

Applied Human Neuroanatomy



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Preface

The clinical assessment of neurologic function is often viewed as an exercise involving difficult to master techniques that frequently generate difficult to interpret findings. We would like to argue an alternative proposition; that the neurologic examination is a reasonable and logical exercise involving the clinical application of basic principles of neuroanatomy and neurophysiology. One of our goals in developing this manual is to convince the reader of the truth of this perspective.

Michael F. Nolan, Ph.D., P.T.
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Introduction

This manual is comprised of two types of learning activities: free response fill-in-the-blank questions focused on the facts and principles of neuroanatomy and neurophysiology that underpin the neurologic examination and specifically developed exercises that demonstrate how the facts and principles are related to the particular tests and procedures that comprise the neurologic examination. Free response questions form the bulk of the Neuroscience Review section of each chapter and are intended as a review of information previously or concurrently being learned regarding the structure, function and organization of the nervous system. Some questions focus on anatomical or physiological facts and relationships that help explain why certain techniques are performed as they are, such as why non-nociceptive tactile stimuli are required in order to activate nerve impulse transmission in the lemniscal system. Other questions are intended to revisit facts and concepts that are needed to properly interpret the elicited findings.

The Application Exercises of each chapter are designed to demonstrate how neuroanatomical and neurophysiological information is used in the design of particular clinical tests of neurologic function. The application exercises are also intended to help users learn how to perform and become comfortable with the various clinical maneuvers and tests that comprise the routine neurologic examination. An important outcome of performing these exercises is that, as a member of a learning group, each individual has the opportunity to experience the neurologic examination from the point of view of the subject (patient) – an experience that arguably provides insight and understanding that can be gained in no other way.

The questions and exercises in the manual are designed as group learning exercises that might complement and reinforce learning acquired in more traditionally structured courses dealing with the clinical examination of a patient. The “group activity” approach, in which the student performs each exercise on a small number of “normal” subjects (classmates), is founded on the belief that the ability to recognize an abnormal finding on clinical examination requires a familiarity with the range of normal findings in the otherwise healthy population. This is particularly true for new learners who may be, for the first time, learning about the structure and function of the nervous system.

It is our hope that the questions and exercises in this manual will help the reader acquire and solidify both knowledge and skill in evaluating the function of the nervous system.

How to Use the Manual

The exercises described in this manual are group activities, intended and designed for small numbers of students working together. Each work group should ideally consist of four to six students, preferably mixed with regard to gender, race, ethnicity, body size and overall shape. The intent of building diversity within the work group is to permit students to gain familiarity with as wide a range of normal findings as class enrollment will permit. Students should dress comfortably in clothing that does not prohibit the proper performance of the exercises described.

Each student in the work group should perform each exercise on all members of the group and take a turn as subject for each of the other members of the group. In this way students can begin the process of gaining familiarity with the range of normal for a particular examination technique and begin to recognize differences among individuals that may affect how the test is performed or how the results are interpreted. In addition, students can begin to gain an appreciation of what it may be like to be the patient in a clinical encounter. Clearly, the greatest benefit is achieved when each student performs each exercise on all of the members of his or her group.

Although these exercises are intended to be performed during regularly scheduled laboratory sessions when faculty or preceptor assistance may be available, there is no reason why they cannot be performed or repeated outside scheduled class time. Both technical skill and the ability to reliably interpret exam results are best developed by practice and conscious reflection. There are simply no substitutes for direct experience and practice.

It is essential that you come to each scheduled laboratory session with all the diagnostic tools and other supplies that may be necessary to complete the exercises. Briefly review the exercises before each session so that you know what to bring in order to benefit from the exercises. Please be conscientious in this regard.

Finally, learning by application, particularly when it involves human subjects, can sometimes be uncomfortable or embarrassing for both the learner and the subjects, whether they are classmates or actual patients. Please view these exercises as important, necessary and serious parts of your educational and professional development, and treat your workgroup partners with the respect and sensitivity you would wish them to extend to you.

Anterolateral System

Objectives

1. Describe the functions of the anterolateral system.
2. Describe the physiological characteristics of the receptors associated with the anterolateral system.
3. Describe the peripheral and central organization and connections of neural structures associated with the anterolateral system.
4. Describe the rationale for using specific stimuli to activate impulse transmission in the anterolateral system.
5. Describe the autonomous zones for the major, commonly tested pre-plexus spinal nerve roots and peripheral nerves.
6. Describe the types of dysfunctions and signs and symptoms that result from lesions/diseases that affect the anterolateral system.
7. List terms commonly used by patients that might suggest dysfunction of the anterolateral systems.
8. Demonstrate the ability to evaluate the function of the anterolateral system.

Neuroscience Review Questions

1. What are the characteristics of the receptors that when activated give rise to nerve impulse transmission in the anterolateral system?

Threshold _____

Adapting _____

2. What types of energy can depolarize nociceptors?

3. Which afferent nerve fibers transmit nerve impulses toward the CNS in response to activation of nociceptors? What is the conduction velocity for each fiber type?

Fiber Type	Conduction Velocity
_____	_____
_____	_____

4. In what part of the spinal gray matter do nociceptive afferent fibers terminate?

5. In which specific laminae of Rexed do nociceptive afferent fibers terminate?

6. Name the region of the spinal cord where axons destined to form the anterolateral tracts decussate.

7. List two (2) major nuclei or regions of the brainstem that receive synaptic input from anterolateral system axons.

8. List three (3) thalamic nuclei that receive synaptic input from anterolateral system axons.

9. Cells of the ventral posterolateral nucleus (VPL) project axons that terminate in the ipsilateral cerebral hemisphere. List the two (2) gyri where these axons terminate and indicate the body part functionally related to each.

Gyrus

Body Part

Gyrus	Body Part
_____	_____
_____	_____

10. In which limb of the internal capsule are these thalamocortical fibers located?

11. Cells of the dorsal medial nucleus (DM) are the origin of axons that terminate in the ipsilateral cerebral hemisphere. List two (2) gyri or parts of the hemisphere where these axons terminate.

12. In which limb of the internal capsule are these thalamocortical fibers located?

13. Describe the orientation of the sensory homunculus on the primary somatosensory cortices.

14. Define the following terms:

anesthesia
analgesia
hypesthesia
hypalgesia
hyperalgesia
allodynia
paresthesia
dysesthesia
nociceptor

Application Exercises

1. On several lab partners identify the area of skin innervated by each of the following pre-plexus spinal nerves:

upper limb - C5, C6, C7, C8, T1

trunk - T4, T10

lower limb - L2, L3, L4, L5, S1

2. With a skin pencil mark the autonomous zone for each of the above listed pre-plexus spinal nerves.

3. On several lab partners identify the area of skin innervated by each of the following post plexus peripheral nerves:

upper limb

median

ulnar

radial

axillary

musculocutaneous

medial antebrachial cutaneous

medial brachial cutaneous

lower limb

lateral femoral cutaneous

obturator

deep peroneal (fibular)

superficial peroneal (fibular)

saphenous

sural

4. With a skin pencil mark the autonomous zone for each of the above listed post-plexus peripheral nerve.

5. On several lab partners demonstrate and describe a method for evaluating the anterolateral system in a patient with a suspected lesion in the posterior limb of the internal capsule.
-

6. On several lab partners demonstrate and describe a method for evaluating the anterolateral system in a patient with a suspected lesion involving the radial nerve.
-

7. On several lab partners demonstrate and describe a method for evaluating the anterolateral system in a patient with a suspected distal peripheral neuropathy such as might be found in a patient with diabetes mellitus.

8. What peripheral nervous system structure is most likely involved in a patient with absent pin prick sensation on the skin of the palmer surface of the left long finger? On which side is the lesion?

Structure Involved

Side of Lesion

9. What peripheral nervous system structure is most likely involved in a patient with absent thermal sensation on the skin of the lateral surface of the right thigh? On which side is the lesion?

Structure Involved

Side of Lesion

10. Which limb or limbs is (are) most likely to be affected in a patient with sensory impairment resulting from damage to Lissauer's tract on the left side extending from C5-T1? Which side of the body is affected?

Limb(s) Affected

Side Affected

11. Which limb of the internal capsule is most likely involved in a patient with increased threshold to pin prick stimulation of the left upper and lower limbs? On which side is the lesion?

Part of Internal Capsule

Side of the Lesion

Lemniscal System

Objectives

1. Describe the functions of the lemniscal system.
2. Describe the physiological characteristics of the receptors associated with the lemniscal system.
3. Describe the peripheral and central organization and connections of neural structures associated with the lemniscal system.
4. Describe the rationale for using specific stimuli to activate impulse transmission in the lemniscal system.
5. Describe the autonomous zones for the major, commonly tested pre-plexus spinal nerve roots and peripheral nerves.
6. Describe the types of dysfunctions and signs and symptoms that result from lesions/diseases that affect the lemniscal system.
7. List terms commonly used by patients that might suggest dysfunction of the lemniscal system.
8. Demonstrate the ability to evaluate the function of the lemniscal system.

Neuroscience Review Questions

1. What are the characteristics of the receptors that when activated give rise to nerve impulse transmission in the lemniscal system?

Threshold _____

Adapting _____

2. Which receptor is involved in the perception of light tactile stimuli?

3. Which receptor is primarily involved in the perception of joint position and movement?

4. Which afferent nerve fiber transmits nerve impulses toward the CNS in response to activation of receptors involved in the perception of light tactile stimuli and what is its conduction velocity?

Fiber Type	Conduction Velocity
_____	_____

5. Which afferent nerve fiber transmits nerve impulses toward the CNS in response to activation of receptors involved in the perception of joint position and movement and what is its conduction velocity?

Fiber Type	Conduction Velocity
_____	_____
_____	_____

6. In which funiculus of the spinal cord are the central processes of these non-nociceptive afferent cells located?

7. Name the two (2) fasciculi in the spinal cord that are formed by the central processes of non-nociceptive afferent fibers AND indicate which limb is associated with each.

Fasciculus	Limb
_____	_____
_____	_____

8. Describe the somatotopic organization of the fibers of the dorsal funiculus.

9. List the nuclei where these fibers terminate and indicate the part of the body functionally related to each.

Nucleus	Body Part
_____	_____
_____	_____

10. At what level of the brainstem do the axons of the above two nuclei cross the midline? (Be as specific as you can.)

11. What fiber tract is formed by these axons after they cross the midline?

12. What is the somatotopic organization of this pathway at the level of the:

Inferior olivary nucleus _____

Mid Pons _____

Mid Midbrain _____

13. Name the thalamic nucleus where the fibers of the medial lemniscus terminate.

14. Describe the somatotopic organization of the cells of this thalamic nucleus.

15. Cells of the ventral posterolateral nucleus (VPL) project axons that terminate in the ipsilateral cerebral hemisphere. List the two (2) gyri where these axons terminate and indicate the body part functionally related to each.

Gyrus

Body Part

16. In which limb of the internal capsule are these thalamocortical fibers located?

17. Describe the orientation of the sensory homunculus on the primary somatosensory cortices.

18. What two (2) functions of a sensory system occur as a result of activating the primary somatosensory cortex?

19. Cells of the primary somatosensory cortex project axons toward two (2) other regions of the cerebral cortex. What are these other cortical areas and what (briefly) are their functions?

Cortical Area	Function
<hr/>	<hr/>
<hr/>	<hr/>

20. Define the following terms:

- hypesthesia
- hyperesthesia
- thigmesthesia
- pallesthesia
- proprioception
- kinesthesia
- topesthesia

Application Exercises

1. On several lab partners identify the area of skin innervated by each of the following pre-plexus spinal nerves:

- upper limb - C5, C6, C7, C8, T1
- trunk - T4, T10
- lower limb - L2, L3, L4, L5, S1

2. Use a skin pencil mark the autonomous zone for each of the above listed pre-plexus spinal nerves.

3. On several lab partners identify the area of skin innervated by each of the following peripheral nerves:

- upper limb
- median
- ulnar

radial
axillary
musculocutaneous
medial antebrachial cutaneous
medial brachial cutaneous

lower limb
lateral femoral cutaneous
obturator
deep peroneal (fibular)
superficial peroneal (fibular),
saphenous
sural

4. Use a skin pencil mark the autonomous zone for each of the above listed post-plexus peripheral nerves.

5. On several lab partners demonstrate and describe a method for evaluating light touch perception in the upper and lower limbs.

6. Describe the findings you would expect on testing light touch sensation in a patient with a suspected lesion in the posterior limb of the internal capsule on the right side.

7. On several lab partners demonstrate and describe a method for evaluating tactile localization in the upper and lower limbs.

8. Describe the findings you would expect on testing light touch sensation in a patient with a suspected lesion in the radial nerve on the left side.

9. Which tuning fork should be used for testing vibratory sense?

10. On several lab partners demonstrate and describe a method for evaluating vibratory sense in the upper and lower limbs.

11. Describe the findings you might expect on testing vibratory sense in a patient with a suspected distal peripheral neuropathy such as might be found in a patient with diabetes mellitus.

12. On several lab partners demonstrate and describe a method for evaluating position sense in the upper and lower limbs.

13. Describe the findings you might expect on testing position sense in a patient with a suspected distal peripheral neuropathy such as might be found in a patient with diabetes mellitus.

14. On several lab partners demonstrate and describe a method for evaluating station using the Romberg test.

15. Describe the findings you would observe in a patient in whom the Romberg test is "positive."

16. Where might a lesion be located in a patient who demonstrates a "positive" Romberg test?

17. What spinal pathway is most likely involved in a patient with impaired vibratory sensation in the right foot? On which side of the spinal cord is the lesion?

Spinal Pathway

Side of Lesion

18. What thalamic nucleus is most likely involved in a patient with increased threshold to light touch stimuli in the left upper and lower limbs? On which side of the brain is the lesion?

Thalamic Nucleus

Side of Lesion

19. An imaging study in a patient with impaired vibratory sense and increased threshold to non-nociceptive cutaneous stimuli in the left upper and lower limbs reveals a focal abnormality in the caudal pons. What neural structure is most likely involved and on which side?

