New insights into how humans learn to walk

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Credit: CDC.gov

(Medical Xpress) -- A new study has revealed that as humans learn to walk the two basic patterns of stepping present in the newborn remain unchanged and two new patterns are added at the toddler stage. This development process and the patterns are similar to those found in other species such as rats, cats, macaques and guineafowl, which suggests that locomotion in the different species could be based on a common ancestral neural network.

Until now the fact that human locomotion is upright and bipedal was thought to suggest that primitive neural control patterns in newborns would be quickly replaced by unique patterns found only in humans, but the new research has found that these original patterns are not discarded at all.

Researchers from Italy and the US, led by neurologist Francesco

Lacquaniti of the Centre of Space Bio-medicine at the University of Rome Tor Vergata, used kinematics, kinetics and electromyograms (EMG) to study locomotion. They recorded the electrical activities in twenty muscles in babies two to seven days old as they were held upright above a flat surface. Newborns automatically start stepping when their feet come into contact with the surface in this way and they are gently persuaded to move forward, but this reflex disappears after a few weeks, later to be replaced by intentional attempts to walk at the toddler stage.

The results found in the newborn babies were then compared with those in human toddlers, young children of preschool age, and adults as they walked. They were also compared with previously published findings on locomotion in newborns and the young of other species.

The research revealed that until a baby reaches around a year old and begins to try to walk alone, the neural mechanisms in place are similar to those of the other animals, such as rats and monkeys. There are two neural patterns in the primitive walking process found in both human babies and babies of the other species: one is a pattern of flexing and extending the legs, and the other is the alternate movement of the legs. Both are seen as distinct patterns in the EMG results.

These mechanisms are then fine-tuned as the baby develops rather than being discarded and replaced by uniquely human patterns. The neural mechanisms that control the muscles producing the human upright bipedal gait are therefore derived from the same primitive signals used in other species.

In toddlers, the original two neural patterns are still in place, but an additional two patterns are also seen. These control fine movements such as shifting weight between the toes and heels, and controlling the timing of muscle flexing. Four patterns are also found in the young of other species as they learn to walk, but by the time humans reach adulthood

the patterns have changed in ways that distinguish them from those found in the other species.

The findings were unexpected because the locomotion of other species, such as cats, rats or birds, is so different to that seen in humans, and because the central nervous system is more complex in humans than in species distant from us on the evolutionary spectrum (birds and mammals having separated around 100 million years ago, for example).

The paper was published in the journal *Science*. All the methods used were non-invasive and safe. Professor Lacquaniti said the results might one day find application in developing aids in the rehabilitation of people who have impaired locomotion.

More information: Locomotor Primitives in Newborn Babies and Their Development, *Science* 18 November 2011: Vol. 334 no. 6058 pp. 997-999. DOI: 10.1126/science.1210617

ABSTRACT
How rudimentary movements evolve into sophisticated ones during development remains unclear. It is often assumed that the primitive patterns of neural control are suppressed during development, replaced by entirely new patterns. Here we identified the basic patterns of lumbosacral motoneuron activity from multimuscle recordings in stepping neonates, toddlers, preschoolers, and adults. Surprisingly, we found that the two basic patterns of stepping neonates are retained through development, augmented by two new patterns first revealed in toddlers. Markedly similar patterns were observed also in the rat, cat, macaque, and guineafowl, consistent with the hypothesis that, despite substantial phylogenetic distances and morphological differences, locomotion in several animal species is built starting from common primitives, perhaps related to a common ancestral neural network.