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If not the brain, then what? A paradigm for preservice intervention specialists that provides an understanding of neurodevelopmental disorders in children

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Abstract: This article contends that although Intervention Specialists are presented with a variety of children with diverse challenges that arise from neurological dysfunction, few teacher education programs adequately prepare teachers to understand, recognize and address these needs. The University of Findlay requires candidates in the post- baccalaureate program to take a course entitled Neurobiology of Learning that was developed to offer preservice teachers of special education insights into the underlying neurobiological causes of learning and behavioral challenges experienced in the classroom. A child neurologist teams with a professor in the college of education to provide the content for the four components of the course, a feature that distinguishes it from related course offerings in other Colleges of Education. This paper outlines the contentof the course and discusses the importance of including neuroscience in the curriculum of preservice teachers, so that they may be better prepared to deliver services to children with special needs.

Keywords: neurobiology, learning, curriculum, preservice teachers, special education, neuroscience

I. Introduction.

Over the last twenty-five years, neuroscience has concentrated on the most complex of its frontiers: the neurobiology of cognition and behavior. Yet, as Carew and Magsamen (2010) lament, researchers and neuroscientists are worlds apart in forming hypotheses about how people learn, and how to translate findings into classroom practice. While it may seem ludicrous to the modern educator to think of any other source of cognition but the brain, the very term “brain based learning” speaks to the disconnect between educational interventions and the state of our neuroscientific knowledge base. It is as if one has to persuade the reader, the majority of whom are teachers, that learning takes place in the brain. More perplexing may be the question: Who should be identifying neuroeducational problems in students? The great majority of medical personnel are not trained to identify, diagnose, or treat the common neurobehavioral and neuroeducational syndromes. There are only small numbers of trained neurodevelopmental specialists. Even amongst the latter, formal training in these areas lags woefully behind that of educators, who, ironically, are taught to defer to these same medical professionals who have limited neuroscientific knowledge. Ideally, all teachers should be equipped to help every child learn and reach his or her full potential. This paper explains the content of a course offered to students pursuing their Intervention Specialist license at the graduate level to help them achieve this goal. The course is comprised of four modules: module one offers an overview of the brain,

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its structure and function, discussing also scientific findings that have been the basis of practical application to the classroom; module two emphasizes the development of language in children, focusing specifically on language disorders that are diagnosed clinically, and which have implications for teachers in the development of interventions; module 3 discusses the controversial issue of Attention Deficit Hyperactivity Disorder (ADHD), giving students a deeper understanding of the complexity of the disorder that is so readily diagnosed and treated with medication that many underlying disorders are missed and go untreated; module 4 discusses right hemisphere dysfunction which includes an examination of autism, Asperger's syndrome and right hemisphere disorder. A fifth module, motor disorders, will be developed in the future and is not included in this paper. The course is designed to offer preservice intervention specialists a paradigm to help them to understand and appreciate neurodiversity and recognize the uniqueness of each individual. With this diversity come challenges: identifying specific needs associated with different learning styles, and the ability to design interventions that address these needs. Neurodiversity is a term described by Thomas Armstrong (2005), "Its basic premise is that atypical neurological wiring is part of the normal spectrum of human differences and is to be tolerated and respected like any other human difference such as race, gender, sexual preference, or cultural background." (Special Education and Concept of Neurodiversity, par. 8)

Fisher et al. (2007) emphasize that it is time for education, biology, and cognitive science to join together to create a new science and practice of learning and development. Education continues to ignore the wide range of state of the art technology, powerful brain imaging tools, the explosion of new discoveries in the study of genetics, and diverse methods, new and old, for assessing cognition and behavior. Consequently, many children are diagnosed incorrectly, labeled erroneously, medicated inappropriately, and rendered inadequate services because teachers are not trained to see beyond observable behaviors.

It is undeniably challenging for every teacher to meet the individual learning needs of each child in a classroom when faced with such diversity. The paradigm described and presented here emphasizes commonalities of brain function in children of all abilities, and looks at the underlying neurological conditions that promote the kinds of behaviors that teachers encounter in the classroom every day. The primary goal in the classroom is to meet children's individual needs, and, in order to better serve children, we must have a solid understanding of how they learn, as well as of how their learning is challenged. When one realizes that there are certain patterns and syndromes that can be identified based on knowledge of brain function, one acquires the ability to understand the complexity of human learning, and this daunting task of individualization is rendered somewhat more manageable. By assessing the language, perceptual, behavioral and motor characteristics of students with challenges, teachers can address and meet needs rather than perseverate on labels that frequently misinterpret perceived behaviors. Fischer et al. (2007) confirm that collaboration between medical and educational professionals is essential to optimum delivery of services:

"Answering key questions about mind, brain and education requires reciprocal interaction between scientific research and practical knowledge of educators and caregivers." (p.1)

The course described in this paper combines the knowledge and expertise of a pediatric neurologist and an educator so that preservice teachers may acquire the knowledge, skills and dispositions needed to adequately serve children with special needs.

It is not an easy task to adequately educate anyone on neuroanatomy, neurophysiology, and brain function in one semester and furthermore to apply this information to the classroom. However, Sylwester (2003) states that colleges need to commit to the implementation of a long-

term strategy that gradually enhances teacher and student understanding of biological functions and systems. It is imperative that the striking parallels existing between processes at the cellular and biological level be perceived by teachers as relating to processes that regulate social systems, specifically, the classroom. The course is divided into four modules. It is a blended class with face-to-face lectures on the topic of each module, as well as online discussion boards, readings and assignments. In addition to the modules, each candidate is required to visit the child neurology clinic, observe an initial evaluation of a child, and write a journal response of the experience. The final project requires candidates to design a one-week teaching unit aligned with Ohio's academic content standards, indicating areas of the brain that are activated during each instructional period.

