

11.5.4

Cranial Nerves

There are lots of great pictures of cranial nerves in any internet search. [CLICK HERE](#) to load an image search of cranial nerves and check some of the thumbnails out to help you get an idea of where these nerves are at. You will also study the location and anatomy of these nerves in Bio 264 lab.

Remember the friend that you took to the emergency room after she got hurt sledding? When the doctor shined a light into her eyes to check her reflexes he was actually performing a small part of a cranial nerve examination. Doing an examination of the cranial nerves can provide valuable clinical information about the state and condition of the nervous system. There are twelve pairs of cranial nerves that originate in the brain and carry information to and from the brain. The cranial nerves are designated by Roman numerals (I - XII) and by names. The numbering starts with those most superior and anterior and progresses posteriorly and inferiorly. The names usually correspond to either the function or the structure of the nerve, hence, the Optic nerve is involved with vision and the Trigeminal nerve has 3 branches. These nerves can carry both sensory and motor information, just as we have seen with spinal nerves. We can subdivide the sensory information further into 1) special senses and 2) general senses. The motor information can also be subdivided into 1) somatic motor and 2) parasympathetic. In contrast to the spinal nerves, however, not all cranial nerves carry both sensory and motor information. In fact, three cranial nerves carry purely sensory information and four cranial nerves carry almost entirely somatic motor information. The remaining cranial nerves carry some combination of sensory, somatic motor and parasympathetic information. Because of the clinical importance of the cranial nerves we will discuss further the major functions of each one and some of the common symptoms observed when the nerves are damaged.

Cranial Nerve 1 (CN I): Olfactory

Major Function: Sensory - Smell (olfaction)

Lesion: Loss of smell on the affected side

*Note: Loss of smell doesn't necessarily confirm a CN I lesion as an upper respiratory tract infection etc. could also decrease olfaction.

Cranial Nerve 2 (CN II): Optic

Major Function: Sensory - Vision

Lesion: Blindness on affected side and loss of pupillary light reflex (Described Later)

Cranial Nerve 3 (CN III): Oculomotor

Major Function: Somatic Motor to four of the six extrinsic muscles that move the eye

ANS Innervation: Parasympathetic to sphincter pupillae muscle for constriction of the pupil

Lesion: Eye deviation causing double vision, pupil dilation and loss of pupillary light reflex

Cranial Nerve 4 (CN IV): Trochlear

Major Function: Somatic Motor to superior oblique eye muscle

Lesion: Eye deviation causing double vision

Cranial Nerve 5 (CN V): Trigeminal

Major Function: Sensory - General sense from the face and forehead (including sensation of much of the mouth and anterior 2/3 of the tongue)

Motor: Somatic Motor to muscles of mastication (chewing muscles)

Lesion: Loss of sensation in face and forehead or increased sensitivity to pain known as Trigeminal neuralgia. (Described Later). Also, muscle weakness of the muscles of mastication

Cranial Nerve 6 (CN VI): Abducens

Major Function: Somatic Motor to lateral rectus eye muscle

Lesion: Medial deviation of the eye causing double vision

Cranial Nerve 7 (CN VII): Facial

Major Function: Sensory - Taste from the anterior 2/3 of the tongue and Motor - Somatic Motor to the muscles of facial expression

ANS Innervation: Parasympathetic to salivary glands and lacrimal glands

Lesion: Facial paralysis often called Facial or Bell's palsy. (Described Later). Decreased ability to taste (particularly on the anterior 2/3 of the tongue). Decreased salivation and lacrimation (tearing)

Cranial Nerve 8 (CN VIII): Vestibulocochlear

This nerve is composed of fibers from two branches: the vestibular nerve and the cochlear nerve, each with specific functions

Major Function: Sensory - Vestibular branch senses balance. Cochlear branch if for hearing.

Lesion: Vestibular-If only the vestibular branch is damaged it would result in loss of balance and dizziness (vertigo). Cochlear-If only the cochlear branch is damaged it would result in loss of hearing. If the lesion occurs after the two branches converge then you could have a combination of the above symptoms.

Cranial Nerve 9 (CN IX): Glossopharyngeal

Major Function: Somatic Motor to swallowing muscles of the throat and Sensory - Taste to the posterior 1/3 of the tongue and Sensory from the pharynx, carotid body and carotid sinus

ANS Innervation: Parasympathetic to salivary glands

Lesion: Trouble swallowing, loss of taste (particularly to posterior 1/3 of tongue), decreased ability to sense and respond to blood pressure changes and decreased salivation

Cranial Nerve 10 (CN X): Vagus

Major Function: Motor - Somatic Motor to throat muscles involved in swallowing and speech and Sensory - Taste from the posterior tongue. Also, sensory from throat, thoracic and abdominal organs

ANS Innervation: Parasympathetic to thoracic and abdominal organs regulating things such as heart and respiratory rate and gastrointestinal peristalsis etc.

Lesion: Trouble swallowing and hoarse speech uvula deviation away from side of lesion

Cranial Nerve 11 (CN XI): Accessory

Major Function: Somatic motor to sternocleidomastoid and trapezius muscles

Lesion: Muscle weakness and trouble turning the head and elevating the scapula

Cranial Nerve 12 (CN XII): Hypoglossal

Major Function: Motor - Somatic Motor to tongue and throat muscles

Lesion: Tongue deviation toward the side of the lesion; trouble manipulating food with tongue and trouble swallowing.

