THE DEVELOPING BRAIN AND EARLY SIGNS OF DYSLEXIA

Early Childhood Language Acquisition and Development: An Introductory Neuroscience Discussion

PART I - THEORY

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Knowledge of developing brain functions in early childhood and brain areas/mechanisms associated with these functions has dramatically increased over the decades. This growth is due mainly to the marriage between neuroanatomical, neuroelectrophysiological/neurochemical studies of functions of learning (attention, perception, memory, speech/language, motor and mood functions) associated with brain damage/dysfunction in young children. This marriage has particularly afforded a more specific understanding of the biological mechanisms and related functions necessary for language acquisition and development in early childhood. Identification and interventions aimed at enhancing these functions and underlying brain mechanisms are quite promising.

PART II – INTERVENTIONS

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As we grasp a more clear idea of what is involved in attending to sensory stimuli, we can determine approaches which will help children who have difficulty with sound, symbol or sound/symbol awareness. As we understand "why" some children have dyslexic profiles we can assist them in building appropriate neural pathways and memories so they may become more effective readers and communicators

Part I – Theory

The focus of this paper is to bring to the reader a neuroscience discussion of the variety of the brain areas and related functions necessary for language acquisition and development in early childhood. Identification and intervention aimed at enhancing these functions and underlying brain mechanisms of language promotes healthy development.

As scientists and educators, we are no longer content to see the brain as a group of passive connections responding to stimuli which are solely dependent upon genes. We are no longer content to directly compare language acquisition with only particular brain areas. This thinking has radically changed. The study of human mental processes, especially language, has sharpened over the decade. It is clear that language is very active in character and demands a relationship of a variety of brain zones and multiple functions, and is dependent upon biological mechanisms, multigenerational transmission, and external/environmental cues. Take for instance the concept of the "word." We know that is not just an image or sound. It is a complex matrix of cues requiring the relationship of multiple brain areas, involving (a) multisensory attention and excitation/inhibition of sensory cues, (b) the reception of analysis of acoustic, visual, affective, morphological, lexical phonetic… cues, (c) the storage/memory of these cues, and (d) the expression and regulation of these cues. We, therefore, understand language as a highly organized and complex functional system. The development of this system incorporating attention, reception, memory, and expressive cues builds upon language as a mechanism foe intellectual (abstraction and generalization…) and thinking.

We must first address the most fundamental basis of language acquisition, sensory attention. We know that subcortical mechanisms, especially higher thalamic/limbic reticular formation and cerebellar areas, and environmental cues are responsible for the excitation and inhibition of multisensory stimuli associated with language acquisition. The rate and intensity of the flow of sensory stimuli is critically important. It is well known in learning theory that the most elementary involuntary forms of attention, the arousal and orienting/attention reflexes, can be attracted by significant sensory stimuli, even very early in infancy. A newborn, for example, stops sucking movements upon presentation of sensory stimuli. In addition, changes in respiratory rate and constriction of blood vessels are present. In electrophysiology, the inhibition (blocking) of the alpha rhythm develops (alerts waking rhythms), so the infant can direct attention/orient to the stimuli presented. Once attended to, the attention/orienting reflex ceases for that stimulus

(habituation). Imagine if we could not habituate to something. We would be attending to everything. (We are all familiar with children having varying degrees of hyperactivity.)

If the excitation/inhibition of sensory cues is disturbed, then the reception, storage and expression of these cues will be disturbed. Some examples of sensory overexcitation or overinhibition follow: 1. Similar sounds such as "s," "f," "th"… or similar looking letters such as "b," "d," "p"… can be confused. 2. If the sound of raindrops against a window sounds like pounding nails, imagine what sounds of words sound like. 3. If light is blinding, imagine how letter configurations look. 4. If the feel of a pencil feels like jello, imagine how writing would look. 5. The impact upon mood heightens as sensory attention is disrupted. Varying degrees of excitation and/or inhibition of sensory attention can critically impede language acquisition. Biological and environmental/external mechanisms govern this excitation/inhibition of sensory stimuli. Learning techniques, and medical interventions when neurological distress is present, must first address these sensory attention mechanisms for healthy acquisition of language.

