

JoVE: Science Education
Newborn Infant Neurologic Examination
--Manuscript Draft--

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1. Department of Newborn Medicine, Boston Children’s Hospital and Winchester Hospital.

Clinical Skills Education Title
Newborn Infant Neurologic Examination

Overview
The neurologic examination of a newborn infant is an important skill for the medical student to master. There are several components to the exam, including history taking, general assessment, motor function, and primitive reflexes. The history component of the examination is obtained by reviewing medical records and by asking for a verbal history from the parents. This should include maternal history complete with pregnancy course and any complications, maternal drug or alcohol use, and delivery history including gestational age and Apgar scores. Next, the infant’s history is gathered, including illnesses, hospitalizations, surgeries, immunizations, medications, and developmental milestones. The last component of the history taking includes family history with pertinent positive or negative findings, such as seizures, neurocutaneous syndromes, neurodegenerative disorders, congenital anomalies, and genetic disorders.

The newborn infant physical assessment includes a neurologic evaluation but it is most often abbreviated. A comprehensive neurologic examination is warranted for any newborn suspected to have a neurologic abnormality either by history (e.g. abnormal movements per parent report), by risk factors (e.g. perinatal asphyxia), by overt physical exam findings (e.g. abnormal arm postures with Erb’s palsy), or by genetic history (e.g. relative with Tuberous Sclerosis).

Procedure and representative findings

There is no exact ordered sequence to the infant neurologic examination. However, it is most useful if certain parts of the exam are done while the infant is quiet (observation of state, posture, involuntary activity (i.e. jitteriness; tremors)), while other parts of the exam are best elicited while the infant is alert and active (muscle strength, tone, voluntary activity).

- 1. Tell the parents you are about to do a neurologic examination on their infant. Let them know that it is a painless exam that helps show how the central nervous systems (brain and spinal cord) are functioning.
- 2. Wash your hands.
- 3. Remove any clothing on the infant and perform the exam either on a warmer examination table or in an open crib, being mindful of the duration of the exam as infants can easily get cold.

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Comment [DM2]: Aaron/production- I asked Anna about grouping the procedures by infant state (quiet, active, etc) as you had asked with the Pediatric Exam 1 manuscript. See her response above. Let us know how you’d like to proceed.

4. Record the infant's growth parameters (weight, length, and head circumference including percentiles on growth chart based on gestational age). A rule of thumb for average head circumference is 35 cm for full-term infant, 40 cm for 3 months-old infant, 45 cm for 6 months-old infants, and 50 cm for 9 months-old infant. Aberrations in head circumference can be an indicator of an underlying neurologic condition.

5. Note the infant's state (e.g. alert, active, sleeping, in no apparent distress or in distress).

6. Note the infant's posture (e.g. flexion, extension, position). Infants in breech positioning in utero frequently demonstrate hip flexion/leg extension at birth. Predominant flexion of limbs is usually present in term newborns.

7. Examine the infant's head size and fontanelle (anterior and posterior) presence and size. The size of the infant's head or the size or presence of fontanelles may help uncover pathology. For example, microcephaly can be seen in chromosomal anomalies (e.g. trisomy 13, 18, 21), while macrocephaly can be seen in Beckwith-Wiedemann syndrome, fragile-X, and achondroplasia. A closed fontanelle at birth may indicate craniosynostosis (premature closure of the cranial sutures), while an enlarged fontanelle may indicate hydrocephalus.

8. Examine the infant's skull.

8.1 Palpate the four suture lines of the skull. **[Figure 1]**

8.2 Assess for craniosynostosis, plagiocephaly (oblique head; asymmetrical flattened skull with compensatory changes), microcephaly (head circumference 2-3 standard deviations below the mean), or macrocephaly (head circumference > 3 standard deviations above the mean).

9. Note any skin manifestation of possible congenital disorder with involvement of the nervous system. This would include neurocutaneous lesions (ash leaf spots, seen with Tuberous Sclerosis), cafe au lait spots or axillary freckling (seen with neurofibromatosis), angiomas and nevus flammeus (seen with Sturge-Weber).

10. Note any overt dysmorphisms (e.g. stigmata of trisomy 21), deformations (e.g. metatarsus adductus), or malformations (e.g. cleft lip).

