GE Healthcare

TiP-TV™ Training in Partnership Program Supplement and Test for Imaging Professionals

MR: Learning Disabilities and Functional MRI

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1.0 ASRT-approved Category A CE Credit

imagination at work

TABLE OF CONTENTS

PROGRAM SUMMARY

This page provides an overview of the program content and learning objectives. Please refer to the Table of Contents for a detailed list of the topics covered. We encourage you to file a copy of this Program Summary and the Table of Contents with your continuing education certificate. We also recommend that you provide a copy of this information to your manager as a record of your educational achievement.

PROGRAM DESCRIPTION

A learning disability is a disorder that affects people's ability to either interpret what they see and hear or to link information from different parts of the brain. These limitations can show up in many different ways. Functional magnetic resonance imaging (fMRI) can be used as a diagnostic tool to reliably identify networks involved in cognitive functions in children and adults. Currently, scientists are trying to understand these problems by conducting a variety of studies utilizing fMRI. This program opens the door to the characteristics of various learning disabilities and the role fMRI plays in understanding the connectivity of the brain processes.

PROGRAM OBJECTIVES

By the end of this program, the viewer should be able to:

1. Explain what a learning disability is and discuss the various types of learning disabilities (LD).
2. Describe the unique areas of the brain that affect learning disabilities.
3. Discuss the anatomical regions of the brain that are most affected by different types of learning disabilities.
4. Explain the most common characteristics of various learning disabilities.
5. Describe how functional magnetic resonance imaging (fMRI) has emerged as a diagnosis and research tool for assessing learning disabilities.

TARGET AUDIENCE

Course objectives for this program specifically target magnetic resonance (MR) technologists. Other technologists and medical personnel may also benefit from viewing this program. While not limited to this audience group, the technical content is most effective when applied to people with this training.

NOTE: Regardless of your imaging specialty, you may apply for continuing education credit. Refer to the Continuing Education Credit page for additional information.

CONTINUING EDUCATION CREDIT

1.0 ASRT-approved Category A CE Credit

CONTINUING EDUCATION CREDIT

After viewing the TiP-TV video presentation and reading this program supplement, please complete the required online CE credit activities (test and feedback form). The TiP-TV test measures knowledge gained and/or provides a means of self-assessment on a specific topic. The feedback form provides us with valuable information regarding your thoughts on the program's quality and effectiveness.

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TiP-TV satellite broadcast subscribers can go online to obtain CE credit – quickly and easily!

hls.gehealthcare.com

1. View the entire video presentation – this is a requirement for obtaining CE credit. This supplement is **not** intended to replace watching the video presentation.
2. Go to the GE Healthcare Learning System (HLS) web site at **hls.gehealthcare.com** and complete the feedback form.
3. Complete the post-program test.
   - You have up to three attempts to successfully complete the test with a minimum passing score of 75% (ASRT-approved programs) or 80% (SNM-approved programs).
   - The test must be completed without aids or assistance of any kind; this is an **individual effort**.
4. Upon successful completion of the online CE information, you can instantly print a certificate.

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If you have already applied for and/or received CE credit for this course, you are encouraged to contact your CE certification organization (ARRT, ARDMS, NMTCB, etc.) to determine if you can repeat this course for CE credit.

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If you have a question or comment on the program content, please send a message to: **PSTIPApps-mr@med.ge.com**

INTRODUCTION

So, what is a learning disability? A learning disability is a disorder that affects a person's ability to either interpret what they see and hear or to link information from different parts of the brain. These limitations can manifest themselves in many different ways.

Functional MRI (fMRI) can be used as a diagnostic tool to reliably identify neural networks involved in cognitive functions in children and adults. Currently, scientists are trying to understand these problems by conducting a variety of studies utilizing fMRI.

In this program, we will:

- Review the characteristics and historical background of several learning disabilities.
- Hold a group discussion with specialists who work with children and adults with learning disabilities.
- Review the functions of the brain that are related to learning and how they play a role in the learning process.
- Define plasticity in the concept of understanding the brain and discuss the role it plays.
- Review how fMRI works, and how this tool can be used in the clinical setting.
- Review some current research that is taking place on this topic and look at a few case studies.

TYPES OF LEARNING DISABILITIES

As stated by the Learning Disabilities Association of America (LDA), learning disabilities (LD) are neurologically-based problems. These processing problems can interfere with learning basic skills such as reading, writing, or math. They can also interfere with higher-level skills such as organization, time planning, and abstract reasoning.

