Anatomical blueprint for motor antagonism identified

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Motion studies of human walking. Photography by Marco Tripodi

(Medical Xpress) -- Walking or movement in general, comes so naturally to us, yet it results from a sophisticated interplay between the nervous system and muscles. Little is known about the neuronal blueprint that ensures the regulation of functionally opposing motor actions, which in turn are responsible for all movement.

Silvia Arber and her team at the Friedrich Miescher Institute for Biomedical Research and the Biozentrum in Basel now provide evidence that spatial separation and timing of neurogenesis light up distinct neuronal circuits in the spinal cord reflecting antagonistic motor function. Arber's results are now published in the latest issue of the journal *Nature*.

Movement is of central importance to humans and animals. For it to work reliably, dozens of muscles must be activated and coordinated by the nervous system through precisely timed impulses. In this process, the execution of antagonistic motor behavior plays a key role. For example during walking, muscles involved in flexion and extension divide labor and are activated in alternation. Commands for flexion or extension are given by motor neurons in the spinal cord, special neurons projecting to the corresponding muscles. Motor neurons themselves receive their input from so called interneurons in the spinal cord, which, analogous to the conductor of the orchestra, relay commands to play or be silent to flexor or extensor motor neurons.

Silvia Arber's research group revealed the distribution of different interneurons in three-dimensional space in the spinal cord and analyzed this crucial functional network. In this study, Arber's research group made use of newly developed tracing methods to visualize the distribution of interneurons responsible for flexion and extension in the spinal cord. Interestingly, these two functionally distinct groups exhibit a strikingly different distribution in space. The foundation for these spatial differences is laid during development. Interneurons with flexor or extensor function are generated at different times during development, which suggests that the developmental timing of neuronal generation is an important parameter for establishing functionally distinct neuronal groups. Both development and the spatial distribution of these neuronal circuits therefore designate the later function of these neurons in motor control.

It was hitherto unknown whether interneuron circuits in the spinal cord are specifically assigned to one of the two described antagonistic functions. Nor was it clear how flexion and extension controlling interneurons differ. It was surprising to find that the corresponding neurons emerge by a precise temporal schedule that prefigures later spatial distributions important for regulation of motor behavior. This

improved understanding of the principles of motor circuit organization has uncovered important entry points for further research. Diseases of the nervous system often lead to motor circuit defects and spinal cord injury impairs motor behavior. A better understanding of the function and organization of motor circuits is essential to rationally target motor and neuromuscular dysfunction.

More information: Tripodi M, Stepien AE, Arber S. (2011) Motor antagonism exposed by spatial segregation and timing of neurogenesis. *Nature*, doi:10.1038/nature10538 , Oct 18, advanced online publication

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