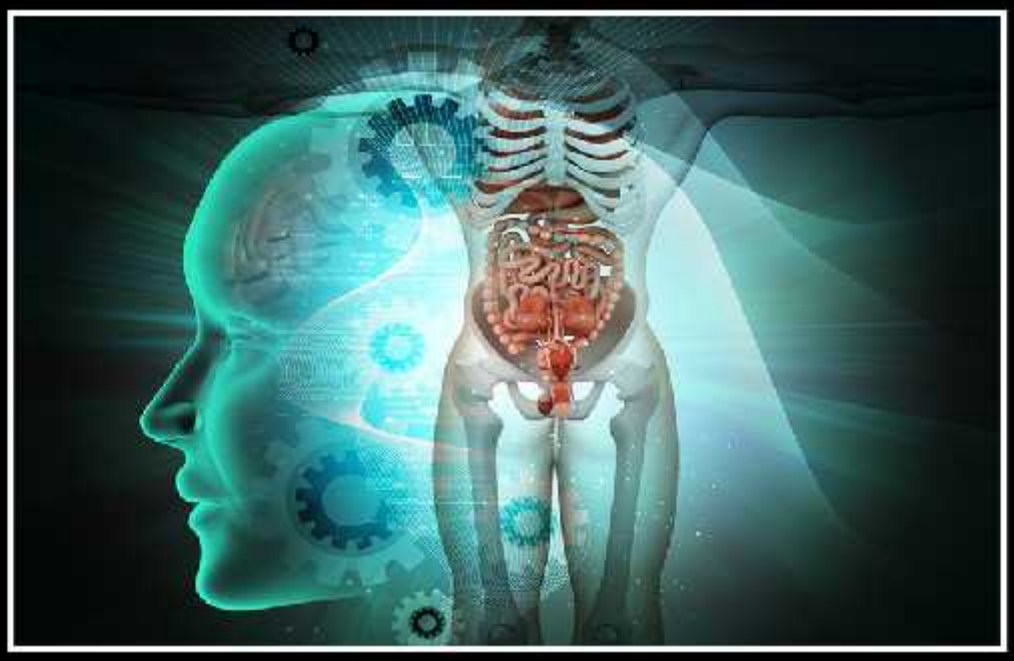
DYSMETRIA OF THE BODY AND MIND



"My mind is a slave to my body. I really don't want to do half the things I do, but my body makes me.

~ Meaghan Buckley

People should understand that autism is first and foremost a motor disorder.

Since his birth 33 years ago, Jonathan Keleher has been living without a cerebellum. This exceedingly rare condition has left Jonathan with a distinctive way of speaking and a walk that is slightly awkward. He also lacks the balance to ride a bicycle. 48

As a child, all Jonathan's milestones were late: sitting up, walking, talking. He got special education, speech therapy and physical therapy and finally, at age 5, he was referred to Dr. Jeremy Schmahmann at Massachusetts General Hospital. The neurologist took one look at his brain scan and pronounced: "He has a very big area of nothingness there where the cerebellum should be." 49

Jonathan also needed to be taught a lot of things that people with a cerebellum learn automatically: how to speak clearly, how to behave in social situations and how to show and understand emotions. 50

For decades, the cerebellum has been the "Rodney Dangerfield of the brain," says Dr. Jeremy Schmahmann, a professor of neurology at Harvard and Massachusetts General Hospital. "It gets no respect because most people only know about its role in balance and fine motor control." 51

> If you've ever tried to walk a straight line while inebriated, you've experienced the effect alcohol can have on your cerebellum's control over your body, balance and coordination. If it is not doing its job right, our posture, muscle movements and sense of equilibrium can be thrown off.

