NEURODEVELOPMENTAL DISORDERS: LEARNING & ATTENTION

Course Overview

New to the DSM-5, is a chapter on Neurodevelopmental Disorders which contains seven disorders that share impairments in a number of developmental areas, including “personal, social, academic or occupational functioning”. Some of the disorders are more likely to be detected early, such as the more severe variants of intellectual disabilities, autism spectrum disorders (ASD), motor disorders, tic disorders and communication disorders. However, other disorders in this category, like the specific learning disorders (SLD) or attention deficit/hyperactivity disorder (ADHD) have been called the “hidden disabilities” (Wolfe, 2001) because they are not obvious disabilities and often are detected only after significant failure has been experienced by the individual. Although once thought of as disorders of childhood, it is becoming increasingly apparent that the majority of these disorders persist over the course of one’s lifetime. These disorders can continue to influence an individual’s success in coping with the obstacles and challenges that they face over the course of their lifespan. The DSM-5 has clustered these disorders in the same chapter because the neurodevelopmental disorders “frequently co-occur; for example individuals with autism spectrum disorder will often have intellectual disability (intellectual developmental disorder), and many children with attention-deficit disorder (ADHD), also have a specific learning disorder” (APA, 2013, p. 31).

In this course, the focus will be on specific learning disorders (specific learning disabilities; SLD) and ADHD. Children with SLD are not a homogeneous group and can present a complex mix of characteristics. Even within categories of disabilities, unique patterns of strengths and weaknesses can be evident. Children with SLD often experience other comorbid disorders, such as ADHD. Although most individuals are familiar with the hyperactive-impulsive form of ADHD, fewer realize that there are three variants of the disorder. The information presented in this paper will provide readers with an increased understanding of:

- The nature of the different types of SLD and how they influence learning at different developmental levels
- The three different types of ADHD
- Etiology, prevalence, and symptoms of SLD and ADHD according to the DSM-5, and
Introduction to Specific Learning Disabilities

Historical Background

Hallahan and Mercer (2001) have outlined five periods in the historical development of our awareness and understanding of SLD: Foundation Period in Europe (1800-1920); Foundation Period in the United States (1920-1960); Emergent Period in the United States (1960-1975); Solidification Period (1975-1985); and Turbulent Period (1985-present).

In the Foundation Periods, the discovery of a case of “word blindness” by a German physician Kussmaul in 1877, prompted several publications by other prominent physicians. James Hinshelwood published several articles on the subject of word blindness, culminating in his major work in 1917, a book on Congenital Word Blindness. In his manuscript, Hinshelwood makes the distinction between “acquired word blindness” such as reading problems cause by brain injury, and “congenital word blindness” which was highly hereditary. The information on “congenital word blindness” came from his work with a family where several members suffered from the same condition. In the United States, a physician, Samuel Orton (1925), set up a mobile assessment unit in Iowa to provide evaluations for children referred by teachers for poor academic performance. Orton discovered that approximately 15% of the children who scored average or above on the Binet (an intelligence test) demonstrated reading problems evident in reversing letters or reading words backwards (mirror reading, e.g., was for saw). Orton attributed the reading difficulties to mixed lateral dominance and recommended multisensory training to remediate deficits. Marion Monroe, a student of Orton, was instrumental in introducing the concept of the discrepancy criterion (significant difference between IQ and reading scores) to identify children with specific reading disabilities.

During the Emergent Period (1960-1975), the term learning disability was first introduced to the public in 1963 by Samuel Kirk. This announcement came at a meeting of parents whose children experienced what had previously been referred to as “perceptual handicaps”. This announcement was the inspiration needed to launch the Association for Children with Learning Disabilities (ACLD) which is known today as the Learning Disability Association (LDA). Despite these auspicious beginnings, the disability was not formally recognized until 1975 with the passing of Public Law 94-142 which ensured that funding would
finally be provided for children with learning disabilities. At this time, the discrepancy criteria was adopted by the federal regulations as the criteria for determining whether a child qualified for funding of direct services as a student with SLD, a criteria that remained as the sole criteria until the most recent revision of IDEA (2005).

