Introduction

Learning disability can be defined as a discrepancy between the actual academic achievement of a student and that student intellectual potential. Children who have learning disability experience seriously impaiered functioning in one or more of the following areas: (1) reading (comprehension); (2) language (expression, comprehension); (3) written expression; (4) mathematics (calculation, reasoning); (5) sustained attention; and (6) goal-directed behaviour. learning disability must be the primary cause of problems in functioning even in the presence of other disabilities (physical, mental, behavioural) ***(Pratt and Patel, 2007).***

It is now accepted that about 5% to 10% of all school-aged children have a fundemental learning problem. Learning problems concern a high number of children, considering also the economical resourses that have to be provided to diagnose and treat these children ***(Lagae, 2008).***

Psychiatric disorders are two to four times as common in chidren with learning disabilities, psychiatric disorders are also less likely to be detected in children with learning disabilities than in the general population because these children have reduced verbal communication ***(Simonoff, 2005).***

Both dyslexia and dyscalculia are familial and hereditary. Numerous studies deal with the variable contributions of family history and genetics. Although the great variability, it is obvious that familial background is a major factor. It becomes a key factor if one wants to identify children at risk for early detection of possible learning problems and start early remedation ***(Cohen and Walsh, 2007).***

Aim of the Work

The aim of the work is to review recent advance in pathogenesis, diagnosis and management of learning disabilities in pediatrics.

Learning Abilities

Learning is a fundemental process that operates in concert with other perceptual and cognitive processes but the extent of its contribution to early cognition is largely unknown ***(Gomez, 2008).***

Normal Learning Abilities:

Cognitive development:

A child's ability to perform simple to complex mental tasks, including sustaining attention, mental processing (speed or alertness), thinking skills, and problem solving skills all combine to define cognitive domain. Learning begins in utero and progresses in a fairly predictable fashion throughout life ***(Levine, 2000).*** Very young children (3-5 years) learn through repetition and trial of error ***(Dixon and Stein, 2000).*** By the age of 6-10 years, children are considered as "concrete thinkers," wherein they usually see things as "here and now," "right or wrong," and "black or white". They generally can't predict the outcomes of their behaviours and may not understand the consequence of their behaviours or actions ***(Pratt and Patel, 2007).*** Young adolescents (age 11-13 years) have developed more refined cognitve ability that includes critical thinking, problem solving, and rapid decision making. They can understand the intent and can follow the oral and written directions and can adapt another person's perspective ***(Levine, 2000).*** They may have difficulty generalizing or extrapolating rules and concepts from familiar to unique or novel situations.

Inductive and deductive reasoning abilities, prepositional logic, a sense of morality and altruism, abstract thinking, analytical abilities, and transitional skills are all in the early stages of development ***(Abe and Izard, 1999).***

Language development:

Preschool children (3-5 years) typically use speech that is 100% intelligible to strangers. Telegraphic speech and three-word sentences are a part of a normal child’s speech learning behaviours. By the age of 5 years they have a vocabulary of about 2500 words, they can speak sentences of up to five words, can use future tense, can name four colors, and can count 10 or more objects. By age of 6 years their vocabulary increases to about 5000 words ***(Dixon, 2000)***. They have some difficulty in understanding homonyms and their ability to comprehend complex or compound sentences is limited. Some children may misuse sounds, words, or not always use correct grammar, which may also be within the norm, but if it persists after consistent correction, then a speech evaluation may be warranted ***(Pratt and Patel, 2007).***

Sensory- perceptual development:

<u>Attention:</u>

The ability to pay attention and to discriminate between relevant and irrelevant stimuli increases with normal growth and maturation of the child’s physical, neurologic, cognitive and emotional systems. Infants learn to attend by gazing in their mother's eyes while feeding, watching objects placed in front of them, and listening to familiar sounds in their environments. This process requires a sophisticated interaction between the following domains: visual, auditory, kinesthetic, and cognitive processing ***(Capute and accardo, 1996).***

Visual-motor:

Visual motor ability referes to the normal development of visual acuity, color vision, visual discriminatory ability, and tracking ability. Children younger than 6 or 7 years are farsighted. Their limited ability to track objects and judge the speed of moving objects is caused by their limited vision and not a lack of coordination. By age of 10 years children have improved visual acuity, tracking ability and have a more mature level of visual-perceptual motor integration ***(Gomez, 2000).***

Auditory:

Normal hearing helps children to locate the source and direction of the auditory stimuli; follow essential instructions or advice (from teacher, parents or other adults); and communicte with friends. All academic activities requires a sophisticated level of auditory listening skills. The ability to listen selectively matures as the child grows ***(Needleman, 2000).*** By middle adolescence children have acquired well-developed listening skills ***(Pratt and Patel, 2007).***

Perceptual-motor:

The child's auditory, cognitive, kinesthetic, language, physical, visual domains, and the ability to plan complex motor functions are influenced by his or her level of perceptual motor development ***(Gomez, 2000).*** This domain involves fine motor responses, gross motor responses (including co-ordination, balance, and agility), reaction time, and visual-motor responses and involves the ability to perceive, interpret and execute an appropriate neuromotor response to a stimulus ***(Pratt and Patel, 2007).***

Physiology of Learning:

The brain has at least 100 billion neurons. Neurons, axons and multiple dendrites make up the central nervous system (CNS), which is divided into two main structures: the brain and the spinal cord ***(Harwell, 1995).*** Communication within the CNS occurs when neural transmitters and inhibitors are released from neurons and supporting cells; an electric charge is generated when a sensory stimulus is recevied by a neuron. Firing occurs in the space between the neurones as charges jump from one neuron to the next across the synaptic gaps. The electric firing continues to stimulate subsequent neurons untill the message has been delivered or it loses its strength ***(Richard, 2001).***

Chemicals produced in the central nervous system fall into two categories (i) to stimulate firing and (ii) to inhibit firing. The chemicals produced to help a message to cross the synaptic gap are known as neurotransmitters and the chemical produced to inhibit the delivery of the message are known as neuroinhibitors. Stimulation of the brain is essentially the process of learning. This stimulation (firing) is the foundation of auditory and visual processing. Stimuli to the brain are processed at different neurological levels, creating pathways to learning ***(Richard, 2001).***

Within the first 6 months of life, babies come to only be able to hear the differences between those sounds that are important in their language, their set of phonemes and they begin to be able to discriminate the sounds of other languages that are not used in their own. In trying to understand how that occurs in the brain there is a big clue to how the brain is actually breaking up this system and beginning to represent the individual sounds as neural firing patterns. Neurons that fire together in time will wire them up, and the more often a set of neurons fire together, the more likely is that they will fire again together and form an easier and easier representations, so it will be easier and easier to get that set of neurons to fire off together and wire up together ***(Tallal, 2007).***

The physiological firing process was also refered to as “a learning connection is created”. As quickly as 48 hours from the introduction of a new stimulus, a new neuron containing connections of learning may be formed. Rapid formation of these connections is through verbal rehearsal, visual stimuli and skilled activities ***(Richard, 2001).***

Language shapes culture, language shapes thinking, and language shapes brains. The verbal bath in which society soaks its students arranges their synapses and their intellects; it helps them learn to reason, reflect, and respond to the world. It is necessary to verbally and visually stimulate students to encourage learning. Meaningful experience creates a more intense stimulus to the brain increasing the neurological activity which results in increased learning ***(Richard, 2001).***

Reading:

Definition:

Reading is a process that incorporates more than just sounds to letters ***(Shaywitz, 2003).*** Reading can be defined as a process that applies meaning for a purpose. Not only must the reader understand and be able to apply the process of reading, but he or she must also have the cognitive ability to implement a variety of linguistic and non-linguistic knowledge and skills ***(Vellutino et al., 2004).*** Factors that affect reading ability are: reading having meaning, knowledge of conventions of print, visual patterning of groups of words and word parts (sound-symbol relationships), and listening to hear the clear breaks between words ***(Clay, 2002).***

Connectionist Model of Reading:

It includes 4 “processors” that interact efficiently in skilled readers (Fig.1).

