Cranial Nerves--- Beyond the Mnemonics
Cranial Nerves
The Inferior Aspect of the Brain

- 12 pairs, numbered with Roman numerals
- Large, easily seen
- Notice circle of Willis
- CN-I and II emerge directly from brain
- CN III-XII from brainstem
Introduction To CNs

- I-II-III-IV at midbrain level
- (I and II just above midbrain)
- V-VI-VII-VIII at pons level
- IX-X-XI-XII at medulla level
- They may have motor (efferent) components
  - Motor tracts leave cranium
- They may have sensory (afferent) components
  - Bring information to cranium
To learn CNs, spare your memory!

• Get some mnemonics in place:
  • We all know the CN acronyms
    – OOOTTAF(A/V)GVAH
  • Learn the CN functions
    – SSMMBMBBSBBMM
    – S=sensory, M=motor, B=Both
And now without further ado...

THE 12 PAIRS OF CRANIAL NERVES
This CN is SUPER SPECIAL:
It does only one thing—smells!
It also has the distinction of going directly into brain regions with connections to the limbic cortex (emotional cortex)
AND it is rarely tested (chart reviews typically stated CN II-XII)
Where olfactory fibers emerge

Olfactory fibers start in the nasal mucosa
• Trauma to the nasal region may damage nasal fibers, cause loss of CSF and meningeal infections

• Aging may result in loss of appetite and weight loss. This is thought to be secondary to anosmia (loss of sense of smell)

• Neurodegenerative diseases, such as AD, PD, and HD, may result in anosmia
CN-II: Optic

- The nose is the organ of smell, the ear is the organ of hearing, but the organ of vision is...
• You can compare the eye to a camera lens: it transduces light and this is what it sees:

• Your brain assembles the images sent in order to be truly representational.
CN-II: Optic

- The optic nerves are large and composed of 1.2 million axons
- The nerves converge onto the chiasm (decussation point)
- And then onto the thalamus
Damage to CN II—Field Defects

Diagram showing the visual pathway from the eyes to the brain, highlighting the effects of damage to CN II on visual field defects.

- **Left Eye**:
  - temporal field
  - nasal retina
  - Optic Nerve
  - Optic Chiasm
  - lateral geniculate body
  - Optic Radiation
  - Visual Cortex

- **Right Eye**:
  - nasal field
  - temporal retina
  - Optic Nerve
  - Optic Chiasm
  - lateral geniculate body
  - Optic Radiation
  - Visual Cortex

**Normal Vision**

- Left Eye: Circles
- Right Eye: Circles

**Optic Nerve: Right Anopsia (=blind)**

- Left Eye: Circle
- Right Eye: Circle

**Optic chiasm: Bitemporal hemianopsia**

- Left Eye: Half-circle, Half-circle
- Right Eye: Half-circle, Half-circle

**Optic tract: Homonymous hemianopsia**

- Left Eye: Half-circle, Half-circle
- Right Eye: Half-circle, Half-circle
Paris

- Normal View
- With a Bi-temporal Hemianopsia
Homonymous Hemianopsia (Right)

- **Normal**
- **Hemianopsia**
Damage to CN II—Field Defects

• Besides damage to the optic nerve and chiasm, insult to the occipital lobe can produce cortical impairments
• Bilateral occipital lobe impairments may cause cortical blindness since the cortex may not be able to make sense of visual information
CN III—Oculomotor
CN IV-Trochlear
CN VI-Abducens

- Motor to the eye
- Light accommodation (pupil), elevate eyelid, move eyes (extra-ocular)
- But definitely must be aware of visual impairments so we know what the patient is going through
  - E.g. ptosis, double vision (diplopia), pupil accommodation difficulties, etc...
CN IV - Trochlear

- CN IV has an interesting characteristic:
- It has the longest intracranial course, but is the smallest CN in terms of axons
- While all other CNs exit from the anterior, this one exits from the posterior brainstem and courses to the anterior aspect,
- This long pathway makes it vulnerable to damage from trauma
  - Vertical diplopia
Three branches, two sensory that cover the upper and middle face and one fabulous mixed branch that is very important as it innervates:

- all muscles of mastication
- Anterior 2/3 of tongue for general sensation
- and some speech muscles.
CN V—Trigeminal

Six week old embryo

Inferior aspect of adult brain

• Remember this?
CN V—Trigeminal
Grows up to be this monster nerve!

Of special concern to dentists, from the ADA literature
Damage to CN V—Trigeminal

Motor damage is rare due to strong bilateral innervation

Sensory damage includes loss of sensory input to anterior 2/3 of the tongue, loss of blink, sensory disturbances to the face, etc...

Trigeminal Neuralgia (Tic Douloureux): severe, shooting pain along course of nerve branch...sometimes called the suicide disease
• A very descriptive name: this CN is important for all the muscles of facial expression
• Mixed motor and sensory
  – Sensory: Gustation to the anterior 2/3 of tongue
  – Motor: Innervates the muscles of the face and scalp
  – Motor: Innervates the submandibular, sublingual and lacrimal glands.
The relationship of CN V and VII
• Upper face has bilateral input, Lower face has contralateral input
Damage to CN VII-Facial

- Can alter articulation
- UMN damage will not produce paralysis
- LMN damage may paralyze facial muscles
  - Bell’s Palsy being the prime example
  - Viral infection, some tick bites, etc...
  - Common, affecting 30,000+ in the US annually, mostly resolving spontaneously
Damage to CN VII-Facial

- Bell’s Palsy
  - Flattened nasolabial fold, asymmetry
Famous People with Bell’s
CN VIII - Vestibulocochlear

- Mediates auditory information and sense of movement
- Mostly sensory
- Dampens output of cilia
Damage to CN VIII-Vestibulocochlear