II. Module 1: Basic Functional Neuroanatomy.

Module One of *Neurobiology of Learning* introduces students to the basics of brain function and the essential components of neuroanatomy, namely the four lobes, the limbic system, neurons, dendrites and axons, in order to give an organized view of brain function in critical areas.

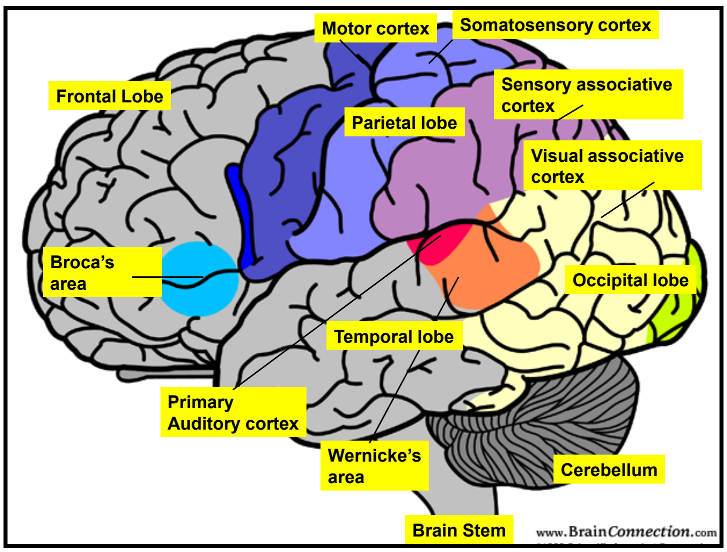


Figure 1. The major exterior regions of the brain (adapted from Posit Science).

A. Syndromes.

This initial overview defines the syndrome as a reproducible constellation of symptoms. This particular definition emphasizes the predictability of behavioral patterns in a diagnosed subject, and highlights one of the major pitfalls of identification of children with special needs: misidentification caused by common or ambiguous manifestations. While the presence of a syndrome raises the possibility of a single medical entity, it does not necessarily mean that members of a syndrome share the same underlying condition. Tourette's syndrome is an example of a syndrome that would be familiar to most teachers, and is characterized by multiple tics, both vocal and physical.

B. The Biological Spectrum.

Molecular definition of a variety of neurological conditions, including some neurodevelopmental disorders, has provided the biological basis for the concept of 'spectrum' of severity in these conditions. An example is Fragile X Syndrome, in which the severity of neurodevelopmental impairment is related to the number of CGG repeats in a segment of the DNA of the X chromosome. The nature of this genetic disorder confirms the fact that our students with special challenges can be perceived as having mild, moderate, severe and/or profound disorders. In Ohio, the Intervention Specialist teaching license is organized in this manner so that, although students are still labeled with specific disabilities, services are delivered in cross-categorical settings depending on levels of severity.

C. Brain Plasticity.

Ongoing research reveals amazing observations of the brain's ability to rewire, repair, and more importantly, to reorganize itself after injury: this is referred to as brain plasticity, and is probably the most exciting and motivating neurological research finding that has emerged in the last twenty years. Examples of brain plasticity have been noted when any repetitive action takes place involving the visual, motor, and sensory or coordination systems that are required for specialized learning activities (Willis, 2006). The implications for teachers are enormous, bordering on miraculous, when a teacher realizes that as a result of classroom interventions, he or she is literally influencing biological changes in the brain. The major question educators need to ask, according to Robert Sylwester (1995) is, "How much does one indeed effect change in students' brains as a result of challenging and stimulating interventions?" The answer to this question lies in individualized instruction based on the perceived needs of the child and his or her learning style.

D. The Elusive Concept of Attention.

A basic understanding of so-called topographical functions, i.e. the organization of brain functions and their location in the brain, is a useful foundation for understanding neurodevelopmental concepts. Still, the biology of the concept of attention has remained elusive. Most neurobiologists see this and other neurobehavioral disorders as originating in more complex interactions of specialized brain processes (Melillo & Leisman, 2009). For instance, if one has difficulty with auditory processing, then being able to follow the content of a teacher's speech becomes a challenge that would translate into a behavior misinterpreted as 'inattentiveness.' Stimulants, the mainstay of treatment for ADD, do not directly address this problem. Ritalin may help a child focus on a reading task or assignment, but it will not improve reading skills, it simply means he or she can stare at the page longer. The same principle applies to other challenges such as dyscalculia, emotional disturbance or spelling dysgraphia.

E. Left vs. Right Hemisphere.

Early neuroanatomical studies led to the conceptualization of the left hemisphere as being specialized in language functions and the right hemisphere as being specialized in visual or spatial functions. This led to the very popular idea of self-describing learning styles as "left-brained" or "right-brained" which became widely prevalent in schools and universities. While mostly correct, this knowledge has been enhanced by functional studies which indicate a greater

distribution of and interaction between cerebral functions. A disconnect between the two hemispheres, whether it be as a result of agenesis of the corpus callosum, the wide band of nerve cells connecting both hemispheres, or mild to severe disconnection syndrome, will certainly result in significant learning difficulties.

