Cranial Nerves

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What is a cranial nerve?

• Cranial nerves exit or enter the CNS through foramena in the skull, rather than through spinal formamena.
• 12 cranial nerves
Spinal foramena vs. cranial foramena
Cranial nerves 1-6

1. Olfactory (smell)
2. Optic (vision)
3. Oculomotor (5 muscles of orbit)
4. Trochlear (one muscle of orbit)
5. Trigeminal (sensation to face + muscles for chewing)
6. Abduccens (one muscle of orbit)
Cranial nerves 7-12

7. Facial (muscles of facial expression)
8. Vestibulocochlear (hearing & balance)
9. Glossopharyngeal (swallowing)
10. Vagus (control of the heart & gut)
11. Spinal accessory/accessory (muscles of throat & shoulders)
12. Hypoglossal (muscles of tongue)
Mnemonic for cranial nerves

“On old Olympus’s towering tops, a Finn and German viewed some hops.”
Mnemonic for cranial nerves

1. On (olfactory)
2. Old (optic)
3. Olympus’s (oculomotor)
4. Towering (trochlear)
5. Tops (trigeminal)
6. A (abducens)
7. Finn (facial)
8. And (“auditory”, i.e. vestibulocochlear)
9. German (glossopharyngeal)
10. Viewed (vagus)
11. Some (spinal accessory)
12. Hops (hypoglossal)
Functions of cranial nerves

• Special sensation
  – Smell, vision, hearing, balance, taste, oxygen, CO2

• Cutaneous sensation
  – Touch, temperature, vibration, pain, etc.

• Visceral sensation
  – E.g., sensors for blood pressure & stomach fullness

• Skeletal muscles
  – E.g., facial muscles; muscles of chewing

• Visceral motor output
  – E.g., vagus slowing heart or increasing gut contraction
CN 1: Olfactory nerve

Midline view of nasal septum
Olfactory nerves synapse onto olfactory bulbs.

Olfactory tracts: carry information about smell into cerebral cortex.
Functions of olfactory nerve

• Special sensation
  – Smell

• Cutaneous sensation
  – Touch, temperature, vibration, pain, etc.

• Visceral sensation
  – E.g., sensors for blood pressure & stomach fullness

• Skeletal muscles
  – E.g., facial muscles; muscles of chewing

• Visceral motor output
  – E.g., vagus slowing heart or increasing gut contraction
CN 2: Optic nerve
Visual system

- Retinal ganglion neurons
- Optic nerve
- Optic chiasm
- Optic tract
- Lateral geniculate nucleus (thalamus)
- Visual cortex (occipital lobe)
Functions of optic nerve

• Special sensation
  – Vision

• Cutaneous sensation
  – Touch, temperature, vibration, pain, etc.

• Visceral sensation
  – E.g., sensors for blood pressure & stomach fullness

• Skeletal muscles
  – E.g., facial muscles; muscles of chewing

• Visceral motor output
  – E.g., vagus slowing heart or increasing gut contraction
CN 3: Oculomotor nerve
Oculomotor nerve: 4 of 6 extraocular muscles (plus eyelid)
Visceral motor (parasympathetic) output of CN3: focuses lens; constricts pupil
Functions of oculomotor nerve

• Special sensation
  – Smell, vision, hearing, balance, taste, oxygen, CO2
• Cutaneous sensation
  – Touch, temperature, vibration, pain, etc.
• Visceral sensation
  – E.g., sensors for blood pressure & stomach fullness
• Skeletal muscles
  – 4 of 6 extraocular muscles; eyelid
• Visceral motor output
  – Pupil constriction; focusing lens (both parasympathetic)
CN 4: Trochlear nerve
CN 4: Trochlear nerve

- Only cranial nerve to exit the dorsal surface of brain
- Cell bodies are on contralateral side of innervated muscles: unique
Trochlear nerve: 1 extraocular muscle (superior oblique)
Functions of trochlear nerve

• Special sensation
  – Smell, vision, hearing, balance, taste, oxygen, CO2
• Cutaneous sensation
  – Touch, temperature, vibration, pain, etc.
• Visceral sensation
  – E.g., sensors for blood pressure & stomach fullness
• Skeletal muscles
  – Superior oblique (extraocular muscle)
• Visceral motor output
  – E.g., vagus slowing heart or increasing gut contraction
CN 5: Trigeminal nerve

Trigeminal nerve: only cranial nerve to exit pons
CN 5: Trigeminal nerve: muscles of chewing

- Temporalis
- Masseter
CN 5: Trigeminal nerve: cutaneous sensation to face & head

Three sensory subdivisions of trigeminal:
- Ophthalmic (forehead)
- Maxillary (cheek & nose)
- Mandibular (lower jaw)
Functions of Trigeminal nerve

- **Special sensation**
  - Smell, vision, hearing, balance, taste, oxygen, CO2
- **Cutaneous sensation**
  - Touch, temperature, vibration, pain, etc.
- **Visceral sensation**
  - E.g., sensors for blood pressure & stomach fullness
- **Skeletal muscles**
  - E.g., facial muscles; muscles of chewing
- **Visceral motor output**
  - E.g., vagus slowing heart or increasing gut contraction
CN 6: Abducens nerve
Functions of cranial nerves

• Special sensation
  – Smell, vision, hearing, balance, taste, oxygen, CO2

• Cutaneous sensation
  – Touch, temperature, vibration, pain, etc.

