Facebook: Brock Post – Post 3 Dysmetria of Thought
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Dysmetria of Thought

The cerebellum, also known as the "little brain," has several roles that include receiving sensory information, learning motoric movements, modifying movements, controlling mood, affect, emotion and regulating immune functions. No matter the role, I like to think of the cerebellum as a major integration center. The input-to-output projection ratio of the cerebellum is 40:1 which means that the cerebellum is responsible for receiving and processing a lot of information. Seeing as there are 20 million projections from the frontal lobes (an area where depression is known to live) to the cerebellum, I can't help but think that altered cerebellar function or decreased communication between the cerebellum and brain can be a causative factor in depressive symptoms.

One way the cerebellum and the frontal lobe communicate is through planning thoughts and movements. Our interaction with our world depends on this communication. When our frontal lobe decides that it wants to do something, it immediately begins talking to our cerebellum. The cerebellum helps the frontal lobe make the best and most accurate decision possible. It does this through a feedforward, efferent copy, feedback mechanism.

The cerebellum will receive information from the frontal lobe on what it wants to do. The cerebellum will then observe and communicate with the frontal lobe certain things such as joint position, where the body is in space, proprioception, head position etc. This is called "feedforward." The brain appreciates the cerebellum's communication and comes up with a specific action plan. That plan is then sent back to the cerebellum and also an area in the spinal cord called the ventral horn cells. The ventral horn cells and the cerebellum collaborate on their plans right before the movement and essentially give the frontal lobe their opinion on best motor output. This is called efferent copy. The frontal lobe then executes the movement by way of descending motor pathways. Meanwhile, several receptors are communicating with the cerebellum on what is actually occurring so the movement can be the best possible. This is the feedback portion.

The deep nuclei of the cerebellum offer the one road that provides this efferent information. The fastigial nucleus is the most medial and seems to fire most during the feedback portion. The interposed, composed of the globus and emboliform, seems to be most involved in the efferent copy

portion and the dentate nucleus, which is the most lateral, seems to be most involved with the feedforward portion.

Although we did not describe the specific pathways involved in this communication, it should make us aware of just how much and how often the cerebellum and frontal lobe are communicating throughout the day. Many of these pathways have become so efficient that we do not have to think about performing movements. However, when there is a breakdown, or a decreased frequency of firing in these communication pathways, the movements become less simple. We can see this on a neurological exam when something as simple as touching one's nose becomes difficult. These movements become "dysmetric" or broken down. One very important consideration is that there is not only dysmetria of motor movements, there is also dysmetria of thought. The same process described above happens when a patient thinks or visualizes certain things. If the cerebellum is not firing optimally, people can develop altered thought patterns or dysmetria of thoughts. This pathway is important to keep in mind when we talk about the effects of exercise on mood and cognitive function.

Take Home Points:
-The cortex and the cerebellum are constantly communicating
-The cerebellum is not only involved in modulating motor movement, it is also involved in higher cognitive functions.
-If during physical examination there are signs of cerebellar dysfunction, it is beneficial to ask the patient about mood, emotion and behavior.

A study done at Duke University showed that aerobic exercise has the same effect as Zoloft on remission of Major Depressive Disorder after just four months. What does this mean from a functional neurological standpoint? This means that increase activation of peripheral tissues create more communication between the brain and the rest of the body, essentially creating a positive central effect on thoughts and emotion. If a patient has the choice to take an antidepressant such as Zoloft or increase their aerobic activity, the latter may be more beneficial in the long term and there is research to prove it. The cerebellum appreciates novel or new stimulation. Several studies have shown that engaging in physical exercise and mastering a new skill enhance self efficacy and self esteem, thus alleviating depressive states of mind.

Very simply, proprioceptive information is gathered by muscle spindles and golgi tendons in the peripheral tissues. This information is sent up specific spinocerebellar tracts to their appropriate destination. This constant barrage of proprioceptive input keeps the cerebellum actively working. All the while, the cerebellum is communicating with the rest of the cortex about the information that is being received. When we exercise we not only increase blood blow, we activate the brain. The cerebellum relies heavily on stimulation and exercise is one really great way to stimulate it. So I believe that it is not too far off in saying that when we exercise we can create positive neuronal plasticity that can create a central effect in augmenting our emotions and behavior.

Take Home Points:
-Increased exercise can increase brain function and alleviate depressive moods.
-Specific cerebellar rehabilitation exercises can have a central consequence on higher cognitive areas in the brain.
-Antidepressant therapy can be augmented with exercise or even possibly replaced by exercise

Let's return to talking about the deep cerebellar nuclei for a moment. When the brain sends a feed forward signal to the cerebellum, a very powerful excitatory signal is sent to the lateral dentate nucleus and to the cerebellar cortex. Proprioceptive information to the cerebellar nuclei can be overexciting. This is why the cerebellar cortex is excited, so it can inhibit the deep nuclei and create smooth and coordinated thoughts and movements. This is essentially a system of checks and balances. The neurons responsible for the inhibitory effect are the purkinje cells. This is important because if the system fails to excite both areas, the cerebellum can not inhibit itself and this can lead to faulty movement and thought patterns.

Anatomical and functional lesions of these deep nuclei, especially the fastigial nucleus, have also been shown to be present not only in patients with altered motor patterns, but with psychiatric conditions such as the schizophrenia, depression, ADHD, autism, etc. This may describe why "dysmetria of thought" is something very real. There exists a functional connection between the cerebellum and the cerebral cortex.