1. The orthographic processor which recognizes parts of letters, whole letters, and whole words. Strong associations form between certain letters that frequently co-occur, which in turn allow words to be read quickly. 2. The phonological processor which includes units that form associations, a representation of words, syllables, or phonemes. The phonological processor provides a backup to other components of the larger system. For example, written letters largely correspond to spoken sounds within the english language, which allows individuals to use the phonological processor to "sound a word out" if it is not recognized in text ***(Grizzle and Simms, 2009).*** 3. The meaning processor which facilitates the reader's ability to understand the meaning of words as they are read ***(Minds, 2001).*** 4. The context processor which allows for understanding text being read. This component differs from the meaning processor because it goes beyond single words and uses syntactic, semantic, and pragmatic knowledge to permit the reader to understand words embedded in a specific context ***(Grizzle and Simms, 2009)***.

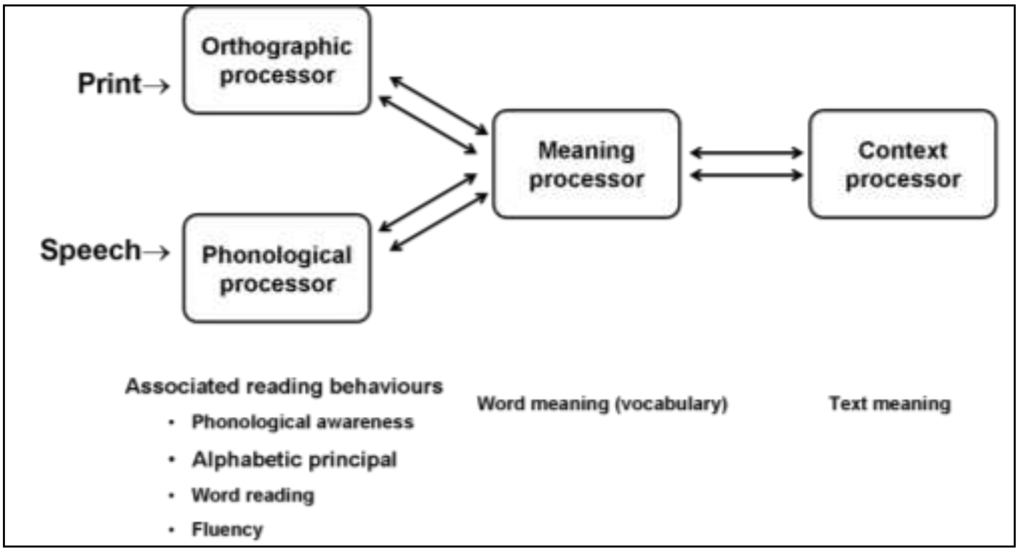

Fig. (1): Processing components in the connectionist model of reading.

Cognitive components of word reading:

The main cognitive components that contribute to the acquisition of reading skill are phonological awareness, phonological coding, orthographic coding, and rapid serial naming ***(McGrath et al., 2006).***

1. <u>Phonological awareness</u>:

An oral language skill characterized by the ability to dissect a spoken word into smaller sound units, the smallest of which are phonemes. For example, the word 'cat' is composed of three phonemes: 'k', 'a' and 't'. Children must be able to segment the speech stream into phonemes to learn the letter-sound correspondences characteristic of an alphabetic language such as English ***(McGrath et al., 2006).*** Phonemic awaness refers to the ability to focus on and manipulate phonemes in spoken words ***(Hulme et al., 2005).***

Phonological awarness tasks are: ***segmenting:*** segmenting sentences into words, segmenting multisyllablic words into syllable and segmenting monosyllabic word into sounds. ***Blending:*** blending words into sentence or compound word, blending syllables into words and blending sounds into words. ***Rhyming*****:** teach the rhym knowledge, differentiating rhym and what words rhym with. ***Sound identification:*** initial sound discrimination, final sound discrimination and middle sound discrimination. ***Phoneme grapheme correspondence:*** phoneme with symbol, phoneme with picture of a word starting with the phoneme, phoneme associated with written words starting with the phoneme, matching phonemes with a word and/or a picture and matching words ***(Troia et al., 1996).***

The following tasks are used to assess children's phonemic awraness:

1. Phoneme isolation: which requires recognizing individual sounds in words, e.g. which requires recognizing first sound in past."(/p/). ***2. Phoneme identity:*** which requires recognizing the common sound in different words.e.g "tell me the sound that is the same in bike,boy,and bell"(/b/). ***3. Phoneme categorization:*** which requires recognizing the word with the odd sound in a sequence of three or four words, e.g "which word doesn't belong ? (bus, bun, rug) (rug).