- Ipsilateral hearing loss, trauma, tinnitus, vertigo, etc...
CN IX-Glossopharyngeal

- Both sensory and motor
- Sensory: gustation and general sensation from posterior 1/3 of the tongue. Also sensory to soft palate, pharynx and Eustachian tube
- Motor: salivation, constrictor muscles of pharynx

The Glossopharyngeal Nerves -IX

- Parotid gland
- Parasympathetic fibers
- Glossopharyngeal nerve (IX)
- Jugular foramen
- Superior ganglion
- Interior ganglion
- Otic ganglion
- Stylopharyngeus
- To carotid sinus and body
- Pharyngeal mucosa
- Common carotid artery
Damage to CN IX-Glossopharyngeal

- CN IX, X, and XI are close and damage to one may imply damage to all 3
- IX: loss of taste and sensation from posterior tongue, absent gag reflex, dysarthria, etc...
• Vagus (vagabond, vagrant) is the wandering nerve. It is the longest by far of all the CNs.
• It is a mixed nerve
• And captain of the parasympathetic nervous system
CN X- Vagus

- Unique to mammals
- Known as “the caretaking nerve”
- Activated when we get that ‘fuzzy, warm’ feeling
- Activated in empathy or compassion (seeing pictures of suffering)
- Theory: the stronger the emotional profile (exercise, volunteer, socialize, etc..) the stronger response of Vagus

Some Facts about Vagus

The Vagus nerve is responsible for the warm fuzzies felt while hugging.
CN X-Vagus

- Stimulated in depression and in epilepsy
CN X-Vagus: Phonation

- This CN innervates all the intrinsic laryngeal muscles
- In fact, one branch, the Recurrent Laryngeal branch, innervates all but one of the intrinsic muscles of the larynx
- The exception is the cricothyroid which is innervated by the superior laryngeal nerve
Damage to CN X- Vagus
Parasympathetic Nervous System

• Just what you would expect from perturbations to the parasympathetic nervous system:
  – palpitation (forcible pulsation of the heart), tachycardia (rapid beating of the heart), vomiting, slowing of respiration, and a sensation of suffocating, paralysis of the vocal cords and other laryngeal disorders, etc....
Damage to CN X- Vagus
SLP concerns

• Damage to pharyngeal branch:
  – swallowing deficit, loss of gag reflex, hypernasality etc...

• Damage to superior laryngeal branch:
  – Laryngeal sensory deficit, paralysis of cricothyroid

• Unilateral damage to recurrent laryngeal:
  – flaccid dysarthria

• If bilateral damage to recurrent laryngeal:
  – harsh (spastic) dysarthria
Testing CN X- Vagus

- Test IX and X together
- Say “aaaah”
- Watch for symmetrical palatal lifting
- The uvula is an indicator; deviation indicates intact side
CN XI- Spinal Accessory

- Both Cranial and Spinal components
- Innervates portions of the larynx, pharynx and velum
- Innervates the SCM and the trapezius
CN XII-Hypoglossal

- This one is easy!
- It is MOTOR TO THE TONGUE (of course!)
- It innervates almost all of the tongue muscles
Mnemonic Art for CNs
So now that we have looked at the CNs in order....

Let us make some **educated guesses** about CN supply to structures we speechies care about
Let us start with innervation to the tongue

• How many total CNs innervate the tongue? 5
• How many CNs provide sensory innervation to the tongue? 3
Sensory innervation to the tongue

• To the anterior 2/3 of the tongue:
  – CN V provide general sensory innervation
  – and CN VII provides gustatory innervation.

• To the posterior 1/3 of the tongue, CN IX provides all sensory innervation
How many CNs provide motor innervation to the tongue?

- This is easier....
- Almost all tongue muscles are innervated by the hypoglossal (XII) except for one, palatoglossus, innervated by Vagus.
How about sensory innervation to the face?

• The main CN is the ginormous Trigeminal (V) with its 3 branches, 2 of which are purely sensory.

• Additionally, Facial (VII) contributes: gustation to the anterior 2/3 tongue and other parts of the face, such as the ears.
What CNs are motor to the face?

- The facial nerve (VII) innervates all muscles of facial expression
- Trigeminal (V) innervates all muscles of mastication
Back in the day before time forgot
Lived a dinosaur, Tyrannosaurus Blot
Blot roamed the land eating all in his path
Once a joke book, just for a laugh!
He ate small things for breakfast,
And large things for lunch...
**CNs of Chewing and Swallowing**

**1. The Oral Stage**
- 1a. The oral prep stage: this includes smelling and tasting the food
- CNs?
- Sealing the lips
- CN?
- Moving the tongue
- CN?
- Mastication
- CN?

[1.7, 7, 12, 5]
CNs of Chewing and Swallowing

1. The oral transport stage: the bolus is ready to swallow
   - Elevate the mandible
   - CN? 5
   - Tongue cups and grooves
   - CN? 12
   - Posterior tongue elevates
   - CN? (hint....exception to the rule CN)
2. The Pharyngeal Stage

A complex sequence of reflexive events involving multiple muscles and nerves

a. hyolaryngeal elevation—Hypoglossal XII

b. pharyngeal timing --- X and XI

c. airway protection--- V, X, XI
   – Trigeminal dilates the Eustachian tube, Vagus elevates the velum and protects the larynx

d. UES---X
CNs of Chewing and Swallowing

- Total tally of CN for this complicated action:
  - 7 CNs working in concert
  - Olfactory
  - Trigeminal
  - Facial
  - Glossopharyngeal (taste to posterior tongue)
  - Vagus
  - Accessory
  - Hypoglossal
WELL DONE!
THANK YOU FOR BEING HERE

Questions?