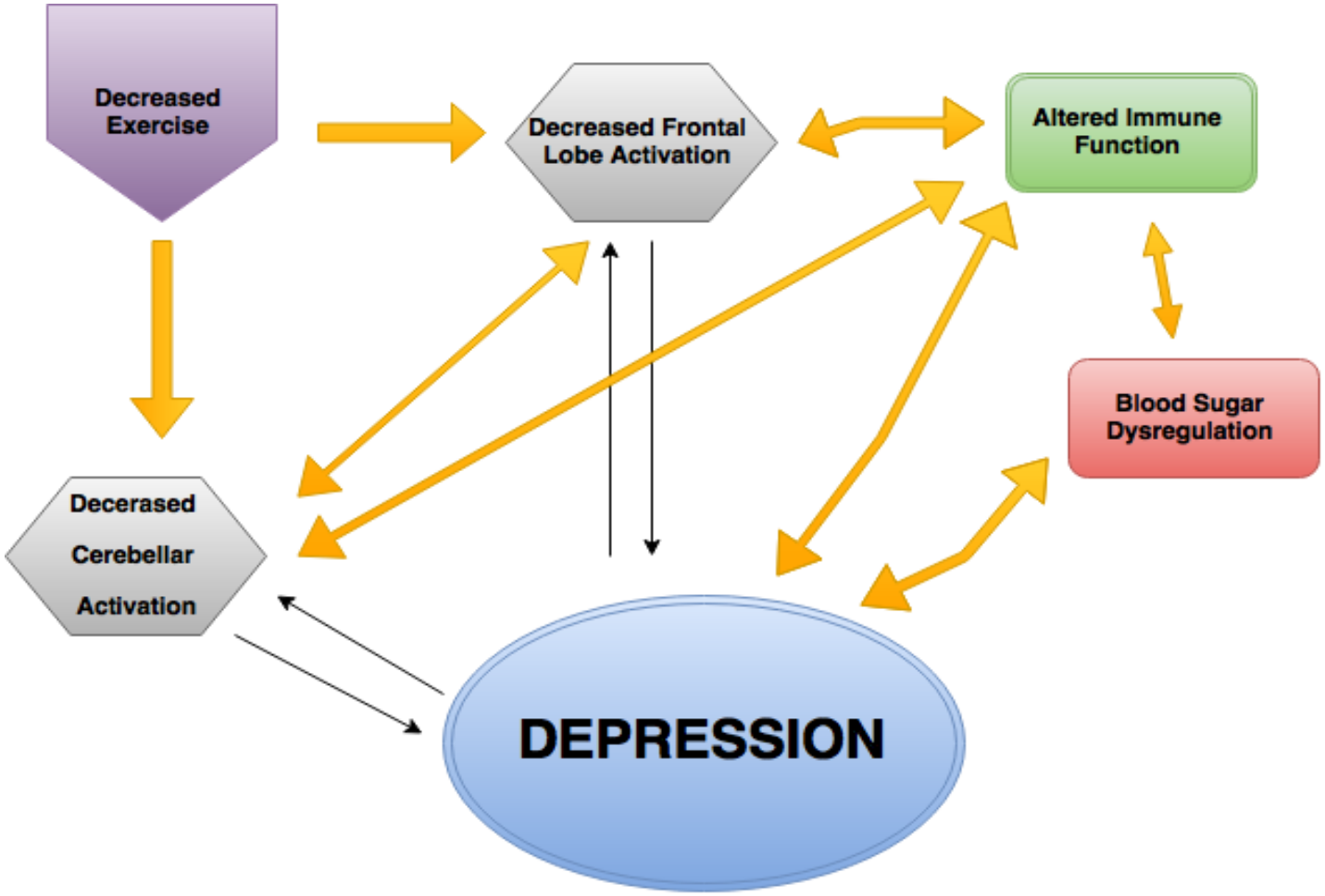
The cerebellum is connected to the primary motor cortex via the dentatorubrothalamocortical pathways. This means the pathway originates in the dentate nucleus of the cerebellum, travels to the red nucleus (rubro) of the brainstem, then off to the thalamus and the cortex. The ventral lateral nucleus of the thalamus conveys sensorimotor information to the frontal lobe. This is a traditional pathway for movement. This pathway, however, also involves many different thalamic regions that connect in a more divergent fashion to areas of the cortex that are involved with cognitive and affective functions. Another example of how the cerebellum plays a role in cognitive and emotional function is by altering neurochemical pathways. Stimulation of the dentate nucleus of the cerebellum has been shown to allow the release of dopamine in the medial prefrontal cortex. Along with serotonin depletion, dopamine depletion has long been a suspect as a causative factor of depressive symptoms.

Take Home Points:
-Traditional motor pathways originating in the cerebellum play a role in mood and affect.
-Specific neurological exercises that impact the lateral cerebellum may increase dopaminergic output.

Movement is crucial for brain health. There is so much more to expand upon, especially in this area. The neat thing is that activating the cerebellum can help the patient and the brain in so many more ways we may give it appreciation for. Next week I will talk about the cerebellum's role in the immune system, and what that means for a patient suffering from depression. Until then, please take

a look at the web diagram I created to show how all of these topics we are covering communicate back and forth with one another when it comes to depression (of course, more will be added as we go).

Multifactorial Causes of Depression



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