichment of indoor training by augmented feedback.

High cost efforts are invested in developments of VE simulators to mimic ecological tasks with high fidelity.

Should we struggle for high adherence to the channels of information feedback afforded during training in ecological vs. simulated task?

Method

Task: Moving the simulated boat's oars (the handle) through three transition points in space (**A**-catch, **B**-finish and **C**-start of recovery) in a coordinated way - repeatedly, smoothly and as accurately as possible, according to the externally cued pace of 15 strokes per minute, provided at the beginning of each stroke (point A).

System design:Concept2 ergometer device; LCD screen; two Vicon motion capture cameras for tracking ergometer's handle;

airflow haptic system and a metronome. Feedback modalities were similar to the ecological task (Visual & Haptic). Feedback on the accuracy of performed arm movement was provided during training trials per stroke.

Haptic feedback - air flow at three critical points along the trajectory of arm movement

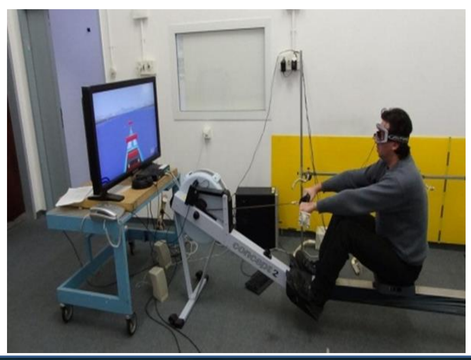
Visual feedback - going through or missing the three critical points along the hand path.

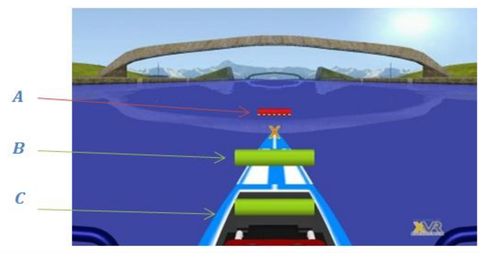
32 naïve to the rowing task healthy young adults were randomly assigned to 4 conditions according to the feedback type:

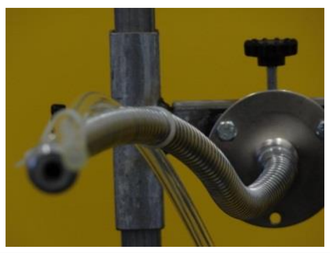
Standard (no augmented FB), Visual, Haptic *and* ***Visual-Haptic training.***

4 Training days	
1 Standard training trial	5 Augmented training trials

Test & Transfer day				
Standard training	Resistance	No metronome	25SPM	Opposite

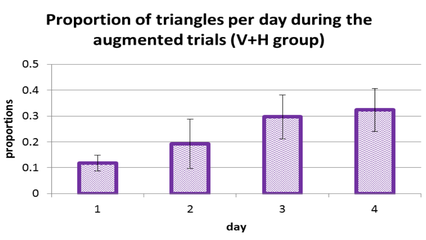






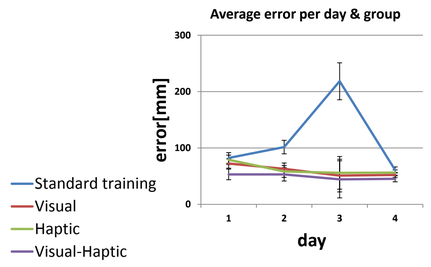
Results

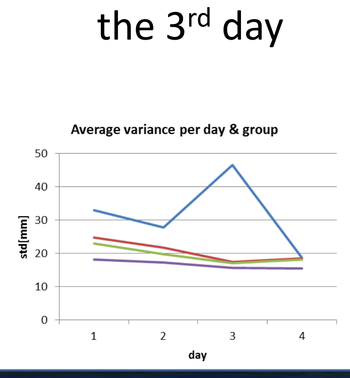
Within session performance



Visual-haptic group Marginally significant increase in triangles (p<0.068),

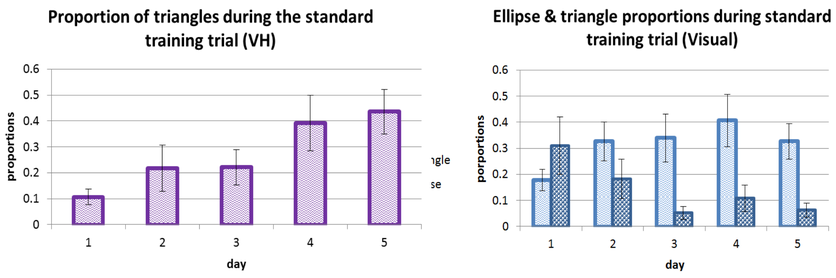
Standard group step increase in error (P<0.029) and variance (P<0.038) at the 3rd day





Visual-haptic group decrease in error (P<0.028) and variance (P<0.00) within day

Long term learning



Visual and **Visual-haptic groups** triangles increase (P<0.035), marginal decrease in ellipses (P<0.078) for VH group

All study groups – overall error decrease, 5th day compared to the 1st day (P<0.021)

Retention & Transfer

- **All groups** – during all transfer conditions a decrease in errors in the last standard training trial compared to the first standard training trial (P<0.021)
- **All groups** – no difference in the accuracy between standard training retest and in the "no metronome" transfer condition
- **Visual-haptic group**, exclusively, no increase in error or variance levels in the "opposite" transfer condition as compared to the standard training retest .

Discussion

- Teaching complex ecological motor tasks in rehabilitation as well as in sports, requires knowledge of how to accurately guide clients during training sessions.
- We found that the extra feedback did not influence long-term skill learning of rowing in terms of accuracy of hand movement's trajectory.
- Fixation on augmented feedback resulted in decrease of variance and errors within sessions, whereas standard training was characterized by transient increase of variance & error in the 3rd day, presumably due to continued strategy exploration processes.
- Feedback modality used to provide accuracy information affected the acquired arm trajectory form: visual feedback favored triangle shape; self exploratory haptic feedback favored ellipse; standard training supported exploration and evolution of a skilled coarticulated shape - drop.
- All groups but visual-haptic, deteriorated in the "opposite" transfer test in terms of accuracy, and changed their trajectory style, but the visual-haptic group preserved its style, probably because multisensory integration contributed for a more effective skill representation.

References: Anderson, J. R. (1982). Acquisition of cognitive skill. *Psychological Review, 89*(4), 369; Donchin, E., Fabiani, M., & Sanders, A. (1989). *The learning strategies program: An examination of the strategies in skill acquisition* Elsevier Science Publishers BV; Newell, K. (1991). Motor skill acquisition. *Annual Review of Psychology, 42*(1), 213-237; Schmidt, R. A. (1991). Frequent augmented feedback can degrade learning: Evidence and interpretations. *Tutorials in motor neuroscience* (pp. 59-75) Springer; Sosnik, R., Hauptmann, B., Karni, A., & Flash, T. (2004). When practice leads to co-articulation: The evolution of geometrically defined movement primitives. *Experimental Brain Research, 156*(4), 422-438.