4. Phoneme blending: which requires listening to a sequence of separaetly spoken sounds and combining them to form a recognizable word.e.g, (what word is /s/c/h/u/l)?) (school). ***5. Phoneme segmentation:*** which requires breaking a word into its sounds by tapping out or counting the sounds or by pronuncing and positioning a marker for each sound.e.g "How many phonemes are there in ship?" (three: /s/I/P/). ***6. Phoneme deletion:*** which requires recognizing what word remains when a specified phoneme is removed.e.g "What is smile without the /s/?" (mile) ***(Hulme et al., 2005).***

2. Phonological coding:

It is the ability to pronounce letter strings that have never been seen before, often measured by the ability to pronounce pseudo words such as 'joop'. This skill demonstrates an understanding of letter-sound correspondences (e.g. gave), which exist even in languages (e.g. English) that have many words with irregular spellings (e.g. have). ***(McGrath et al., 2006).***

3. Orthographic coding:

It is the ability to encode the specific spelling pattern of a word, including words that are pronounced the same but spelled differently (e.g.' gate' and 'gait'). Orthographic coding also aids in the identification and spelling of exception words such as 'yacht'***(McGrath et al., 2006).***

4. <u>Rapid serial naming:</u>

The ability to retrieve rapidly names for items presented in a series, often measured by the time taken to name an array of letters, numbers, colors, or objects. This skill is often associated with reading fluency ***(McGrath et al., 2006).***

Routes of Reading:

Scientists have used theories about reading to help to understand dyslexia. One of the most widely accepted theories of reading is called the dual route theory. In this theory, there are two mechanisms that individuals use to read words: the direct (orthographic) route and the indirect (phonological) route. ***The direct route*** involves looking at a word and automatically knowing what it says. For frequently used words and words that have been seen before, this route is probably the one that is used. Skilled readers use this route for most of what they read, although they can use another route when they encounter words that are either new or relatively unfamiliar. ***The indirect route*** involves translating the letters into sounds and knowing the pronunciation of words from the combination of sounds. The use of this route involves what is called phonological processing. This route is commonly used at the beginning of the development of reading skills in which words are carefully sounded out and in more advanced readers when they encounter new words ***(Siegl, 2006).*** Novice readers appear to rely more on the indirect route during the early stages of reading acquistation, when they need to sound out novel words. As experience and skill in reading increase, word recognition is believed to rely increasingly on the direct route ensuring fluency and automaticity ***(Sarkari et al., 2002).***

Brain regions of reading: (Fig. 2)

1- Posterior circuits: dorsal (tempro-pareital) circuit and ventral (tempro-occipital and basal temporal circuit) circuit.

A-The dorsal circuit includes Wernicke's area in the posterior part of the superior temporal gyrus and inferior pareital areas (the angular and supramarginal gyri), that appear to be specialized for processing linguistically relevant aspects of print (eg. phonologic structure and lexial semantic structure). This circuit is critical for extracting the relations between orthography, phonologic form, morphologic and lexial-semantic dimentions for printed stimuli, allowing these features to become bound into higly integrated representations ***(Sarkari et al., 2002).***

B-The ventral circuit consists of visual association areas in the occipito-temporal junction, the lingual and the fusiform gyri, and aspects of middle temporal gyrus. This circuit serves as the point of contrast between the ventral visual areas and the middle to inferior temporal lobe and may constitute memory-based word identification system (i.e. a word from area) supporting fluent word identification in skilled readers ***(Price et al., 1996).***

2-Anterior circuit (involving primeraly inferior frontal regions in the left hemisphere): it includes the left inferior frontal gyrus (Broca's area). It may be involved in recoding