11. Observe for jitteriness. This abnormal behavior may be a sign of drug exposure or possible hypoglycemia.

12. Describe motor activity, tone, and muscle strength. The etiology of abnormal tone in the newborn infant is vast. However, hypotonia is seen more commonly than hypertonia. Some etiologies of hypotonia in the infant are: chromosomal abnormalities (e.g. trisomy 21, Prader-Willi syndrome), infection, hyperbilirubinemia, metabolic disorders, and hypermagnesemia.

12.1 Observe the infant's resting posture. The infant should have flexion of the elbows, hips, and knees (n.b. variable based on gestational and corrected age). Hypertonia in the extremities decreases after 3 months of age, first in upper extremities, then in the lower extremities while tone in the trunk and neck increases.

12.2 Assess resistance of passive movements of the joints while the infant is calm and awake. Perform the "scarf sign" maneuver where the infant's arm is pulled across the chest to help determine abnormal resistance of passive movements. Hypotonia is present if the elbow crosses midline.

12.3 Assess the infant's active tone. Perform the traction response by grasping the infant's hands and wrists and slowly raising the infant from supine to a seated position. The infant's elbows normally flex and the neck raises the head. If hypotonia is present, the head lags backward, and once erect, the head drops forward. If hypertonia is present, the head is maintained backwards.

13. Primitive reflexes are inborn reflexes which are present at birth or in a predictable fashion during infancy. These reflexes are elicited in the normal newborn as they respond to stimuli and are inhibited as the infant matures.

13.1 Elicit the Moro reflex by carefully dropping the infant's head in relation to the trunk. The infant should respond by symmetrically opening the hands and spreading the fingers with abduction and extension of the arms and legs followed by flexion and midline embrace. The onset of this reflex is at ~ 28-32 weeks gestation (established by 37 weeks) while this reflex disappears by 4-6 months.

13.2 Elicit the palmar/plantar grasp by placing your finger in the infant's palm or beneath their toes. The infant should respond by closing fingers and grasping examiner's finger tightly. In addition, their toes should curl around examiner's finger as the same procedure is done for the plantar grasp. This reflex is noted at ~ 28 weeks gestation (established by 32 weeks) and disappears by 6 months for palmar grasp and by 9-10 months for plantar grasp.

13.3 Observe the rooting reflex by touching the infant's cheek near the corner of the mouth. The infant should respond by turning their head to the side that was stroked. This reflex appears at 38 weeks gestation and disappears around 4 months.

13.4 Assess the sucking reflex by touching the lips or inside of mouth of the infant as the infant responds by sucking. This reflex appears by 28 weeks gestation and disappears by 4 months.

13.5 Elicit the tonic neck reflex when the infant is relaxed. Rotate the infant's head to one side and watch as the infant extends the leg or arm on the side towards which the head was turned while flexing the arm on the contralateral side (fencing posture). This reflex appears around 35 weeks gestation and disappears at 4 months.

13.6 Observe the stepping reflex while holding the infant upright with feet touching the surface of a table, then tilt the trunk forward. The infant should lift their legs as though marching. This reflex appears at ~ 32 weeks gestation (established by 37 week) and disappears around 3 months.

13.7 Elicit the Gallant reflex by holding infant in ventral suspension, then stroking along paravertebral from thoracic to sacral region. The infant should respond by curving their body toward side being stroked. This reflex appears at 38 weeks gestation and disappears by 4 months.

13.8 Observe for the Babinski reflex while firmly stroking the lateral aspect of the sole of the foot. The infant should demonstrate symmetric splaying of toes and dorsiflexion of the great toe. This reflex appears at 38 weeks gestation and disappears around 9 months.

14. Describe the quality and symmetry of upper extremity movements and check for presence of clinical findings suggestive of brachial plexus injury. The brachial plexus is the network of nerves that sends signals from the spine to the shoulder, arm, and hand. Injury to the brachial plexus is a result of stretching these nerves, which leads to loss or decreased movement of the arm and abnormal arm/hand positioning. Many instances of brachial plexus injury are associated with large-for-gestational-age infants and/or associated complications of the labor and delivery process. There are two types of brachial plexus injuries: proximal injury, called Erb's palsy and distal injury, referred to as Klumpke's palsy.

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14.2 Observe for abnormalities suggestive of Klumpke's Palsy with presence of isolated hand paralysis, Horner's syndrome (ptosis (drooping of the eyelid), miosis (pupil constriction), anhydrosis (decreased sweating of the face on the same side as the injury), and absent biceps, grasp, and Moro reflexes.