**Applying the Discrepancy Criterion:**

Intelligence tests measure IQ in terms of standard scores. Standard scores have a mean of 100 and a standard deviation of 15 points. Sixty-eight percent of the population would score within one standard deviation of the mean. The average IQ range is anywhere from 85 to 115. Academic assessments can also be measured in standard scores. If Joe has an IQ of 100, he should score close to that on an academic test. The discrepancy criterion is applied by subtracting the achievement score from the IQ score. If Joe takes an academic test and scores 80 on a reading test, then there would be a 20 point discrepancy between his IQ and his score for academic achievement on that test (100-80).

The next ten years (*Solidification Period, 1975-1985*), marked a decade of affluence with significant monetary contributions available in the form of grants and funding for research devoted to program development and training initiatives in the area of SLD. The period yielded some positive outcomes and some programs that did not meet the test of time.

The current state of affairs with respect to SLD has been designated by Hallahan and Mercer (2001) as the *Turbulent Period (1985-Present)* to reflect the significant controversy and debate that has been on-going regarding the most appropriate methods of defining and identifying SLD. Some of the most salient topics that have been the focus of heated debate, include: how SLD should best be conceptualized; the best method of identifying individuals with SLD (discrepancy criteria versus response to intervention); and whether identification methods are biased in favor of the identification of minority children as SLD.

**Definitions and Issues in Classification:**

In the past twenty years, there has been on-going debates concerning how SLD is best defined and how children with SLD are best identified. Children with a SLD have problems learning specific types of information, while their skills remain intact in areas unrelated to their...
disability. For our purposes, after a general discussion of the global nature and course of SLD, (including some of the general controversies), there will be a more detailed discussion of five specific types of SLD, including, disorders of reading, written expression, mathematics, nonverbal learning disabilities and disabilities related to motor skills (dyspraxia, or developmental coordination disorder).

**Definition of specific learning disability:**
The following definition of SLD is the definition recognized by federal special education law in the United States. The definition has remained unchanged since its inception in the mid 1970’s. As such, a SLD is defined as:

*a disorder in one or more of the basic psychological processes involved in understanding, or in using language, spoken or written, that may manifest itself in the imperfect ability to listen, think, speak, read, write, spell or do mathematical calculations, including conditions such as perceptual disabilities, brain injury, minimal brain dysfunction, dyslexia and developmental aphasia. Specific learning disability does not include learning problems that are primarily the result of visual, hearing or motor disabilities, of mental retardation of emotional disturbance, or of environmental, cultural or economic disadvantage (Federal Register, 2006: 300.8 (10). p. 46757).*

**Issues in Identification: The Discrepancy Criterion**
Since the discrepancy criterion went into effect in 1975, there has been growing discontent regarding the exclusive use of this criteria in the identification of SLD.

*What is the Discrepancy Criterion and How is it calculated?*

The discrepancy criterion is used to determine whether the difference between an IQ score and an academic score is significant. As was highlighted earlier, Intelligence scores (IQ) and academic scores can both be expressed as standard scores (which have a mean of 100, and a standard deviation of 15). If a student scores in excess of one standard deviation below the mean, then the discrepancy begins to take on more significance. In the previous example, Joe has an IQ of 100 but only achieves a score of 80 on an achievement test for reading. This would mean that the discrepancy between these two scores (20 points) is greater than one standard deviation (15 points).

It is also possible to compare scores from different achievement tests in different areas to determine the degree of discrepancy between scores in specific areas and the IQ score. For
example, if John has an IQ of 100, we would expect that he should score within one standard deviation of the score on his achievement tests. However, on the Math test, John obtains a standard score of 90, while on the tests for reading and written expression, John scores considerably lower (reading 78, written expression 70).

When we subtract these achievement scores from his Full Scale IQ score we get the discrepancies depicted in the table below.

