Body and Brain – an inseparable Team

Getting up, shopping or going for a walk with friends: All activities of our everyday life require a precise interaction of the motor system, the sensory system and the central nervous system. The brain, which is responsible for coordinating these subsystems, plays a major role in this. This interaction usually works perfectly in healthy, young people. In old age, following an illness or an accident, people often find it difficult to optimally interact with their environment due to disturbances in the above-mentioned subsystems or in their coordination. This can lead to limitations in everyday functions, a lack of mobility, falls and the loss of independence.

Falls - causes, consequences and prevention

In industrialised countries, on average, every third person over the age of 65 suffers a fall once a year. In the over 85s, the annual risk of falling actually increases to 50%. Falls in older people result in serious injuries in approximately 15% of cases. These injuries lead to pain, a reduction in mobility and independence and often an increased fear of falling. In addition to personal suffering, falls also lead to high costs for society and represent a socio-economic problem.

In medicine, a fall is classed as an accident that results from losing one's balance whilst standing or moving. The following degenerative changes, which can be triggered by aging processes, injuries or diseases, are cited in the literature as reasons for an increased risk of falls:

- **Changes in the motor system:**
  e.g. reduced muscle mass/muscle strength
- **Changes in the sensory system:**
  e.g. impaired sensory perception
- **Changes in the central nervous system:**
  e.g. reduced signalling

Loss of muscle mass (sarcopenia) and muscle strength (dynapenia) are given as the main causes for an increased risk of falls. Interestingly, dynapenia progresses faster than sarcopenia, so there is no linear relationship. This shows that muscular weakness, one of the most significant fall risk factors, can be traced back to deficits not only in the motor system but also in the nervous system [1], can be traced back to deficits not only in the motor system but also in the nervous system [1].

The complex process of walking requires higher-level brain functions (cognitive processes) in addition to an intact brain signal pathways and functional motor brain areas. Above all, attentional and executive functions are necessary for a safe gait pattern. Executive functions are cognitive abilities that enable targeted actions (e.g. controlling attention span). The executive functions are located in the front part of the brain (frontal lobe), which is subject to particularly strong degenerative changes during the aging process. If age, illness or injury lead to an impairment of cognitive functions, this results in an increased risk of falls [2].

Especially in so-called dual-task paradigms, it becomes apparent that walking requires cognitive resources. If a person is given a cognitive task such as arithmetic (dual-task condition) in addition to walking, the gait pattern changes. The additional task needs resources that are no longer available for controlling walking. The so-called dual-task interference, which can also be observed in perfectly healthy people, is intensified not only by the aging process but also by neurological diseases [3].

In addition to improving muscle strength and balance, cognitive function training must also be taken into account for successful fall prevention. Central to this is the training of the interaction between the body (motor and sensory system) and the brain. For this reason physical activity should be combined with cognitive challenges. This type of training is commonly known as cognitive-motor training [4].

Cognitive-motor training - benefits and implementation

A new and particularly promising type of training should start with this combined concept. The interactive cognitive-motor training (also called dual-task training) links movements to cognitive tasks. It simulates the demands of our daily lives and trains brain-body communication in a targeted way [4]. There is much evidence in the research literature that cognitive motor training is effective [5;6;7;8]. There are improvements in physical functions (e.g. balance, coordination, gait) as well as in cognitive functions (e.g. attention span or executive functions). It also shows that cognitive-motor training can minimize the risk of falls in older people [9].

Researchers suspect that combined cognitive-motor training can result in superior outcomes, compared to sequential training methods. Findings from animal research confirm this assumption, which is caused by a synergy effect [10]: Physical activity seems to trigger positive changes in the brain (neuroplasticity effects) (e.g. the formation of new nerve cells), whereby the cognitive challenge can be key to obtaining these effects (e.g. integration of the new cells into the existing cell network).

The senso was developed in cooperation with the Zurich University (ETH Zurich), and it enables this kind of interactive cognitive-motor training in combination with exergames (exercise games). Training games are presented to the user on a screen, each addressing specific brain functions. The games are controlled by body movements such as steps or shifts in balance. The movements are recorded by a pressure-sensitive plate.

Fields of application and scientific evidence

Cognitive-motor training is suitable for all those who want to improve their brain-body communication. It is used in prevention as well as in therapy and rehabilitation. The senso is often used in the field of „active aging", fall prevention and geriatrics as well as in neurorehabilitation.

Studies with healthy seniors in the context of fall prevention have shown that training on the senso can improve the most important gait parameters (e.g. walking speed or step length) [11,12]. These parameters are in turn directly related to a reduced risk of falls.

Cognitive-motor training on the THERA-Trainer senso is also suitable for use in people with neurological conditions such as dementia, Parkinson's, stroke or multiple sclerosis. A study with stroke patients showed that both improvements in physiological parameters (e.g. gait pattern) and optimisation of brain functions (e.g. psychomotor speed) can be achieved by training with the THERA-Trainer senso [13]. A study involving patients with severe cognitive impairments caused by dementia showed positive effects of THERA-Trainer senso training on walking speed and the speed of step execution, on the general cognitive status and on their mental health [14].

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