15. Perform the cranial nerve (CN) examination as indicated for the newborn infant. There are twelve cranial nerves that emerge from the brain and brainstem. [Table 1] Two of the cranial nerves are generally not tested in the newborn infant as it is difficult to elicit a response to smell (CN I) and to assess function of the sternocleidomastoid muscle in the newborn (CN XII). The remainder of the cranial nerves can be assessed.

15.1 1 Doll's Eye Test: Rotate the infants head from side to side and observe eye movements (CN III, IV, and VI). [Figure 2]

15.2 Observe suck and swallow activity by watching the infant feed to test CN V, VII, IX, X, and XII.

Comment [AS3]: This is an important step. I know they won't be demonstrating reflexes. My understanding is that during this part the authors would be examining the baby and the narrator would say – "Observe for abnormalities suggestive of brachial plexus injury." - or more extensive narrative.

15.3 Note any tongue fasciculations to assess for hypoglossal nerve degeneration (CN XII).

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Summary

The neurologic examination of the infant is a core clinical skill to be attained by the medical professional. Obtaining the skills to uncover normal or abnormal neurologic findings along with the ability to link the pathology to a neurologic diagnosis can be very challenging. As with any examination of an infant, the procedure should be described to the parent or caregiver and any questions should be answered. A complete history is obtained prior to and sometimes during the hands-on examination. The examiner should describe what they are doing during each step and provide parents with feedback as to alleviate any anxiety or to prompt further questioning. Any abnormal findings should be addressed with qualifications as to whether further testing may be warranted. Throughout the exam, the examiner should point out reassuring normal findings as well as any deviations with qualification as to whether additional testing or follow-up may be warranted. Abnormalities uncovered during the newborn neurologic examination provide with information to guide care, to refer for more definitive testing (e.g. MRI, EEG, EMG, genetic testing), and to potentially predict outcome, although limited at times. Importantly, the infant will continue to have multiple physical exams throughout the first year of life but early detection of any neurologic abnormality is crucial to provide optimal care and services for the infant.

Figures and legends

Figure 1: Cranial Sutures

Schematic representing four major suture lines of the skull

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Schematic representation of normal (A) and pathological (B) Doll's eye (oculocephalic) reflex

- A. Normal oculocephalic reflex
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Table 1. Cranial Nerves

The list of the cranial nerves and their function

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Comment [AS3]: Dr Doherty made a few suggestions for drawings to illustrate physical signs characteristic to Erb's palsy and Klumpke's palsy. Images are attached for your consideration.

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15. Perform the cranial nerve (CN) examination as indicated for the newborn infant. There are twelve cranial nerves that emerge from the brain and brainstem (Table 1). Two of the cranial nerves are generally not tested in the newborn infant as it is difficult to elicit a response to smell (CN I) and to assess function of the sternocleidomastoid muscle in the newborn (CN XI). The remainder of the cranial nerves can be assessed.

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15.2 To test CN V, VII, IX, X, and XII, observe suck and swallow activity by watching the infant feed.

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Schematic representing four major suture lines of the skull.

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A. Normal oculocephalic reflex

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B. Suppression of oculoccephalic reflex

Table 1: Cranial Nerves.

