

Understanding Dyslexia in Children through Human Development Theories

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فهم عسر القراءة لدى الأطفال من خلال نظريات التطور البشري

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الملخص: عسر القراءة هو إعاقة التعلم المحددة ذات المنشأ العصبي، وتشير التقديرات إلى إصابة 5-10% من السكان في جميع أنحاء العالم. يتميز عسر القراءة بوجود صعوبات في القراءة والدقة والإملاء والطلاقة والتهجي وقدرات فك الترميز. فقد أشارت غالبية المنشورات إلى أن فرز الحالات يتم تنفيذها في فترة ما قبل المدرسة. كما يمكن أيضا إجراء الفحص عند الولادة أو خلال السنة الأولى من الحياة. فهم نظرية التنمية البشرية، على سبيل المثال، نظرية بياجيه للتنمية البشرية، قد تساعد في تحديد المرحلة العمرية المناسبة للكشف عن عسر القراءة، ووضع العلاج اللازم لها. الهدف من هذه المراجعة هو تقديم لمحة موجزة وحديثة عن عسر القراءة وعلاجها عند الأطفال من خلال قضايا التنمية البشرية.

مفتاح الكلمات: عسر القراءة، اضطراب القراءة، اضطرابات التعلم، صعوبات التعلم، طفل، عُمان، تنمية بشرية، عائلة.

ABSTRACT: Dyslexia is a specific learning disability that is neurological in origin, with an estimated overall worldwide prevalence of 5–10% of the population. It is characterised by difficulties in reading, accuracy, fluency, spelling and decoding abilities. The majority of publications reviewed indicated that screening is performed at the preschool level. Screening can also be conducted at birth or the first year of life. Understanding human development theory, for example, Piaget's human development theory, may help determine at which stage of childhood development dyslexia is more detectable, and therefore guide the management of this disability. The objective of this review is to provide a brief and updated overview of dyslexia and its management in children through human development issues.

Keywords: Dyslexia; Reading Disorder; Learning Disorders; Learning Disabilities; Child; Oman; Human Development; Family.

THE WORD DYSLEXIA IS DERIVED FROM two Greek words: *dys* (inadequate or lack of) and *lexicon* (word and/or verbal language).¹ Dyslexia thus means problems learning how to read words and deal with language in print. Historically, dyslexia has been used to describe difficulty in reading as a result of brain damage.² There are two models used in defining dyslexia: the Orthodox Model and the Davis Model.² The Orthodox Model describes dyslexia as developed rather than innate, with difficulty in reading as a result of cerebral disease rather than brain injury. The Davis Model describes dyslexia as difficulty in reading or language processing as a result of

intermittent disorientation. This disorientation comes from conflicting messages to the brain, for example, when the eyes are telling the brain one thing but senses of balance and movement are saying something different.²

Another way of understanding dyslexia is the dual-route model.^{3,4,5} This model explains two pathways from print to speech.³ One pathway operates via the use of grapheme-phoneme correspondence rules which are termed the non-lexical route for reading aloud. The other pathway operates via access to a semantic system, the lexical route for reading aloud.³ The non-lexical route successfully allows an individual to read non-words,

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that is, words not in the English language, but words that can be pronounced by using reading and grammar rules, for example, reading the words *gop* or *tachet*; and, regular words, which are real words that conform to typical English grapheme-phoneme conversion rules, for example, *tree* or *market*. The lexical route results in successful reading of all words but inability to produce a correct response to non-words.³ Impairment in either one of these routes can present with a specific subtype of dyslexia (see section Types of Dyslexia below).^{3,4,5}

Currently, the definition of dyslexia is not limited to difficulty in reading: dyslexia also includes difficulty in literacy acquisition, cognitive processes and discrepancies in educational outcomes.⁶ In 2002, the International Dyslexia Association adopted the following definition of dyslexia: "Dyslexia is a specific learning disability that is neurological in origin. It is characterized by difficulties with accurate and/or fluent word recognition and by poor spelling and decoding abilities. These difficulties typically result from a deficit in the phonological component of language that is often unexpected in relation to other cognitive abilities and the provision of effective classroom instruction. Secondary consequences may include problems in reading comprehension and reduced reading experience that can impede the growth of vocabulary and background knowledge."⁶

According to the American Psychiatric Association's Diagnostic and Statistical Manual (DSM-IV), dyslexia is a term used to describe brain-based difficulty in reading, now simply called a reading disorder. It is one of many disorders referred to as learning disorders. A learning disorder exists when a score on an individual achievement test of reading, writing, or mathematics is substantially below expectations for age, schooling, and level of intelligence.⁷