F. Memory.

Learning does not occur without memory. Indeed, without memory one would be deprived of the things that make up life: understanding, relationships, plans, goals, language, in a word, life. It is the essence of who we are and how we function. Yet, as Sousa (2006) asks

"What is a memory? Is it actually located in a piece of the brain at a specific spot? Are memories permanent? How does the brain manage to store a lifetime of memories in an organ the size of a melon? Is forgetting actually losing the memory or just access to it? "(p.78)

These are all questions that teachers need to answer for themselves because retention of information is the essence of education. Memories are formed based on the brain's ability to receive incoming sensory information. The brain then acknowledges, recognizes, and processes the incoming data that must be connected with prior information or memories, to be stored permanently to be retrieved later. (Willis, 2007).

The physical apparatus through which information is conveyed throughout the brain is a network of billions of neurons, or nerve cells. Communication between neurons occurs as a result of electrical and chemical signals that travel at speeds of up to 400 feet per second (Restak, 2001) along axons, or neural pathways and dendrites, or branched extensions of nerve cells, across a space called the synaptic gap to the target neuron(s). Memory is enhanced with repetition and practice, as long as connections are made and can be repeated efficiently. This occurs in all facets of learning: motor, language, social skills, emotions, and behavior, meaning that all areas of the brain are involved during the formation of memories.

G. Myelination, Neural Tube, Neuronal Migration.

In the developing brain, neurons migrate to areas of the brain where they will take up residence to carry out the function for which they were born. Neuronal migration, and the development of myelin, the fatty tissue that insulates the axons and dendrites, both occur as early as the second month of gestation (NINDS, 2007). If something disrupts the signals that guide these neurons to their assigned function, and they do not arrive at their designated area, structural abnormalities will occur in the brain. Symptoms vary depending on the abnormality, and present themselves on a spectrum of severity. Some common features that could be seen in the classroom include poor muscle tone and function, seizures, developmental delays, cognitive delay, failure to thrive, difficulties in feeding, swelling in the extremities, and abnormalities in head size. (NINDS, 2007)

H. Sketching a Neurological Picture.

Participants in the Neurobiology of learning class are required to observe an initial evaluation of a child by a pediatric neurologist in the clinic. This is an experience that could be baffling for the poorly informed observer. For this reason, the instructor simulates an initial evaluation of a child in the clinic, demonstrating the process of diagnosis and the steps taken to arrive at a

conclusion about the child's condition. Students are introduced to the elements that are considered during this evaluation, so that they may have a better understanding of the process and how the physician reaches a clinical decision based on observation of the child. The child's language, motor, sensory, and attention skills are evaluated in this initial examination. Language is addressed in more depth in the second module, because it is considered the most sensitive index of child development, and characteristics of language problems are central to the diagnosis of many syndromes.

Similarly, attention, a controversial topic in education is addressed more comprehensively in a later module. Anatomical and functional characteristics of attention are examined, emphasizing that there is no specific area of the brain that is responsible for attention. It is also interesting to note that Attention Deficit Disorder (ADD) and Attention Deficit Hyperactivity Disorder (ADHD) are not specified as categories of special education. Most teachers already know that attention issues are typically present, to some degree, in all children who struggle in school, no matter the reason.

The motor examination includes analysis of pyramidal, cerebellar, and basal ganglia functions. The neurologist is able to identify abnormal pyramidal function by examining the child's strength, motor control initiation, tone, and gait. Cerebellar functions are evaluated by observing the following: child's ability to rhythmically finger tap, gait, fluency, and tonality of speech, and presence or absence of tremors during motor activity. The basal ganglia is responsible for integrating contraction and simultaneous release of agonistic/antagonistic muscles. The neurologist observes the child at rest, looks for the existence of tremors, checks for rigidity of muscle tone, and considers the child's posture. Figure 2 demonstrates a link between some of the syndromes that a teacher may encounter in the classroom and the accompanying features that may be present, indicating problems in the areas of the brain responsible for motor function.

MOTOR DISORDERS

Syndromes	**Features**
	• Acathisia
• Tourette's/Tics	• Tics
• Sydenham's Chorea	• Chorea
• Athetoid CP	• Dystonias
• Cerebral Palsy	• Weakness
• Hemiparesis	• Rigidity
• PANDAS	• Spasticity
	• ADD/ADHD

Figure 2. Syndromes and features associated with motor disorders.

I. Sensory Examination.

The sensory examination involves an understanding of the anatomical location of the sensory system in the brain. See figure 3

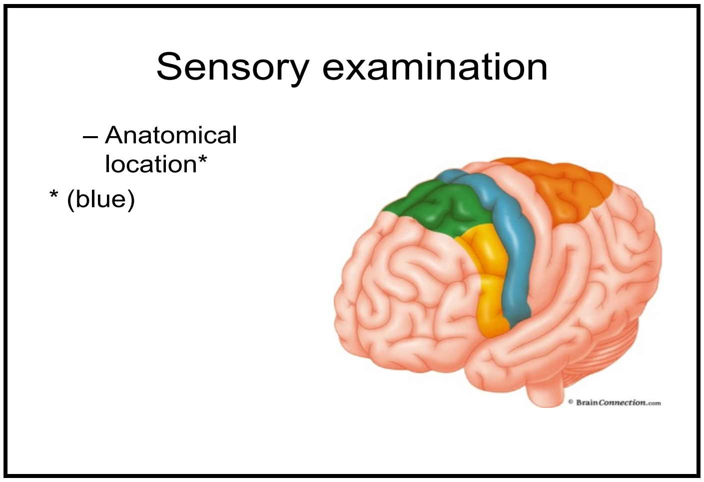


Figure 3. Anatomical location of the sensory system (Posit Science).