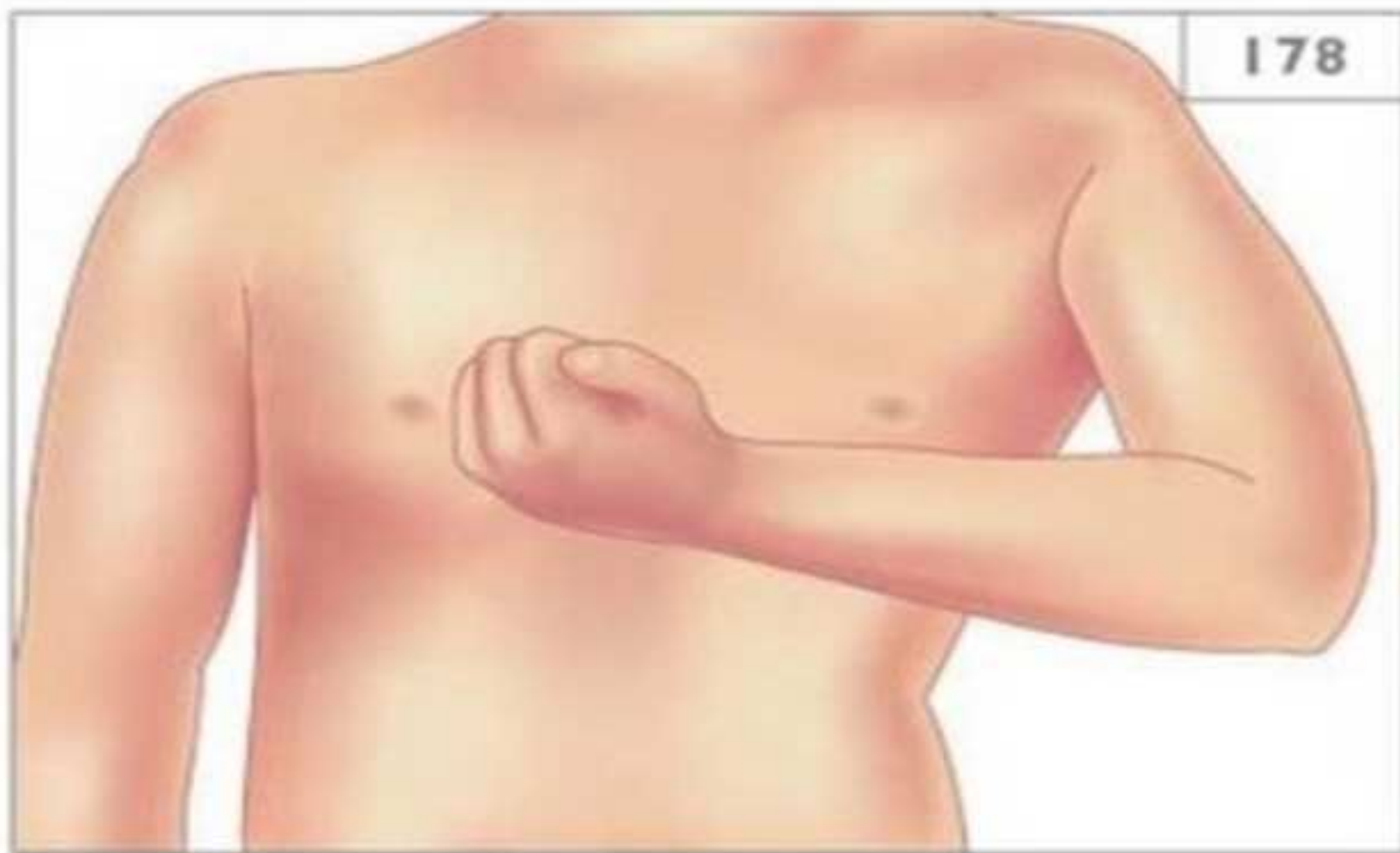
The list of the cranial nerves and their function.

Table 2: Brachial plexus injury.

Table describing the clinical manifestations of the two types of brachial plexus injury, Erb's palsy and Klumpke's palsy.



177 Erb's palsy.



178 Klumpke palsy.

Table 2: Brachial Plexus Injuries

Brachial Plexus Injury	Nerve Roots	Description
Erb’s Palsy	C5-C7	<ul style="list-style-type: none">• proximal brachial plexus injury• accounts for 90% of brachial plexus injuries• upper arm adduction and internal rotation with forearm extension• if C7 is involved, there will be forearm pronation and wrist/ finger flexion (known as “waiter’s tip” positioning)• absent biceps reflex• intact palmar grasp• absent shoulder Moro; present hand Moro
Klumpke’s Palsy	C8-T1	<ul style="list-style-type: none">• distal brachial plexus injury• occurs infrequently• manifests in isolated hand paralysis and Horner’s syndrome<ul style="list-style-type: none">○ <i>Horner’s syndrome includes ptosis (drooping of the eyelid); miosis (pupil constriction); and anhydrosis (decreased sweating) of the face on the same side as the injury.</i>• absent biceps reflex• absent grasp reflex• complete Moro absent

Doll's Eye = (Suppression of the oculocephalic reflex)

