Motor abundance, compensation and adaptability in the stroke-damaged nervous system.

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Background

In motor tasks such as reaching from sitting or standing, the nervous system has to organize the action of a large number of body segments and joints in order to maintain reaching accuracy. Reaching can be accomplished by different combinations of joint movements permitting the system to adapt to unexpected situations, a process known as motor equivalence. Following a stroke or damage to the central nervous system, deficits in motor planning and execution may ensue, leading to a reduced capacity to use the affected upper limb to meaningfully interact with objects in the environment. The capacity for adaptability depends on the residual ability of the nervous system to use its kinematic redundancy to find solutions to motor problems. Reductions in redundancy may be related to deficits in threshold control and the specification of referent body postures.

Methods & Results

Results of studies investigating how the stroke-damaged nervous system organizes reaching movements based on limited redundancy will be presented, while considering the extent to which compensatory motor patterns are adaptive. For example, people with stroke use excessive arm-plane motion to compensate for limited shoulder flexion, however, those with more severe stroke were unable to adapt such movements to improve reaching accuracy. Further investigation of adaptability will be illustrated with results of studies of kinematic adaptability to sudden perturbation of the trunk when reaching from sitting and when reaching from standing. These studies show that people with even mild stroke have difficulty in rapidly changing elbow-shoulder interjoint coordination patterns to adapt reaching movements to sudden perturbation and that this difficulty may be related to a limited ability to regulate the tonic stretch reflex threshold of muscle groups recruited for the motor action.

Conclusion

The ability to appropriately adapt interjoint coordination to changing task conditions is impaired in individuals with stroke, which may be explained by impairments in threshold control leading to deficits in the specification of referent body configurations for control of reaching.

Significance

Deficits in higher order motor control skills related to the use of motor compensations to adapt to unexpected situations, may restrict motor recovery. This capacity is not routinely identified in commonly used clinical scales.