**Table 1 IQ Scores, Academic Scores and the Discrepancy Criterion**

<table>
<thead>
<tr>
<th>IQ Score</th>
<th>Academic Area</th>
<th>Discrepancy</th>
<th>Discrepancy as Standard Deviation Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>Math</td>
<td>-10</td>
<td>Less than 1 SD</td>
</tr>
<tr>
<td>100</td>
<td>Reading</td>
<td>-22</td>
<td>+ 1.5 SD</td>
</tr>
<tr>
<td>100</td>
<td>Writing</td>
<td>-30</td>
<td>+ 2 SD</td>
</tr>
</tbody>
</table>

In Table 1, we can see that the difference between his IQ score and Math Score is 10 points (less than 1 standard deviation. However, the discrepancy between his IQ score and his score for Reading (-22 points) is 1 ½ standard deviations, while the discrepancy for written expression (-30) is two standard deviations below his IQ score.

The important question is:

*Which of the above scores would meet the discrepancy criteria and represent a significant discrepancy between the IQ score and the score for academic performance (Reading)?*

**The Discrepancy Criterion: Issues and Controversies:**

The question posed above, regarding which of the scores would meet the discrepancy criteria, is one of the crucial issues which has caused debate regarding the use of this criterion, namely the lack of consistency in definitions and application. Critics of the use of this criterion cite the inconsistencies in the application of this procedure. While some school districts might say that scores in excess of 1 standard deviation would represent a significant discrepancy, other districts might use 1 ½ or 2 standard deviations as the required variation. Lack of a universal protocol resulted in wide variations in whether a student was classified as SLD depending on the actual discrepancies used by different school districts. Another criticism of the discrepancy criteria is that there is an inherent bias towards the extremes (older children and those with higher IQ’s were more likely to meet the discrepancy criteria than younger children and those with lower IQ’s).
IQ’s). The procedure has also been criticized for using a failure based model (e.g., children have to wait until the discrepancy is significant before they are identified). Critics have also suggested that the procedure is unfair due to what has been termed “Matthew effects” (e.g., poor readers acquire cumulative deficits thereby lowering overall IQ which makes it more difficult to obtain a significant discrepancy (Stanovich, 1986). Finally, there is lack of research support for the discrepancy criteria (Stanovich, 1991).

Given these criticisms, the latest revision of the law (IDEA, 2004), added an alternative method of identification for SLD, which is called response to intervention (RTI) which allows for the option of identification of SLD based on the child’s failure to response to a scientific, research-based intervention (Federal Register, 300.307(a), p. 46789).

**Response to Intervention (RTI): Issues and Controversies**

RTI involves a multi-tiered approach to intervention which most often includes three tiers or stages, although as many as four or five different stages can be involved. The levels proceed from the least to the most intensive interventions. The first level of intervention (Tier 1) would involve interventions used within the classroom. Interventions are provided for students who are determined to be “at risk” (school or state tests), and students are regularly monitored to determine the success of the interventions in meeting goals or benchmarks for that grade. Students who continue to struggle after tier one interventions are applied for a given time period would proceed to the next level or tier of intervention which would likely entail some form of small-group interventions. These interventions continue to be offered within the regular classroom but are more intensive and target specific areas of weakness with respect to benchmarks. At this stage, the student continues to be monitored and interventions that do not seem to be assisting the student are replaced with alternative forms of more individualized instruction. Progress is monitored in the initial two stages through the use of curriculum-based measurements (CBM). The CBM are administered by teachers and provide data regarding student progress with respect to the benchmarks for the grade. If the student continues to struggle, then there is need for a comprehensive assessment by the psychologist to determine if the child will qualify for assistance from the special education program. If the child meets criteria, then they will likely be pulled out of the regular class for part of the day to receive more individualized instruction in the resource room.

Like the discrepancy criterion, the RTI system has also met with criticism, including
concerns that RTI fractured the connection between the historical definition of SLD as a disorder in “the basic psychological processes” and the proposed identification procedures which in essence ignored assessment of cognitive processing deficits. According to Kavale (2005) “changes to the operational definition (RTI) without changes to the formal definition are “indefensible” and result in a “disconnect between the formal definition and the operational definition”, (p. 553). Semrud-Clikeman (2005) noted that RTI ignored intellectual ability which was crucial to developing an appropriate intervention (Semrud-Clikeman, 2005), and that RTI was a failure-based system of identification based on a student’s failure to respond to intervention.

