Heart Rate Asymmetry and Emotional Response to Robot-assist Task Challenges in Post-stroke Patients

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Learning the use of a robot-assist device for walking is influenced by the level of motivation or stress experienced by patients that if over-challenged withdraw and have difficulty learning the task. It is therefore important in neurological rehabilitation to set tasks at an appropriate level of motivation/stress. Psychological tests cannot be conducted whilst patients are strapped into the robot-assist devices. However the regulation of heart rate by the autonomic nervous system is characterized by reciprocal connections to the cortex and deeper cerebral hemisphere structures and thus measures of heart rate variability (HRV) can be used as an indicator of cognitive involvement. Heart rate asymmetry (HRA) is a measure indicates the level of parasympathetic involvement in heart rate regulation by the autonomic nervous system. The asymmetry index is based on the ratio of positive entropy divided by total entropy where the positive and negative entropy changes indicate either more autonomic nervous system acceleration or inhibition respectively. Values above 0.5 indicate an increased acceleration probability, whereas values below 0.5 indicate an increased inhibition probability. Patients were part of a group that was using robot-assist devices for a walking task under different levels of motivation (under-challenged, challenged and over-challenged). During the training task patients showed an increase in the level of stress and motivation ($0.524\pm$ 0.02) compared to healthy participants (0.485 ± 0.03). The latter indicates a parasympathetic predominance. As the task complexity increased from walking without any additional challenges to under-challenged, challenged and over-challenged conditions, the patient group showed an atypical response (HRA$<$0.5) compared to control, which had values above 0.5 in accordance with the requirement of increased cognitive involvement and a higher probability of accelerations in heart rate variability. Our results indicate an interesting phenomenon in that the asymmetry index in stroke patients (n=3) were opposite to the control group (N=10) suggesting that the pathology (stroke) has affected the response to the task challenges. In conclusion, cognitive response to increasing mental and physical challenge leads to an inversion of heart rate symmetry in stroke patients compared to controls.