Head to Left



Eyes to right

Central



Head to right



Eyes to left

Normal

oculocephalic reflex

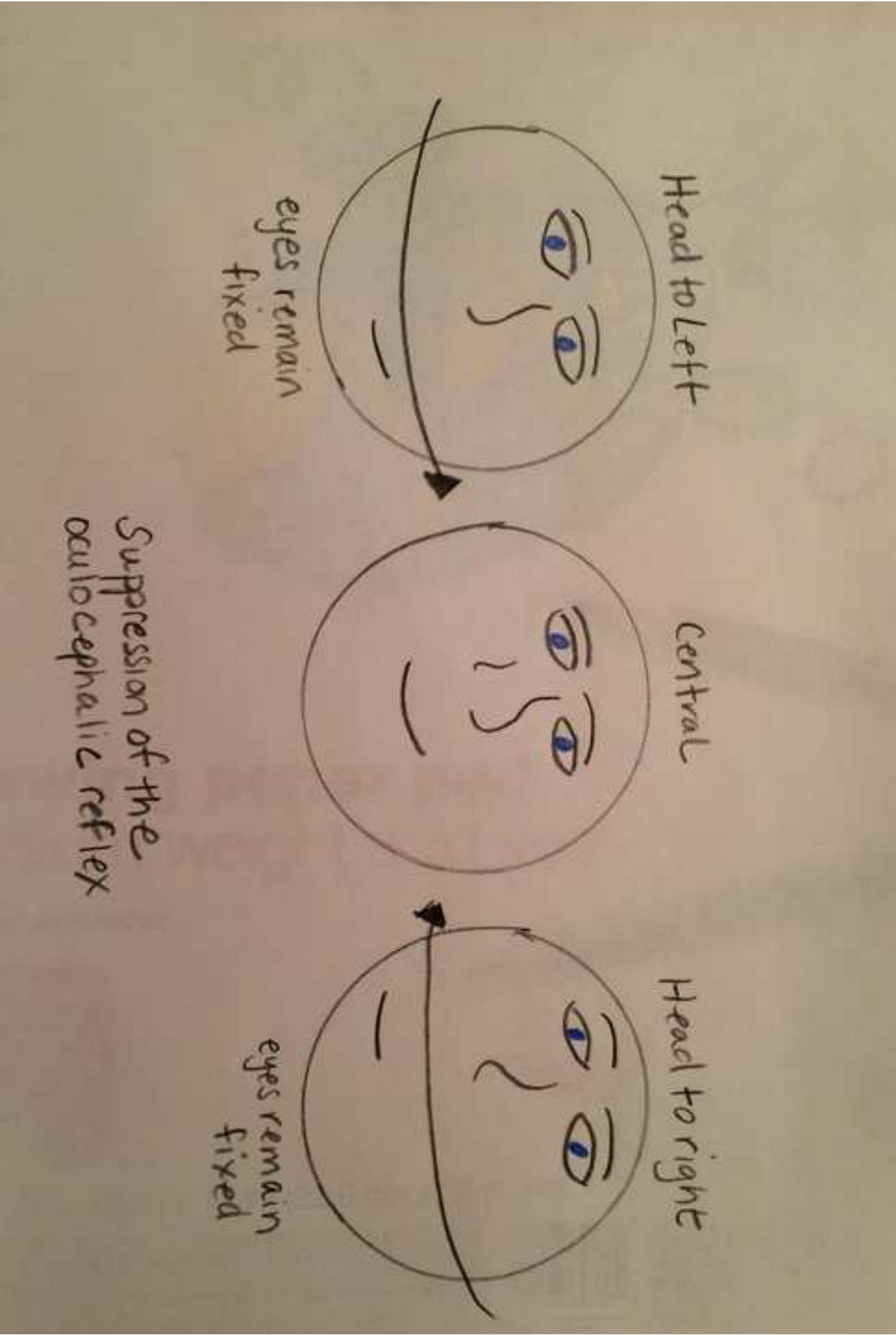


Figure 2: Cranial Nerves

Cranial Nerve Number	Cranial Nerve	Function
I	Olfactory	Smell
II	Optic	Vision
III, IV, VI	Occulomotor, Trochlear, Abducent	Extraocular movements
V	Trigeminal	Facial sensation, masticatory power <ul style="list-style-type: none">• V1: ophthalmic• V2: maxillary• V3: mandibular
VII	Facial	Facial expression
VIII	Auditory	Hearing and balance
V, VII, IX, X, XII	Trigeminal, Facial, Vagus, Glossopharyngeal, Hypoglossal	Sucking and swallowing
XI	Vagus	Shoulder elevation and head turning
XII	Spinal Accessory	Tongue movement
VII, IX	Hypoglossal	Taste

Figure 1: Cranial Sutures