Neural Structure

Side of Lesion

Cortical Sensory Functions

Objectives

1. Describe the functions of the cerebral cortex referred to as cortical sensory functions.
2. Indicate which gyrus is implicated in patients with abnormalities in cortical sensory functions.
3. Demonstrate the proper technique for evaluating cortical sensory functions.

Neuroscience Review Questions

1. Which receptor is involved in the perception of light tactile stimuli?

2. Which afferent nerve fiber transmits nerve impulses toward the CNS in response to activation of receptors involved in the perception of light tactile stimuli and what is its conduction velocity?

Fiber Type

Conduction Velocity

- | | Fiber Type | Conduction Velocity |
|----|---|---------------------|
| 3. | Name the ascending fiber tract transmits non-nociceptive nerve impulses from the upper limbs. | <hr/> |
| 4. | Name the fiber tract in the brainstem that transmits non-nociceptive impulses from the upper limbs. | <hr/> |
| 5. | Name the thalamic nucleus where the fibers of the medial lemniscus terminate. | <hr/> |
| 6. | Describe the somatotopic organization of the cells of this thalamic nucleus. | <hr/> |

7. Cells of the ventral posterolateral nucleus (VPL) project axons that terminate in the ipsilateral cerebral hemisphere. List the two (2) gyri where these axons terminate and indicate the body part functionally related to each.

Gyrus	Body Part
_____	_____
_____	_____

8. In which limb of the internal capsule are these thalamocortical fibers located?

9. Describe the orientation of the sensory homunculus on the primary somatosensory cortices.

10. What two (2) functions of a sensory system occur as a result of activating the primary somatosensory cortex?

11. Cells of the primary somatosensory cortex project axons toward two (2) other regions of the cerebral cortex. What are these other cortical areas and what (briefly) are their functions?

Cortical Area	Function
_____	_____
_____	_____

12. Name the three (3) neurological functions tested when evaluating cortical sensory functions.

13. What types of objects should be used when evaluating stereognosia?

14. Define the following terms:

stereognosia (object identification)
graphesthesia (traced figure identification)
extinction (to double simultaneous stimulation)
tactile agnosia

Application Exercises

1. Describe and demonstrate in several lab partners a method for evaluating stereognosia.
2. Describe and demonstrate in several lab partners a method for evaluation graphesthesia.
3. Describe and demonstrate in several lab partners a method for evaluating sensory extinction to double simultaneous stimulation.

Motor System (Strength)

Objectives

1. List the commonly tested movements when measuring strength.
2. For each of the routinely tested movements, list the pre-plexus spinal nerve roots and peripheral nerves that primarily contribute to that movement.
3. Describe the system used for grading muscle strength.
4. Describe the features that distinguish weakness resulting from lower motor neuron injury from weakness resulting from upper motor neuron injury.
5. Demonstrate the ability to measure muscle strength in the upper limb, lower limb and trunk.

Neuroscience Review Questions

1. Indicate the peripheral nerve being tested when you evaluate the strength of each of the following movements.

Upper Limb

Peripheral Nerve

shoulder abduction

elbow flexion

elbow extension

wrist extension

wrist flexion

finger extension

finger flexion (grip strength)

finger abduction

finger adduction

Lower Limb

- hip flexion _____
- hip adduction _____
- hip abduction _____
- hip extension _____
- knee extension _____
- knee flexion _____
- ankle dorsiflexion _____
- ankle plantar flexion _____
- toe extension _____

2. Indicate the spinal segments being tested when you evaluate the strength of each of the following movements.

Upper Limb

Spinal Segments

- shoulder abduction _____
- elbow flexion _____
- elbow extension _____
- wrist extension _____
- wrist flexion _____
- finger extension _____
- finger flexion (grip strength) _____
- finger abduction _____
- finger adduction _____

Lower Limb

- hip flexion _____

- hip adduction _____
- hip abduction _____
- hip extension _____
- knee extension _____
- knee flexion _____
- ankle dorsiflexion _____
- ankle plantar flexion _____
- toe extension _____

3. What lobes of the brain contain corticospinal tract cell bodies?

4. What lobe(s) of the brain contains cortical upper motor neurons that influence lower motor neurons that innervate muscles of each of the following limbs?

upper limbs _____

lower limbs _____

5. What gyrus/gyri contain cortical upper motor neurons that influence lower motor neurons that innervate muscles of each of the following limbs?

upper limbs _____

lower limbs _____

6. In what white matter structure of the brain are corticospinal axons located at the level of each of the following structures?

thalamus _____

midbrain _____

pons _____

medulla oblongata _____

7. What is the name of the white matter structure where corticospinal fibers decussate (cross the midline)?

8. Which limb is influence by corticospinal fibers that decussate in each of the following?

rostral part of the pyramidal decussation? _____

caudal part of the pyramidal decussation? _____

9. What percentage of corticospinal fibers typically decussate in the pyramidal decussation?

10. What descending spinal cord pathway is formed by corticospinal fibers that:
decussate in the pyramidal decussation?

do not decussate in the pyramidal decussation?

11. What percentage of fibers of the lateral corticospinal tract terminates at:

upper limb segments (C5 – T1) _____

lower limb segments (L2 – S2) _____

non-limb segments (T2 – L1) _____

12. In segments of the spinal cord that contain lower motor neurons that innervate the limbs, which muscle groups are innervated by lower motor neurons primarily located in each of the following?

Muscle Groups

medial part of the ventral horn _____

intermediate part of the ventral horn _____

lateral part of the ventral horn _____

13. Define the performance criteria/characteristics for each of the following muscle strength grade.

normal (5/5) _____

good (4/5) _____

fair (3/5) _____

poor (2/5) _____

trace (1/5) _____

zero (0/5) _____

14. Define the following terms:

lower motor neuron
motor unit
disuse atrophy
denervation atrophy
hypertrophy
paresis
hemiparesis
flaccid paralysis
spastic paralysis
pronator drift
fibrillation
fasciculation
paraplegia
hemiparesis
quadriplegia
wrist drop
foot drop

claw hand
Erb's Palsy
Klumpke's Palsy

Application Exercises

1. Inspect and compare the two upper limbs and the two lower limbs. Focus on symmetry, specifically regarding muscle bulk and contour. Describe and characterize any observed asymmetry or side to side differences in bulk and contour.
2. Is an observed asymmetry necessarily a sign of abnormality or pathology? (Y/N)

3. If not, how much asymmetry might be seen in the normal population AND how might you explain the presence of visible asymmetry between muscles or muscle groups?

4. On several lab partners demonstrate and describe how to measure strength of each of the following movements AND assign an appropriate strength grade.

Upper Limb	Strength Grade
shoulder abduction	<hr/>
elbow flexion	<hr/>
elbow extension	<hr/>
wrist extension	<hr/>
wrist flexion	<hr/>
finger extension	<hr/>
finger flexion (grip strength)	<hr/>
finger abduction	<hr/>
finger adduction	<hr/>

Lower Limb

- hip flexion _____
- hip adduction _____
- hip abduction _____
- hip extension _____
- knee extension _____
- knee flexion _____
- ankle dorsiflexion _____
- ankle plantar flexion _____
- toe extension _____

5. What are the likely locations of lesions that result in denervation atrophy?

6. What peripheral nervous system structure is most likely involved in a patient with 0/5 strength of ankle dorsiflexion and 0/5 strength of great toe extension on the right side? Which side is involved?

Structure Involved

Side of Lesion

7. What peripheral nervous system structure is most likely involved in a patient with 3/5 strength of elbow flexion and 3/5 strength of shoulder abduction on the left side? Which side is involved?

Structure Involved

Side of Lesion

8. What peripheral nervous system structure is most likely involved in a patient with 0/5 strength of finger abduction, finger adduction and wrist flexion with ulnar deviation on the right side? Which side is involved?

Structure Involved

Side of Lesion

9. What peripheral nervous system structure is most likely involved in a patient with 2/5 strength of knee extension and 3/5 strength of hip adduction on the left side? Which side is involved?

Structure Involved

Side of Lesion

Coordination, Station, and Gait

Objectives

1. Define and describe the differences between metric movements and diadochokinetic movements.
2. Describe commonly used techniques for evaluating metric and diadochokinetic movements in the upper limbs.
3. Describe commonly used techniques for evaluating metric and diadochokinetic movements in the lower limbs.
4. Describe the characteristic features of dysmetric movements.
5. Describe the characteristic features of dysdiadochokinetic movements.
6. Describe the neural bases for the ability to stand erect (station).
7. Describe the commonly used technique for evaluating station.
8. List and describe the characteristics of gait that are commonly evaluated in the clinical setting.
9. Describe several common gait abnormalities.
10. Demonstrate the ability to measure coordination, station and gait.

Neuroscience Review Questions

1. List the three (3) gross anatomic parts of the cerebellum.

2. List the three (3) developmental (embryological) components of the cerebellum.

3. List the three (3) functional regions of the cerebellar cortex.

4. Name the fissure that separates the anterior lobe from the posterior lobe.

5. Name the fissure that separates the posterior lobe from the flocculonodular lobe.

6. Name the three (3) major cerebellar peduncles and the region of the brainstem with which each is anatomically associated.

Cerebellar Peduncle	Related Brainstem Region
<hr/>	<hr/>
<hr/>	<hr/>
<hr/>	<hr/>

7. Name the three (3) layers of the cerebellar cortex.

8. Name the two (2) cells with cell bodies located in the molecular layer.

9. Name the two (2) cells with cell bodies located in the granular layer.

10. List the major cerebellar afferent and efferent tracts located in each of the cerebellar peduncles.

Afferent Tract

Efferent Tract

Superior Cerebellar Peduncle

<hr/>	<hr/>
<hr/>	<hr/>
	<hr/>

Middle Cerebellar Peduncle

Inferior Cerebellar Peduncle

Juxtarestiform Body

11. What nucleus is the origin of climbing fibers?

12. Name two (2) nuclei in the spinal cord that are the origin of mossy fibers.

13. Name two (2) nuclei in the medulla oblongata that are the origin of mossy fibers.

14. In what layer of the cerebellar cortex are glomeruli located?

15. What cell is the “output” cell of the cerebellar cortex?

16. What is the neurotransmitter synthesized and used by this cell?

17. Name the cerebellar deep nuclei from medial to lateral AND indicate the functional region(s) of the cerebellar cortex with which it is related.

Nucleus	Functional Cortical Region(s)
<hr/>	<hr/>
<hr/>	<hr/>
<hr/>	<hr/>
<hr/>	<hr/>

18. List the cerebellar deep nuclei from medial to lateral AND indicate the main nucleus that each projects to.

Nucleus	Nuclear Target
_____	_____
_____	_____
_____	_____
_____	_____

19. Define the following terms:

ataxia
 dysmetria
 truncal ataxia
 metric movements
 diadochokinetic movements
 dysdiadochokinesia
 dysarthria
 intention (kinetic) tremor
 titubation
 check and rebound
 tandem gait
 astasia
 astasia-abasia
 finger to nose testing
 heel to shin testing
 Romberg test

Application Exercises

1. On several lab partners demonstrate and describe a method for evaluating coordination (metric movements) in the upper and lower limbs.

2. Describe the findings you might expect who demonstrated dysmetria of the upper limb and of the lower limb.

Upper Limb _____

Lower Limb _____

3. On several lab partners demonstrate and describe a method for evaluating coordination (diadochokinetic movements) in the upper and lower limbs.

4. Describe the findings you might expect in a patient who demonstrates dysdiadochokinesia involving the right upper limb and of the lower limb.

Upper Limb _____

Lower Limb _____

5. On several lab partners demonstrate and describe a method for evaluating station using the Romberg test.

6. Describe your observations in a patient in whom the Romberg test is “positive.”

7. Where might a lesion be located in a patient who demonstrates a “positive” Romberg test?

8. On several lab partners demonstrate and describe a method for evaluating gait.

9. List and describe several specific components of gait that you might focus on during an evaluation of gait.

10. Describe the characteristics of a hemiparetic gait.
-
11. Describe the features of the gait of a patient with unilateral foot drop.
-
12. Describe the features of the gait of a patient with a destructive lesion involving the cerebellar vermis.
-
13. Describe the features of the gait of a patient with Parkinson disease.
-
14. Describe the features of the gait of a patient with Huntington disease.
-
15. Describe the features of the gait of a patient with tabes dorsalis (sensory ataxia).
-
16. A 27 y/o man presents with the sudden onset of difficulty walking. On examination he demonstrates impaired performance on finger-to-nose testing and heel-to-shin testing on the right side. An imaging study reveals a tumor mass in the cerebellum. On which side is the tumor mass most likely located?
-
17. Lesions of the cerebellar hemisphere are sometimes associated with hypotonia. Which hemisphere of the cerebellum is most likely to be affected in a patient who demonstrates hypotonia in the left upper and lower limbs?
-

Gait

Objectives:

1. Define and describe the individual components of the gait cycle.
2. List the components of the general physical examination that should be evaluated when assessing gait.
3. Describe the movements that occur at the ankle, knee, hip, shoulders and elbow during the gait cycle.
4. Describe the specific effects on individual components of the gait cycle that would be expected in a patient with weakness or paralysis of each of the following muscle groups:
 - ankle dorsiflexors
 - ankle plantar flexors
 - knee extensors
 - knee flexors
 - hip abductors
 - hip elevators (hip hikers)
 - hip extensors
5. Describe the compensatory movements that might be used by patients with weakness/paralysis of the muscle groups listed above.
6. Describe the gait characteristics “typically” observed in patients with arthritis of the hip, Parkinson disease and stroke.

