Effect of timing training in golf and soccer players: skill, movement organisation, and brain activity

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DOCTORAL DISSERTATION

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Although trainers and athletes consider ‘good timing skills’ to be critical for optimal sport performance, little is known in regard to how sport-specific skills may benefit from timing training. Thus, assuming that all motor performances are mediated by an internal timing mechanism, enhanced motor timing is expected to have positive effects on both planning and execution of movement performance, and consequently on complex sports actions as golf or soccer. Accordingly, in order to increase our knowledge of the importance of motor timing and possible effects of timing training, this thesis examines the effects of synchronized metronome training (SMT), thought to improve the execution of motor programs and to enhance motor skills in golf and soccer players.

Study I examined the effects of SMT on motor timing abilities and its potential effect on golf shot accuracy and consistency in 25 experienced male golfers. Additionally, Study II examined the effects of SMT on the spatiotemporal movement organisation and dynamics of the golf swing performance, as captured by kinematic measurements and analyses in thirteen male golfers. Study III examined the effect of SMT on accuracy and variability in a soccer specific, cross-pass task in elite and sub-elite female soccer players. Moreover, the underlying brain activity was assessed by means of functional magnetic resonance imaging (fMRI) to investigate the corresponding neural activity when passively observing the cross-pass task, and the possible pre- to post training effects.

SMT was shown to improve motor timing ability, by means of less timing asynchrony and with associated changes in timing variability, in both golf- and soccer-players. Additionally, significant improvements in golf shot and soccer cross-pass performance, by means of significant increase in outcome accuracy combined with a decrease in outcome variability was found. From the kinematic investigation in Study II, results indicate that improved motor timing, as an effect of SMT, lead to a more coordinated and dynamic swing performance, and with decreased variability in the temporal structure of the swing motion. Finally, it was found that SMT induces changes in the activity of the action observation network (AON), underpinning action observation and action prediction, by means of decreased activation within bilateral cerebellum, fusiform gyrus and superior temporal gyrus. These findings hint at a more efficient pattern of neural recruitment during action observation, after SMT.

In summary, this thesis provides evidence that four weeks of SMT improved the participant’s motor timing and synchronization abilities, and showed influence on both behavioral and neurophysiological motor programs and skill performance in golf and soccer players. Thus, by improved outcome accuracy and decreased variability, affecting the coordinated movement pattern and organisation, as well as affecting the associated underlying brain activation.

Keywords
Motor timing, rhythmicity, timing training, golf shot, golf swing, kinematics, precision, variability, coordination, movement dynamics, soccer, fMRI, mirror neurons, action observation, cerebellum, perception - action.