"What we now understand is that what the cerebellum is doing to movement, it's also doing to intellect and personality and emotional processing," Schmahmann says. "Unless you don't have a cerebellum. Then, a person's thinking and emotions can become as clumsy as their movements." 52

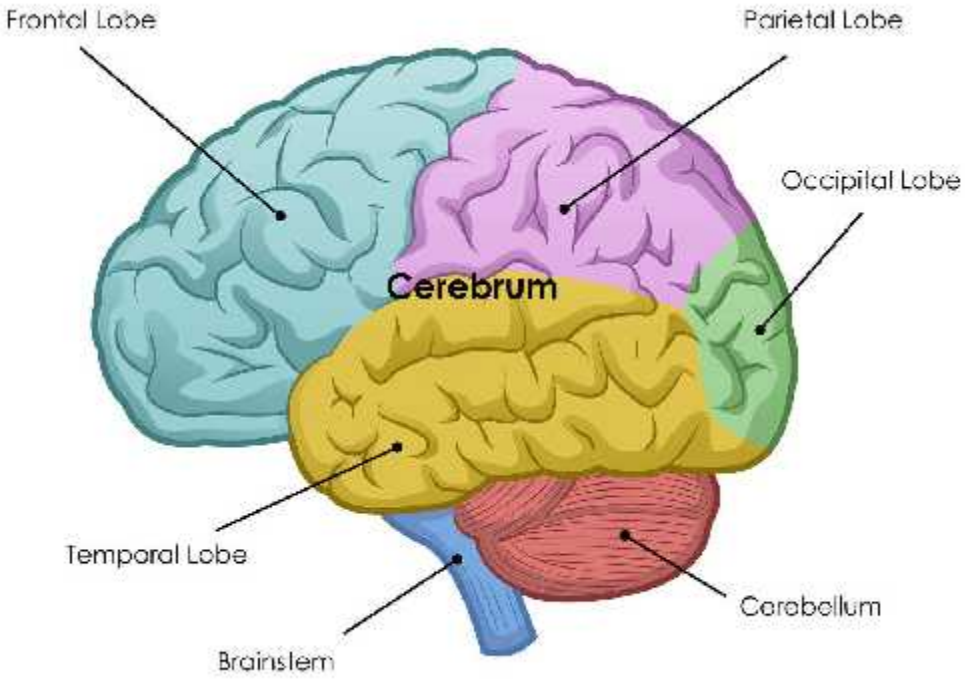
Jonathan got a reminder of this at a busy intersection soon after he got his driver's license. There was a bus behind him, cars were whizzing by, and his brain simply couldn't coordinate all the information. In his confusion, he wound up totaling his father's car. 53

"Reaction time, not my strong suit," he concluded, adding that he doesn't drive anymore. 54

Thanks to wonderfully supportive parents and an exceptional doctor, Jonathan is managing to live pretty well these days, but it isn't as though things come easy for him. Without a cerebellum, planning and coordinating one's thoughts and actions takes a lot of effort.

Imagine if we had to go back to the days before computers. We would have a difficult time managing today, keeping track of everything we have to do and doing most of the stuff we do. Computers have taken a lot of the hard, tedious work out of our lives, so we can spend more time on things we enjoy doing.

The cerebellum is kind of like the computer system for our brain and body. It's job is to keep track of information about the movements and tasks that we do every day. Walking, talking, getting dressed, brushing our teeth etc. These routine activities and motions have been programmed into the cerebellum so we don't have to think about them any more.



The cerebellum is one of three main brain structures, the other two being the cerebrum and the brainstem. Although the cerebellum comprises only 10% of brain volume, it houses well over 50% of your brain's total neurons.