Neuroscience Review Questions

1. What percent of the normal gait cycle is spent in stance phase?

2. What percent of the normal gait cycle is spent in swing phase?

3. What percent of the gait cycle is spent in single limb support?

4. What percent of the gait cycle is spent in double limb support?

5. Describe the movement of the ankle joint that occurs between heel strike and foot flat.

6. Describe the movement of the ankle joint that occurs between toe off and heel strike.

7. Describe the movements that occur at the knee joint between heel strike and foot flat.

8. Describe the movements of the knee joint that occur between toe off and toe off and heel strike.

9. Describe the movement of the center of gravity from the middle of single limb support (SLS) to the middle of double limb support (DLS).

10. What muscle group of the ankle joint is most active during the time from heel strike to foot flat?

11. What muscle group of the hip joint is most active during stance phase?

12. What muscle group of the hip joint is most active during swing phase?

13. What muscle group of the knee joint is most active during the first half of swing phase?

14. What muscle group of the knee joint is most active during the second half of swing phase?

15. What muscle group of the knee joint is most active at heel strike?

16. What muscle group of the ankle joint is most active during the first half of swing phase?

17. What muscle group of the ankle joint is most active at heel strike?

18. Describe the movements of the hip, knee and ankle joints in a patient who sustained a stroke several months ago and is now ambulatory.

19. During swing phase of the right lower limb is the right upper limb (shoulder) moving from flexion into extension OR from extension into flexion?

20. During single limb support is the line of gravity aligned over the limb in swing phase OR the limb in stance phase?

21. Is the center of mass at its highest vertical point during single limb support OR double limb support?

22. Define the following terms:

base of support
center of gravity
line of gravity
step length
stride length
stance phase
swing phase
single limb support
double limb support
heel strike
foot flat
toe off
gait cycle
cadence
velocity
stride width
propulsion
retropulsion
abnormal gait patterns
 spastic gait
 antalgic gait
 hemiparetic gait
 steppage gait
 festinating gait
 ataxic gait

Application Exercises

Lateral Observation

Instruct a subject to walk in a straight line from point "A" to point "B" and back again for a distance of approximately 25 feet at a comfortable speed. Place yourself approximately 8 feet to the side of the subject's line of progression, midway between the starting and ending points, so that you can observe the subjects' right and left sides as he/she passes from point "A" to point "B."

1. Compare the duration of stance phase on each limb.

Are they essentially the same for each limb? _____

If not, describe. _____

2. Compare the time from heel strike to foot flat for each limb.

Are they essentially the same for each limb? _____

If not, describe. _____

Weakness or paralysis of what muscle group would likely decrease the time from heel strike to foot flat?

3. Compare the movements of the knee joint during both stance phase and swing phase for each limb.

Are these movements essentially the same for each limb? _____

If not, describe. _____

4. Compare the movement of the hip joint during both stance phase and swing phase for each limb.

Are these movements essentially the same for each limb? _____

If not, describe. _____

5. Compare the movements of the shoulder and elbow joints during the gait cycle.

Are these movements essentially the same for each limb? _____

If not, describe. _____

Forward and Backward Observation

Instruct a subject to walk in a straight line from point "A" to point "B" and back again for a distance of approximately 25 feet at a comfortable speed. Place yourself in line with the subject's line of progression so that you can observe the subject walking away from you and directly towards you.

6. Observe and estimate the distance between the right and left foot during single limb support phase on each limb. _____

7. Observe and estimate the angle subtended between the axis of the foot and the line of progression during stance phase for each limb.

Are these angles essentially the same for each limb? _____

If not, describe. _____

8. Observe and estimate the lateral movement of the center of mass from the midline during stance phase on each limb.

Is the lateral distance moved essentially the same for each limb? _____

If not, describe the differences. _____

9. Observe the movements of the shoulder and elbow joints during the gait cycle.

Are these movements essentially the same for each limb? _____

If not, describe. _____

Reflexes (including Muscle Tone)

Objectives

1. List the commonly tested muscle stretch reflexes.
2. For each of the commonly tested muscle stretch reflexes, list the pre-plexus spinal nerve roots and peripheral nerves that primarily contribute to that reflex response.
3. Describe a system for grading muscle stretch reflexes.
4. List and describe some common abnormal muscle stretch reflex responses.
5. Describe a method for evaluating muscle tone.
6. List some common causes of abnormal muscle tone.
7. Characterize and describe the basic mechanism of clonus.
8. List the commonly evaluated cutaneous reflexes.
9. List and describe some abnormal cutaneous reflexes.
10. Demonstrate the ability to elicit and grade commonly tested muscle stretch reflexes.
11. Demonstrate the ability to elicit and interpret commonly tested cutaneous reflexes.

Neuroscience Review Questions

1. Name the two (2) muscle-related receptors that play a role in mediating muscle tone.

2. Which of these receptors is activated when eliciting a muscle stretch reflex?

3. What is the adequate stimulus for activating a muscle spindle?

4. Name the two types of afferent endings that associated with the muscle spindle AND indicate the afferent nerve fiber type associated with each.

Afferent Ending

Afferent Fiber Type

5. What is the conduction velocity for each of these two afferent nerve fibers?

Afferent Fiber Type

Conduction Velocity

6. What is the physiological effect of activating muscle spindles on efferent (motor) cells in the CNS?

7. Name the nerve cell that provides motor innervation to the muscle spindle AND indicate the conduction velocity of the axon of that cell.

Motor Cell Type

Conduction Velocity

8. What is the adequate stimulus for the Golgi tendon organ?

9. What fiber type is associated with the Golgi tendon organ AND what is the conduction velocity for this afferent nerve fiber?

Afferent Fiber Type

Conduction Velocity

10. What is the physiological effect of activating Golgi tendon organs on efferent (motor) cells in the CNS?

11. List the peripheral nerves that mediate each of the following muscle stretch reflexes.

Reflex	Peripheral Nerve
biceps reflex	_____
triceps reflex	_____
brachioradialis reflex	_____
finger flexor reflex	_____
quadriceps reflex	_____
Achilles reflex	_____

12. List the spinal segments that mediate each of the following reflexes.

Reflex	Spinal Segment
biceps reflex	_____
triceps reflex	_____
brachioradialis reflex	_____
finger flexor reflex	_____
quadriceps reflex	_____
Achilles reflex	_____

13. Define each of the following reflex grades.

0/5 _____

1/5 _____

2/5 _____

3/5 _____

4/5 _____

5/5 _____

14. List three (3) features that characterize and distinguish spasticity from rigidity.

Spasticity

Rigidity

15. Several muscle stretch reflexes are “suppressed” in the neurologically intact individual and become manifest with certain type of CNS injuries. List two (2) of these normally suppressed reflexes.

16. What is the adequate stimulus for eliciting the plantar reflex?

17. What is the normal response when eliciting the plantar reflex?

18. What is the term used to refer to an abnormal plantar reflex?

19. Is an abnormal plantar reflex a sign of an upper or lower motor neuron injury?

20. Define the following terms:

normal muscle tone
atonia, hypotonia, hypertonia
spasticity
clonus
reflex spread
withdrawal reflex
placing reaction
lead pipe rigidity
cogwheel rigidity
rest tremor
dystonia
tics
myoclonus
athetosis
chorea
ballismus (hemiballismus)
asterixis
blepharospasm
myotatic reflex
withdrawl reflex
placing reacton
Babinski sign

Application Exercises

1. In several lab partners demonstrate and describe a method for eliciting the static component of the tonic stretch reflex.

2. In several lab partners demonstrate and describe a method for eliciting the dynamic component of the tonic stretch reflex.

3. List the four (4) observable response variables for the phasic component of the muscle stretch reflex.

4. On several lab partners demonstrate and describe a method for evaluating muscle tone in the upper and lower limbs.

5. On several lab partners demonstrate and describe a method for evaluating clonus in the lower limb.

6. On several lab partners demonstrate and describe a method for eliciting each of the following muscle stretch (deep tendon) reflexes AND assign an appropriate grade.

Reflex	Grade
biceps reflex	_____
triceps reflex	_____
brachioradialis reflex	_____
finger flexor reflex	_____
quadriceps reflex	_____
Achilles reflex	_____

7. On several lab partners demonstrate and describe a method for eliciting the plantar reflex.

8. What muscle stretch reflex is most likely to be affected in a patient with a lesion involving the C7 spinal nerve on the right side? On which side would the reflex be affected?

Reflex Affected

Side Affected

9. What muscle stretch reflex is most likely to be affected in a patient with a lesion involving the femoral nerve on the left side? On which side would the reflex be affected?

Reflex Affected

Side Affected

10. In several lab partners demonstrate and describe a method for eliciting the abdominal reflex.

11. In several lab partners demonstrate and describe a method for eliciting the Hoffman reflex.

Olfactory Nerve

Objectives

1. Describe the cellular organization of the olfactory epithelium.
2. Describe the peripheral and central connections of the olfactory system.
3. List the major central projections of fibers of the olfactory tract.
4. List and describe major physiological and behavioral responses to varying types of olfactory stimuli.

Neuroscience Review Questions

1. List the four (4) cell types found in the olfactory epithelium.

2. Which of the above listed cells is associated with a cellular process that forms the olfactory fila?

3. How do the olfactory fila gain access to the intracranial compartment?

4. Name the gross neural structure where the axons of the olfactory fila terminate.

5. Name the cells in the above-named structure that give rise to the axons of the olfactory tract.

6. What is the affect (excitation/inhibition) of activating cells of the anterior olfactory nucleus?

7. List three (3) major targets of axons of the lateral olfactory stria.

8. List one (1) major synaptic target of the axons of the medial olfactory stria.

9. List several odorants that might be used to evaluate olfactory function.

10. Briefly explain why you do NOT use irritant substances (volatile hydrocarbons such as ammonia) to test olfactory function.

11. Define the following term:

anosmia

Application Exercises

1. In several lab partners inspect the nares. (Note the position of the nasal septum and look for obstructions.)
2. In several lab partners demonstrate and describe a method for evaluating olfactory function. (Be sure to evaluate each side separately.)

Visual System and Pupillary Reflexes

Objectives

1. Briefly describe the visual pathway from the retina to the primary visual cortex.
2. Name and describe the visual field deficit resulting from lesions affecting the optic nerve, optic chiasm, optic tract and different regions of the visual radiations.
3. Describe methods for evaluating visual fields and visual acuity.
4. Demonstrate the ability to evaluate visual fields and visual acuity.
5. Describe the neural organization of the pupillary light reflexes and the accommodation response.
6. Describe the structures of the eye important in mediating the light and accommodation reflexes.
7. Describe the effects of various lesions affecting the light reflex and accommodation pathways on the light and accommodation reflexes.
8. Demonstrate the ability to evaluate the pupillary light reflexes.
9. Demonstrate the ability to evaluate the accommodation responses.

Neuroscience Review Questions

1. Describe the relationship between visual fields and retinal quadrants.

2. Indicate the extent of vision (in degrees of arc) in each of the four directions indicated below with the eye maintained in the position of primary gaze.

Superiorly _____

Medially _____

Inferiorly _____

Laterally _____

3. Describe the location and size (in degrees of arc) of the binocular visual field of an individual with both eyes viewing and in the position of primary gaze.

4. Describe the location and size (in degrees of arc) of the monocular visual fields for each eye an individual with both eyes viewing and in the position of primary gaze.

5. Which retinal quadrants from which eye are represented in the right optic nerve?

Retinal Quadrant

Eye

6. Which retinal quadrants from which eye are represented in the right optic tract?

Retinal Quadrant

Eye

7. In which part of the optic chiasm will you find the decussating fibers from the macular part of each retina?

8. What percentage of the axons of the optic nerve decussate (cross) in the optic chiasm?

9. Which retinal quadrant is represented by the axons that form Wilbrand's knee?

10. Which retinal quadrants are the origin of axons that synapse in the lateral part of the lateral geniculate nucleus on the right side?

Right Eye _____

Left Eye _____

11. Which retinal quadrants are the origin of axons that synapse in the medial part of the lateral geniculate nucleus on the left side?

Right Eye _____

Left Eye _____

12. Which part of the lateral geniculate nucleus is the origin of axons that course through Meyer's loop?

13. Name the gyrus of the occipital lobe that receives synaptic input from cells in each of the following:

Lateral Geniculate Nucleus

Gyrus

Lateral Part _____

Medial Part _____

14. What part of the visual field projects visual information to the:

anterior part of the calcarine cortex _____

occipital pole _____

15. What artery supplies the primary visual cortex? _____

16. What Brodmann areas are considered visual association cortices?

17. Name the visual field defect associated with lesions affecting each of the following parts of the visual pathway. (Assume a complete lesion.)

Right optic nerve _____

Left optic tract _____

Optic chiasm _____

Right lateral geniculate _____

Left Meyer's loop _____

18. What type of vision is measured using a Snellen chart?

19. What type of vision is measured using a Rosenbaum card?

20. Where are the cell bodies of the two nerve cells that mediate pupillary constriction?

Preganglionic Cell

Postganglionic Cell

21. Where are the cell bodies of the two nerve cells that mediate pupillary dilatation?

Preganglionic Cell

Postganglionic Cell

22. What nerve serves as the afferent limb of the pupillary light reflex?

23. What nerve serves as the efferent limb of the pupillary light reflex?

24. Describe the response referred to as the direct light reflex.

25. Describe the response referred to as the indirect (consensual) light reflex.

26. List the three (3) components of the accommodation response.

27. What is the likely location of a lesion in a patient with a relative afferent pupillary defect (RAPD) on the right side?

28. Define the following terms:

- macular vision
- peripheral vision
- temporal crescent
- occipital pole
- Meyer's loop
- macular sparring
- anopsia (anopia)
- blind spot
- hemianopsia
- quadrantanopsia
- homonymous
- heteronymous
- scotoma
 - positive scotoma
 - negative scotoma
- amaurosis fugax
- myopia
- hyperopia
- amblyopia
- diplopia
- miosis
- mydriasis
- anisocoria
- iridoplegia
- cycloplegia
- hippus
- presbyopia

relative afferent pupillary defect (RAPD)
light-near dissociation
Marcus-Gunn pupil
Adie's pupil
direct light reflex
indirect light reflex

Application Exercises

1. On several lab partners demonstrate and describe a method for evaluating visual fields.
2. On several lab partners demonstrate and describe a method for evaluating visual acuity for distant vision.
3. On several lab partners demonstrate and describe a method for evaluating visual acuity for near vision.
4. On several lab partners demonstrate and describe a method for evaluating the direct light reflex.
5. On several lab partners demonstrate and describe performance of the "swinging flashlight test."
6. In a patient with a lesion involving the left optic nerve, what would you expect to observe in the left eye in response to illumination of the left eye?