The types of LDs are identified by the specific processing problems involved. They might relate to getting information into the brain, referred to as input, making sense of this information or organization, storing and later retrieving this information or memory, or getting this information back out, referred to as output.

LD is a broad term that covers a pool of possible causes, symptoms, treatments, and outcomes. Often it is difficult to diagnose or to pinpoint the causes.

Usually, people with LDs are of average or above average intelligence. However, there often appears to be a gap between the individual's potential and actual achievement. A learning disability cannot be cured or fixed; it is a lifelong challenge. However, the appropriate support and intervention can provide individuals with LD the tools necessary to achieve success in school, at work, in relationships, and in the community.

Learning disability types can be categorized as:

- Developmental speech and language disorders
- Academic skills disorders
- "Other" – a catch-all that includes coordination disorders and learning handicaps not covered in other types

We will review the following types of learning disabilities but there are many more:

- Attention deficit/hyperactivity disorder (AD/HD)
- Dyslexia
- Dyscalculia
- Dysgraphia

ATTENTION DEFICIT/HYPERACTIVITY DISORDER (AD/HD)

Attention deficit disorder or attention deficit hyperactivity disorder has been recognized for more than 100 years, but it hasn't always been called the same thing. In the past, different terms have been used for what we now call attention deficit/hyperactivity disorder.

Why the change? The American Psychiatric Association publishes the official guidelines for naming and diagnosing mental disorders. This book, called *Diagnostic and Statistical Manual of Mental Disorders* or DSM, is regularly updated as scientists learn more and more. Research in the 1970s and 1980s began to show there are different types of attention deficit. Although there are major differences, the types are more alike than different. In 1994, the DSM changed the name from attention deficit disorder (ADD) to AD/HD because of the advances in research.

There are three types of the condition called AD/HD. They are:

- Inattentive
- Hyperactive/impulsive
- Combined

Some clinicians and mental health professionals still use the term ADD. If this is your or your child's diagnosis, it most likely means you or your child have the inattentive type of AD/HD. This is not the child who is "bouncing off the walls" or "simply can't sit still." Rather, it's the individual who seems to be always daydreaming, is forgetful, is easily distracted, is disorganized, and just can't seem to pay attention.

Criteria for AD/HD – Inattentive Type

- Fails to give close attention to details or makes careless mistakes
- Has difficulty sustaining attention
- Does not appear to listen
- Struggles to follow through on instructions
- Has difficulty with organization
- Avoids or dislikes tasks requiring sustained mental effort
- Loses things
- Is easily distracted
- Is forgetful in daily activities

Criteria for AD/HD – Hyperactive Type

- Fidgets with hands or feet or squirms in chair
- Has difficulty remaining seated
- Runs about or climbs excessively
- Has difficulty engaging in activities quietly
- Acts as if driven by a motor
- Talks excessively
- Blurts out answers before questions have been completed
- Has difficulty waiting or taking turns
- Interrupts or intrudes upon others

Criteria for AD/HD – Combined Type

The criteria for the combine type of AD/HD consists of individuals that meet both sets of inattentive and hyperactive/impulsive criteria.

DYSLEXIA

Dyslexia is one of the most common learning disabilities. The word dyslexia was first used in 1895 to describe a child with normal intelligence who exhibited difficulty in learning to read. The word's Greek derivation means "difficulty with words or language."

Dyslexia is believed to have a biological basis, caused by an unusual organization of certain neuronal connections, the details of which are under active investigation.

Individuals with dyslexia may experience difficulty in reading, spelling, speaking, listening, or writing. These individuals show lower achievement on reading and reading-related measures than would be expected given their overall aptitude. Dyslexia seems to run in families and it is now thought to have a genetic basis. According to the International Dyslexia Association (IDA), current studies suggest that 15% to 20% of the population has a reading disability. Of those, 85% have dyslexia.

Recent advances in functional neuroimaging techniques provide a way to identify the regional specialization and spatial congruence of the cortical areas engaged in low-level sensory and language processing. These techniques make possible new investigations of the pathophysiology of the reading disorder developmental dyslexia.

Signs and Symptoms of Dyslexia

Some of the signs and symptoms of dyslexia are:

- Reads slowly and painfully
- Experiences decoding errors, especially with the order of letters
- Shows wide disparity between listening comprehension and reading comprehension of some text
- Has trouble with spelling
- May have difficulty with handwriting
- Exhibits difficulty recalling known words
- Has difficulty with written language
- May experience difficulty with math computations
- Has difficulty with some often used sight words such as: a, is, are

Some types of dyslexia may be due to what is known as a dissociation disorder, which is a missing or inactive connection between two brain modules. We will discuss the function of the brain in more detail later in this program.