**Current Conceptualizations:**
The Learning Disabilities Association of America (LDA) responded to changes in the federal regulations with a working paper, the *Expert Panel White Paper* (LDA, 2010) based on responses from 56 professionals recognized by their peers for expertise in the area of SLD. The report criticizes altered identification procedures for SLD on two fronts: bypassing consideration of the cognitive nature of the disorder in the decision making process; and allowing the use of age and grade criteria for determining achievement lags in performance rather than using the discrepancy between academic performance and ability level (IQ). There are a number of recommendations in the report, including: the need to strengthen identification procedures to match the definition of SLD; emphasis on the recognition that students with SLD require individualized interventions, not more intensive general interventions (more of the same); and stressing the importance of using cognitive and neuropsychological assessments to identify strengths and weaknesses in the learning profile necessary for the development of interventions based on the individual’s profile.

**Specific Types of Learning Disabilities:**
Given the differences in definitions for SLD, it has been difficult to provide consistent estimates for prevalence rates for the disorder. However, it has been estimated that between 5% to 15% of the school aged population and 5% of the adult population will meet criteria for SLD (APA, 2013). The following discussion will concentrate on five different types of specific learning disabilities that can influence academic performance in several different areas.

Historically, the DSM initially introduced the learning disorders with the advent of the DSM-III (APA, 1980). At that time, the two disorders (developmental reading disorder and
developmental arithmetic disorder) were considered to be part of the Specific Developmental Disorders coded on Axis II, along with developmental language disorder and developmental articulation disorder. In the DSM-IV, the disorder, now labeled a “learning disorder” was expanded to include four categories, including disorders of: reading, mathematics, written expression and learning disorder NOS (not otherwise specified). The DSM states that the disorder represented functioning “that is substantially below that expected given the person's chronological age, measured intelligence, and age-appropriate education” (APA, 1994, p. 38). Currently, the DSM-5 lists criteria for three specific learning disorders based on the academic area affected: reading, written expression and mathematics. The DSM-5 no longer retains the NOS category for SLD, and guidelines for the identification of the disorder (which will be discussed in greater detail shortly) have changed from what was suggested in the DSM-IV-TR. In the DSM-IV-TR, it was stated that:

“A variety of statistical approaches can be used to establish that a discrepancy is significant. Substantially below is usually defined as a discrepancy of more than 2 standard deviations between achievement and IQ” (APA, 2000, pg. 50).

Currently, the DSM-5 lists four criteria necessary for the diagnosis of a specific learning disorder, including:

- Difficulties learning or using academic skills, persisting for at least six months
  (in areas or reading, written expression, mathematics;

- Academic skill levels are “substantially and quantifiably below those expected
  for the individual’s chronological age… causing significant interference with academic
  or occupational performance… as confirmed by individually administered standardized
  achievement measures and comprehensive clinical assessment”.

- Onset during the school years, although it may not manifest until skills exceed the
  capacity to cope (e.g., as in timed tests, reading or writing lengthy complex reports for a
  tight deadline, excessively heavy academic loads).

- Learning difficulties are not better accounted for by other conditions, such as
  intellectual disabilities, other mental or neurological disorders, psychosocial adversity,
  language proficiency or inadequate educational instruction (APA, 2013, pp. 66-67).

The DSM-5 defines academic skill deficits as “low achievement scores on one or more
standardized tests or subtests within an academic domain (i.e., at least 1.5 standard deviations
[SD] below the population mean for age, which translates to a standard score of 78 or less, which is below the 7th percentile) are needed for the greatest diagnostic certainty. However, precise scores will vary according to the particular standardized tests that are used” (APA, 2013, p. 69).

Furthermore, the DSM states that “On the basis of clinical judgment, a more lenient threshold may be used (e.g., 1.0–2.5 SD below the population mean for age), when learning difficulties are supported by converging evidence from clinical assessment, academic history, school reports, or test scores (p. 69). The DSM-5 has cautiously omitted any reference to an IQ/ Achievement discrepancy, and while it does emphasize the need to conduct a comprehensive assessment, it also states that although cognitive processing deficits are often seen in individuals with SLD, this is not unique to SLD (e.g., ADHD also evidence processing problems) and suggests that “assessment of cognitive processing deficits in not required for diagnostic assessment” (p. 70).