7. In a patient with a lesion involving the left optic nerve, what would you expect to observe in the right eye in response to illumination of the left eye?

8. In a patient with a lesion involving the left optic nerve, what would you expect to observe in the left eye in response to illumination of the right eye?

9. In a patient with a lesion involving the left optic nerve, what would you expect to observe in the right eye in response to illumination of the right eye?

10. In a patient with a lesion involving the right abducens nerve, what would you expect to observe in the left eye in response to illumination of the left eye?

11. In a patient with a lesion involving the right abducens nerve, what would you expect to observe in the right eye in response to illumination of the left eye?

12. In a patient with a lesion involving the right abducens nerve, what would you expect to observe in the left eye in response to illumination of the right eye?

13. In a patient with a lesion involving the right abducens nerve, what would you expect to observe in the right eye in response to illumination of the right eye?

14. In a patient with a lesion involving the right oculomotor nerve, what would you expect to observe in the left eye in response to illumination of the left eye?

15. In a patient with a lesion involving the right oculomotor nerve, what would you expect to observe in the right eye in response to illumination of the left eye?

16. In a patient with a lesion involving the right oculomotor nerve, what would you expect to observe in the left eye in response to illumination of the right eye?

17. In a patient with a lesion involving the right oculomotor nerve, what would you expect to observe in the right eye in response to illumination of the right eye?

Ocular Motor Nerves

Objectives

1. List the actions of each of the individual extraocular muscles.
2. Describe the resting position of the eye as a result of paralysis of each individual extraocular muscle.
3. List the eye movement that will result in maximal strabismus for each extraocular muscle.
4. Describe movements of each eye used to assess the function of the muscles acting on that eye.
5. Describe compensatory changes in head position expected in a patient with an acute, unilateral injury involving the abducens, trochlear and oculomotor nerves.
6. Describe the strabismus resulting from lesions affecting each of the extraocular nerves.
7. Describe the neural structures and connection involved in horizontal and vertical gaze shifts.
8. Describe the neural structures and connections involved in volitional and pursuit eye movements.
9. Demonstrate a method for evaluating the function of each extraocular muscle.
10. Demonstrate a method for evaluating a patient with tropia.

Neuroscience Review Questions

1. Define and describe Listing's plane.

2. Define and describe Fick's axes.

X axis _____

Y axis _____

Z axis _____

3. List the extraocular muscles AND indicate the cranial nerve that innervates each.

Muscle	Nerve
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

4. List the primary and secondary actions for each extraocular muscle.

Muscle	Primary Action	Secondary Actions	
lateral rectus	_____		
medial rectus	_____		
superior rectus	_____	_____	_____
inferior rectus	_____	_____	_____
superior oblique	_____	_____	_____
inferior oblique	_____	_____	_____

5. Describe the action for each muscle used for testing that muscle.

lateral rectus _____

medial rectus _____

superior rectus _____

inferior rectus _____

superior oblique _____

inferior oblique _____

6. Describe the resting position of the eye in a patient with damage to each of the extraocular nerves.

abducens nerve _____

oculomotor nerve _____

trochlear nerve _____

7. Where in the brainstem is the oculomotor nucleus located?

8. Where in the brainstem is the trochlear nucleus located?

9. Where in the brainstem is the abducens nucleus located?

10. Which of the ocular motor nerves emerges from the brainstem from its dorsal surface?

11. Which intraorbital muscle is innervated by cells located on both the ipsilateral and contralateral sides?

12. Which of the ocular motor nerves passes through (rather than in the wall of) the cavernous sinus?

13. Which of the ocular motor nerves does NOT pass through the annulus of Zinn?

14. Which of the ocular motor nerves carries autonomic as well as somatic motor fibers?

15. According to Sherrington's law, when the right lateral rectus muscle contracts, what other muscle will be affected AND will it contract or relax?

Muscle

Side

Contract/Relax

16. According to Hering's law, when the right lateral rectus muscle contracts, what other muscle will be affected AND will it contract or relax?

Muscle

Side

Contract/Relax

17. Where in the brainstem is the center for horizontal gaze?

18. Where in the brainstem is the center for vertical gaze?

19. What is the name of the fiber pathway that interconnects the brainstem gaze centers with the ocular motor nuclei?

20. What area of the cerebral cortex (Brodmann area) is associated with volitional eye movements AND what is the Brodmann number of this area?

Cortical Area

Brodmann Number

21. What areas of the cerebral cortex are associated with pursuit (tracking) eye movements AND what are the Brodmann numbers of these areas?

Cortical Area

Brodmann Number

22. Define the following terms:

saccades
visual pursuit
heterotropia (tropia)
 comitant heterotropia
 incomitant heterotropia
heterophoria (phoria)
strabismus
nystagmus
diplopia
ptosis
duction movements
version movements
vergence movements
primary deviation
secondary deviation
oscillopsia
Sherrington's law
Hering's law
cover-uncover test
alternate cover test

Application Exercises

1. What are the two (2) steps involved in the single cover test?

2. What are the two (2) steps involved in the cover-uncover test?

3. What are the two (2) steps involved in the alternate cover test?

4. In several lab partners perform and describe a method for evaluating the function of each the extraocular muscles individually.

5. In several lab partners perform the single cover test and describe the findings you would expect in a patient with a lesion involving the right abducens nerve.

6. In several lab partners perform the cover/uncover test and describe the findings you would expect in a patient with a lesion involving the left abducens nerve.

7. In several lab partners perform the alternate cover test and describe the findings you would expect in a patient with an esophoria.

8. Which of the ocular motor nerves may be injured in a patient with transtentorial (uncal) herniation?

9. Describe the strabismus expected in a patient with a unilateral lesion involving the right oculomotor nerve.

10. What movement will result in maximal diplopia in a patient with a lesion that affects the left abducens nerve?

11. Damage to which ocular motor nerve will result in anisocoria?
-
12. Name the ocular motor abnormality likely to be observed in a patient attempting to look straight ahead who has a lesion affecting the cavernous part of the left carotid artery.
-
13. If the patient in the above question reports diplopia in the position of primary gaze, shifting the gaze in which direction will result in a worsening of the diplopia?
-
14. In the patient in the above question, will you expect to find anisocoria? Explain.
-
15. In several lab partners demonstrate and describe a method for evaluating volitional eye movements.
-
16. Describe the findings you would expect in a patient with a destructive lesion involving the posterior part of the frontal lobe on the left side.
-
17. In several lab partners demonstrate and describe a method for evaluating pursuit eye movements.
-
18. Describe the findings you would expect in a patient with a destructive lesion involving the occipital cortex on the left side.
-

Trigeminal Nerve

Objectives

1. Describe the peripheral and central organization and neural connections of the trigeminal nerve.
2. List and describe the functions mediated by the trigeminal nerve.
3. List, define and describe the major signs and symptoms associated with lesions affecting the peripheral and central parts of the trigeminal nerve.
4. Describe the anatomical and physiological bases of clinical examination techniques used to evaluate the function of the trigeminal nerve.
5. Demonstrate the ability to evaluate the function of the trigeminal nerves.

Neuroscience Review Questions

1. List the three divisions of the trigeminal nerve AND name the intracranial foramen through which each passes.

Division	Foramen
_____	_____
_____	_____
_____	_____

2. Name the part of the trigeminal nuclear complex where the nociceptive afferent fibers terminate.

3. Name the part of the trigeminal nuclear complex where the non-nociceptive afferent fibers terminate.

4. Name the tract formed by the trigeminothalamic axons that cross the midline.

5. Name the tract formed by the trigeminothalamic axons that do NOT cross the midline.

6. Name the three (3) thalamic nuclei that receive synaptic input from the trigeminothalamic tracts.

7. Name the gyrus where thalamocortical fibers subserving the face terminate.

8. What artery supplies the primary sensory cortical area that subserves the face?

9. Through which limb of the internal capsule do these face-related thalamocortical fibers pass?

10. Describe the orientation of the homunculus of the face on the primary sensory cortex.

11. Name the nucleus comprised of motor neurons with axons that are part of the trigeminal nerve.

12. Which division of the trigeminal nerve includes these motor axons?

13. Name the four (4) major muscles innervated by the trigeminal nerve.

14. Name the four (4) smaller muscles innervated by the trigeminal nerve.

15. Name the four (4) reflexes in which the trigeminal nerve serves as the afferent limb.

16. Name the reflex in which the trigeminal nerve serves as the efferent limb.

17. Where are the nerve cell bodies of the afferent limb of the masseter reflex?

18. In addition to the skin of the face, what two (2) other structures or region of the head receive sensory innervation by way of the trigeminal nerve?

19. Define the following terms:
 masseter reflex
 lacrimation reflex
 salivation reflex

Application Exercises

1. On several lab partners mark and describe the areas of skin innervated by each division of the trigeminal nerve.

2. On several lab partners demonstrate and describe a method for evaluating the sensory function of the trigeminal nerve.

3. On several lab partners demonstrate and describe a method for eliciting the masseter reflex.

4. What is the expected response to elicitation of the masseter reflex in a neurologically intact individual?

5. On several lab partners demonstrate and describe a method for eliciting the corneal reflex.

6. Indicate the cranial nerves that subserve the afferent limb AND the efferent limb of the corneal reflex.

Afferent Limb

Efferent Limb

7. What is the expected response to elicitation of the corneal reflex in a neurologically intact individual?

8. On several lab partners demonstrate and describe a method for evaluating the integrity of the motor division of the trigeminal nerve.

9. What two (2) muscles can you palpate to evaluate the motor division of the trigeminal nerve?

10. A 40 y/o man presents to the clinic with a sore eye. When you lightly touch the right cornea both eyes close briskly. When you lightly touch the left cornea neither eye closes. What structure is affected in this patient AND on which side?

Structure Affected

Side Affected

11. A 54 y/o woman presents to the clinic with a sore eye. When you lightly touch the right cornea the right eye closes briskly but the left eye does not close. When you lightly touch the left cornea the right eye closes briskly but the left eye does not close. What structure is affected in this patient AND on which side?

Structure Affected

Side Affected

Facial Nerve

Objectives

1. Describe the peripheral and central organization and neural connections of the facial nerve.
2. List and describe the functions mediated by the facial nerve.
3. List, define and describe the major signs and symptoms associated with lesions affecting the peripheral and central parts of the facial nerve.
4. Describe the anatomical and physiological bases of clinical examination techniques used to evaluate the function of the facial nerve.
5. Demonstrate the ability to evaluate the function of the facial nerve.

Neuroscience Review Questions

1. List the two (2) major divisions of the facial nerve.

2. Name the cranial foramen through which the facial nerves passes to exit the cranial cavity.

3. Name the part of the brainstem that marks the attachment of the facial nerve.

4. Name the nucleus comprised of lower motor nerve cell bodies that is the origin of motor nerve fibers of the facial nerve.

5. Name the nucleus that is comprised of nerve cells bodies that are the origin of the autonomic nerve fibers in the facial nerve.

6. Name the foramen through which the facial nerve proper passes to exit the skull.

7. In addition to the muscles of facial expression, list two (2) other muscles innervated by the facial nerve.

8. Name the two (2) parasympathetic ganglia that receive synaptic input from preganglionic fibers of the facial nerve.

9. Name the two (2) targets of the autonomic nerve fibers of the facial nerve.

10. Name the two (2) branches of the facial nerve that carry preganglionic autonomic nerve fibers.

11. Name the sensory function of the facial nerve.

12. Name the ganglion comprised of the sensory (afferent) cells bodies of the facial nerve.

13. Name the nucleus that receives synaptic input from the afferent nerve fibers of the facial nerve.

14. Name the ascending tract (pathway) formed by the axons of the cells of the above-named nucleus.

15. Name the two (2) diencephalic nuclei and two (2) brainstem nuclei that receive synaptic input from this ascending gustatory pathway.

Diencephalic Nuclei

Brainstem Nuclei

16. Name the gyrus where thalamocortical fibers subserving taste terminate.

17. Through which limb of the internal capsule do these thalamocortical fibers pass?

18. Name the gyrus that contains cortical upper motor neurons that innervate the facial nucleus.

19. Through which limb of the internal capsule do these descending fibers pass?

20. Define the following terms:

Bell's palsy

Bell's phenomenon

ageusia

Application Exercises

1. What four (4) muscles are commonly tested when evaluating the motor function of the facial nerve?

2. On several lab partners demonstrate and describe a method for evaluating the somatic motor function of the facial nerve.

3. Which facial muscles will be affected by a lesion that damages the internal capsule on the left side AND on which side will each be affected?

Muscle Affected	Side Affected
<hr/>	<hr/>
<hr/>	<hr/>
<hr/>	<hr/>
<hr/>	<hr/>

4. Which facial muscles will be affected by a lesion that damages the facial nerve on the right side AND on which side will each be affected?

Muscle Affected	Side Affected
<hr/>	<hr/>
<hr/>	<hr/>
<hr/>	<hr/>
<hr/>	<hr/>

5. A 36 y/o man underwent a surgical procedure in which the chorda tympani was inadvertently damaged on the right side. What two (2) functions will be affected in this patient?

6. A 12 y/o girl was diagnosed with a glioma that has invaded the Vidian canal and damaged the neural structure located therein. What sign or symptom would you look for in this girl?