Let us now look at the mechanisms involved with reception, storage and analysis of stimuli. We know that the lateral zones of the cortex, including temporal (auditory), occipital (visual), and parietal (tactile/motor) zones are responsible for converting sensory stimuli into discrete cues. Lines convert to letters and pictures… sounds convert into phonemes and words… touch converts to complex sensation… Complex synthesis of sensory stimuli produces integrative sounds, images and sensations. The meaning of words and images as wholes and spatial orientation is developed. Symbolic/semantic language, the meaning of word order sequencing/sentences, the meaning of fundamental codes… is developed.

Memory consolidation and storage of these traces are dependent upon the flow of stimuli from lower brain zones of sensory attention. Of the many stimuli which reach us, we respond to only those few which are particularly strong. We use only the necessary memory traces, from the host of traces we have, to complete a certain task. Necessary connections are excited and unnecessary connections are inhibited. For example, we use only those movements necessary to reach our goals. We respond only to those sounds with which we are familiar. This is why infants quickly become "functionally deaf" to sounds other than their native tongue. As we develop, these lateral brain zones also influence the lower zones. We all have seen children throughout varying degrees of developmental spectrum disorders, for example, who cannot consolidate and integrate phonemes into words for spelling… or who cover their ears in the presence of loud noises, impeding phonetic reception, or who recognize an acoustic cur but cannot associate it with a visual representation… or who recognize a phoneme but sensory motor formations affect the phonemic articulation… or who read but don't comprehend… Repetition can consolidate memory traces. This is why as young children we learn by repetition. As we grow older, we learn by recollection and reflection. We are also familiar with children who can compensate well in early school years, due to repetitive techniques, but who reach third and fourth grades and experience failure because the expected levels of recollection/reflection, (i.e., of sounds, images…necessary for reading…) have not been well consolidated.

Let us now address frontal lobe mechanisms involved in language expression and regulation. We know that frontal areas are strongly connected to all other brain areas, especially the medial and subcortical areas of sensory attention and nonspecific memory. As we develop language skills, these frontal areas dominate. This is why our words can activate our voluntary attention and govern our behaviors. We develop our ability to express and regulate stimuli. Disturbance to these areas can significantly impede language. Even very mild disturbances can impede one's ability to selectively attend and one can become quite distracted. We are all familiar with the impact of an attention, voluntary or involuntary, upon learning. This attention variant also has a significant impact upon expression and regulation of memory traces. Frontal disturbances produce little or no difficulty with memory of isolated or well consolidated phonemes, words, or sentences…Several stimuli at one time or less consolidated traces can, however, cause much confusion and difficulty, performing a sequence of tasks or result in continuous repetition of a task with poor switching of tasks (perseveration). For example, the regulation (order) of thematic pictures, even if the memory of each isolated picture is understood, can be confusing. Following a sequence or order of movements with verbal direction, even if the isolated words are understood, can be quite difficult.

Frontal expression and regulation demands thinking by recollection and reflection. Reasoning/thought develops our executive functions skills and promotes higher level language and communication. Although always forming, these frontal areas are passive in very early children and rely upon the integrity of lower brain areas for input. Over time, voluntary attention, repetition, analysis and consolidated memory traces aid in the expression of language cues, increasing language development.

It seems imperative that in early childhood we must significantly emphasize this developmental scheme. The integrity of developing subcortical and lateral brain areas in the first 5 years of life significantly influence frontal lobe development. this may be why our educational system formally begin schooling at age 5. it is the global age at which children can

voluntarily modulate complex attention, complex reception, analysis and storage of information and learn complex expression and regulation of their behaviors.

Healthy language acquisition and development in early childhood certainly depends upon healthy biological integrity of these developing brain areas (structural, electrical, and chemical activity). It is also very dependent upon environmental cues and learning techniques which specifically promote excitation and inhibition of multisensory attention, reception, memory consolidation and expression of language. Neurodevelopmental evaluations and educational assessing these mechanisms and learning techniques directed at developing these related functions (especially focusing upon multisensory attention and memory modulating the higher brain zones) are critical for language acquisition and development during these early childhood years.

