Movement, Balance, and Coordination
the essence of co-
yr well to muscles, coordination is the
ed movements is
ich helps us keep
er the presence of
space, there is no
balance. Bodies animals, by means
edge of balancing
are. Yet it is, com-
gratuitously and
to perform many
tancing, and
balance, we maintain
bility emerge when
and effort for
to reach, and to
get the frustra-
ments that our
machine, and, for a lucky few, walking a tightrope?
For the first time in years, we are forced to think
about how we are moving and to train ourselves to
move and balance in new ways. It is no wonder
that training these skills can make us feel as help-
less as children.
We learn most of our basic motor skills during
infancy and childhood and acquire different and
more refined motor skills throughout adult life.
Highly coordinated movements develop gradu-
ally from simpler components. For example, initial
niching movements are initially composed of
small, sequential, poorly coordinated movements.

These smaller movements gradually disappear
and are replaced by larger movements that ulti-
marily lead to smooth, single-continuous reach-
ing movements several months after birth.
Similarly, our initial unsteady toddling leads grad-
ually to well-coordinated locomotion, and the
same holds for other motor skills (manipulating
objects, coloring within the lines, dressing, tying
shoelaces, and so on). Most motor skills require
good body balance, which develops gradually dur-
ing the first year of life. Parents acquire the im-
portance of balance when they applaud their
babies' first steps. The most important factors in
uniting movement, balance, and coordination
into a tightly linked whole are practice, prac-
tice, and practice.

Movement and the Brain

The important breakthroughs in understanding
how our brains control movement occurred in the
second half of the nineteenth century. First, John
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responding orderly pattern in the brain repre-
senting movements of those various body parts.
Then Fritsch and Hitzig in Germany were able to
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ly stimulating the motor cortex area of their
brains. Later, neurosurgeons evolved similar
measurements in humans who were awake on the
operating table.

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nation and balance, and specifically into the role
These smaller movements gradually disappear and are replaced by larger movements that ultimately lead to smooth, single-component reaching movements several months after birth. Similarly, our initial unsteady toddling leads gradually to well-coordinated locomotion, and the same holds for other motor skills (manipulating objects, recognizing within the limits, dressing, tying shoelaces, and so on). Most motor skills require good body balance, which develops gradually during the first year of life. Parents recognize the importance of balance when they applaud their babies' first steps. The most important factors in unifying movement, balance, and coordination into a tightly linked whole are practice, practice, and practice.

Movement and the Brain

Two important breakthroughs in understanding how our brains control movement occurred in the second half of the nineteenth century. First, John Hughlings Jackson in England made astute observations on how epileptics suffered seizures that spread in patterns through their bodies. He inferred that there must be a corresponding, orderly pattern in the brain representing movements of those various body parts. Then Fritsch and Hitzig in Germany were able to evoke movements in dogs' body parts by electrically stimulating the motor cortex area of their brains. Later, neurosurgeons evoked similar movements in humans who were awake on the operating table.

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Some muscles them to extend, all ing moves while the balance.

Axons that go from the spinal cord to muscles originate from motor neurons situated in the spinal cord and emerge from the cord in the roots toward the front. Axons carrying sensation to the spinal cord all come from a collection of nerve cells or ganglia adjacent to the spinal cord.

The neurons in the dorsal (toward the back) root ganglia are by far the largest cells known. These neurons send axons out to the body and to the spinal cord. The peripheral end of the neuron may go to the toes. The other end enters the cord and goes all the way to the brain stem. Depending on your height, the neurons may be several feet long. Large axons carry position and touch sensations while smaller fibers carry pain and temperature sensations.

About 20 million nerve fibers, or axons, are packed inside the human spinal cord. Some axons go from one part of the spinal cord to another while others connect the brain to the cord and vice versa. The spinal cord also contains many nerve cells that connect to muscles, called motor neurons (see figure above). Other spinal neurons receive signals from the brain or sensory signals from the body and then relay these signals to other neurons in the spinal cord or brain. These spinal neurons mediate reflexes and even complex behaviors such as walking. In addition, they filter incoming sensory signals and differentiate between normal and painful sensations. In fact, the spinal cord can support walking without the brain's involvement past the initial impulse to walk.

One major source of information sent to the
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Movement, Balance, and Coordination

It's a Reflex

To call these spinal reflexes, and feeling the urge to flex, the leg's and by causing the help us stand steadily, is the brain.

It, such as a hot stove, cvont as their quick being burned.

No way, the opposite is sharp, for instance, is also com-

mons comes in handy in our fetal development, such natural by shortly after birth.

Movement Disorders

Lesions in specific areas of the motor cortex can activate the area, and this can cause a variety of motor abnormalities such as hemiplegia (difficulty in initiating movement), rigidity, and tremor. Widespread cortical atrophy and a variety of motor deficits characterize Alzheimer's disease (C67).

The most obvious motor deficits result from serious brain damage and are hard to miss. For example, strokes (C59, C60) often result in paralysis and spasticity of the arm and leg on one side (hemiplegia) due to damage of the internal capsule—the tract connecting the motor cortical outflow to the brain stem, cerebellum, and spinal cord. Lesions in certain areas of the parietal or frontal cortex can affect motor functions more insidiously. Such lesions frequently result in apraxia of various kinds (C71), meaning difficulty in performing motor skills a person has already learned (for example, how to dress, strike a match, and so on), copying shapes from a template or from memory, assembling objects from component parts, or initiating common gestures. Such difficulties will not become apparent until the person is asked to perform these actions.

Disorders of coordination and balance are more commonly the result of cerebellar damage. These diseases can interfere with the fine-tuning of muscular movement and result in coarse, uncoordinated movement. This type of condition is called ataxia (C46) and is easily seen in a person's jerky to-and-fro motion of the trunk and unsteady gait.

A very different class of motor abnormality comprises involuntary movements that a person cannot stop. These include:

- rather innocuous tics (C45)
- slow, writhing, well-coordinated movements of the arm (choreo-athetosis)
- rhythmic movements of the fingers (resting tremor; C43)
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