Dyslexia is not a disease but a lifelong condition. The symptoms of this condition are variable from one child to another, but usually, the child has normal or above average intelligence. Some children have problems with speech and poor vocabulary, and some have problems in decoding symbols and sounds that are not registered properly in the brain. For example, some children with dyslexia see letters as mixed up, as in reading *b* for *d*; read words backwards, as in *tac* for *cat*; and, do not see numbers in line, which results in incorrect

computations. Some children with dyslexia learn how to compensate for their learning difficulties. There are many famous people who had dyslexia including Thomas Edison, Nelson Rockefeller, and Hans Christian Andersen.¹

Around 20 terms are used to describe dyslexia, however the most common include learning disability, specific learning difficulty, minimally brain damaged, neurologically impaired, and perceptually handicapped.¹ Many specialists do not agree with the use of the general descriptor *dyslexia*, and think that the specific learning disability should be identified and described in order to effectively inform management.^{1,8}

There may be an association between dyslexia and attention deficit disorders (ADD) as, out of 100 children with dyslexia, 46 were also reported to have ADD or attention deficit hyperactivity disorders (ADHD), manifesting lack of concentration, behavioural problems and/or allergic reactions to certain foods/drinks.^{9,10} However, there is also conflicting information that suggests that children with dyslexia are unlikely to show the symptoms of hyperactivity and impulsiveness that are common in some forms of ADHD.^{9,10} Children with dyslexia, unlike some ADHD-affected children, will still have a healthy fear of danger and an awareness of the consequences of their actions. They will also have no obvious problems waiting their turn, sitting still or paying attention, especially when activities do not involve reading.¹⁰

Understanding and summarising human development, specifically Piaget's theory of development and its relation to dyslexia, may contribute to the understanding of challenges encountered by children with dyslexia. That, along with effective communication between health care workers, teachers and parents, and appropriate counselling, may enhance current treatment practices and outcomes.¹¹

The objective of this review is to provide a brief and updated overview of dyslexia and to understand dyslexia through human development issues in children. Literature searches were conducted in PubMed and Medline (1995–2010), and several text references also reviewed. The key words used were *dyslexia*, *human development*, and *children*, yielding a total of 95 various types of publications. We reviewed those that included children with dyslexia up to 18 years of age, including studies,

reviews, and case reports. Publications on secondary dyslexia due to other causes such as hearing problems, cancer or other disabilities, and studies in adults with dyslexia were excluded.

Epidemiology

The overall prevalence of dyslexia, in a study of Thai primary school students, was estimated to be 5–10%.¹² Between 2% and 16% of all school age children were in need of special education services.⁸ Specifically, the prevalence was estimated to be as follows: England 14%, Canada 10–16%, United States 10–15%.⁸ The ratio of boys to girls was variable from country to country, however, dyslexia had a higher prevalence in boys, approximately 3.4:1.¹²

Aetiology of Dyslexia

The exact aetiology of dyslexia is unknown but there are many theories about contributing factors. Genetic factors can play a major role in the aetiology of dyslexia, and it is estimated that the risk of a father with dyslexia having a son with dyslexia is as high as 40%.^{13,14} Many dyslexia gene studies have identified chromosome 6 as the main chromosome responsible for dyslexia.⁶ Magnetic resonance imaging (MRI) and positron emission tomography (PET) studies have indicated that structural and functional brain-related factors were found in dyslexic children, for example, visual and temporal processing, magnocellular visual system, cerebellum and hemispheric asymmetry.^{1,6,15–20}

Reid indicated that there are deficiencies in processing information and decoding words. Children with dyslexia have difficulties when transferring the information from one hemisphere of the brain to another.⁶ Phonological deficit at 6 years of age was the strongest predictor of reading difficulty, and it has been argued that there is extensive evidence of morphological difficulties in dyslexic readers.^{1,6,21} Glue-ear syndrome (fluid build up behind the tympanic membrane) has also been postulated as a causal factor in dyslexia. Children with dyslexia can have problems in memory and speed of processing, and can also have a double deficit which is difficulty in both phonological and naming speed. The learner's awareness of thinking can be affected in dyslexia, with difficulties in

reading and writing in foreign languages as well. Environmental, cultural, social and socioeconomic factors can also contribute to dyslexia.^{1,6,22,23} Finally, some studies indicate a relationship between dyslexia and motor system dysfunction.^{24–26}

