Becoming Better Therapists

Understanding Motor Sensory Apparatus

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Our motor sensory apparatus requires three sets of inputs to respond to our movement environment: ocular, vestibular, and proprioceptive. These three sets determine the quality of output or motor response. This is a bottom-up approach. The bottom-up strategy relies on the inputs to derive output. The top-down approach includes motor planning.

Our somatic experience is based on perception. How we perceive and respond to the world around us is directly affected by the three lenses of perception: sensory, limbic, and thought. There is seemingly a lot going on with the input and response relationship of our motor sensory apparatus. We can dissect these inputs and outputs into these three general categories. Those three categories can then be expanded into subsets. The sensory set is based on how our structure is relaying somatic inputs from our five primary senses: smell, taste, touch, hearing, and vision. There are non-primary senses as well. Proprioception is considered one of them. Proprioception is the set of inputs that allows us to close our eyes and touch our nose. There is an inner map of where our body is in space and the relationship to movement. Without proprioception, we would not be able to develop fine motor skills.

Proprioception relies on the other two motor sensory apparatus inputs to respond appropriately. Impede any of these inputs, and the output will be impeded as well. The three inputs of sensory apparatus and the three of lenses of perception are intrinsically interdependent. Understanding this helps us become better therapists as we fundamentally cannot separate or compartmentalize any of these attributes when working with people.

Ocular

There are two sets of inputs for our vision: foveal and peripheral.[1] Simply put, foveal vision is what we directly see and interpret. When playing darts, as we focus on the bullseye, we are learning to hit the target. With each subsequent toss we calibrate the sensory motor inputs with the motor output. The complex coordination of bones, joints, connective tissue and muscles is a non-thinking process. Instead the brain can focus on the goal and incrementally calibrate achieving that goal with each toss.

Our peripheral vision is a much different set of inputs. We may or may not be able to distinguish how our foveal and peripheral inputs are creating the experience of our visual field. Whereas the majority of input from our foveal vision is conscious, the majority of input from our peripheral is non-conscious. Our peripheral inputs are registered by the limbic center's vigilance to keep us safe. Our peripheral vision can stimulate associations and emotions. Our peripheral vision brings awareness to our environment that our foveal is not picking up. For example, when someone throws a ball our way and we "instinctively" duck or evade being struck. When we look at the world around us with "soft" eyes, we can start to develop a greater connection to our peripheral vision.

Vestibular

Our vestibular system is a part of the autonomic nervous system. The inputs are part of the non-conscious, or non-felt sense of the motor sensory apparatus. The function of the vestibular system has been compared with a GPS system of the body. I also like to think of the vestibular system as a gyroscope that compares head/neck/spine position in relation to gravity.

The vestibular system has several roles. The commonly understood role is our balance sense. The relationship of head position and axial alignment of spine contribute to our balance. When we consider walking is simply moving from stance phase on one leg to stance phase on the other, our balance sense is key in that relationship. The vestibular system also provides spatial sense and direction changes. The direction we move in is calibrated by the vestibular inputs so that we can accomplish a motor task. The third and certainly not the least, is the vestibular-ocular reflex.[2] This coordinates eye to

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[1] https://en.wikipedia.org/wiki/Visual_system "Along with proprioception and vestibular function, the visual system plays an important role in the ability of an individual to control balance and maintain an upright posture"

[2] https://en.wikipedia.org/wiki/Vestibulo–ocular_reflex "

cranium position. This reflex allows us to orientate our eyes to the horizon without conscious thought. When we consider the survival strategy of evading danger. We can turn our head, use our visual field to qualify our response as we utilize locomotion to evade danger. This is extremely useful when being chased by a predator. Eye tracking drills and neck flossing drills while walking are ways to challenge and develop the vestibular-ocular reflex.

