Chapter 15

Implications of Diffuse Neurological Dysfunction

Autism is considered to be one of the most severe forms of childhood neuropsychiatric disorders. Autistic disorders involve impairment in social reciprocity & communication, often together with cognitive deficits (Cook and Leventhal, 1992). Neuropsychological profiles of children with cognitive mental retardation differ from those of children with autism. Children with autism often show strengths in visual-spatial processing ability and remote memory with more significant problems in the area of verbal comprehension. Children with cognitive mental retardation usually show fairly consistent delays in all areas of cognitive performance (Dawson & Castelloe, 1995).

Neurological deficits that have been associated with autism include, abnormal cell density and reduced dendritic growth (Raymond, Bauman, & Kemper, 1989), abnormalities of the cerebellum (Courchesne, 1989), differences in sensorimotor, temporal, and Broca's regions (Chiron, et al., 1993), dysfunction in the reticular activating system (Rimland, 1964), abnormalities of the amygdala (Brothers, 1989;1985; Fotheringham, 1991), irregularities of limbic involvement (Boucher, & Warrington, 1976), left and right asymmetry abnormalities (Prior & Bradshaw, 1979), ventricular enlargement (Bigler, 1989a; Hauser, Delong, & Rosman, 1975), abnormalities in thalamic nuclei (Coleman, 1979), cortical atrophy (Bigler, 1989a) and abnormalities of the hippocampus (Minshew & Goldstein, 1993).

In most individuals the two hemispheres of the brain are specialized for different functions. The dominant hemisphere usually governs language function. Visual, auditory, tactile, vestibular and kinesthetic sensations are integrated with emotional and intellectual input in the dominant hemisphere to enable the expression of thoughts and emotions through language. Receptive and expressive language, along with reading, writing and the use of written symbols to communicate are all processed by the perisylvian language arc in the dominant cerebral hemisphere. Deficits in one area involved in the language arc are often associated with deficits in other areas of language functioning.

The non-dominant hemisphere is thought to provide a mixture of inflection and rhythm providing an affective component to speech. Dominance in one hemisphere is usually accompanied by control of fine rapid hand movements on the opposite side of the body. Vision and hearing, are also thought to be mildly effected by dominance. This normal asymmetry of the temporal lobe's superior surface is sometimes lacking or reversed in individuals with autism (Kaufman, 2001).

Language development can be affected by central nervous system deficits, decreased hemisphere specialization, disordered vocal structures, and an impaired auditory system (Rosenblith & Sims-Knight, 1985). Impulses conveying speech travel from the ears along the acoustic nerves into the brainstem and travel through the thalamus. They then travel crossed and uncrossed to the primary auditory cortex. Language impulses travel to Wernicke's area in the dominant temporal lobe. They circle toward the back of the head through the temporal lobe and then back forward toward the front of the head through the parietal lobe to Broca's area which is toward the bottom of the motor strip located just above the temporal lobe. Broca's area receives processed and integrated language information from the primary auditory cortex in the temporal lobe and is involved in the production of and articulation of speech.

The perisylvian language arc starts with Wernicke's areas travels through the Angular Gyrus and the Arcuate Fasciculus and ends in Broca's area. This area perceives and integrates language with other cerebral activities and results in the articulate expression of language. Imitation of phrases requires an intact perisylvian arc. If there is a problem anywhere along the way vocal imitation will not occur. If this arc is intact, but not integrated with the surrounding cerebral cortex, verbal imitation can occur but initiation of conversation will not occur (Kaufman, 2001).

Impulses from the visual system cross at the optic chiasm and then travel through the optic nerve to the thalamus. From the thalamus they travel to the right and left visual cortex in the occipital lobe. The impulses from the left visual field travel to the right occipital cortex where they must pass through the posterior corpus callosum to reach the left dominant hemisphere. From here right and left signals integrate and travel through the Arcuate Fasciculus to Broca's area for articulation. Reading aloud would involve visual perception leading to articulation (Kaufman, 2001). Problems located near Broca's area may cause the nonfluent production of speech often seen in children with autism which includes the use of single words with preference for basic nouns and verbs, a slow rate, and telegraphic speech. Problems emanating from this area are often associated with oral apraxia resulting in poor articulation as a result of problems producing voluntary movements of the tongue, lips and face.

As noted earlier depression is significantly correlated with autism (Lainhart & Folstein, 1994). Depression is also associated with dysfunction near Broca's area as are problems with movement, emotions and non-responsiveness also know as abulia. The neurological explanation for why depression, apathy and lack of responsiveness often cooccur with speech problems is that Broca's area is located in the frontal cortex where these problems often occur (Kaufman, 2001).

Fluent aphasias occur as a result of dysfunction of Wernicke's area or the pathways leading to Broca's area (arcuate fasciculus). Signs of fluent aphasia include word finding difficulties and word substitutions including nonsense words (neologisms), rhyming words, and tangential diversions. Anomia is a common fluent aphasia which involves the inability to name objects. Another form of fluent aphasia (transcortical or isolation aphasia) involves the dysfunction of the cortical area surrounding the perisylvian language arc (Kaufman, 2001).

People with isolation aphasia can usually repeat whatever they hear but they can not name objects, follow requests, or participate in a conversation. In the case of isolation aphasia the language arc is not communicating with the rest of the cerebral cortex. Individuals with isolation aphasia can repeat long lines of sentences involuntarily and compulsively (movie talk) and can echo the word of others (echolalia). Isolation aphasia can be divided into sensory and motor isolation aphasias. Both involve the preservation of repetition but motor isolation aphasia would also include low verbal output. Conduction aphasia occurs when Wernicke's area is separated from Broca's area along the arcuate fasciculus and results in good comprehension with the inability to repeat phrases or short sentences (Kaufman, 2001).