• Visceral sensation
  – E.g., sensors for blood pressure & stomach fullness

• Skeletal muscles
  – Lateral rectus (“shifty eye”)

• Visceral motor output
  – E.g., vagus slowing heart or increasing gut contraction
CN 7: Facial nerve
Superficial muscles embedded in, and attached to, the skin of the face.
CN 7: Facial nerve
Visceral motor

Tears, snot, and saliva

- Pterygopalatine ganglion
- Submandibular ganglion
CN 7: Facial nerve
Special sensory

Mediates taste in the anterior 2/3 of the tongue
Functions of facial nerve

• Special sensation
  – Taste to anterior 2/3 of tongue

• Cutaneous sensation
  – A small area around the ear is innervated by CN7

• Visceral sensation
  – E.g., sensors for blood pressure & stomach fullness

• Skeletal muscles
  – Muscles of facial expression

• Visceral motor output
  – Control of sublingual & submandibular salivary glands via submandibular ganglion; to nasal cavity and lachrimal glands (tears) via pterygopalatine ganglion
CN 8: Vestibulocochlear nerve
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Vestibular apparatus (balance)

Cochlea (hearing)
Functions of vestibulocochlear nerve

• Special sensation
  – Hearing and balance

• Cutaneous sensation
  – Touch, temperature, vibration, pain, etc.

• Visceral sensation
  – E.g., sensors for blood pressure & stomach fullness

• Skeletal muscles
  – E.g., facial muscles; muscles of chewing

• Visceral motor output
  – E.g., vagus slowing heart or increasing gut contraction
CN 9: Glossopharyngeal nerve

Small nerve with complicated function
CN 9: Glossopharyngeal nerve
Skeletal muscle of throat

Stylopharyngeus m.
- Elevates pharynx during swallowing
CN 9: Glossopharyngeal nerve

Visceral motor

Parotid salivary gland

- Innervated by otic ganglion ↔ CN 9
CN 9: Glossopharyngeal nerve

General sensation

Touch, pain, etc. from posterior 1/3 of tongue
CN 9: Glossopharyngeal nerve
Special sensation

Taste from posterior 1/3 of tongue
CN 9: Glossopharyngeal nerve
Sensation: carotid body & sinus

Carotid **sinus**: senses blood pressure (general sensation)

Carotid **body**: senses oxygen concentration in blood (special sensation)
Functions of glossopharyngeal nerve

- **Special sensation**
  - Taste receptors in posterior 1/3 of tongue; oxygen receptors in carotid body
- **Cutaneous sensation**
  - Touch, temperature, vibration, pain, etc. in posterior 1/3 of tongue
- **Visceral sensation**
  - Blood pressure sensors in carotid body
- **Skeletal muscles**
  - Stylopharyngeus muscle
- **Visceral motor output**
  - Salivation from parotid gland (via otic ganglion)
CN 10: Vagus nerve

Major cranial nerve with complicated function
CN 10: Vagus nerve
Skeletal muscles of throat & larynx
CN 10: Vagus nerve
Visceral motor output to heart & most of digestive system

• Slows heart
• Speeds digestion
CN 10: Vagus nerve

• General sensation
  – Behind ear (small region)
  – Larynx

• Special visceral sensation
  – Blood oxygenation & CO2
    • Sensors in aortic arch
  – Taste receptors in back of throat
Functions of Vagus nerve

- **Special sensation**
  - Taste to back of throat; O2 & CO2 sensors in aorta
- **General sensation**
  - Touch, temperature, vibration, pain, etc. behind ear and in digestive system
- **Visceral sensation**
  - Sensors for blood pressure in aortic arch
- **Skeletal muscles**
  - Muscles of throat (swallowing)
- **Visceral motor output**
  - To heart (slowing) and gut (contracting)
CN 11: Spinal accessory nerve

Unusual cranial nerve

• One component arises from brain stem

• Another component arises from spinal cord—fibers form bundle (arrows) that enters skull through foramen magnum

• Components join, & exit through jugular foramen
CN 11: Spinal accessory nerve

• Skeletal muscle
  – Spinal component innervates sternocleidomastoid and trapezius
  – Cranial component innervates parts of larynx
Functions of spinal accessory nerve

• Special sensation
  – Smell, vision, hearing, balance, taste, oxygen, CO2

• Cutaneous sensation
  – Touch, temperature, vibration, pain, etc.

• Visceral sensation
  – E.g., sensors for blood pressure & stomach fullness

• Skeletal muscles
  – Sternocleidomastoid, trapezius; larynx

• Visceral motor output
  – E.g., vagus slowing heart or increasing gut contraction
CN 12: Hypoglossal nerve
CN 12: Hypoglossal nerve
Skeletal muscles in tongue
Functions of hypoglossal nerve

- **Special sensation**
  - Smell, vision, hearing, balance, taste, O2, CO2
- **Cutaneous sensation**
  - Touch, temperature, vibration, pain, etc.
- **Visceral sensation**
  - E.g., sensors for blood pressure & stomach fullness
- **Skeletal muscles**
  - Muscles of tongue
- **Visceral motor output**
  - E.g., vagus slowing heart or increasing gut contraction