7. What symptom would you expect in a patient with a lesion affecting the nerve to the stapedius?

Cochlear Nerve

Objectives

1. Describe the basic neuroanatomical organization of the auditory system.
2. Describe the technique of performing the Rinne' test and indicate the inferences that can be drawn from the results.
3. Describe the technique of performing the Weber test and indicate the inferences that can be drawn from the results.

Neuroscience Review Questions

1. Name the middle ear ossicles AND indicate the branchial arch each is derived from.

Ossicle	Branchial Arch
_____	_____
_____	_____
_____	_____

2. Two of the ossicles listed above have muscular attachments. Name the two ossicles with attached muscles AND name the muscle attached to each.

Ossicle	Muscle
_____	_____
_____	_____

3. Name the two (2) muscles attached to ossicles AND name the nerve that innervates each.

Muscle	Nerve
_____	_____
_____	_____

4. On which membrane of the organ of Corti do the auditory receptor cells rest?

5. Which membrane of the organ of Corti separates the scala vestibuli from scala media (cochlear duct)?

6. Which membrane of the organ of Corti separates the scala tympani from the scala media (cochlear duct)?

7. Which membrane of the organ of Corti makes contact with the cilia of the auditory receptor cells?

8. Describe the tonotopic organization of the auditory receptor cells. (Which tones are represented at the base and which tones are represented at the apex?)

9. Name the ganglion comprised of the afferent cell bodies of the auditory nerve.

10. Name the cranial foramen through which the auditory nerve passes to enter the cranial cavity.

11. Name the nuclei where the axons of the auditory nerve terminate.

12. Name the three (3) decussating pathways that originate from the cochlear nuclei.

13. Which of the above decussating pathways is referred to as the trapezoid body?

14. Name the ascending auditory pathway that arises from the cochlear nuclei.

15. Name the mesencephalic nucleus that receives synaptic input from the above-named pathway.

16. Name the thalamic nucleus that receives auditory information.

17. Name the pathway (tract) formed by the axons that arise from the mesencephalic nucleus named above and terminates in the thalamic nucleus named above.

18. Name the gyrus where thalamocortical fibers subserving auditory function terminate AND indicate its Brodmann number?

Gyrus Name

Brodmann Number

19. Through which limb of the internal capsule do these thalamocortical fibers pass?

20. Describe the tonotopic organization of the primary auditory cortex. (Which tones are represented anterolaterally and which tones are represented posteromedially in the primary auditory cortex?)

21. What Brodmann areas are referred to as auditory association areas?

22. What specific auditory association area is related to language function?

23. Sudden loud sounds can elicit two (2) reflex responses that help to dampen the movements of the ossicles. List the two muscles involved AND indicate the nerve that innervates each.

Muscle

Nerve

24. Define the following terms:

tonotopia
hypacusis
conduction deafness
sensorineural deafness
tinnitus
presbycusis
stapedius reflex
 Rinne' test
 Weber test
 tonotopia

Application Exercises

1. Does most of the auditory information that reaches the cerebral cortex arise from the ipsilateral side or contralateral ear?

2. On several lab partners demonstrate and describe a screening method for evaluating auditory function.

3. On several lab partners demonstrate and describe a method for performing the Rinne' test.

4. Which tuning fork is recommended for use when performing the Rinne' test?

_____ Hz

5. In a patient with suspected hearing loss in the right ear, the Rinne' test reveals that $AC > BC$. Is this finding suggestive of conduction deafness or sensorineural deafness of the right ear?

6. In a patient with suspected hearing loss in the left ear, the Rinne' test reveals that $BC > AC$. Is this finding suggestive of conduction deafness or sensorineural deafness of the left ear?

7. On several lab partners demonstrate and describe a method for performing the Weber test.

8. Which tuning fork is recommended for use when performing the Weber test?

_____ Hz

9. In a patient with suspected hearing loss in the right ear, the Weber test lateralizes to the left side. Is this finding suggestive of conduction deafness or sensorineural deafness of the right ear?

10. In a patient with suspected hearing loss in the left ear, the Weber test lateralizes to the left side. Is this finding suggestive of conduction deafness or sensorineural deafness of the left ear?

Vestibular Nerve

Objectives

1. List and briefly describe the stimuli appropriate for activating receptors in the semicircular canals and otolithic organs.
2. List the signs and symptoms commonly associated with unilateral disease affecting vestibular receptors or vestibular nerve.
3. Describe the neuroanatomical organization and functions of the vestibulo-ocular reflexes (oculo-cephalic and oculo-vestibular).
4. List and describe the major causes of dizziness.
5. Describe a mechanism for jerk nystagmus.
6. Describe the technique of cold caloric testing.

Neuroscience Review Questions

1. Which vestibular receptor is responsive to angular (rotatory) acceleration and deceleration AND where are these receptors located?

Receptor

Location

2. Which vestibular receptor is responsive to linear acceleration and deceleration AND where are these receptors located?

Receptor

Location

3. Which of the receptors indicated above is associated with otoconia?

4. Name the ganglion comprised of the afferent cell bodies of the vestibular nerve.

5. Name the cranial foramen through which the vestibular nerve passes to enter the cranial cavity.

6. Name the nuclei where the axons of the vestibular nerve terminate.

7. Which of the vestibular nuclei preferentially receive synaptic input from the receptors in the semicircular canals?

8. Which of the vestibular nuclei preferentially receive synaptic input from the receptors in the utricle and saccule?

9. Which of the vestibular nuclei preferentially give rise to axons that ascend in the medial longitudinal fasciculus?

10. Which of the vestibular nuclei preferentially give rise to axons that descend in the medial vestibulospinal tract?

11. In which region of the spinal cord is the medial vestibulospinal tract located?

12. Which nucleus gives rise to axons that descend in the lateral vestibulospinal tract?

13. In which region of the spinal cord is the lateral vestibulospinal tract located?

14. Which lobe of the cerebellum is reciprocally connected with the vestibular nuclei?

15. What is the name of the fiber pathway that interconnects the vestibular nuclei with the cerebellum?

16. What nucleus of the brainstem receives projections from the vestibular nuclei and plays a role in vomiting?

17. What nucleus of the brainstem receives projections from the vestibular nuclei and plays a role in pharyngeal muscle activity?

18. What region of the brainstem that receives projections from the vestibular nuclei plays a role in mediating sweating and facial pallor?

19. Name three (3) nuclei of the diencephalon that receive synaptic input from the vestibular nuclei.

20. What is the effect on impulse frequency in the left vestibular nerve when the head is rotated to the left?

21. Describe the pathophysiological bases for each of the following:

vertiginous dizziness
presyncopal dizziness
disequilibrium
lightheadedness

22. Define the following terms:

vertigo
oscillopsia

nystagmus
positional nystagmus
gaze-evoked nystagmus
vestibulo-ocular reflexes
 oculo-vestibular reflex
 oculo-cephalic reflex
canal paresis
Dix-Hallpike maneuver
Epply maneuver

Application Exercises

1. Slowly rotate a lab partner to the left on a revolving stool at a rate of 1/2 revolution per second for eight (8) revolutions. Stop the subject and observe the subject's eyes. Name the type of nystagmus you observe.

2. Describe the response you would expect to elicit in a neurologically intact individual in whom you irrigate the right external ear canal with cold water.

3. Describe a method for eliciting the oculo-cephalic reflex.

4. Describe a method for eliciting the oculo-vestibular reflex.

5. Demonstrate the use of "past-pointing" in the evaluation if suspected vestibular nerve dysfunction.

6. Describe the observation you might expect when using "past-pointing" in a patient with damage to the right vestibular nerve

7. Demonstrate the use of "marching-in-place" in the evaluation if suspected vestibular nerve dysfunction.

8. Describe the observation you might expect when using “marching-in-place” in a patient with damage to the left vestibular nerve
-
9. Name the type of nystagmus that might be observed in a patient with an acute destructive lesion affecting the right vestibular nerve.
-
10. Describe the findings you might expect with cold caloric testing of the right side in a patient with a supra-tentorial lesion.
-
11. Describe the findings you might expect with cold caloric testing of the right side in a patient with damage to the vestibular nerve on the right side.
-
12. What is the term used to describe the type of rigidity observed in a patient with a lesion above the level of the midbrain?
-
13. What is the term used to describe the type of rigidity observed in a patient with a lesion at the level of the mid pons?
-
14. A 30 y/o man with dizziness and an imaging-confirmed lesion involving the left vestibular nerve presents to the ENT clinic. The patient demonstrates rotation when performing marching in place. Which direction will he rotate during this test?
-
15. A 42 y/o woman presents with hearing loss and left horizontal jerk nystagmus. She is diagnosed with disease resulting in damage to the vestibular nerve. On which side is her disease?
-

Glossopharyngeal and Vagus Nerves

Objectives

1. Describe the peripheral and central organization and neural connections of the glossopharyngeal and vagus nerves.
2. List and describe the functions mediated by the glossopharyngeal and vagus, nerves.
3. List, define and describe the major signs and symptoms associated with lesions affecting the peripheral and central parts of the glossopharyngeal and vagus nerves.
4. Describe the anatomical and physiological bases of clinical examination techniques used to evaluate the function of the glossopharyngeal and vagus nerves.
5. Demonstrate the ability to evaluate the function of the glossopharyngeal and vagus nerves.

Neuroscience Review Questions

1. Name the sulcus of the brainstem that marks the attachment of the glossopharyngeal nerve.

2. Name the cranial foramen through which the glossopharyngeal nerves passes to exit the cranial cavity.

3. Name the skeletal muscle that is innervated by the glossopharyngeal nerve.

4. Name the nucleus in the brainstem that is the origin of axons that innervate the muscle indicated above.

5. Name the gland that is innervated by the glossopharyngeal nerve.

6. Name the nucleus in the brainstem that is the origin of preganglionic axons that are part of the glossopharyngeal nerve.

7. Name the ganglion that receives synaptic input from the preganglionic axons of the glossopharyngeal nerve.

8. Name the structure that is innervated by the postganglionic nerve cells indicated above.

9. Name the two sensory receptors that, when activated, transmit impulses toward the brainstem by way of the glossopharyngeal nerve AND name the sensory ganglia formed by the cell bodies that innervate each.

Receptor

Ganglion

10. Name the nucleus in the brainstem where the central processes from each of the ganglia listed above terminate.

Ganglion

Brainstem Nucleus

11. Name the sulcus of the brainstem that marks the attachment of the vagus nerve.

12. Name the cranial foramen through which the vagus nerves passes to exit the cranial cavity.

13. Name the two (2) skeletal muscle groups that are innervated by the vagus nerve.

14. Name the muscle innervated by the external laryngeal nerve.

15. Name the branch of the vagus nerve that innervates the laryngeal muscles.

16. Name the nucleus in the brainstem that is the origin of axons that innervate the laryngeal muscles.

17. Name the nucleus in the brainstem that is the origin of axons that influence activity of the heart.

18. Name the nucleus in the brainstem that is the origin of axons that influence activity of the circular and longitudinal muscles of small intestine.

19. Name the ganglion comprised of nerve cell bodies with axons that carry afferent (sensory) information from the duodenum.

20. Name the ganglion comprised of nerve cell bodies with axons that carry afferent (sensory) information from the meninges.

21. Name the two sensory receptors that, when activated, transmit impulses toward the brainstem by way of the vagus nerve AND name the sensory ganglia formed by the cell bodies that innervate each.

Receptor

Ganglion

22. Name the nucleus in the brainstem where the afferent (sensory) fibers from the stomach terminate.

23. Name the nucleus in the brainstem where the afferent (sensory) fibers from the meninges terminate.

24. Define the following terms:

dysphagia
dysarthria
dysphonia
carotid sinus reflex
carotid body reflex

Application Exercises

1. What cranial nerves serve as the afferent and efferent limbs of the pharyngeal (gag) reflex?

Afferent Limb

Efferent Limb

2. What ganglion is formed in part by the nerve cell bodies of the nerve that serves as the afferent limb of the pharyngeal (gag) reflex?

3. What muscle is innervated by the nerve that serves as the efferent limb of the pharyngeal (gag) reflex?

4. What muscle forms the posterior pillar of the tonsillar fossa?

5. What muscle forms the anterior pillar of the tonsillar fossa?

6. What cranial nerve innervates the carotid sinus?

7. What cranial nerve innervates the carotid body?

8. In a patient with a lesion involving the left glossopharyngeal nerve, which way will the uvula deviate when the patient is asked to say, “AAAHHH”?

9. In a patient with a lesion involving the right vagus nerve, which way will the uvula deviate when the patient is asked to say, “AAAHHH”?

10. In a patient with a lesion involving the left glossopharyngeal nerve, what will you likely observe when you touch the right tonsillar fossa?

11. In a patient with a lesion involving the left glossopharyngeal nerve, what will you likely observe when you touch the left tonsillar fossa?

Accessory Nerve

Objectives

1. Describe the peripheral and central organization and neural connections of the accessory nerve.
2. List and describe the functions mediated by the accessory nerve.
3. List, define and describe the major signs and symptoms associated with lesions affecting the peripheral and central parts of the accessory nerve.
4. Describe the anatomical and physiological bases of clinical examination techniques used to evaluate the function of the accessory nerve.
5. Demonstrate the ability to evaluate the function of the accessory nerve.

Neuroscience Review Questions

1. Name the nucleus formed by the cell bodies that give rise to the axons of the accessory nerve.

2. Are the cortical upper motor neurons that innervate the above named nucleus located on the ipsilateral or contralateral side?

3. Name the foramen through which the fibers of the accessory nerve enter the cranial cavity.

4. Name the foramen through which the fibers of the accessory nerve exit the cranial cavity.

5. Name the two (2) muscles innervated by the accessory nerve.

6. Define the following term:

torticollis

Application Exercise

1. In several lab partners demonstrate and describe a method for evaluating the function of the accessory nerve.
-

Hypoglossal Nerve

Objectives

1. Describe the peripheral and central organization and neural connections of the hypoglossal nerve.
2. List and describe the functions mediated by the hypoglossal nerve.
3. List, define and describe the major signs and symptoms associated with lesions affecting the peripheral and central parts of the hypoglossal nerve.
4. Describe the anatomical and physiological bases of clinical examination techniques used to evaluate the function of the hypoglossal nerve.
5. Demonstrate the ability to evaluate the function of the hypoglossal nerve.