DYSCALCULIA

The learning disability, dyscalculia, is a term derived from Latin stems. The stem “dys” indicates that a state of dysfunction is involved. The word "calculus," originally from the Greeks, denotes in direct translation a stone used for making calculations. The resulting word, dyscalculia, means difficulty in performing mathematical calculations of certain types.

There are a number of different types of dyscalculia, each involving a specific type of problem in solving mathematical tasks.

Children and adults with dyscalculia tend to be of normal intelligence, but often present an uneven picture in their results on intelligence tests. Their problems reflect not emotional problems, but difficulties in connection with specific types of thought processes. What distinguishes dyscalculia from other types of difficulties with math is the fact that particular aspects of mathematical calculations are involved.

There are various types of difficulties in mathematics, such as:

- Acalculia – A form of dysplasia characterized by the inability to perform simple mathematical problems; found with lesions of various areas of the cerebral hemispheres and often an early sign of dementia.
- Dyscalculia – Difficulty in performing mathematical calculations of certain types.
- Difficulties with mathematics in general.
- Pseudo-dyscalculia, which can be caused by emotional blockings.

Signs and Symptoms of Dyscalculia

Typical signs and symptoms of dyscalculia are as follows:

- Difficulty in learning to read a clock.
- Weakness in time perception that can, in part, be a matter of having difficulty in grasping the sequence involved in a particular course of events.

On intelligence or aptitude tests, such children tend to score on the low side, and tend to have results that are all at about the same level. There is thus a kind of consistency in their level of day-to-day performance. In general consensus, these children simply need a bit longer to learn.

DYSGRAPHIA

Another type of disorder is dysgraphia, which is a neurological disorder characterized by writing disabilities. This disorder causes a person's writing to be distorted or incorrect. The word dysgraphia simply means difficulty expressing thoughts in writing.

Children with dysgraphia may have other learning disabilities, however, they usually have no social or other academic problems. Causes of dysgraphia in adults generally occur after some trauma.

Signs and Symptoms of Dysgraphia

Some of the signs and symptoms of dysgraphia are:

- May exhibit strong verbal but particularly poor writing skills.
- Random or non-existent punctuation and spelling errors such as: reversals, syllable omissions, errors in common suffixes, disordered numbering.
- General, illegible writing.
- Mixtures of print and cursive, upper and lower case or irregular size, shapes or slant letters.
- Unfinished words or letters or omitted words. Cramped or unusual grip, especially holding the writing instrument very close to the paper.
- Talking to self while writing, or carefully watching the hand that is writing.
- Slow and labored copying or writing, even if it is neat and legible.

Treatments for dysgraphia vary and may include treatment for motor disorders to help control writing movements. Other treatments may address impaired memory or other neurological problems. Some physicians recommend that individuals with dysgraphia use computers to avoid the problems of handwriting.

When listening to the various traits of these learning disabilities, we may feel that we fall into some of these categories. This has been an overview of a few of the learning disabilities and more in-depth evaluations need to take place when assessing an individual. For additional information on these topics, please check out the resource page of the program supplement.

Panel discussion with Betty Adams, M.S., and Suzanne Brandley, Ed.D.

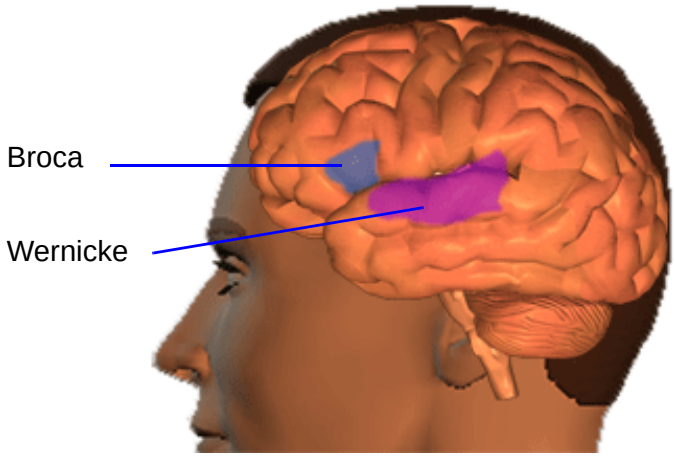
Notes:

UNDERSTANDING FUNCTIONS OF THE BRAIN

Towards the end of the 19th century, a craze for biological psychiatry took root in European universities, and neurologists started to use localized electrical brain stimulation and animal lesion experiments to identify which areas of the brain did what. Others researchers observed the association between certain behavior and specific brain injuries. Many important landmarks were identified during the first era of brain mapping.