Cerebral Cortex - 16 billion neurons
Cerebellum - 69 billion neurons

For a long time it was believed that the cerebellum was primarily responsible for 'non-thinking' brain functions, such as balance, motor control and finely-tuned muscular coordination, and that the cerebral cortex was solely responsible for our higher cognitive functions. 55

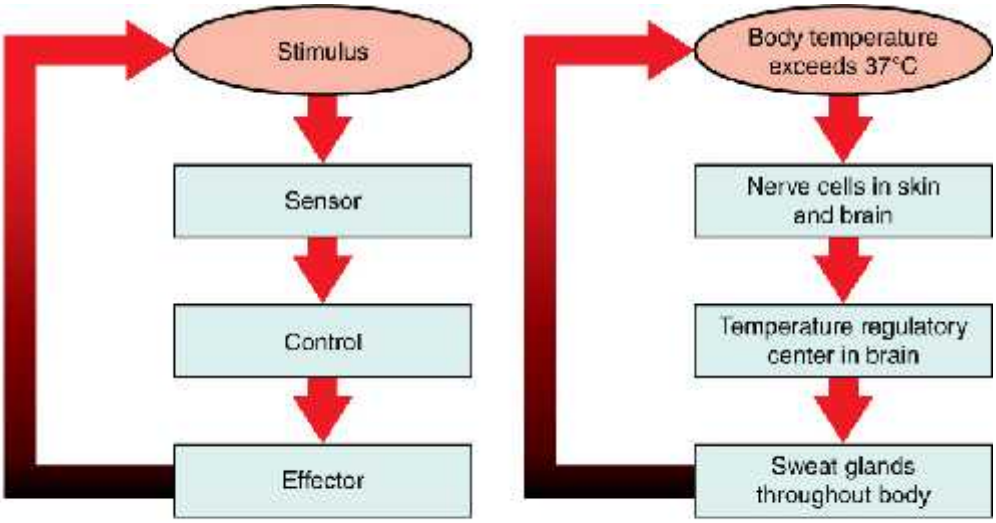
But this viewpoint has evolved in recent years and it is now believed that all those billions neurons in the cerebellum are there for a reason. It is now believed that they play a pivotal role in many cognitive and language functions, as well as in the regulation of our emotions and behavior. 56

"The big surprise from functional imaging was that when you do these language tasks and spatial tasks and thinking tasks, lo and behold the cerebellum lit up," Schmahmann says. 57

Through his research at Massachusetts General Hospital, Schmahmann has developed a theory he calls "Dysmetria of Thought." Basically, his hypothesis is that the cerebellum fine-tunes and coordinates our learning and thinking just like it fine-tunes and coordinates muscle movements. And that when there is structural or functional damage to a particular "microzone" of the cerebellum, it impacts the workings of the cerebral mind in a specific manner. 58

The definition of dysmetria is actually the lack of coordination or the undershoot or overshoot of movement. "Dysmetria of movement is matched, in the cognitive realm, by an unpredictability and illogic to social and societal interaction. The overshoot and inability in the motor system to check parameters of movement are equated with a mismatch between reality and perceived reality, and erratic attempts to correct errors of thought and behavior." 59

To understand how this works, we first have to understand how the cerebellum operates. I am going to simplify things here, because my intent is only to help you to understand the big picture. Basically the cerebellum regulates behavior around a homeostatic baseline. 60 Homeostasis, derived from the Greek words for "same" and "steady," refers to any process that living things use to actively maintain fairly stable conditions necessary for survival. 61