Neuroscience Review Questions

1. Name the sulcus of the brainstem that marks the attachment of the hypoglossal nerve.

2. Name the nucleus formed by the cell bodies that give rise to the axons of the hypoglossal nerve.

3. Are the cortical upper motor neurons that innervate the above-named nucleus located on the ipsilateral or contralateral side?

4. Name the foramen through which the fibers of the hypoglossal nerve exit the cranial cavity.

5. Name the three (3) extrinsic muscles of the tongue innervated by the hypoglossal nerve.

6. Name the one (1) extrinsic muscle of the tongue that is NOT innervated by the hypoglossal nerve.

7. Define the following terms:

dysphonia
dysarthria

Application Exercises

1. Which extrinsic muscle of the tongue is used to protrude the tongue as performed as part of the evaluation of the hypoglossal nerve?

2. On several lab partners demonstrate and describe a method for evaluating the function of the hypoglossal nerve.

3. In a patient with a lesion involving the right hypoglossal nerve, which side of the tongue will demonstrate atrophy?

4. In a patient with a lesion involving the left hypoglossal nerve, which way will the tongue deviate on protrusion?

Consciousness

Objectives

1. Describe the differences between level of consciousness and content of consciousness.
2. Describe behaviors commonly associated with level and content of consciousness.
3. Describe the relationship between consciousness and the reticular formation.
4. Describe selected tests used to evaluate consciousness.

Neuroscience Review Questions

1. What are the two categories of consciousness?

2. List four (4) terms that refer to altered levels of consciousness.

3. List four (4) brainstem reflexes commonly used to localize lesions that affect level of consciousness.

4. List four (4) physiological processes mediated by brainstem centers that may be affected in patients with brainstem lesions that alter level of consciousness

5. List the three (3) categories of responses observed when administering the Glasgow Coma Scale.

6. Decreased level of consciousness suggests brainstem dysfunction. List the main causes of brainstem injury associated with altered level of consciousness.

- a. primary (direct) causes of brainstem injury

- b. secondary (indirect) causes brainstem injury

7. List four (4) cerebral (higher cortical) functions commonly assessed when evaluating a patient with altered content of consciousness.

8. Decreased content of consciousness suggests cerebral dysfunction. List the main cause of cerebral injury associated with altered content of consciousness.

9. Describe the alterations in muscle tone and resulting changes in limb position (upper limbs and lower limbs) in a patient that exhibits decerebrate rigidity.

Upper Limbs _____

Lower Limbs _____

10. Describe the alterations in muscle tone and resulting changes in limb position (upper limbs and lower limbs) in a patient that exhibits decorticate rigidity.

Upper Limbs _____

Lower Limbs _____

11. Define the following terms:

level of consciousness (arousal)
content of consciousness (awareness)
alert
lethargy
obtundation
stupor
coma
confusion
delirium
acute confusional state
vegetative state
minimally conscious state
decorticate rigidity
decerebrate rigidity

Application Exercises

1. On several lab partners demonstrate and describe a method for evaluating and documenting the results of testing each of the following brainstem reflexes:
- pupillary light reflexes
 - corneal reflex
 - vestibule-ocular reflex (oculo-cephalic reflex)
 - pharyngeal reflex

2. On several lab partners demonstrate and describe a method for evaluating and documenting the results of testing each of the following cerebral functions:
 - a. attention
 - b. orientation
 - c. memory function
 - immediate recall
 - short term memory
 - long term memory

Attention

Objectives

1. Define the three major attention-related cognitive tasks: capturing, focusing, and maintaining.
2. Describe the concepts of selective attention and divided attention.
3. Describe several simple clinical tests of attention.

Neuroscience Review Questions

1. Identify the three (3) major nuclei of the ascending reticular activating system (ARAS) and indicate the main neurotransmitter synthesized by the cells that form each.

Nucleus

Neurotransmitter

2. The axons of the cells identified in the above question ascend to the cerebrum where they terminate in wide variety of nuclei and cortical areas. Identify the pathway formed by the axons of these cells as they pass through the diencephalon.

3. Describe the location within the diencephalon of the pathway identified in the previous question.

4. Describe the location and function of the reticular nucleus of the thalamus.

5. Define the following terms:

reticular formation
reticular activating system
attention
 selective
 divided
delirium
concentration
vigilance
hemispheric neglect

Application Exercises

1. Demonstrate and describe the method used to evaluate attention embedded in the Mini Mental State exam.

2. Demonstrate and describe one or more alternative and more reliable test for evaluating attention.

Orientation

Objectives

1. List and describe the three (3) primary domains of orientation.
2. Indicate several, standard questions commonly used for evaluating orientation.
3. Discuss the diagnostic and functional implications for patients with impaired orientation.

Neuroscience Review Questions

1. Being oriented indicates an awareness of self and one's surroundings. List the areas of orientation commonly assessed in the neurologic exam.

(_____)

2. List two (2) questions that might be asked to evaluate orientation to person.

3. List five (5) questions that might be asked to evaluate orientation to place.

4. List five (5) questions that might be asked to evaluate orientation to time.

5. Disorientation to which of the above is MOST likely to be indicative of a psychiatric disorder?

6. Define the following terms:

disorientation
psychosis

Application Exercises

1. Demonstrate and describe a method for evaluating orientation.

2. Describe a method for documenting the findings in a patient who is disoriented to place.

Language Function

Objectives

1. Identify areas of the right and left cerebral hemispheres that are important in language function.
2. Describe the pathways interconnecting the cortical language areas.
3. List and describe specific language deficits associated with focal lesions affecting different parts of the cerebral cortex.
4. Describe simple tests for evaluating language function.

Neuroscience Review Questions

1. Speaking and language are two separate functions. Speaking involves the production of sounds. Language involves the use of symbols (auditory or visual) to communicate information. List the four (4) physiological operations involved in speaking (speech).

2. What is the term used to describe visual symbols used for communication?

3. What is the term used to describe auditory symbols used for communication?

4. Both the left and the right hemispheres are involved in language function. What components of language function are mediated by each?

Functional Component

Left hemisphere _____

Right hemisphere _____

5. List the three (3) major operations associated with oral language function and indicate the main brain regions/structures important for each.

Language Operation	Important Brain Region/Structure
_____	_____
_____	_____
_____	_____

6. What are the Brodmann areas (numbers) associated with each of the following:

Broca's area _____

Wernicke's area _____

7. What is the arterial blood supply to Broca's area? (Be specific.)

8. What is the arterial blood supply to Wernicke's area? (Be specific.)

9. What four (4) terms can be used synonymously with Broca's aphasia?

10. What four (4) terms can be used synonymously with Wernicke's aphasia?

11. Define the following terms:

fluency
prosody
aphasia
 transcortical motor aphasia
 transcortical sensory
 conduction
 global aphasia
non-fluent aphasia
 fluent aphasia
neologism
anomia
dysphasia
dysarthria
dysphonia
planum temporale
aphasia
agraphia
anomia
alexia
phoneme
grapheme
propositional language
prosodic language
paraphasia
Wernicke's aphasia
Broca's aphasia

Application Exercises

1. List the five (5) language operations commonly evaluated.

2. On several lab partners demonstrate and describe a method for evaluating fluency.

3. On several lab partners demonstrate and describe a method for evaluating comprehension.

4. On several lab partners demonstrate and describe a method for evaluating repetition.

5. On several lab partners demonstrate and describe a method for evaluating object naming.

6. On several lab partners demonstrate and describe a method for evaluating reading.

7. On several lab partners demonstrate and describe a method for evaluating writing.

8. What percentage of naturally right-handed individuals who sustain a lesion in the left hemisphere are likely to demonstrate impaired fluency or comprehension?

9. What percentage of naturally right-handed individuals who sustain a lesion in the right hemisphere are likely to demonstrate impaired fluency or comprehension?

10. What percentage of naturally left-handed individuals who sustain a lesion in the left hemisphere are likely to demonstrate impaired fluency or comprehension?

11. What percentage of naturally left-handed individuals who sustain a lesion in the right hemisphere are likely to demonstrate impaired fluency or comprehension?

12. Describe the clinical findings regarding language function in a right-handed man who sustains a lesion that damages the arcuate fasciculus on the right side.

13. What finding on clinical examination helps to distinguish a patient with a Broca's aphasia from a patient with a transcortical motor aphasia?

14. What finding on clinical examination helps to distinguish a patient with a Wernicke's aphasia from a patient with a transcortical sensory aphasia?

15. Mr. Dextra is a right-handed man with an infarction involving the middle cerebral artery territory in the right cerebral hemisphere. Mr. Sinstra is a left-handed man with an infarction involving the middle cerebral artery territory in the right cerebral hemisphere. Which of these two individuals is most likely to demonstrate dysprosody on examination?

16. What is the most likely location of a lesion that results in a global aphasia?

17. What is the most likely location of a lesion that results in a Broca's aphasia?

18. What is the most likely location of a lesion that results in a Wernicke's aphasia?

19. What is the basic pathophysiological mechanism leading to the development of a transcortical sensory aphasia?

Learning and Memory

Objectives

1. List the structures that comprise the limbic system.
2. Describe the functions commonly associated with the hippocampal formation.
3. Describe the histological organization of the hippocampal formation.
4. Describe the afferent and efferent connections of the hippocampal formation.
5. Describe and discuss the neural mechanisms associated with the processes of learning and remembering.

Neuroscience Review Questions

1. What is the major cortical area involved in the formation of memories?

2. What are the three (3) cortical structures that comprise the hippocampal formation?

3. What is the distinctive histological feature that distinguishes the hippocampal formation from other cortical areas of the hemisphere?

4. What are the names of the two (2) fiber pathways that transmit information into the hippocampal formation from the adjacent cortex (entorhinal cortex)?

5. What is Sommer's sector and what is its functional/clinical significance?

6. Where are the cell bodies of fibers referred to as Schaffer collaterals?

7. Where are the cell bodies of fibers referred to as mossy fibers?

8. What is the location of the majority of cells that give rise to the fornix?

9. What three (3) nuclei do most of the fibers of the fornix terminate in?

10. Describe the Papez circuit (beginning in the temporal lobe).

11. What are the time frames associated with each of the following types of memory?

working memory _____

short term memory _____

long term memory _____

12. Define the following terms:

hippocampal formation
hippocampus
cornu ammonis
alveus
fimbria
declarative (explicit) memory
procedural (implicit) memory
amnesia
 retrograde
 anterograde
emotion
Papez circuit

Application Exercises

1. List the four (4) words that YOU will use (now and forever more) when you evaluate memory function in your patients. (Hint: select an object, a color, a characteristic and a number; and present them to the patient always in this order.) Write them below, memorize them and use them consistently.

_____ (object)

_____ (color)

_____ (characteristic)

_____ (number)

2. On several lab partners demonstrate and describe a method for assessing working memory (immediate recall).

3. On several lab partners demonstrate and describe a method for assessing short term memory.

4. On several lab partners demonstrate and describe a method for assessing long term memory.

5. In patients who may be unable to speak, visual memory for objects hidden in the room may be tested. In several lab partners demonstrate a method for evaluating visual memory.

6. Describe a method for documenting findings on memory testing.

7. Lesions affecting what cortical area are most likely to result in impaired short-term memory?

8. Lesions affecting what nuclear structure are most likely to result in impaired short-term memory?

9. Where are long term visual memories most likely stored?

10. Where are long term auditory memories most likely stored?

Cognitive Function

Objectives

1. List and describe several behaviors (there are many!) that rely of the functional and structural integrity of the cerebral hemisphere operating as a whole.
2. Describe some commonly used approaches for evaluating these cognitive functions.
3. Discuss how impairment of these cognitive functions can affect patient's lives including activities of daily living (ADL's).

Neuroscience Review Questions

1. Cognitive function (higher cortical function) generally means operations mediated by cells of the cerebral cortex other than simply perceiving stimuli and initiating movement. These functions typically include thinking, planning, judging, deciding, calculating. The cortical cells involved are described as forming the modality specific and integrative association cortices of both cerebral hemispheres.
2. Typical "cognitive functions" tested include fund of knowledge, calculation ability, proverb interpretation and praxis.
3. List the three (3) clinical findings that define Balint's syndrome.

4. List the four (4) clinical findings that define Gerstmann syndrome.

5. Define the following terms:

acalculia
agnosia
 apperceptive agnosia
 associative agnosia
 prosopagnosia
 stereognosia
praxis
apraxia
 ideational apraxia
 ideomotor apraxia
 limb-kinetic apraxia
 buccofacial apraxia
 dressing apraxia
 ocular motor apraxia
 constructional apraxia
amnesia
transitive movements
intransitive movements

Application Exercises

1. Evaluating fund of knowledge involves having the individual describe/discuss topics of general understanding in areas that the individual would be expected to have some understanding of. An adequate history is required in order to identify appropriate topics for discussion. In several lab partners whom you have some previous familiarity with demonstrate and describe a method for evaluating fund of knowledge. Document your finding as you would in a patient's chart.

2. Calculation ability refers to the ability to correctly perform simple arithmetical calculations and is determined by asking the individual to solve simple arithmetic problems involving addition, subtraction, multiplication, and division. In several lab partners demonstrate and describe a method for evaluating calculation ability. Document your findings as you would in a patient's chart.