A pair of prominent neurologists discovered two language processing areas (Figure 1). Pierre Broca, a highly respected French physician, discovered the Broca language area. Carl Wernicke, a German neurologist, discovered the Wernicke language area. We will discuss these areas in more detail as we proceed.

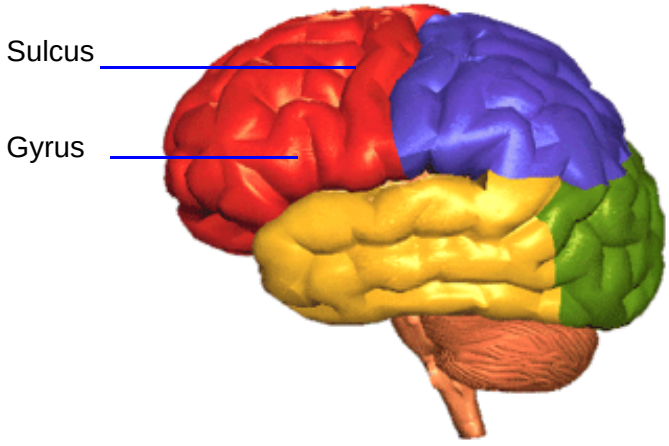
Figure 1 Language Processing Areas



The brain has two hemispheres that are covered in a thin layer of deeply wrinkled grey tissue called the cerebral cortex. The cortex refers to the nerve cells close to the surface of the brain.

Each infold on this surface is known as a sulcus, and each bulge is known as a gyrus (Figure 2).

Figure 2 Sulcus and Gyrus

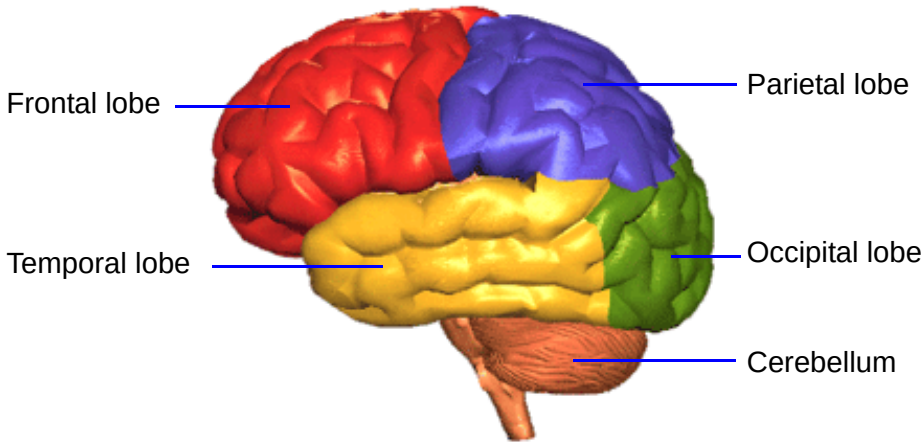


The frontal lobe is located at the anterior portion of the brain and has a right and left hemisphere. The left frontal lobe, identified in Figure 3, is where language processing, thinking, conceptualizing, and planning take place.

The parietal lobe, located at the top section of the brain, deals mainly with functions connected with movement, orientation, calculation, and certain types of recognition.

The temporal lobes, located at the lower side around the ears, deal with sound, speech comprehension, and some aspects of memory.

Figure 3 Lobes of the Brain



The occipital lobe, which is located posteriorly, is made up almost entirely of visual processing areas.

The cerebellum, also called the "little brain," attaches posteriorly to the brain stem and occupies the posterior cranial fossa. The cerebellum is the coordination center for motor functions.

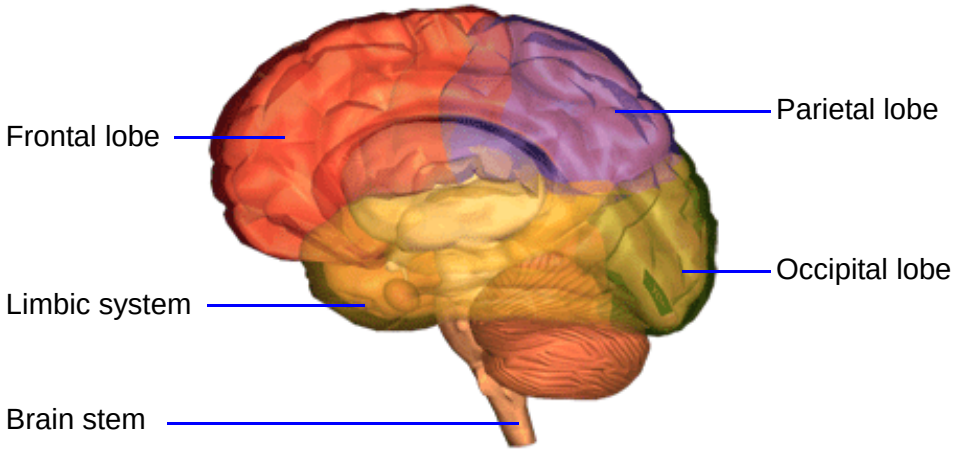
When slicing the brain in half down the center, the two hemispheres fall apart. Figure 4 shows the right side of the brain.