Basic sensory components include touch, temperature, pressure, vibration, and tactile discrimination. Sensory components are evaluated by examining stereognosis, graphesthesia and proprioception. Stereognosis is the ability to perceive the form of an object by using the sense of touch. Graphesthesia is the ability to recognize writing on the skin by the sensation of touch. Proprioception is the awareness of one's own body, and how one perceives pain and movement of one's body parts in relation to each other. A child experiencing deficits in any of these areas may not necessarily be diagnosed with a disability, but may present a puzzling array of difficulties in the classroom that might prevent him or her from performing to full academic potential.

III. Module 2: Neurobiology and Clinical Features of Language in Children.

The neurocognitive examination attempts to analyze the integrity of each step of the process of language in a child. Many expressions of neurological functions as well as their related disorders/disabilities are displayed in a spectrum. A spectrum in many instances is biogenetically based, with the best documented examples being Fragile X syndrome, Huntington's disease and Myotonic dystrophy. Language is processed in one of two anatomical locations in the brain; receptive language is processed in Wernicke's area, in the posterior temporal lobe, while expressive language is processed in Broca's area, in the posterior frontal lobe.

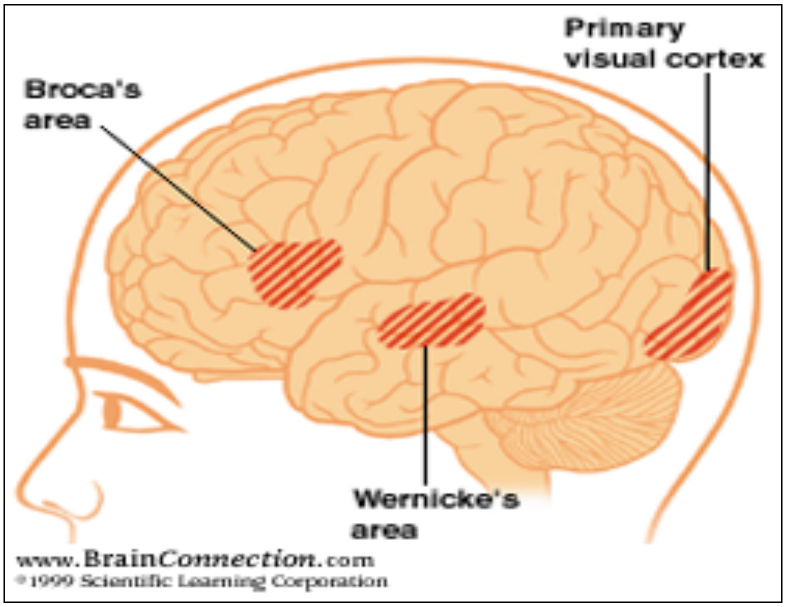


Figure 4. Anatomical locations of receptive and expressive language (Posit Science).

Processing of receptive language is complex and multivariate, including auditory processing, auditory figure ground, filtering, auditory memory, phonemic decoding, word to image conversion, and grapheme decoding. Executive function of language that a teacher sees in the classroom and which might be influenced by inadequate processing of receptive and/or expressive language will be manifested in difficulty with comprehension, reading, writing, following directions, speech and communication skills. The neurological exam of receptive language includes evaluation of word comprehension, sentence comprehension, letter identification, number identification, and reading. As might be expected, the neurological exam of expressive speech includes evaluation of spontaneous speech, letter substitution, word substitution, anomia, the inability to name an object, writing, and copying. In order to adequately diagnose language dysfunction, it is imperative to be cognizant of, and consider the developmental features of language in children, as well as the parallels in thought development and characteristics of attention. Language development is initiated from birth with phonologic discrimination, followed by responding to voices, vocalization, turn taking, and cooing vowel sounds by the age of 4 months. Between 6 to 8 months, the baby continues to develop babbling consonants and vowels, as well as syllables, including “dada”, and “mama”. Between 10 and 12 months, word utterances that signify meaning, begin to appear in the child’s language, and at about the end of the first year, the child generally has a vocabulary of around 10 words. Subsequently, receptive language develops more rapidly than expressive language, which is manifested in mainly a clear discrepancy between how much the child understands and how well he may be able to express himself. By the age of two, two-word combinations develop and from this time onwards, there is a dramatic increase in vocabulary. By three years of age, words are intelligible to strangers and utterances are formed in grammatical sentences, although one may still observe continued phonological and morphological errors. Figure 5 below demonstrates the development of attentional processes, and clearly indicates that language develops according to the child’s ability to focus on stimuli long enough to produce imitative utterances which exemplify speech.