3. Proverb interpretation is an example of abstract interpretation. It involves the ability to make an interpretation of a statement other than a literal one. In several lab partners demonstrate and describe a method for evaluating proverb interpretation. Document your findings as you would in a patient's chart.
-

4. Praxis refers to the ability to perform previously learned movements. In several lab partners demonstrate and describe a method for assessing the ability to perform an intransitive movement.
-

5. Praxis refers to the ability to perform previously learned movements. In several lab partners demonstrate and describe a method for assessing the ability to perform a transitive movement.
-

6. In several lab partners demonstrate and describe a method for evaluating tactile gnosis. Document your findings as you would in a patient's chart.
-

Answer Key

Anterolateral System

Neuroscience Review

1. high
slowly
2. mechanical
chemical
thermal
3. C 0.5 – 2.0 m/sec
A δ 12 – 30 m/sec
4. dorsal horn
5. laminae I, II, V
6. anterior white commissure
7. reticular formation
superior colliculus
8. ventral posterolateral (VPL)
dorsal medial (DM)
central medial (CM)
9. post central gyrus upper limb
posterior paracentral gyrus lower limb
10. posterior limb
11. cingulate gyrus
superior frontal gyrus, medial surface
12. anterior limb
13. upper limb – dorsolateral surface
lower limb – medial surface

Application Exercises

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.
8. C7 spinal nerve root left
9. lateral femoral cutaneous nerve right
10. upper limb left
11. posterior limb right

Lemniscal System

Neuroscience Review

1. low
rapidly adapting and very rapidly adapting
2. Meissner's corpuscle
3. muscle spindle
4. A β 30 – 70 m/sec
5. Ia 70 – 120 m/sec
 II 30 – 70 m/sec
6. dorsal columns
7. fasciculus gracilis lower limb
 fasciculus cuneatus upper limb
8. lower limb – medial, upper limb – lateral

9. nucleus gracilis – lower limb
nucleus cuneatus – upper limb
10. rostral part of caudal half of medulla oblongata
11. medial lemniscus
12. upper limb – dorsal, lower limb – ventral
upper limb – medial, lower limb – lateral
upper limb – ventromedial, lower limb - dorsolateral
13. ventral posterolateral (VPL)
14. upper limb – medial, lower limb – lateral
15. post central gyrus upper limb
posterior paracentral gyrus lower limb
16. posterior limb
17. upper limb – dorsolateral surface, lower limb – medial surface
18. perception
localization
19. somatosensory association cortex – interpretation and recognition
motor and premotor cortex – planning and execution of movements

Application Exercises

- 1.
- 2.
- 3.
- 4.
- 5.
6. increased threshold (decreased perception) to stimulation on entire left side of body
- 7.

8. anesthesia to stimulation on posterior surface of forearm and dorsal surface of hand (in distribution of radial nerve)
9. 128Hz tuning fork
- 10.
11. reduced duration of perception
- 12.
13. increased number of incorrect responses to changes in joint position
- 14.
15. eyes open – stable, eyes closed – unstable
16. dorsal columns of spinal cord
17. fasciculus gracilis right side
18. ventral posterolateral nuc. right side
19. medial lemniscus right side

Cortical Sensory Functions

Neuroscience Review

1. postcentral gyrus Brodmann areas 3,1,2
2. superior parietal lobule Brodmann areas 5,7
3. middle cerebral artery
4. 128 Hz
5. upper limb – index or long finger lower limb – great toe
- 6.

Application Exercises

- 1.
2. 8 -10 or until you are satisfied of the reliability of your evaluation
3. 1 – 3 degrees of arc are all that is necessary
- 4.
- 5.
- 6.
- 7.

Motor System

Neuroscience Review

- | | | |
|----|--------------------------------|----------------------------------|
| 1. | Upper Limb | Peripheral Nerve |
| | shoulder abduction | axillary |
| | elbow flexion | musculocutaneous |
| | elbow extension | radial |
| | wrist extension | radial |
| | wrist flexion | median |
| | finger extension | radial |
| | finger flexion (grip strength) | ulnar |
| | finger abduction | ulnar |
| | finger adduction | ulnar |
| | Lower Limb | |
| | hip flexion | obturator |
| | hip adduction | superior gluteal |
| | hip abduction | inferior gluteal |
| | hip extension | femoral |
| | knee extension | sciatic (tibial/common peroneal) |
| | knee flexion | anterior tibial (deep peroneal) |
| | ankle dorsiflexion | tibial (posterior tibial) |
| | ankle plantar flexion | anterior tibial (deep peroneal) |
| | toe extension | |

2.	Upper Limb	Spinal Segments
	shoulder abduction	<u>C5</u> , C6
	elbow flexion	C5, <u>C6</u>
	elbow extension	C6, <u>C7</u>
	wrist extension	C6, <u>C7</u>
	wrist flexion	C7, <u>C8</u>
	finger extension	<u>C7</u> , C8
	finger flexion (grip strength)	<u>C8</u> , T1
	finger abduction	C8, <u>T1</u>
	finger adduction	C8, <u>T1</u>

Lower Limb

hip flexion	L2, L3, <u>L4</u>
hip adduction	L2, L3, <u>L4</u>
hip abduction	L4, <u>L5</u> , S1
hip extension	L5, <u>S1</u> , S2
knee extension	L2, L3, <u>L4</u>
knee flexion	<u>L5</u> , <u>S1</u> , S2
ankle dorsiflexion	<u>L4</u> , L5
ankle plantar flexion	L5, <u>S1</u> , S2
toe extension	L4, <u>L5</u>

3. frontal lobe
parietal lobe_
4. upper limbs - frontal
Lower limbs - frontal
5. upper limb - precentral gyrus
Lower limb – anterior paracentral gyrus
6. thalamus – posterior limb of the internal capsule
midbrain – cerebral peduncle
pons – basis pons (longitudinal pontine bundles
medulla oblongata – medullary pyramid
7. pyramidal decussation (decussation of the medullary pyramid)
8. rostral part – upper limb
caudal part – lower limb
9. 80% - 90%
10. decussate – lateral corticospinal tract
do not decussate – anterior corticospinal tract

11. upper limb – 55%
lower limb – 25%
non limb – 20%
12. medial part of ventral horn – axial muscle groups
intermediate part of the ventral horn – girdle and proximal muscle groups
lateral part of the ventral horn – distal muscle groups
13. normal (5/5) full ROM against gravity with maximal resistance
good (4/5) full ROM against gravity with some resistance
fair (3/5) full ROM against gravity only
poor (2/5) full ROM with gravity eliminated
trace (1/5) palpable or visible muscle contraction with little or no movement
zero (0/5) no palpable or visible muscle contraction
- 14.

Application Exercises

- 1.
2. no
3. activity or occupation related hypertrophy OR disuse atrophy
- 4.
5. ventral horn (lower motor neuron)
peripheral nervous system (ventral roots, spinal nerve, plexus or peripheral nerves)
6. anterior tibial (deep peroneal) nerve right side
7. C5 or C6 spinal nerve root left side
8. ulnar nerve right side
9. L2 or L3 or L4 spinal nerve root left side

Coordination, Station, and Gait

Neuroscience Review

1. anterior lobe
posterior lobe
flocculonodular lobe
2. archicerebellum (vestibulocerebellum)
paleocerebellum (spinocerebellum)
neocerebellum (cerebrocerebellum)
3. vermal region
paravermal region
hemispheric region
4. primary fissure
5. posterolateral fissure
6. superior cerebellar peduncle midbrain
middle cerebellar peduncle pons
inferior cerebellar peduncle medulla oblongata
7. molecular
Purkinje
granular
8. stellate
basket
9. granule
golgi

10. Afferent Tract Efferent Tract

Superior Cerebellar Peduncle

ventral spinocerebellar tr	cerebello-rubral tr
trigemino-cerebellar tr	dentato-thalamic tr
	cerebello-olivary tr

Middle Cerebellar Peduncle

pontocerebellar tr

- 5.
6. standing with eyes open – stable
standing with eyes closed – unstable
7. dorsal columns of spinal cord
- 8.
9. heel strike
foot flat
heel off
toe off
swing phase
10. stiff knee and hip with circumduction during swing phase
11. excessive hip and knee flexion during swing phase with toe hitting before heel
12. unsteady progression, wide-based steps
13. short steps, limited ROM at all joints, difficulty turning in place
14. dance-like steps impaired arm swing
15. high stepping with “slapping” of foot at heel strike
16. right side
17. left side

Gait

Neuroscience Review

1. 60%
2. 40%
3. 80%
4. 20%
5. the ankle moves from dorsiflexion into plantar flexion
6. the ankle moves from plantar flexion into dorsiflexion (to clear the floor)

7. the knee moves from full extension into slight flexion
8. the knee moves from extension at toe off into flexion during swing phase and back into extension as heel strike approaches
9. the center of mass moves slightly (variably) toward the side of SLS during stance phase on each limb
10. tibialis anterior (ankle dorsiflexors)
11. gluteus maximus and gluteus medius (hip extensors and hip abductors)
12. iliopsoas (hip flexors)
13. hamstrings (knee flexors)
14. quadriceps femoris (knee extensors)
15. quadriceps femoris (knee extensors)
16. tibialis anterior (ankle dorsiflexors)
17. tibialis anterior (ankle dorsiflexors)
18. all movements are reduced as a result of spasticity
19. shoulder moves from flexion to extension during ipsilateral swing phase
20. stance phase
21. single limb support

Application Exercises

- 1.
2. a. tibialis anterior
- 3.
- 4.
- 5.
- 6.

- 7.
- 8.
- 9.

Reflexes (including Muscle Tone)

Neuroscience Review

1. muscle spindle
Golgi tendon organ
2. muscle spindle
3. muscle elongation (stretch)
4. primary (annulospiral) Ia
Secondary (flower spray) II
5. Ia 70 – 120 m/sec
II 30 – 70 m/sec
6. excitation
7. gamma motor neurons 15 – 30 m/sec
8. increase in tension applied to the tendon
9. Ib fiber 70 – 120 m/sec
10. inhibition of lower motor neurons
11. Reflex

	Peripheral Nerve
biceps reflex	musculocutaneous
triceps reflex	radial
brachioradialis reflex	radial
finger flexor reflex	median/ulnar
quadriceps reflex	femoral
Achilles reflex	tibial (posterior tibial)
12. Reflex

	Spinal Segment
--	----------------

biceps reflex	<u>C5</u> , C6
triceps reflex	C6, <u>C7</u> , C8
brachioradialis reflex	C5, <u>C6</u> , C7
finger flexor reflex	<u>C8</u> , T1
quadriceps reflex	L2, L3, <u>L4</u>
Achilles reflex	L5, <u>S1</u> , S2

13.
 - 0/5 no visible or palpable muscle contraction with reinforcement
 - 1/5 slight muscle contraction with little or no joint movement
 - 2/5 distinct muscle contraction with slight joint movement
 - 3/5 brisk muscle contraction with moderate joint movement
 - 4/5 strong muscle contraction with 1-3 beats of clonus and possible spread
 - 5/5 strong muscle contraction with sustained clonus

14. Spasticity
 - velocity dependent
 - clasp-knife phenomenon
 - more pronounced in antigravity muscles
 Rigidity
 - velocity independent
 - cog wheeling or lead pipe resistance
 - affects all limb muscle groups equally

15. masseter
Hoffman

16. tactile stimuli (stroking) applied to sole of foot

17. flexion of the toes (downgoing toes)

18. Babinski sign

19. upper motor neuron disease

Application Exercises

- 1.
- 2.
3.
 - threshold
 - latency
 - magnitude (amplitude and spread)
 - duration
- 4.

- 5.
- 6.
- 7.
8. triceps brachii right
9. quadriceps femoris left
- 10.
- 11.

Olfactory Nerve

Neuroscience Review

1. olfactory receptor cell
 Bowman's gland cell
 basal cell
 sustentacular cell
2. olfactory receptor cell
3. pass upward through the cribriform plate of the ethmoid bone
4. olfactory bulb
5. mitral cells
6. inhibition
7. lateral olfactory gyrus (in prepiriform cortex)
 hippocampus
 amygdaloid nucleus
8. septal nuclei
9. coffee
 soap
 mint
10. irritant substances activate trigeminal nerve chemoreceptors

Application Exercises

- 1.
- 2.

Visual System and Pupillary Reflexes

Neuroscience Review

1. inversely related both vertically and horizontally
2. superiorly 60°
medially 70°
inferiorly 80°
laterally 90°
3. 120° (60° in both lateral directions from central vision in primary gaze)
4. 30° (far lateral peripheral vision for each eye – from 60° – 90° from primary gaze)
5. Retinal Quadrant Eye
upper nasal right
lower nasal right
upper temporal right
lower temporal right
6. Retinal Quadrant Eye
upper nasal left
lower nasal left
upper temporal right
lower temporal right
7. posterior
8. 53%
9. lower nasal
10. right eye lower temporal
left eye lower nasal
11. right eye upper nasal
Left eye upper temporal
12. lateral part

13. lateral part lingual gyrus
 medial part cuneate gyrus
14. anterior part – peripheral fields
 osterior part (occipital poles) – central fields (macular fields)
15. posterior cerebral artery
16. Brodmann areas 18 and 19
17. right optic nerve right anopsia
 left optic tract right homonymous hemianopsia
 optic chiasm bitemporal heteronymous hemianopsia
 right lateral geniculate left homonymous hemianopsia
 left Meyer's loop right superior homonymous quadrantanopsia
18. far vision
19. near vision
20. Edinger-Westphal nucleus ciliary ganglion
21. intermediolateral nucleus superior cervical ganglion
22. optic nerve
23. oculomotor nerve
24. prompt constriction of the pupil in the illuminated eye
25. prompt constriction of the pupil in the non-illuminated eye
26. ocular adduction
 pupillary constriction
 accommodation of the lens
27. right optic nerve
- 28.

Application Exercises

- 1.
- 2.

- 3.
- 4.
- 5.
6. no change in pupil size (no pupillary response)
7. no change in pupil size (no pupillary response)
8. pupillary constriction
9. pupillary constriction
10. pupillary constriction
11. pupillary constriction
12. pupillary constriction
13. pupillary constriction
14. pupillary constriction
15. no change in pupil size (no pupillary response)
16. pupillary constriction
17. no change in pupil size (no pupillary response)

Ocular Motor Nerves

Neuroscience Review

1. a coronal plane that divides the eye into anterior and posterior halves
2. X- axis (lateral-horizontal axis) permits supraduction and subduction
 Y- axis (anterior-posterior axis) permits intorsion and extorsion
 Z -axis (vertical axis) permits abduction and adduction
3.