The right frontal portion of the brain deals with creativity and emotion.

The parietal and occipital lobes are also identified.

The C-shaped structure separating the two hemispheres is called the corpus callosum and acts as a bridge between them. This bridge constantly shunts information back and forth from one hemisphere to the other. The limbic system, nestled beneath the corpus callosum, is a complex group of brain structures and fiber tracts located within, and adjacent to, the medial surface of the temporal lobes.

Figure 4 Right Side of the Brain



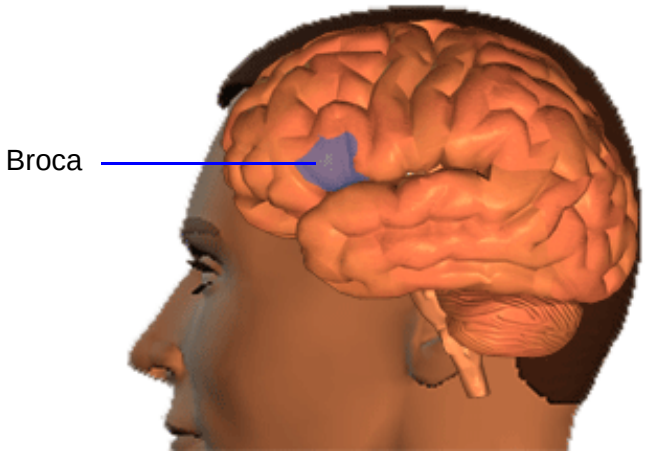
The limbic system is involved in functions dealing with emotions, along with most of the many appetites and urges that direct us to behave in a way that promotes survival.

The brain stem is formed from the nerves that run up from the body via the spinal column and it carries information from the body into the brain. Various clumps of cells in the brain stem determine the brain's general level of alertness and regulate the vegetative processes of the body, such as breathing, heartbeat, and blood pressure.

On the left side of the brain, Broca's area, highlighted in Figure 5, seems to hold functional programs that instruct the neighboring motor cortex to articulate speech and use expressive language.

A loss of language is aphasia, and the specific kind of language difficulty in Broca's area is called Broca's aphasia. When damage to this part of the brain occurs, a language difficulty happens, resulting in a loss of fluent speech. Even so, the individual may retain the ability to understand language.

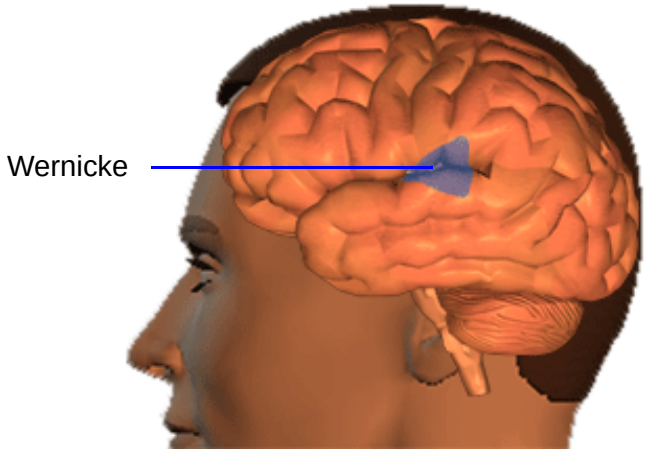
Figure 5 Broca's Area



Analysis of word meaning is carried out either in or very close to Wernicke's area – a patch of cortex that is splayed over the top and back of the temporal lobe, and edges up to the parietal lobe (Figure 6). Damage to the connections between the primary auditory cortex and Wernicke's area can result in a peculiar language disorder known as word deafness.

People with this condition cannot understand spoken words, yet they may still be able to read, write, and speak quite normally. Damage to Wenicke's area itself causes another type of disorder called Wernicke's aphasia, where patients speak with ease but do not understand language and utter gibberish.