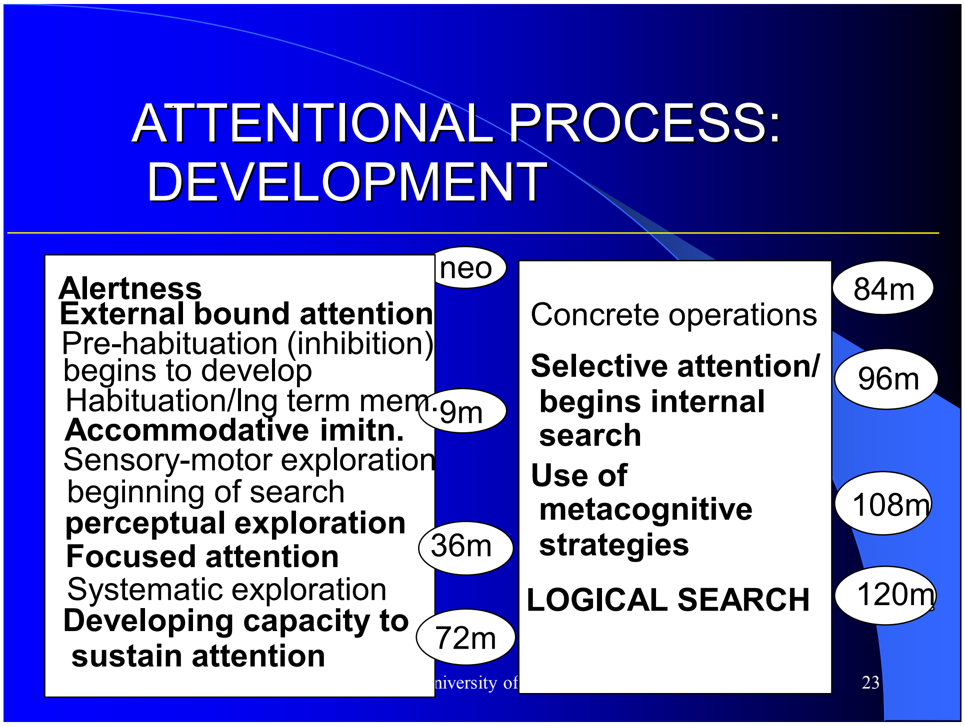
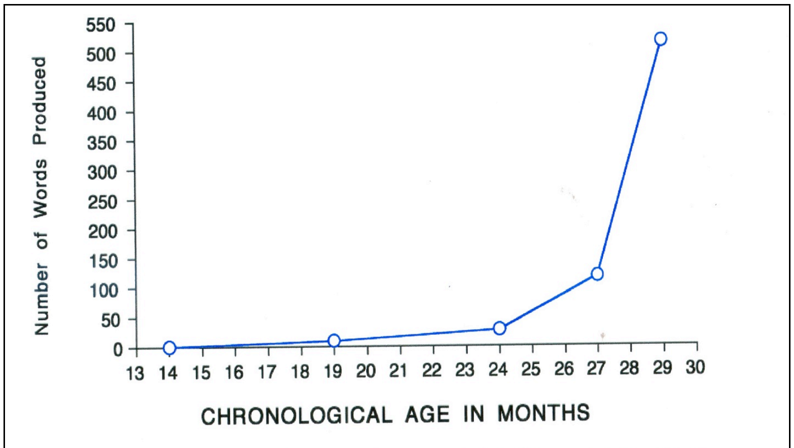


Figure 5. Developmental Scale in months of Attentional Processes (adapted from Blondis et al. 1991).

Aphasia, or disorder of language production, can involve all aspects of language: auditory and visual as well as receptive and expressive skills. This translates into an array of behaviors that are present in the classroom: reading, writing, listening, comprehension, speech, spelling, and copying. These skills are utilized not only in language arts, but throughout the curriculum in all subject areas. The typical syndrome of expressive aphasia includes dyslexia, behavior dysfunction manifested in anger and excitability, difficulty uttering speech, poor prosody (expression), poor grammar in speech, and poor writing. The typical syndrome of receptive aphasia includes dyslexia; poor phonological awareness; impaired language; dependent, aggressive or erratic behavior; anosognosia, or the inability to recognize one's own challenges; fluent yet shallow or meaningless speech; parahrasias, difficulty copying; and inability to master visual to auditory signals. A variety of clinical circumstances can lead to damage or destruction of the language areas in children: traumatic brain injury, hemorrhage or stroke, and respective surgery for epilepsy, to mention a few. Most commonly, in clinical practice, children are referred with observation of delay of language or behavioral abnormalities which usually are described as 'autistic'. As autism has become the fastest growing category of disability and is now approaching epidemic proportions, teachers should be aware of the possibility of mistaken categorization of children. Characteristics of developmental language delay in children are: failure to acknowledge voice interactions, delay in expressive vocabulary, and earlier development of receptive skills which are selective. For example, the child may have better comprehension of caregivers than strangers. Frequently delayed walking and autistic spectrum behaviors are associated with language aphasia; as the child grows, one sees an association with dyslexia, dysgraphia, and speech dyspraxia. It is interesting to note that the recovery rate of language seems to be standard regardless of whether the child has developmental aphasia or acquired lesional aphasia. Figure 6 below shows the rapid rate of growth in the number of

vocabulary words in a child with a brain lesion, which would be similar in a child with developmental aphasia. One should not infer, however, that a child who does not develop language according to typical developmental milestones should not receive speech and language therapy. All services that will help a child achieve his or her full potential should be considered.



Number of Words Produced by a Child (Case G.L.) with a Congenital Left Frontal Lesion from 14 to 29 Months (from Dall'Oglio, Bates, Volterra, Di Capua & Pezzini, 1994)

Figure 6. Number of words produced by a child with a congenital left frontal lesion from 14-29 months (Dall'Oglio et al, 1994 in Bates et al).