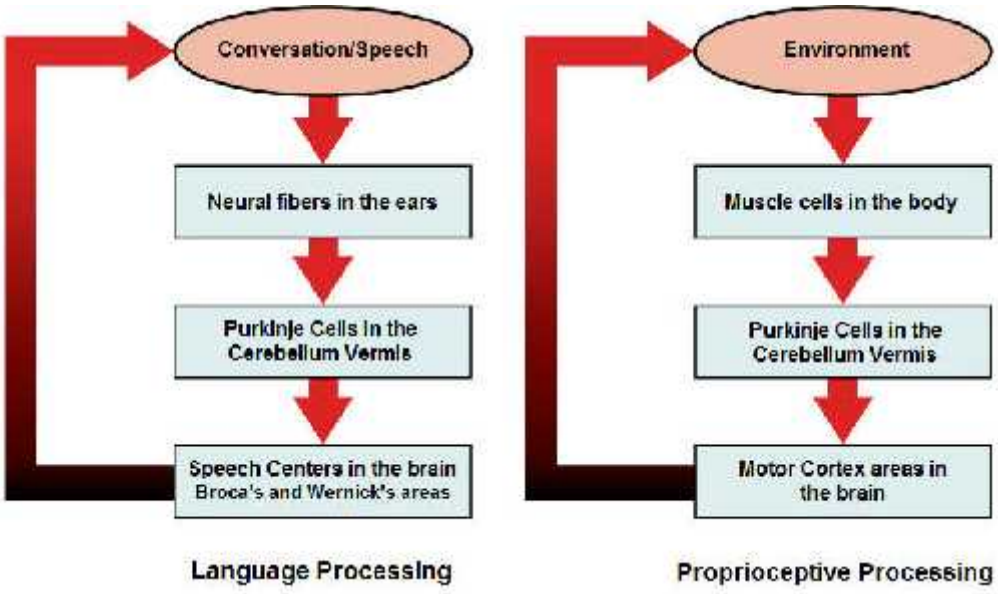
(a) Negative feedback loop (b) Body temperature regulation

For instance, the human body uses a number of processes to control its temperature, keeping it close to the average norm of 98.6 F (37 C) degrees.

One of the most obvious physical responses to overheating is sweating, which cools the body by making more moisture on the skin available for evaporation.

> I want to note here that Meaghan's homeostasis in this regard is not normal. When exposed to even the slightest heat, she sweats profusely.

Now, let's plug in some variables of our own into a hypothetical cerebellar homeostatic loop. Again, I am purposely keeping this model very simple.



What we see, is that the one area the two feedback channels, both of speech and movement, have in common is the cerebellum, in particular the cerebellum *vermis*. I think this is what Schmahmann is getting to with his dysmetria theory. The cerebellum, with all its billions of neurons, most of which are Purkinje cells, acts upon stimuli it receives in some way before moving it forward into the final centers in the cerebral cortex.

How the cerebellum acts on the stimuli depends on what form it receives it in.

If poor proprioceptive sensations are being fed into the cerebellum from the eyes, ears and vestibular system, the homeostatic balance of the brain and body is going to be off.

The cerebellum can only work with the information it is given, and if it is not getting enough data from the body, the data it relays to other parts of the brain is going to be flawed or insufficient.

1. If you feed incorrect or incomplete data into the control system, you are going to get incorrect or incomplete data out, resulting in dysmetria.

2. If you do this on a continuous basis, the dysmetria will get progressively more pronounced. (When movement dysmetria gets worse it results in a form of ataxia; when speech dysmetria gets worse it results in a form of apraxia.)

3. With so many billions of neurons at play, a genetic or abnormal "microzone" in the cerebellum vermis, could easily result in all the symptoms of autism.

The question is, which comes first, the abnormality causing the dysmetria or the proprioceptive dysfunction causing the abnormality? We will explore this further in the next chapter. (HINT: It happens in the womb.)

We can see evidence of the cerebellum's involvement in autism by the way they walk, talk and the difficulty they display with hand eye coordination. In fact, many individuals have symptoms of ataxia not just dysmetria.

Either way, control and coordination of movement does not come easy to many individuals with autism, and, as my daughter points out, the more complicated the movement, the more difficult it is for them.

> I get so annoyed that I can't control my body. My mind is a slave to my body. I really don't want to do half the things I do, but my body makes me.
>
> People think that I am stupid because I have difficulty with sports, but you try to learn sports when you can't feel or differentiate your body parts. It is not so easy. I understand what I am supposed to do perfectly well. But again, my body does not pay any attention to my mind.

If, like Jonathan, you lack a cerebellum, your master organizer for coordinating thought, emotion and movement is missing, BUT you still have all the sensations in tact. It is just going to take longer for everything to come together.

If, on the other hand, your sense of proprioception off or missing - the muscle sensory information your body takes in is not going to be reliable, so your cerebellum may be working, but it is working with bad information.