PART II – Interventions

As mentioned above, "normal" brain development follows the following pattern:

1. Initial attention comes from the activation of the brain stem and works its way upward.
2. The infant's brain is quite "general" and relies upon all input to all sensory areas in order to develop (primary sensory areas).
3. Toddlers' experiences develop sensory input and memories which begin connecting with each other – auditory connects to auditory, -- visual to visual, etc. (secondary areas).
4. Sensory experience begins to combine from eyes to ears, eyes to touch, taste to touch, etc. (tertiary zones).
5. The left and right halves of the brain increase cross-communication…<u>if the child is able to attend to sensory input.</u>

If the child is unable to attend efficiently, sounds will not be perceived well and not stored as complete auditory impressions which will be linked to other listening experiences. Sights will be incompletely received and recorded causing piecemeal visual memories. The "normal" attention ----perception----memory sensory pathways will be partial, jumbled and inaccurate. Therefore, /a/, /b/. may not even e noticed as discreet sounds and may become confused in memory with /e/, or /d/. The corners of shapes may not be noticed. Thus, a square and circle may not be perceived as different from each other or /a/ and /o/ may not be perceived as separate letters. As incomplete or confused memories build upon one another, the perception and, thus, memory of the world of language becomes skewed and confusing.

If attention is insufficient due to chemical, electrical or structural brain variations, the child may experience deficits in the skills which lead to reading.

Auditory/Verbal Precursors

Difficulty with articulation
Difficulty following and remembering oral directions
Difficulty with word retrieval
Difficulty learning letter names and sounds
Difficulty blending sounds into words
Transposing sounds in words

Visual Weaknesses Precursors

Difficulties recognizing letters
Difficulty with basic sight words
Reversals and transpositions (more than usual)
Difficulty with tracking
Difficulty blending sounds into words (visual memory)

Based on the concept presented by Dr. Nowinski in the first part of this paper, the child's brain must be assisted in attending to the sounds and sights of his world if these deficits become apparent as more than just passing developmental stages. appropriate training should begin with the attention reflex, build toward strengthening memory pathways – simple to sequential – and lead to repetitive multisensory phonemic/letter awareness techniques.

<u>Auditory</u> attention can be attracted by switching various sounds "on" (exciting) and "off" (inhibiting).

Variations can be made in:

- Speed
- Volume
- Pitch
- Tone…to consistently hold the child's attention to what she is hearing. Once heard more clearly, memories can be built which are clear and meaningful.

Visual attention can be attracted by switching various visual elements "on" and "off" and creating variations through clear:

- Shape presentation
- Color alteration
- Size variation
- Etc.

Tactile attention can be clarified and expanded through variations in:

- Texture
- Size
- Shape
- Temperature, etc.
- Etc.

Motor or movement awareness can be stimulated through:

- Physioballs
- Swings
- Balance boards and/or balance beams
- Talking pens
- Pencil grippers, etc.
- Etc.

Taste and smell should be alternatively stimulated to increase the brain's awareness of full sensory input.

- Tasting exercises
- Smelling exercises
- Etc.

Of pervading importance in any intervention is awareness of and attention to the child's mood (limbic) system. The integrity of the child's limbic system affects his ability to attend to sensory input, analysis, memory and expression. Multisensory exercises must always be planned which allow the child's sense of success to increase. A sense of well-being allows all learning to occur more easily.

As each sensory brain area has been helped to more carefully attend to stimuli, MULTISENSORY attention can be approached – two senses combined at a time. Slowly. Clearly. After the child's brain is able to focus clearly upon each pure sense and build connecting sound memories, sight memories, tactile memories, etc,. through repetition, **then** multisensory techniques can work more effectively. The "early signs" or precursors of possible reading/spelling/written language difficulties can be reversed and replaced with clear, unconfused awareness of sensory experience and memories.

Tell-tale symptoms of dyslexia will then be able to be dealt with directly and more quickly diminish.

Auditory Deficits – Reading

- Substitution of sounds
- Poor sounds blending to make words
- Knows names not sounds of letters
- Poor phonic attack
- When stuck on a word may not sound it out
- Substitutes words
- Uses synonyms – mummy/mother

Auditory Deficits – Spelling

- Omits endings
- Uses synonyms
- Omits 2nd letter in blends – ted for fle

Confuses voices and unvoiced pairs p/b f/v sh/ch
Doesn't hear subtle differences – leaves out vowels
Confuses vowels
Wild guesses

Visual Deficits – Reading
May invert or reverse letters
Rate of perception is slow
Adds words which aren't there occasionally changing meaning
May omit an dread through punctuation, distorting meaning
May confuse order (place/palace)

Visual Deficits – Spelling
May visualize beginning and end of word but omit the middle
Spells phonetically (site/sight)
Mixes capital and small letters
Reverses letters
Gives correct letters in wrong sequence

Quality intervention for dyslexic symptoms must, therefore, take into account all elements of the child's cognitive development which are necessary for a person to become an efficient reader, writer and/or mathematician.