When one considers the complex processes that are involved in the production of language, it is encouraging and motivating for teachers to know that the brain has the capacity to recover language lost and enhance developmental potential. With appropriate stimulation the language center of the brain can repair itself, significantly diminishing the devastating effects that language delay has on all areas of a child's curriculum.

IV. Module 3: Disorders of Attention.

There has been an unprecedented increase in the diagnosis of attention deficit disorder with or without hyperactivity (ADD/ADHD) in children, which has resulted in the prescription of stimulant, and, more recently, non-stimulant medications by practitioners who may not always understand the complexity of this disorder. Disagreement persists as to whether attention deficit is a primary neurological disorder, or a symptom of an underlying biological, psychiatric, or neurological condition.

ADD and ADHD are best thought of as only two examples of multiple disorders on a spectrum, rather than as a single diagnostic entity. Multiple processing deficits can lead to a behavior of inattention, e.g. central auditory processing deficits, dyslexia and complex visual processing deficits. Unfortunately, inattention is more readily observed and diagnosed than any processing deficit, so there are many children whose real challenges are not being addressed, who are sometimes overmedicated, and who continue to fail and fall behind their peers. It is also important to recognize the important role of more complex neurobehavioral disorders that interfere with attention. Examples of these include obsessive compulsive disorder (OCD), depression, hypomania, impulse control disorders, and frontal lobe syndromes, particularly post

traumatic brain injury. Movement disorders such as Tourertte's syndrome, Sydenham's chorea, and pediatric autoimmune disorder associated with strep (PANDAS) are other important contributors to attention deficit syndromes.

Pharmacological studies have identified a variety of neurotransmitters that are associated with ADD/ADHD: dopamine, serotonin, and norepinephrine. Desch (1991) contends that the very existence of so many effective medications for the treatment of ADD/ADHD, with each medication having many different biochemical effects, adds further evidence that more than one neurotransmitter system is involved in the disorder. In terms of anatomical correlates, Melillo and Leisman (2009) explain that the prefrontal cortex, the cerebellum, and the basal ganglia are all involved in functions that affect attention. Lesions in these areas of the brain can result in a wide range of clinical manifestations. For example, patients with frontal lobe dysfunction may exhibit distinct symptoms, depending on the location of the lesion. Left prefrontal lobe dysfunction exhibits symptoms that might include apathy, depression with increased avoidance and perseverative (repetitive) behaviors, such as one might see in a child with autism. Right prefrontal lobe dysfunction results in distractibility and inappropriate or impulsive behaviors. There is no specific area of the brain that is primarily responsible for attentional processes.

There seems to be a growing consensus that ADD and ADHD are often comorbid with a wide variety of disabilities, primarily psychiatric disorders. Hudziak and Todd (1993) noted that the rates of comorbidity in children for ADHD and (OCD) was 35%, Cognitive Disability (CD) was 50%, mood disorders 15-75%, and learning disabilities (LD) 10-92%.

Clinical syndromes for ADD could be classified as follows: the restless child, the aggressive child, the inattentive child, the disorganized child, the disruptive child, and the failing child. The restless child may experience movement disorders that exhibit tics, akathisia (compelling need to be in constant motion), or seizures. As mentioned above, restlessness could be symptomatic of frontal lobe dysfunction resulting from trauma, stroke, or brain degeneration. The aggressive child might have a communication disorder, be hearing or language impaired, or may be diagnosed with a genetic disorder such as Cornelia de Lange or XYY both of which cause increased aggression in children. A child with petit mal seizures, one who is suffering from anxiety or depression, one who may be hearing/language impaired, or one with a thyroid disorder, anemia, or chronic pain, will present clinically as an inattentive child. Disorganized behavior in a child might be the result of visual spatial and visual perceptual dysfunction, as well as partial prosopagnosia, or difficulty with face recognition. ADD/ADHD behaviors can be the outward manifestations of neurobehavioral syndromes such as learning dysfunction, affective disorders, disorders of socialization, paroxysmal rage dysfunction, obsessive compulsive behaviors, autistic spectrum disorders, and/or movement disorders.

Accardo and Whitman (1991) emphasize that medication should never be the first treatment approach to ADD/ADHD, and should only be involved in a multimodal treatment program. The classroom teacher should be encouraged to work closely with the physician, clinical therapist, and parents in order to design appropriate, evidence-based interventions that will assist the student in achieving the best possible outcomes and eventual success in and out of the classroom.

V. Module 4: Spatial and Constructional Disorders.

This module addresses the anatomical distribution of spatial and constructional skills, the functions of the non-dominant hemisphere, and clinical syndromes that one may encounter in

children with right hemisphere or non-dominant hemisphere dysfunction. The right hemisphere controls movement on the right side of the body, including left-sided sensory control, spatial processing, visual spatial processing, and body perception. Other non-dominant hemispheric functions are social praxis, or understanding and perception of social behaviors, motor praxis otherwise understood as the ability to carry out learned movements, organization of oneself in space and time, and the decoding of facial features.

The learning and behavior characteristics that one might observe in Asperger's syndrome can be attributed to anatomical correlates in the right posterior parietal cortex. When these areas of the brain, as shown in the shaded sections of Figure 7, become dysfunctional, the individual demonstrates poor social skills, hyperdysprosody, hypodysprosody, hyper emotionality (R1), discomfort in social settings, and decreased emotionality (R2).