Muscle	Nerve
lateral rectus	abducens
medial rectus	oculomotor
superior rectus	oculomotor
inferior rectus	oculomotor

	superior oblique inferior oblique	trochlear oculomotor		
4.	Muscle lateral rectus medial rectus superior rectus inferior rectus superior oblique inferior oblique	Primary Action abduction adduction supraduction subduction intorsion extorsion	Secondary Actions adduction intorsion adduction extorsion subduction abduction supraduction abduction	
5.	Muscle lateral rectus medial rectus superior rectus inferior rectus superior oblique inferior oblique	abduction adduction supraduct the abducted eye subduct the abducted eye subduct the adducted eye supraduct the adducted eye		
6.	abducens nerve oculomotor nerve trochlear nerve	adducted subducted and abducted extorted and supraducted		
7.	rostral midbrain			
8.	caudal midbrain			
9.	caudal pons			
10.	trochlear nerve			
11.	levator palpebrae superioris			
12.	abducens nerve			
13.	trochlear nerve			
14.	oculomotor nerve			
15.	medial rectus	right side	relax	
16.	medial rectus	left side	contract	
17.	paramedian pontine reticular formation (PPRF)			
18.	rostral interstitial nucleus of the medial longitudinal fasciculus (riMLF)			

19. medial longitudinal fasciculus (MLF)
20. prefrontal eye fields area 8
21. visual association cortex areas 18 and 19

Application Exercises

1. cover fixating eye
observe response of non-fixating eye
2. cover an eye
uncover the eye and observe the response in that eye
3. alternately cover each eye
observe the response in the uncovered eye
- 4.
5. cover the fixating left eye
observe abduction in the non-fixating right eye to take up fixation
6. cover the right eye
uncover the right eye and observe abduction of the right eye to take up fixation
OR
cover the left eye
uncover the left eye and observe that it remains adducted
7. the alternately uncovered eye will abduct to take up fixation
8. oculomotor nerve
9. exotropia and subduction of the right eye
10. left lateral gaze shift
11. oculomotor nerve
12. esotropia involving the left eye
13. to the left
14. no – abducens nerve does NOT innervate pupillary muscles
- 15.

16. impaired gaze shift to the right
- 17.
18. impaired visual pursuit from primary gaze to the left

Trigeminal Nerve

Neuroscience Review

1.

Division	Foramen
ophthalmic	superior orbital fissure
maxillary	foramen rotundum
mandibular	foramen ovale
2. spinal trigeminal nucleus (pars caudalis)
3. principle (main, chief sensory) trigeminal nucleus
4. ventral trigeminothalamic tract
5. dorsal trigeminothalamic tract
6. ventral posteromedial nucleus (VPM)
dorsal medial nucleus (DM)
central medial nucleus (CM)
7. postcentral gyrus
8. middle cerebral artery
9. posterior limb
10. forehead and scalp – dorsal, mid face – intermediate, chin and mouth – ventral
11. masticator (motor) nucleus
12. mandibular
13. masseter
temporalis
lateral pterygoid
medial pterygoid

14. tensor tympani
anterior belly of digastric
mylohyoid
tensor veli palatini
15. corneal reflex
lacrimal reflex
sneeze reflex
masseter reflex
16. masseter reflex
17. mesencephalic nucleus
18. meninges
anterior part of oral cavity, including tongue, teeth and gingiva

Application Exercises

- 1.
- 2.
- 3.
4. no contraction of the masseter muscle
- 5.
6. ophthalmic nerve (V1) facial nerve (VII)
7. bilateral contraction of the orbicularis oculi
- 8.
9. masseter muscle
temporalis muscle
10. Structure Affected Side affected
trigeminal nerve left
11. facial nerve left

Facial Nerve

Neuroscience Review

1. facial nerve proper
nervous intermedius
2. internal auditory meatus
3. pontomedullary angle
4. facial nucleus
5. superior salivatory nucleus
6. stylomastoid foramen
7. stapedius
posterior belly of the digastric
8. pterygopalatine ganglion
submandibular ganglion
9. lacrimal gland
salivary glands (submandibular and sublingual glands)
10. greater superficial petrosal nerve
chorda tympani
11. taste appreciation from the anterior 2/3 of the tongue
12. geniculate ganglion
13. nucleus solitarius
14. solitariothalamic tract
15. Diencephalic Nucleus Brainstem Nucleus
ventral posteromedial nucleus ambiguus, reticular formation
hypothalamus hypoglossal nucleus, dorsal motor nucleus
16. postcentral gyrus or insula
17. posterior limb of the internal capsule
18. precentral gyrus

19. genu of the internal capsule

20.

Application Exercises

1. frontalis
orbicularis oculi
risorius
orbicularis oris

2.

3.	Muscle Affected	Side Affected
	risorius	right
	orbicularis oris	right

4.	frontalis	right
	orbicularis oculi	right
	risorius	right
	orbicularis oris	right

5. taste perception
salivation

6. dry, possibly sore eye on ipsilateral side

7. hyperacusis

Cochlear Nerve

Neuroscience Review

1.	Ossicle	Branchial Arch
	Malleus	1st
	Incus	1st
	Stapes	2nd

2.	Ossicle	Muscle
	malleus	tensor tympani
	stapes	stapedius

3.	Muscle	Nerve
	tensor tympani	trigeminal
	stapedius	facial

Application Exercises

1. contralateral ear
- 2.
- 3.
4. 512 Hz
5. sensorineural
6. conduction
- 7.
8. 512 Hz
9. sensorineural
10. conduction

Vestibular Nerve

Neuroscience Review

1. crista ampullaris semicircular canals
2. macula utricle and saccule
3. macula
4. vestibular (Scarpa's) ganglion
5. internal auditory meatus
6. superior, medial, lateral and inferior vestibular nuclei
7. superior and medial
8. inferior and lateral
9. superior and medial
10. medial

11. anterior funiculus
12. lateral vestibular nucleus
13. ventrolateral fasciculus
14. flocculonodular lobe
15. juxtarestiform body
16. dorsal motor nucleus (of X)
17. nucleus ambiguus
18. reticular formation
19. ventral posteromedial (VPM)
hypothalamus
pulvinar
20. impulse frequency increases

Application Exercises

1. right horizontal nystagmus
2. left horizontal nystagmus
- 3.
- 4.
- 5.
6. past pointing to the right side
- 7.
8. marching in place with rotation to the left
9. left horizontal nystagmus
10. tonic deviation of the eyes to the right
11. no ocular response

12. decorticate rigidity
13. decerebrate rigidity
14. to the left
15. right side

Glossopharyngeal and Vagus Nerves

Neuroscience Review

1. post olivary sulcus
2. jugular foramen
3. stylopharyngeus
4. nucleus ambiguus
5. parotid gland
6. inferior salivatory nucleus
7. otic ganglion
8. parotid gland
9. Receptor Ganglion
 carotid sinus petrosal (inferior) ganglion
 mechanoreceptor jugular (superior) ganglion
10. Ganglion Brainstem nucleus
 petrosal (inferior) ganglion nucleus solitarius
 jugular (superior) ganglion spinal trigeminal nucleus
11. post olivary sulcus
12. jugular foramen
13. pharyngeal muscles
 laryngeal muscles
14. cricothyroid muscle
15. inferior branch of recurrent laryngeal nerve

16. nucleus ambiguus
17. dorsal motor nucleus
18. dorsal motor nucleus
19. nodose (inferior) ganglion
20. jugular (superior) ganglion
21. Receptor Ganglion
 carotid body nodose
 mechanoreceptor jugular
22. nucleus solitarius
23. spinal trigeminal nucleus
- 24.

Application Exercises

1. Afferent limb Efferent limb
 glossopharyngeal nerve vagus nerve
2. petrosal ganglion
3. levator veli palatini
4. palatopharyngeus
5. palatoglossus
6. glossopharyngeal nerve
7. vagus nerve
8. straight up in the midline
9. to the left
10. bilateral pharyngeal muscle contraction (normal response)
11. no pharyngeal muscle contraction (no response)

Accessory Nerve

Neuroscience Review

1. accessory nucleus
2. ipsilateral side
3. foramen magnum
4. jugular foramen
5. sternocleidomastoid
trapezius

Application Exercises

- 1.

Hypoglossal Nerve

Neuroscience Review

1. preolivary sulcus
2. hypoglossal nucleus
3. contralateral side
4. hypoglossal canal
5. styloglossus
hyoglossus
genioglossus
6. palatoglossus
- 7.

Application Exercises

1. genioglossus
- 2.

3. right side
4. to the left

Consciousness

Neuroscience Review

1. level of consciousness (arousal)
content of consciousness (awareness)
2. lethargy
obtundation
stupor
coma
3. pupillary light reflexes
corneal reflex
pharyngeal (gag) reflex
vestibulo-ocular reflexes
4. blood pressure
heart rate
respiration rate
sweating (galvanic skin response)
5. eye opening
best verbal response
best motor response
6. a. trauma/vascular
b. compression/displacement
7. attention
orientation
cognitive function
memory
8. toxic/metabolic
9. upper limbs – increased tone and extension
lower limbs – increased tone and extension
10. upper limbs – increased tone and flexion
lower limbs – increased tone and extension

11.

Application Exercises

1.

2.

Attention

Neuroscience Review

1. locus coeruleus norepinephrine
 raphe nuclei serotonin
 ventral tegmental area dopamine
2. medial forebrain bundle
3. lateral hypothalamus
4. between the internal capsule and the thalamic external medullary lamina
 modulates (inhibits) thalamocortical activity
- 5.

Application Exercises

1.

2. list the months of the year forward, then backward

Orientation

Neuroscience Review

1. person
 place
 time
 (situation)
2. what is your name?
 who am I?

3. what country are we in?
what state are we in?
what county are we in?
what city are we in?
what kind of a place are we in?
4. what year is this?
what season is this?
what month is this?
what day of the week is this?
what is the date today?
5. person

Application Exercises

- 1.
- 2.

Language Function

Neuroscience Review

1. respiration
phonation
resonation
articulation
2. graphemes
3. phonemes
4. left hemisphere – propositional components
right hemisphere – prosodic components
5. fluency Broca's area
comprehension Wernicke's area
repetition arcuate fasciculus
6. Broca's area 44, 45
Werniche's area 42, 22
7. superior branch of the middle cerebral artery (MCA)

8. inferior branch of the middle cerebral artery (MCA)
9. motor, expressive, anterior, non-fluent
10. sensory, receptive, posterior, fluent
- 11.

Application Exercises

1. fluency
comprehension
repetition
reading
writing
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.
8. 95%
9. 5%
10. 70%
11. 30%
12. impaired repetition with relatively preserved fluency and comprehension
13. repetition is relatively intact
14. repetition is relatively intact
15. Mr. Dextra
16. proximal (main stem) segment of the MCA (M1 segment) on the left side

17. superior branch of the MCA on the left side
18. inferior branch of the MCA on the left side
19. heart (pump) failure/hypovolemia/hypoperfusion

Learning and Memory

Neuroscience Review

1. hippocampal formation of the medial temporal lobe
2. dentate gyrus
hippocampus (coru ammonis)
subiculum
3. it is 3 layered (archicortex)
4. perforant pathway
alveolar pathway
5. CA1 region of the hippocampus
high susceptibility to hypoxia
6. CA3 region of the hippocampus
7. dentate gyrus
8. subiculum
9. mammillary nuclei
anterior nucleus of the thalamus
septal nuclei (area)
10. temporal lobe → mammillary nucleus → anterior thalamic nucleus → cingulate cortex → temporal lobe
11. working memory – seconds
short term memory – minutes to days
long term memory – months to years
- 12.

Application Exercises

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.
7. hippocampal formation in medial temporal lobe
8. mammillary nuclei
9. occipital association cortices
10. temporal association cortices

Cognitive Function

Neuroscience Review

- 1.
- 2.
3. simultagnosia
ocular apraxia
optic ataxia
4. agraphia
acalculia
finger agnosia
right – left confusion
- 5.

Application Exercises

- 1.
- 2.

3.

4.

5.

6.

7.

8.

9.

About the Authors

Michael F. Nolan is professor of Basic Science Education at the Virginia Tech Carilion School of Medicine in Roanoke. He received his Physical Therapy training at Marquette University and his PhD in Human Anatomy from the Medical College of Wisconsin. Nolan spent the first 34 years of his career teaching gross anatomy and neuroanatomy to medical students and resident physicians at the University of South Florida. He has received more than 20 awards for excellence in teaching including the Master Teacher Award in 2014 from the International Association of Medical Science Educators and the John M. Thompson Outstanding Teacher Award in Neurosurgery in 2006. He has published over 40 peer-reviewed articles and book chapters as well as four textbooks in human gross anatomy and neuroanatomy.

John P. McNamara is the Director of Anatomy and Assistant Professor of Basic Science Education at the Virginia Tech Carilion School of Medicine in Roanoke. His doctoral training is in chiropractic from Life University (Marietta, GA) with undergraduate (Lock Haven University of Pennsylvania) and graduate (Shippensburg University of Pennsylvania) degrees. He is also ABD from Virginia Tech in Educational Leadership and Policy Studies. For nearly the past 30 years, McNamara has maintained a private practice in Salem, VA, and taught full-time anatomy and physiology, gross anatomy, neuroanatomy, and pathophysiology at the College of Health Sciences (Jefferson College) in Roanoke. From 2013 to 2017 he taught the gross anatomy course for the Doctor of Physical Therapy program at Radford University in Roanoke. He is licensed to practice as a Doctor of Chiropractic in both Virginia and Pennsylvania, and he is certified as an Emergency Medical Technician in Virginia.