Figure 6 Wernicke's Area

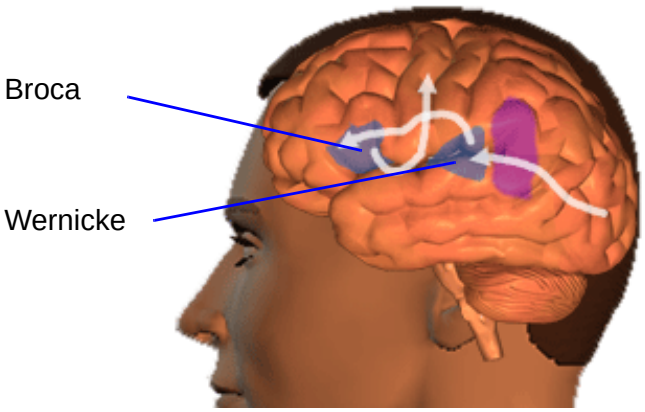


The motor cortex is the region of the cerebral cortex that influences movements of the face, neck and trunk, and arms and legs (Figure 7).

Reading and writing involves more than just the language areas of the brain. The visual cortex feeds information from the page, and the motor cortex is required to activate the muscles used for writing. It is therefore important that information flows freely between Broca's, Wernicke's, and other areas; if it is blocked or disrupted, a form of dyslexia may result.

The function of the brain is a complex and interesting topic to explore. There are many resources available to help you understand this complex organ. Please review the program supplement for additional resources that may help you in furthering your knowledge on this topic.

Figure 7 Motor Cortex



WHAT IS FUNCTIONAL MRI?

Functional MRI (fMRI) is looking at the activation of the brain during some activity or process. Dr. Debbins clearly explains the following in this section:

- What is brain function?
- Blood Oxygenation Level Dependent (BOLD) contrast
- Echo Planar Imaging (EPI) techniques used

BRODMANN AREAS

The areas of the cerebral cortex mapped out on the basis of the cortical cytoarchitectural (arrangement of nerve-cell bodies in the brain) patterns.

Interview with Joseph Debbins, Ph.D.

Notes:

For a visual understanding of how the physics, role, and applications of fMRI work, refer to the video program.

MR FILES

WHAT IS PLASTICITY?

Plasticity, or in the context of the brain, neuroplasticity, is the lifelong ability of the brain to reorganize neural pathways. Dr. Sunaert helps us to understand the concept of plasticity and how it functions in brain development.

Interview with Stefan Sunaert, M.D., Ph.D.

Notes:

For a visual understanding of how plasticity works, refer to the video program.

Neuroplasticity is the lifelong ability of the brain to reorganize neural pathways.

- Occurs during normal brain development when the immature brain first begins to process sensory information through adulthood (developmental plasticity and plasticity of learning and memory).
- Is an adaptive mechanism to compensate for lost function and/or to maximize remaining functions in the event of brain injury.

CASE STUDIES

Earlier in this program, both Dr. Brandley and Betty Adams discussed "how recent technical advances in the medical field have contributed to a better understanding of brain functioning for educators." Let's hear from other medical experts who share their knowledge on this fascinating topic.

Interviews with Denis LeBihan, M.D., Ph.D., Joseph Debbins, Ph.D., and Stefan Sunaert, M.D., Ph.D.

Notes:

For a visual understanding of various case studies on fMRi of the brain, refer to the video program.

RASMUSSEN ENCEPHALITIS (RASMUSSEN SYNDROME)

A type of encephalitis where antibodies to a stimulatory glutamate receptor (major excitatory neurotransmitter in the particular portion of the central nervous system) in the central nervous system are found; perhaps autoimmune.

APPENDIX A: PRESENTERS

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APPENDIX B: GLOSSARY

90° Pulse: A pulse that rotates the magnetization vector 90° from longitudinal static magnetic field direction. This converts the longitudinal magnetization into transverse magnetization.

A/P: Anterior/posterior

ACR: American College of Radiology

ADD: Attention Deficit Disorder

AD/HD: Attention Deficit/Hyperactivity Disorder

ASNR: American Society of Neuroradiology

B_0: Static magnetic field or main magnetic field

Blood Oxygenation Level Dependent: BOLD

BOLD: Blood Oxygenation Level Dependent

Brodmann Areas: The areas of the cerebral cortex mapped out on the basis of the cortical cytoarchitectural (arrangement of nerve-cell bodies in the brain) patterns.