Some Important Cranial Nerve Functions and Clinical Conditions

Pupillary Light Reflex

The pupil diameter is closely regulated and responds to the amount of light available. The pupil will dilate in a dark environment to allow in more light and constrict in a light environment to restrict the amount of light entering the eye. This dynamic control has two branches. The afferent (sensory) limb of the reflex is regulated via CN II, which sends action potentials to the control center in the midbrain regarding light intensity. The midbrain then sends signals through the efferent (motor) limb of the reflex, which is CN III, to constrict the pupil. Dilation of the pupil is achieved via a sympathetic nerve which exits the CNS in the spinal cord and is not mediated by a cranial nerve. **Clinical**

Manifestation: When you shine a light into a patient's left eye the optic nerve should increase signals to the midbrain which will then cause the oculomotor nerve to stimulate the constrictor pupillae muscle to contract, thus constricting the pupil of the left eye. This is referred to as the direct light reflex. In addition to pupil constriction in the left eye, the pupil of the right eye will also constrict, which is known as the consensual light reflex. Any deviation from this pattern represents a pathological condition that would warrant further investigation.

Trigeminal Neuralgia (Tic Douloureux)

CN V gets its name from the fact that it has three branches, trigeminal means "three twins." The three branches (V1, V2, and V3) are responsible for providing innervation to specific regions of the anterior head. V1 (ophthalmic) supplies sensory innervation to the forehead down to the nose. V2 (maxillary) supplies sensory innervation to the maxillary region inferior to the nose and superior to the lower jaw. V3 (mandibular) supplies sensory innervation to the mandibular region or the lower jaw and anterior to the ear, as well as somatic motor innervation to the muscles involved in chewing. The maxillary and mandibular branches of the trigeminal nerve are also responsible for supplying sensory innervation to the teeth.

When you "visit" the dentist to fill a cavity the dentist tries to minimize the trauma by anesthetizing the area that he is going to subsequently abuse with various power tools! The most common way this is done is by performing a "nerve block" in which inject lidocaine, or some other local anesthetic is injected into the area surrounding either the maxillary nerve, if they need to work on your upper teeth, or the mandibular nerve, if they are working on your lower teeth. This "nerve block" literally blocks or prevents action potentials from being sent to your brain.

Trigeminal neuralgia involves intense episodic pain in any or all three facial areas supplied by CN V. It has been described as one of the most intensely painful conditions known to man! It is characterized by hypersensitivity of the nerve to the point where a light touch on the face or even a mild breeze can cause intense, debilitating pain. Those with

trigeminal neuralgia often describe the pain as burning, electrical, stabbing, crushing, or even exploding pain. And if that doesn't sound bad enough it is also quite difficult to control. Fortunately, there are several pharmacologic treatments to help manage the pain.

The leading theory to explain the cause of this condition involves compression of the myelin sheath around the nerve, likely due to an enlarged artery or an aneurysm. This compression can lead to the destruction of the myelin sheath, causing the nerve to become hypersensitive to the slightest stimulation. Likewise, this can also make it difficult for the trigeminal nerve to stop the afferent pain signals once they have begun.

Facial Palsy (Bell's Palsy):

Bell's palsy is a condition that results in partial or complete facial paralysis on one side of the face, although some cases can manifest bilaterally. This is a result of a lesion of the Facial Nerve (CN VII), most likely due to inflammation although the precise cause is unknown. The leading explanation is that a dormant herpes viral infection becomes reactivated causing the facial nerve inflammation. Stress, trauma, environmental and other factors may precipitate the reactivation of the virus. There are other causes of facial paralysis, the most common being a brain tumor or stroke.

Treatment: The symptoms of Bell's palsy generally resolve on their own over the course of days to weeks, but corticosteroids administered early after onset of symptoms has been shown to improve recovery. Because the affected eyelid is often unable to close, it is important to prevent drying of the cornea by using eye drops and/or physically closing the eye! (Taping the eye closed and using an eye patch can be helpful and who doesn't love a pirate, arrrrrrr!)

Speaking of pirates, it has been rumored that pirates wore eye patches so that as they went from the deck where it was very bright to the rooms below deck where it was quite dim they could remove the patch and maintain their ability to see. Based on the consensual light reflex described above, it is unlikely that pupil constriction/dilation would be the mechanism allowing pirates to see as they move from light to dark environments. Keep this in mind as you learn about vision in subsequent modules and, in particular, the rhodopsin cycle.

A cranial nerve examination is an important part of any physical examination where you suspect that there might be some level of brain trauma, but particularly when there are no clear symptoms that suggest brain injury. Because of their connections with various parts of the brainstem and cerebrum, functional deficits related to one of the cranial nerves can provide valuable insight into the location and severity of damage. Often a medical provider can perform a brief cranial nerve exam at the same time that they are performing their routine physical exam. For example, when they look at your throat and you say "ahhhhhh" they are not only looking for redness and inflammation etc. associated with viral or bacterial infection. After all, do you think your throat would immediately become redder by doing this? The answer is no. The physician is really looking for elevation of the palate or deviation of the uvula, which would signal a cranial nerve problem. The following is a link to a YouTube video of a brief cranial nerve examination.

<https://books.byui.edu/-PfY> (Video Transcriptions Available)



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