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Exercise stress affects brain-mapping changes in EEG and open up new vistas in sportsmedicine research - Analysis of movement-related-cortical-potentials (MRCPs) and electroencephalography (EEG)

Physical stress in sports and its consequences are not limited to peripheral muscular system only, but also affects the central-nervous-system too.

Methods: To assess cortical movement preparation in voluntary bicycle-kicks movement-related-cortical-potentials (MRCP) are registered. Similarly Electroencephalographic (EEG) recordings are used to examine recovery reaction of the central nervous system. In two trials standardized stress close to individual maximum is induced by bicycle- (FB) and upper arm exercise (OB) as well as mental concentrative exercise (KB) to differentiate central from peripheral fatigue. MRCP-Tests are performed during increasing work load with stressed and relaxed test muscles. 14 right-handed, endurance-trained, healthy, male, volunteers are included in the FB-study with 11 also participating in the OB- and 10 in the KB-trial.

In the second examination EEG *recordings* in 21 healthy, voluntary, male students, differentiated in groups of physical performance (<4 Watt/kg <) are analysed in the recovery from a standardized exhausting stress test. As stress control cardiovascular-,metabolic-, stress-, and psychometrical parameters are analysed.

Results: High and equal physical workload conditions are confirmed by controlparameters (94-97% of max. pretestpower). The KB-*paradigm* is not exhaustive and has no impact on MRCPs. Qualitative and quantitative changes are found in increased negative potentials in motor potential (MP) and MRCP-Power (area between curve and baseline) with increasing physical workload in frontal (Fz) and cenral (Cz) areas. With stressing of the test muscles (FB) MRCPs increase significantly in frontal brain areas. With regards to the absence of these frontal changes in motor preparation in exhaustive condition with relaxed test muscles, an effect of altered sensory inputs from the tested muscles must be discussed.

In the second examination significant electroencephalographic group-effects are found with decreased fronto-central Theta-Power in trained athletes in early and late recovery time. Except in heart-rate no group effect is found anymore. However higher concentrations of catecholamines can be demonstrated in trained subjects. During recovery time the EEG reveals a significant decrease in Delta-, Alpha2, Beta2 and Beta2 frequency.

Conclusions: Cortical movement preparation of voluntary pedal-kick-movements can be documented in MRCPs after physical strain, close to maximal exhaustion. MRCPs show increased negative potentials in centro-parietal areas after higher loads. Additionally frontal brain areas are more involved in movement preparation, when test-muscles are also stressed. This can be interpreted as compensation of fatigue . So, frontal control of incoming sensory afferents after transfer above somato-sensory brain areas ensures voluntary movement.

Significant reversal processes in all frequencies in EEG during physical recovery indicate equal stress coping strategies. Good physical abilities may lead to less emotional involvement in recovery.

Perspective: Physical load and recovery in sports are caused by central nervous properties and its information processing. Inclusion of neuro-scientific methods in studies of movement sciences contributes to a better understanding of the highest control-system, the brain. This is necessary to achieve an optimal physical and psychological progression of performance in athletes.