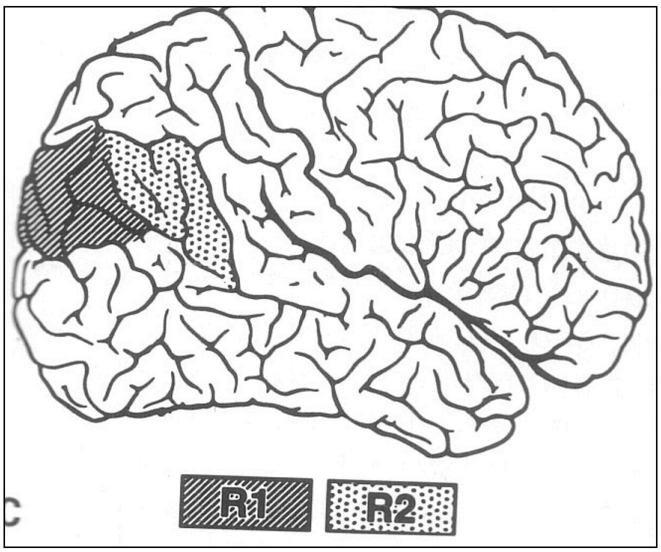


Figure 7. Anatomical correlates of Asperger's Syndrome (Weinberg et al. 1995).

Some of the learning and behavioral correlates for Gerstmann Syndrome, which manifests many of the same symptoms as autism and Asperger's Syndrome, are found in the areas of the brain that are responsible for finger dysgnosia, namely the right angular and supramarginal gyri. Damage or abnormality in these areas will result in poor skills in ordering, difficulty with transpositions, and dysgraphia. When malfunction of the visual association cortex occurs, the child will experience poor picture to word identification, and will also experience defective wit and logic. Problems in the right inferior parietal and supramarginal gyrus will produce poor sequencing of symbols, designs, objects, and events, and will lead to transposition of symbols in spelling and number tasks, and dysgraphia. In addition one will see right left confusion and poor organizational skills. Figure 8 below illustrates damage to the visual association and prestriate cortex of both hemispheres.

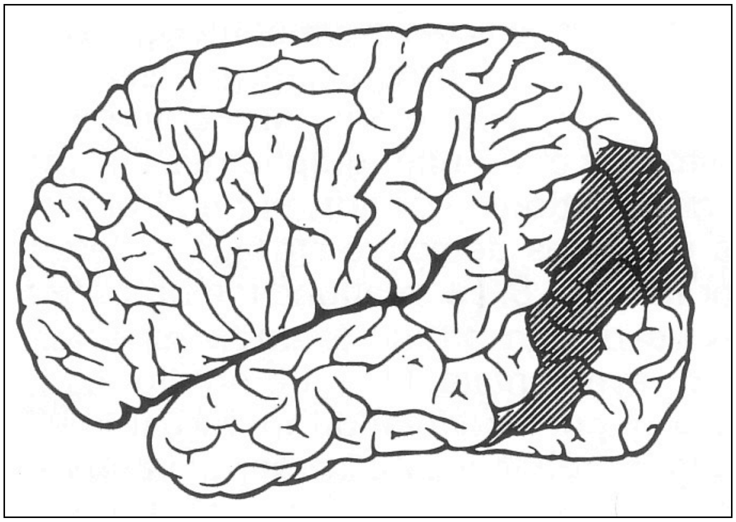


Figure 8. Visual Association and prestriate cortex of both hemispheres (Weinberg et al. 1995).

Damage to this area causes difficulty with verbal and non verbal communication, inability to accept inanimate interaction, defective logic and humor, stereotypic mannerisms, compulsive behavior, and poor adaptation to novel situations. These behaviors are all evidenced in the autism spectrum.

Anatomical correlates for depression are dysfunctional right posterior temporal cortex, prestriate, and inferior parietal lobe. Clinically, patients present with dysphoric moods, inability to anticipate or experience pleasure, loss of interest, hypovigilance, disturbed sleep, appetite, and mood disorders. Damage to the right inferior parietal lobule and parts of the right supramarginal gyrus and prestriate cortex can also produce many of the above mentioned behaviors with the addition of fidgety behavior inattentiveness and learning disabilities.

Weinberger et al (1999) continue to describe anatomical correlates between sociopathic type behaviors and damage to the right orbital frontal cortex. In addition to these behaviors subjects may exhibit difficulty with societal rules, compliance, obedience, and volition, all of which are indicative of sociopathy.

Clinical syndromes associated with right hemisphere dysfunction include amorphosynthesis, visual neglect, sensory neglect and anosognosia (also a frontal lobe function), motor apraxia, visual ataxia and sensory perceptual disorders must be included in this list of syndromes.

Upon close examination of the DSM-IV criteria for the diagnosis of autism, students taking this course readily see the connection between the descriptors outlined in the manual and the manifestations of right hemisphere dysfunction. These fall under three main headings: impairments in social interaction, impairments in communication, and restricted, repetitive, and stereotyped patterns of behavior, interests and activities. However, these behaviors are equally prevalent in children with Rett's disorder, a neurodevelopmental disorder affecting gray matter, children with childhood disintegrative disorder, a rare condition characterized by delays in language, social function, and motor skills, and at times in children with profound hearing loss and speech delay. Children with Asperger's syndrome also exhibit behaviors that are immediately recognizable as exhibiting right hemisphere dysfunction. Patients display normal or near normal intelligence, a spectrum of severity of social dyspraxia, i.e. little understanding of

social constructs and associated gestures, poor eye contact and facial fixation, and a high incidence of psychiatric disorders. Students with this disorder are often obsessive and perseverative, appear to lack social and affective modulation of expression and thus appear aloof and unemotional. Poor visual-spatial skills may contribute to learning difficulties in reading or math. Speech is observed to be dysprosodic and frequently too loud or high pitched. They struggle with semantic and pragmatic language, often displaying a lack of humor, both verbal and non-verbal. There are numerous behaviors that teachers observe and experience in the classroom that might be symptomatic of right hemisphere dysfunction. It is our belief that with greater knowledge and understanding of these syndromes, one will be more likely to address the needs and challenges of these individuals, regardless of the category of special education by which they are identified.