CE: Continuing education

Contrast-to-Noise Ratio (CNR): Ratio of the absolute difference in intensities between two regions to the level of fluctuations in intensity due to noise.

Coronal: The horizontal plane along the longitudinal axis of the body dividing it into anterior and posterior halves.

CSF: Cerebrospinal fluid

CNR: Contrast-to-noise ratio

DSM: *Diagnostic and Statistical Manual of Mental Disorders*

Echo Planar Imaging: EPI

Echo Train Length: ETL

EPI: Echo planar imaging

ETL: Echo train length

FFT: Fast fourier transform (mathematical process)

Field of View (FOV): The area of the anatomy being imaged, usually expressed in centimeters.

FLAIR: Fluid Attenuated Inversion Recovery

FLASH: Fast low angle shot

fMRI: Functional magnetic resonance imaging

FOV: Field of view

fps: Abbreviation for foot-pound-second unit

Frequency: The scanning direction associated with the frequency gradient. Usually corresponds to the image's long axis.

FSE: Fast spin echo

Functional Magnetic Resonance Imaging: fMRI

GAD, gd, or Gd: Gadolinium

IR: Inversion recovery

Isocenter: The point where the three gradient planes cross.

LD: Learning Disabilities

LDA: Learning Disabilities Association of America

Magnetic Resonance (MR): The absorption or emission of electromagnetic energy by nuclei in a static magnetic field after excitation by a suitable RF pulse.

Magnetic Resonance Imaging (MRI): The creation of images using the magnetic resonance phenomenon. The current application involves imaging the distribution of hydrogen nuclei (protons) in the body. The image brightness in a given region usually depends jointly on the spin density and the relaxation times. Image brightness is also affected by motion, such as blood flow.

Magnetic Resonance Signal: The electromagnetic signal (in the radiofrequency range) produced by the precession of the transverse magnetization of the spins. The rotation of the transverse magnetization induces a voltage in the coil. This voltage is amplified by the receiver.

N/A: Not applicable

Neuroplasticity: The lifelong ability of the brain to reorganize neural pathways.

NEX: Number of excitations or averages

Number of Excitations (NEX): The number of times a pulse sequence is repeated in a given acquisition.

Number of Signal Averages: The number of times a pulse sequence is repeated in a given acquisition.

PE: Phase encoding

Phase Encoding: The act of localizing an MR signal by applying a gradient pulse to alter the phase of spins before signal readout.

Plasticity: The lifelong ability of the brain to reorganize neural pathways.

Proton Density-Weighted (PD-Weighted): Images that have contrast that is primarily due to the number of protons in the structures. PD-weighted images result when scan timing parameters are selected that minimize the T1 (long TRs) and the T2 (short TEs) contrast effects.

R/L: Right/left

Radiofrequency (RF): The frequency (intermediate between audio and infrared frequencies) used in magnetic resonance systems to excite nuclei to resonance.

Radiofrequency Pulse (RF Pulse): A burst of RF energy, if it is at the correct Larmor frequency, rotates the macroscopic magnetization vector by a specific angle, depending on the amplitude and duration of the pulse.

Rasmussen encephalitis (Rasmussen syndrome): A type of encephalitis where antibodies to a stimulatory glutamate receptor (major excitatory neurotransmitter in the particular portion of the central nervous system) in the central nervous system are found; perhaps autoimmune.

Repetition Time (TR): The time between successive excitations of a slice. That is, the time from the beginning of one pulse sequence to the beginning of the next. In conventional imaging, it is a fixed value equal to a user-selected value. In cardiac-gated studies, however, it can vary from beat to beat depending on the patient's heart rate.

RF: Radiofrequency

SE: Spin echo

S/I: Superior/inferior

SNR: Signal-to-noise ratio

SP: Spatial resolution

Spatial Encoding: Selective identification of the signal within the imaging volume.

SPGR: Spoiled gradient echo

Spin Echo Imaging (SE Imaging): A magnetic resonance imaging technique where the spin echo magnetic resonance signal rather than the free induction decay is used.

SR: Spatial resolution

T/R: Transmit/receive

T: Tesla

T1: The characteristic time constant for the magnetization's return to the longitudinal axis after being excited by an RF pulse. Also called spin lattice or longitudinal relaxation time.

T1-Weighted: Scan protocols that allow the T1 effects to predominate over the other relaxation effects.

T2*: The characteristic time constant for loss of transverse magnetization and MR signal due to T2 and local field inhomogeneities. Since such inhomogeneities are not compensated for by gradient reversal, contrast in gradient echo images depends on T2*.