Types of Dyslexia

Dyslexia can be developmental, with no obvious organic damage. Acquired dyslexia is a disorder in reading, usually due to confirmed damage to the nervous system, such as a stroke.^{27,28} Acquired dyslexia was studied in the late 19th century by neurologists such as Carl Wernicke. It can be peripheral where the visual analysis system is damaged, or central where processes beyond the visual analysis system are damaged, resulting in difficulties in comprehension and/or pronunciation of written words.²⁷

Peripheral dyslexia can be subdivided into three subtypes: neglect dyslexia, attentional dyslexia, and letter-by-letter reading dyslexia. In neglect dyslexia, there is no attempt to read the first few words of each line. When single words are shown to an affected individual, there are errors affecting the first letter or two, for example, *nun* misread as *run*, *yellow* as *pillow*, and *clove* as *love*. In attentional dyslexia, there is a problem when there are several letters in a row or several words on the page: in the dyslexic's view the letters may migrate from one word to another, and the individual may read *glove* and/or *spade* as *glade*. In letter-by-letter reading, the child does not read phonetically, but rather converts letters into their names, such as *aitch* and *vee* for *h* and *v*, instead of their sounds *huh* and *vuh*, respectively.²⁷

Central dyslexia, on the other hand, can be subdivided into non-semantic reading, surface dyslexia, phonological dyslexia and deep dyslexia. In non-semantic reading, the comprehension of written words is very poor. Affected children have impaired semantic systems but are still able to read words aloud using the connections between the visual input lexicon and the speech output lexicon. In surface dyslexia, there is high reliance on the sublexical procedure in reading aloud. Children pronounce once familiar words as if they were unfamiliar, breaking them down into their component letters and letter groups, converting each into phonemes and pronouncing

the resulting sound sequence. While this may work well for regular words, they are prone to misreading irregular words, and may pronounce them as if they were regular words, for example, *island* becomes *izland*, *sugar* becomes *sudger*, and *broad* becomes *brode*. Phonological dyslexia is mirror image of surface dyslexia. Affected children are not able to make effective use of the sublexical reading procedure. They are unable to read unfamiliar words or invented non-words. In deep dyslexia, the individual finds words like *baby*, *church* or *table* which have concrete, imaginable referents easier to read than abstract words like *belief*, *truth* or *justice*.²⁷ Both phonological and surface dyslexia occur in both developmental and acquired dyslexia. Another subtype of dyslexia is direct dyslexia where words are read aloud without comprehension, including irregular words, despite the fact that they cannot be understood.³

Stages of Childhood Development

Children with dyslexia demonstrate similar stages of development to those without this condition. In early childhood, from 2–5 years, children produce clear imagery, a reason why their nightmares can be so terrifying. Their thoughts are bigger, broader, more global, dynamic, less systematic, and less rational than those of older children. As playfulness is a hallmark of this stage, a child with dyslexia may not appear to be affected due to lack of detection of the problem. The second stage is middle childhood, from 5–7 years, where children are starting to acknowledge the significance of things and feel responsibility. Imagination is still more important than knowledge at this stage, and the dyslexic child may consider reading, writing or arithmetic as bad or ugly, and may hate going to school. The last stage is late childhood, (the exact age range was not defined in the literature reviewed), when children become part of various social groups. This is a critical stage where maturation of the cortex of adrenal glands occurs, resulting in the initiation of sexual tension between boys and girls. In this stage, learning disabilities will be more obvious as the child may not meet the greater scholastic expectations. In this stage of ingenuity and brainstorming, learning disabilities and dyslexia will be more obvious as the child is scholastically overwhelmed.²⁹ To gain

a better understanding of dyslexia, it is important to learn about developmental theories of cognition, for example, Piaget's theory of cognition, briefly described below.