VI. Conclusion.

This discussion does not imply that teachers should be neuroscientists, and certainly, one course cannot begin to give a complete picture of the research and information available on the brain. It is the intent of this course to improve the understanding of etiology so that teachers, particularly intervention specialists, will make the connection between these underlying etiologies and the behaviors that are so commonly misunderstood in children with special needs. It is not customary in teacher education programs to include courses in neurobiology, which is an issue that ought to be addressed. As the country, and particularly Ohio, is attempting to establish standards to guide the assessment of teacher effectiveness, it becomes the distinct responsibility of teacher training programs to take the necessary steps to increase rigor in an effort which will ultimately provide well trained, competent teachers who will make a difference in the classroom. If teachers are struggling, bemused, and incapable of designing appropriate interventions for students because of a basic lack of knowledge of neurodevelopmental disorders of children, students' needs will not be adequately met. Here, one needs to state the obvious: that teachers have a major impact on how well students learn and perform in the classroom. It is no secret that reform of the educational system is sorely needed, as our students leave school barely literate and unprepared for the challenges of the workplace, not to mention the complications of technology and social interactions.

It is the opinion of the author that teachers should have a more balanced education which would include knowledge of neuroscience and the application of scientific research to the classroom. Aggregated data from the University of Findlay course evaluations collected between 2000 and 2008 reveal positive feedback from participants of this course. The chart below illustrates the students' responses to the following criteria: adequate amount of work, instructor was well prepared, teaching style suited my learning style, tests were appropriate, instructor demonstrated concern for my learning.

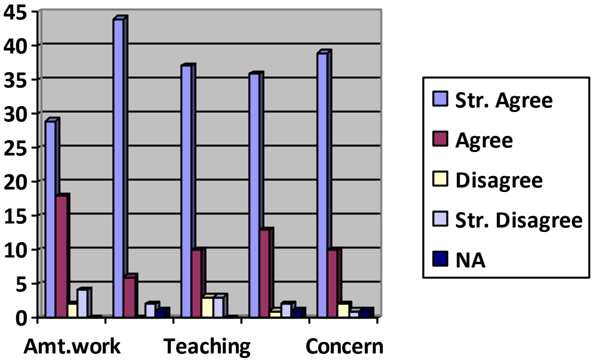


Figure 9. Results of course evaluation from 2000-2008 (N=53).

While these responses do not speak to the significance or usefulness of the content being taught, the following sampling of comments most certainly lend credibility to the worth of this unique opportunity that is afforded to our students: “Really enjoyed this class;” “Thankful for the opportunity to observe a clinical setting;” “taught me a lot about symptoms to look for in my students;” “super class-this is information ALL (sic) teachers should have;” “extremely beneficial.”

If one increases the comfort level of intervention specialists in the identification and integration of neurocognitive syndromes, the quality of relevant interventions will enhance the quality of instruction, minimize labeling and mislabeling, and better serve children in the classroom. As Carew et al (2010) conclude:

“The bottom line is everyone wins…For each young mind served by Neuro-Education knowledge, all societies have the opportunity to regain lost ground-and build the potential for better academic achievements and opportunities for both young people and society at large.” (p. 687)

It would be gratifying to see improved communication between the educational and medical models. Fisher et al (2007) assert that “Biology and cognitive science have as much to learn from education as education has to learn from them.” While this sounds simple, it is not easy. The system that is in place is rooted in big government and political policy. Currently, there is no way of avoiding labels in special education because these labels drive funding, without which there would be no services. Unfortunately for those children with special needs, money driven labels become their identity. It is not uncommon for teachers to refer to students in the classroom as, “my LD kids” or ‘my two autistic kids”, my “IEP kids”. Furthermore, the majority of school districts require teachers in special education to implement curricula that are standardized, scripted, and mandated; having the freedom and luxury to think and act creatively in the classroom is a difficult challenge for teachers both now and in the foreseeable future. But it must be said: it is imperative that teachers become more cognizant if the individual challenges that children experience in the classroom as a result of specific neurological conditions, whether they are mild, moderate, or severe. As Sylwester (1995) says:

> Current brain theory and research now provide only the broad, tantalizing outlines of what the school of the future might be but we can anticipate that the rate of new discoveries will escalate. Educators who are willing to study the new

> cognitive science developments, and then to imaginatively explore and experiment in their search for appropriate educational applications, will have to work out the specifics in the years ahead. If our profession does not do it, nothing will happen. Things will remain as they are. (p.141)

Preservice teacher programs should evaluate their curricula and examine the benefits that would result from the inclusion of courses in the biological sciences that offer teachers a better understanding of the children that they will serve. Insights into the neurobiology of learning have provided our students with the knowledge and understanding that if afforded to all preservice intervention specialists, could lead us to that enhanced level of services that we are seeking.

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