T2*-Weighted: Scan protocols that allow the T2* effects to predominate over the other contrast effects. There are three primary gradient echo pulse sequences that can be used to produce varying T2*-weighted images: gradient echo, SPGR, and SSFP.

T2: The characteristic time constant for loss of phase coherence among spins caused by their interaction and the resulting loss in the transverse-magnetization MR signal. Also referred to as spin-spin or transverse relaxation time.

T2-Weighted: Scan protocols that allow the T2 effects to predominate over the other contrast effects.

TE: Time of echo

Time of Echo (TE): The time between the center of the excitation pulse and the peak of the echo, usually occurring at the center of the readout.

TR: Time of repetition or repetition time

TSE: Turbo spin echo

APPENDIX C: RESOURCES

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Electronic Resources

American Speech, Language and Hearing Association: www.asha.org

Council for Learning Disabilities (CLD): www.cldinternational.org

Dyscalculia: www.dyscalculia.org

Learning Disabilities Association of America (LDA): www.ldanatl.org

Learning Disabilities OnLine: www.ldonline.org

National Association of School Psychologists (NASP): www.nasponline.org

National Resource Center on AD/HD: help4adhd.org

The International Dyslexia Association: www.interdys.org

Wisconsin Branch of the International Dyslexia Association: www.wis-dys.org

NOTE: The Internet is an ever-evolving environment and links are subject to change without notice.

APPENDIX D: POST-TEST

LMS Course Number: 2785

To be eligible for CE credit, you MUST view the video presentation first and then submit your answers using the online process (go to **hls.gehealthcare.com**). The post-test must be completed by the due date listed online for this program.

1. Functional MRI (fMRI) can be used as a diagnostic tool to reliably identify _____ networks involved in cognitive functions of children and adults.
   a. cranial
   b. fiber
   c. neural
   d. white matter
2. Regarding learning disabilities and processing problems involved, getting information into the brain is also called _____.
   a. input
   b. memory
   c. output
   d. organization
3. The _____ published the book called *Diagnostic and Statistical Manual of Mental Disorders*.
   a. American Psychiatric Association
   b. International Dyslexia Association
   c. Learning Disabilities Assocation of America
   d. Wisconsin Branch of the International Dyslexia Association
4. According to the International Dyslexia Association (IDA), current studies suggest that _____% to _____% of the population has a reading disability.
   a. 5; 10
   b. 10; 15
   c. 15; 20
   d. 20; 30
5. Some types of dyslexia may be due to what is known as a/an _____ disorder, which is a missing or inactive connection between two brain modules.
   a. anxiety
   b. dissociation
   c. emotional
   d. neurotic
6. What type of learning disability involves a specific type of problem in solving mathematical tasks?
   a. Attention deficit/hyperactivity disorder
   b. Dyscalculia
   c. Dysgraphic
   d. Dyslexia
7. A form of dysplasia characterized by the inability to perform simple mathematical problems that can also be an early sign of dementia is called _____.
   a. acalculia
   b. dyscalculia
   c. dyslexia
   d. pseudo-dyscalculia

8. Dysgraphia is a type of neurological disorder characterized by what type of disability?
   a. Mathematics
   b. Organization
   c. Reading
   d. Writing
9. The cortex refers to what type of cells close to the surface of the brain?
   a. Basal
   b. Germ
   c. Nerve
   d. Olfactory
10. What lobe of the brain deals mainly with functions connected with movement, orientation, calculation, and certain types of recognition?
    a. Frontal
    b. Occipital
    c. Parietal
    d. Temporal
11. Which part of the brain seems to hold functional programs that instruct the neighboring motor cortex to articulate speech and use expressive language?
    a. Broca's area
    b. Brodmann's area
    c. Motor cortex
    d. Wernicke's area
12. Damage to the connections between the primary auditory cortex and Wernicke's area can result in a peculiar language disorder known as _____.
    a. Broca's aphasia
    b. Brodmann's aphasia
    c. Wernicke's aphasia
    d. word deafness
13. Areas of the cerebral cortex mapped out on the basis of the cortical cytoarchitectural patterns is called _____ area.
    a. Broca's
    b. Brodmann's
    c. motor cortex
    d. Wernicke's
14. _____ is the lifelong ability of the brain to reorganize neural pathways.
    a. Dyslexia
    b. Aphasia
    c. Acalculia
    d. Neuroplasticity
15. What type of encephalitis involves antibodies stimulated by a glutamate receptor in the central nervous system?
    a. Dawson
    b. Powassan
    c. Rasmussen
    d. Varicella