Human Developmental Theory: Piaget's Developmental Theory of Cognition

In Piaget's developmental theory of cognition, there are two stages of cognition development: Stage-Independent Conception and Stage-Dependent Conception.¹¹

STAGE-INDEPENDENT CONCEPTION

Cognition and intelligence are both parts of biological systems which are stage-independent, that is, independent of a particular stage of development. There are two important processes in cognition: the complementary process and the adaptive system/process.¹¹ The complementary process is composed of assimilation and accommodation. Assimilation happens when reality is distorted by changing the external object to fit the subject, as when a baby knows the breast of its mother by sucking the nipple. Accommodation is alteration of already existing cognitive structures in the subject to match new external stimulus objects, as when the same baby will suck differently on a thumb than when nursing.¹¹

The adaptive system is composed of equilibration and functional (reproductive) assimilation. Equilibration occurs when there is balance between assimilation and accommodation. After reaching a balance, the child continues with higher assimilation which can cause disequilibrium which needs a return to accommodation: this is called functional (reproductive) assimilation.¹¹ In this stage, the child with dyslexia cannot maintain equilibrium between assimilation and accommodation, with resultant manifestations of disorientation and difficulty with reading/writing.¹

STAGE-DEPENDENT CONCEPTION

These are divided into four sub-stages. The first is the Sensorimotor Stage from birth to 2 years. This stage begins with development of primitive reflexes such as sucking, rooting and the Babinski reflex. The baby develops a sensory system by way of the

Table 1: The elements of Crombie's Screening Program – Learning in the Preschool Years

- Emotional, personal and social development (home background and culture)
- Communication and language (poor phonological skills, lack of awareness of rhyme and rhythm)
- Difficulty in listening to stories
- Difficulty in remembering sequence of events in a story
- Knowledge and understanding of the world (categorisation, naming, ordering and sequencing)
- Expressive and aesthetic development (singing games and simple dance sequence)
- Physical development and movement
- Coordination skills in physical activities, (writing and balancing on one foot)

Source: Reid G. *Dyslexia: A Practitioner's Handbook*.⁶

environment (external stimuli such as sound and touch), and via responses to sensory stimuli that use the motor system like muscle movement.^{11,24,25} The child with dyslexia has a similar clinical presentation to normal children at this stage. The second is the Preoperational Stage from 2 to 6 years, a stage of representation or symbolic functioning, for example, language development. As some studies have found that speech perception and production is affected in children with dyslexia at the preschool age, there is some evidence that screening for dyslexia should be conducted during this period.^{11,15,16,18,30–41} The third stage is the Concrete Operational Stage from 6 to 11/12 years. Here, it is difficult to distinguish between learned knowledge and that acquired by personal experience. This may be more pronounced in children with dyslexia.²¹ The fourth stage is the Formal Operational Stage from 11 or 12 years and continuing for life. In this stage, the individual can distinguish between thoughts about reality and actual reality. There is the ability to explore all possible solutions to solve problems. This may be why some children with dyslexia can adapt to function satisfactorily or better with their learning disabilities, for example, by working harder and/or spending more time on reading/writing.¹¹

Screening

Although dyslexia is more often clinically noted in later childhood, screening methods can be utilised at various stages of childhood development. There are many methods for screening, and it can be done as early as at birth or in the first year of life.^{38,42–44} The majority of publications indicate that screening is done during preschool years.^{30–41} Two publications

indicated screening at 7 years of age, and one showed that screening was conducted between 11 and 16 years of age.^{45–47} An example is Crombie's screening programme, conducted in the preschool years, outlined in Table 1.⁶ Of note, there is often confusion as to whether the problems manifested are normal variations of preschool development, or manifestations of dyslexia.^{2,6}

Diagnostic Tests

Diagnostic tests are usually performed by teachers, specialists, doctors, nurses, psychologists, and others who may be involved in care and development of the affected child. A battery of tests should be conducted to rule out other causes: physical examination of the child should be done to make sure that there are no visual, hearing or other physical problems; intelligence tests such as intelligence quotient (IQ) tests should be performed to measure mental ability; perception tests should be conducted to see if problems occur when information is flashed back and forth between ears, eyes, hands and brain, and language and reading tests are needed to measure understanding of language and to determine specific reading problems.²

Researchers in dyslexia often adopt a set of criteria for diagnosis, for example, a verbal IQ of greater than or equal to 90 with a reading age of at least 2 years behind that the child's actual, chronological age, (assuming, of course, adequate opportunity to learn how to read), and no obvious hearing or visual impairments.²⁷

Table 2: Factors that worsen dyslexia and confusion

• insufficient rest	• poor lighting
• varying print styles	• certain smells
• drugs or medications	• excess motion
• illness, pain or injury	• rearranged furniture
• loss	• moving house
• very small print	• fear
• very faint print	• unscheduled changes
• specific sounds	• family strife
• loud noises	• threats of punishment
• reminder of unpleasant experience	• change in the orderliness of the environment
• poor diet or not enough food	

Source: Temple R. *Dyslexia: Practical and Easy-to-Follow Advice*.²

Management

There are four types of approach in managing a child with dyslexia, summarised by Reid:⁶ 1) individualised programmes, which are based on multisensory teaching methods, and are highly structured and phonetically-based; 2) supportive approaches and strategies which have the same principles as individualised programmes, but which are carried out more selectively by teachers, for example, alphabet cards; 3) assisted learning techniques where there is learning from peers, and use of different methods such as word games, paired reading, cued spelling and peer tutoring, and 4) class-wide approaches such as policy framework and whole school screening.