Proprioception

Proprioception can be categorized as the sensory somatic inputs that our body is sending to the brain.[3] Proprioception makes up for both the felt-sense and the non-felt sense inputs. I further categorize the group of felt-sense inputs as our kinesthetic sense. We have conscious awareness of those inputs. Bones, joints, ligaments, connective tissue, fascia, muscles and skin have an array of receptors that are relaying information to the brain for processing. We have a conscious relationship to some of those inputs. This makes up our kinesthetic field of awareness.

The field of proprioception that does not register consciously in our experience is very important. These inputs allow for us to have complex motor output without having to think about all the individual pieces or building blocks of movement for that motor task to be accomplished. For example, when we walk, we don't have to think about lifting one leg, balancing on the other, or engaging contralateral arm swing. Our nervous system takes care of all those details automatically. Up to 80% of the sensory input from ligaments go directly to the cerebellum. The spinocerebellar tract directs this information so that our motor output is expedited because it is non-thinking.[4] Ligaments will act as neuromuscular switches. When sufficient load is detected, the cerebellum will deactivate the muscles that would contribute to that load. This is how joint position contributes to muscle response. All movement is contingent to these non-felt sense inputs.Joint flossing is an excellent modality to develop the attributes of proprioception.

The Human Experience
The Three Lenses of Perception

There are three lenses that color the perception of our reality. Our sensations, emotions, and thoughts are in an interdependent relationship interpreting and responding to the environment as it changes around us.

Sensory

Most sensations are processed in our limbic center. The limbic center receives the neurological inputs from the peripheral nervous system. That information is then routed to the appropriate area in the brain so that the nervous system can respond. This is referred to as the input / output relationship that makes up the kinesthetic awareness that provides context to respond to our environment.[5]

Limbic

The emotional center of our brain, the limbic center, is perpetually interpreting the information received from our environment. As that information is received, it is processed, collated, prioritized so that we can respond.[6] Our memory centers look for similar traits so that an association can be attached to the neurological inputs. Once that happens, we form an emotion based on the association. Associations bring past events into the present moment.

The vestibulo-ocular reflex is driven by signals arising from the vestibular system of the inner ear".

[3] https://en.wikipedia.org/wiki/Proprioception "The central nervous system integrates proprioception and other sensory systems, such as vision and the vestibular system, to create an overall representation of body position, movement, and acceleration"
[4] https://en.wikipedia.org/wiki/Spinocerebellar_tract "into the cerebellum, where unconscious proprioceptive information is processed"
[5] https://en.wikipedia.org/wiki/Sensory_nervous_system "the primary processing center of the somatosensory cortex as it receives significantly more input from the thalamus"
[6] https://en.wikipedia.org/wiki/Limbic_system "the limbic system is involved in lower order emotional processing of input from sensory systems"

Thought

Our thoughts are a product of our conditioning. The information, both conscious and unconscious, is moved up to our forebrain. Here we can cognitively process the information from our environment. There are two distinct tracts we take when we engage the cognitive thought process. We are either reactive or proactive. Reactive thought is when the associations from the limbic inputs pull us out of the present moment. We react to the environment as past events are brought forward. Proactive thought is when we engage mindfulness and make a choice on how we can appropriately respond to the changing environment around us.[7]

Summary

Our motor sensory apparatus is a complex array of inputs that in turn define the output. Our perception of our environment is intrinsic with the somatic inputs. We have two fundamental strategies that become a feedback loop so that we can respond.

One strategy is the bottom-up. The bottom-up strategy relies on the inputs to derive output.[8] The other strategy is top-down. The top-down strategy relies on cognition and need. We have a need to initiate a motor task. As that task is evolving to meet the goal, we shift to the bottom-up strategy. Bottom-up is regarded as feed-back, and top-down is regarded as feed-forward. When we work with our patients and clients, it is important to engage both of these aspects. I call this completing the feed-back loop.

[7] https://en.wikipedia.org/wiki/Thought "Thinking allows humans to make sense of, interpret, represent or model the world they experience"
[8] https://en.wikipedia.org/wiki/Top-down_and_bottom-up_design " Bottom-up processing is a type of information processing based on incoming data from the environment to form a perception"