The cerebellum's effect on learning and memory

What would happen if the **cerebellum**, an area most commonly linked to movement, turned out to be a virtual switchboard of cognitive activity? The first evidence of a linkage between mind and body originated decades ago with **Henrietta Leiner and Alan Leiner, two Stanford University neuroscientists**. Their research began what would eventually redraw "the cognitive map" (S. Richardson 1996).

The Leiners' work centered on the cerebellum, and they made some critical discoveries that spurred years of fruitful research. First, the **cerebellum takes up just one-tenth of the brain by volume. But it contains over half of all its neurons**. It has some 40 million nerve fibers, 40 times more than even the highly complex optical tract. Those fibers not only feed information from the cortex to the cerebellum, but they feed them back to the cortex. If this was only for motor function, why are the connections so powerfully distributed in both directions to all areas of the brain? In other words, this subsection of the brain -- long known for its role in posture, coordination, balance, and movement -- ***may be our brain's sleeping giant*.**

Just how important is movement to learning? Neurophysiologist Carla Hannaford says the vestibular (inner ear) and cerebellar system (motor activity) is the first sensory system to mature. In this system, the inner ear's semicircular canals and the vestibular nuclei are an information gathering and feedback source for movements. This area is critical to our attentional system, since it regulates incoming sensory data. This interaction helps us keep our balance, turn thinking into actions, and coordinate moves. That's why there's value in playground games that stimulate inner ear motion like swinging, rolling, and jumping.

Carla Hannaford is a neurophysiologist and educator at the University of Hawaii and has worked as a counselor for elementary and intermediate school children with learning difficulties. Her experiences and research point toward the addition of ExerLearning, like Red Octane's "*In the Groove*" and GENERATION FIT as integral curriculum components. Peter Strick at the Veteran Affairs Medical Center of Syracuse, New York, made another link. His staff has traced a pathway from the cerebellum back to parts of the brain involved in memory, attention, and spatial perception. *Amazingly, the part of the brain that processes movement is the same part of the brain that's processing learning.*

In one field study using Red Octane's "*In the Groove*" with a fourth grade class, an autistic student whose entire left side was affected by cerebral palsy, 10-20 minutes per day using the dance mat changed his balance, coordination, social engagement and enthusiasm for PE. **Studies done by neuroscientist Eric Courchesne of the University of California have shown that autistic children have smaller cerebellums and fewer cerebellar neurons.** He says the cerebellum filters and integrates floods of incoming data in sophisticated ways that allow for complex decision making. Once again, the part of the brain known to control movement is involved in learning. There is no single "movement center" in our brain (Greenfield 1995). Movement and learning have constant interplay.

Simple Explanation of Learning at Cellular level

There is, in fact, substantial biological, clinical, and classroom research that supports this conclusion, "Learning is a critical function of neurons that cannot be accomplished individually - it requires groups of neurons. "(Greenfield 1995) As neural pathways become more efficient, a fatty substance called myelin forms around the axon. Myelin appears to reduce interference from nearby impulses thereby increasing efficiency in the brain. "When we say cells "connect" with other cells, we really mean that they are in such close proximity that the synapse is easily, and almost effortlessly, "used" over and over again. New synapses usually appear after learning. (Jensen 1998) Intelligence is the end result of learning. A better, smarter brain results from growing more dendrites and synaptic connections and not losing existing ones. Our challenge as educators is to ensure our students have lots of opportunities to grow dendrites through such things as exploring new ideas, practicing patterns, movement and rhythmic exploration, finding many different solutions to the same problem, and activating creative insights.