According to the Davis Model, there are simple manifestations to look for and simple measures to implement for every stage and age. For example, in a child of 6–9 years of age, there may be difficulties in learning to read and write; determining left and right; learning the alphabet and multiplication tables, learning to tie shoes, learning to catch a ball or skip. These problems together with inattention, poor concentration skills, and frustration may all lead to behavioural problems. Early awareness and interventions are critical steps, and may help the child compensate for the learning disabilities. Examples of specific interventions for reading and spelling are to keep the text covered, exposing one line at a time only, and even one letter of each word

at a time. This may facilitate teaching of reading from left to right, often a key problem.²

Remedial programmes should be selected so as to be as specific as possible to the learning disability(ies). If the condition is moderate, health care workers and teachers can foster and encourage other interests and strengths of the child, possibly in music, mechanics or arts.¹ Short term auditory pacing can also be useful as a management tool.⁴⁸ Children with dyslexia who used audio books showed a significant improvement in reading accuracy with a reduction in emotional-behavioural disorders and improvement in school performance and activities.⁴⁹ Rapid automatic naming, spelling instruction, orthographic coding and automatic coordination of phonological and orthographic codes may facilitate transfer of spelling learned to application.⁵⁰

Appropriate counselling is critical for parents and children with dyslexia as it is very important for them to understand the specifics of the condition and how best to manage it. As a general rule, counselling should be conducted with both the parents and child present. A plan of action to improve the child's learning outcomes should be developed. It is important to provide love and support, and also minimise factors that may worsen dyslexia [Table 2].^{2,6,51,52}

It is important to consider the emotional aspects of the child and the parents when applying remedial programmes. Parents/caregivers can experience various emotional responses to dyslexia such as denial, guilt, fear, anxiety, depression and frustration. The whole family can be affected when the parents realise that their child has dyslexia. The parents' relationship may be weakened and, if one or both parents work in health care, the anxiety may worsen, especially in the early stages of diagnosis. Sometimes, parents who are also health care workers may be more reluctant to talk about the child's problems.^{2,6}

Reid interviewed a number of parents to identify the challenges and learn about the agenda of the parents who have a child with dyslexia.⁶ The main challenges noted were to maintain the child's self-esteem, help the child to learn something new, protect the dignity of the child when dealing with professional therapists, help develop the child's individual organisational skills, and, minimise peer insensitivity and misconceptions of dyslexia.⁶

Parents can be advocates for their affected child(ren) by supporting them in the early developmental years, teaching them to be their own advocates, offering encouragement to overcome obstacles, and fostering development of their strengths, talents and good working habits.⁶ Good communication with children is paramount through the developmental years, and along with the above, may help minimise the complications of dyslexia such as low self-esteem, refusal to attend school, repetitive failure in school and abnormal/criminal behaviour.⁵¹

Conclusion

Understanding dyslexia in children, through the application of human development theories such as Piaget's, can positively inform its detection, management and outcome. In early childhood (2–5 years), the child may not be obviously affected by or manifest dyslexia, and therefore, parents/caregivers may not detect the problem. In middle childhood (5–7 years), when the child starts to become aware of the significance of things and develop feelings of responsibility, the child with dyslexia may not value scholastic achievements, and therefore may dislike school. Early detection is very important for early intervention and management of dyslexia, especially before reaching the later childhood stage when socialisation is important and school work demands are greater. Appropriate family counselling is also important. We have learned that some children try (successfully) to compensate for their dyslexia by creating equilibrium and balance between their sensory disorientation, reading and writing. This is described in Piaget's Developmental Theory of Cognition (Stage-Independent Conception). While there is a paucity of published information, it is clear that the application of existing human development theories can help explain different types of dyslexia, and why the presentation varies from child to child. For the child with dyslexia, all possible solutions to their problems should be explored in order to foster optimal learning outcomes.

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