Alexia (inability to read) and agraphia (inability to write) often go along with aphasia. Apraxia involves the inability to execute motor acts despite normal motor strength, sensation, coordination and comprehension. It usually involves disruption of the motor areas and or a disconnection from language centers. Ideo-motor apraxia theoretically involves the separation of language areas from motor areas and results in the inability to convert thought into action. Ideational apraxia involves the inability to sequence steps requiring self-monitoring and following a simple plan and usually involves frontal lobe dysfunction (Kaufman, 2001).

Dysfunction of the non-dominant hemisphere can result in constructional apraxia which involves a visual-spatial perceptual impairment. This results in difficulty organizing visual information and integrating visual information with motor skills. Non-dominant hemisphere dysfunction results in aprosody. Aprosody involves the inability to understand the emotional or affective qualities of speech or the inability to convey emotion or affect while speaking. Aprosody is often accompanied by difficulty understanding or conveying nonverbal communication. The non-dominant hemisphere is often considered to be involved in the expression and perception of emotions and complex non-verbal behaviors (Kaufman, 2001).

The frontal lobes are considered to be the main site of personality, emotions, executive decision making, and inhibitory control of behavior. Problems with frontal lobe functioning may result in lack of initiative and indifference to the environment, as well as slowed and impoverished thoughts and emotions. People with problems in the frontal cortex may have difficulty not attending to new stimuli and are often very stimulus bound. They may show rigidity and obsessive compulsive symptoms. Initiation of movements may be impaired and perseveration of movements is often seen (Kaufman, 2001).

Viewing the symptoms of autism within the context of the way the brain processes information provides helpful guidance for treatment planning and intervention.

Deficits can occur anywhere along the information processing pathways from sensory input to motor or vocal output. From this perspective, any neurological deficit along the information processing path will affect output. The diverse neurological deficits that have been documented in autism lead to the heterogeneous symptoms of autism.

Neurological deficits earlier along the path of information processing lead to a wider array of symptoms. For example, thalamic dysfunction with all of its reciprocal connections to the cerebellum, amygdala, and hippocampus can lead to difficulty forming perceptions within the primary visual and auditory cortexes. This dysfunction may be small resulting in minor problems setting sensory thresholds resulting in a child being sensitive to normal everyday sound. Conversely the thalamic problems may be severe leading to the inability to form perceptions.

Analysis of each individual child will yield evidence of varying neurological deficits that should lead to diverse treatment strategies to remediate those deficits. Deficits earlier along the information processing chain should lead the therapist to consider classical learning methods to remediate the deficits. Classical learning as described earlier involves one environmental event predicting another. Classical learning is used to directly affect physiology such as the altering of sensory thresholds. A child that has significant sensory threshold issues will have a difficult time accepting the environment and hence, will not learn from experience.

The thalamus relays sensory information. It also helps to coordinate integration of the senses though it's reciprocal connections to the cerebellum. The amygdala imbues sensory information with emotion as the hippocampus imbues historical perspective through respective reciprocal connections with the thalamus and cortical structures.

Emotional meaning can be changed via classical learning (Kingsley, 2000). As stimulating events in the environment become predictive of other incompatible emotions they change the historical perspective. Events take on the qualities of the events they predict and change underlying physiology accordingly.

From the thalamus auditory sensory information travel to the primary auditory cortex. Visual sensations travel from the thalamus to the primary visual cortex. In both of these areas information is broken down and analyzed by feature detecting cells These primary areas of sensory/perceptual processing continue to be influenced by reciprocal connections to the thalamus, amygdala, hippocampus, and cerebellum (Kingsley, 2000).

Children who have problems forming perception will not be able demonstrate their ability to match identical objects or sounds. A significant problem in both primary perception areas will result in very chaotic behavior as the child will have a very difficult time forming accurate perceptions of the world. Usually children with autism have strengths in visual processing. A child that can not do visual 1:1 matching is likely having a problem with primary visual perception. The solution is to break the visual perception down to basic units and to teach 1:1 matching. Through repeated trials the child learns to perceive the world in a systematic fashion.

From the primary visual and auditory areas the sensations now called perceptions travel through the primary association areas of the parietal and temporal lobes. Here multiple senses are compared and senses are compared across senses. Information is integrated and associated. Meaning is attached to symbols and objects (Kingsley, 2000). Connections from the association areas to the frontal and orbital frontal lobes occur through the arcuate fasciculus. The frontal and orbital frontal cortexes influence perception in the association areas and imbue sensory information within social context and provide inhibitory control over motor and verbal output (Kingsley, 2000). Problems organizing perceptions for motor or verbal output will occur here. If a problem occurs in the primary association areas a child will not have very good cause and effect associations or abstraction abilities. If the problem occurs in the frontal or orbital frontal cortex social context, emotional understanding of sensory images and impulse control will be lacking.

Finally the integrated and associated neural impulses travel to the primary motor strip and Broca's area. Problems in the primary motor strip and Broca's area will result in motor production problems. A child will have difficulty talking and moving.

Admittedly this is a very gross estimate of neurological information processing but it provides a framework or heuristic understanding to guide treatment strategies. An understanding of neurological dysfunction, apraxia and aphasia make individual symptom complexes of autism understandable. The goal is to understand areas of strength and to work on using a child's information processing strengths to remediate and circumvent difficulties. At the same time information has to be broken down to the level where information processing can begin in areas of deficit. Information that is too complex will be ignored. As we decrease complexity of sensory input, making sensory input predictive, and behaviors predictive, of control over the environment development progresses through assimilation and accommodation.