Researchers have also provided strong empirical support for the existence of a nonverbal learning disability associated with deficits in processing information in the right hemisphere, as opposed to the left hemisphere which is responsible for poor ability to read and problems with written expression. A non-verbal learning disability is not mentioned in the DSM-5. Finally, although the DSM-5 considers developmental coordination disorder (DCD) as a separate motor disorder, it is also possible to consider DCD as a specific learning disability that influences academic performance in a number of ways, including the amount of time required to complete written tasks due to difficulties in fine motor control (e.g., coordination, including handwriting). A summary of the five types of learning disabilities is presented in Table 2.

Table 2. Five Types of Specific Learning Disabilities

<table>
<thead>
<tr>
<th>Disability</th>
<th>Nature of Disability</th>
<th>Associated Problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dyslexia</td>
<td>Reading Disability</td>
<td>Problems associated with left hemisphere dysfunction, evident in difficulties with decoding, comprehension, fluency of reading. Associated problems may also be evident in spelling and speaking.</td>
</tr>
<tr>
<td>Dysgraphia</td>
<td>Disability in Written Expression</td>
<td>Problems in executing written responses, organizing information, sequencing ideas, grammatical structure, and poor handwriting.</td>
</tr>
<tr>
<td>Dyscalculia</td>
<td>Disability in Mathematics</td>
<td>Problems with “number sense”, estimation of quantity, money, spatial configurations, concept of time, recall for number facts, and</td>
</tr>
</tbody>
</table>
problem solving using numbers.

<table>
<thead>
<tr>
<th>Nonverbal Learning Disability</th>
<th>Disability in visuo-spatial areas.</th>
<th>Problems associated with right hemisphere dysfunction, evident in poor math ability, interpretation of symbols (numbers, graphs, charts), poor sense of proprioception (sense of body in space), balance and social pragmatics.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dyspraxia</td>
<td>Developmental coordination disorder (DCD)</td>
<td>Problems with fine and gross motor skills, physical coordination, posture, eye-hand coordination, balance and manual dexterity.</td>
</tr>
</tbody>
</table>

**Specific Reading Disability (Dyslexia):**

Traditionally, children with a reading disability (dyslexia) experience a significant discrepancy between general cognitive ability (IQ which is usually in the average range or above) and achievement in reading (which is significantly below IQ, by about 2 standard deviations). The disability is not the result of inadequate teaching, impaired sensory processes (vision or hearing problems), or second language factors. The DSM-5 emphasizes that SLD “are not attributable to intellectual disabilities (intellectual disability [intellectual developmental disorder]); global developmental delay; hearing or vision disorders, or neurological or motor disorders) (Criterion D). Specific learning disorder affects learning in individuals who otherwise demonstrate normal levels of intellectual functioning (generally estimated by an IQ score of greater than about 70 [+/-] 5 points allowing for measurement error)” (APA, 2013, p. 69).

Reading problems can be evident in several areas, including: **decoding** words (recognition of sound/symbol association); reading **comprehension** (understanding the meaning); and/ or issues of reading **fluency** (the ability to read with appropriate speed and in an uninterrupted manner).

**Definition of Reading Disability:**

Dyslexia (a specific reading disability) is defined as:

- a specific learning disability that is neurobiological 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 phonological component of language that is often unexpected in relation to other cognitive abilities and the provision of effective classroom instruction (Lyon & Shawitz, 2003, p.2)
Although identification of low academic achievement (reading, written expression, math) is the hallmark of a SLD (Johnson, Humphrey, Mellard, Woods & Swanson (2010), there continues to be debate and on-going investigation regarding how intelligence and underlying cognitive processes influence the development and course of SLD. Ferrer and colleagues (2010) conducted a longitudinal study of 232 children in grades 1 through 12, and found that while typical readers evidence a bidirectional influence between IQ and reading, compensated readers (who eventually master reading, but are not fluent readers) and persistently poor readers demonstrate a “disruption in the interconnection between IQ and reading over time” (p. 99). The researchers go on to explain that in typical readers there is a naturally occurring feedback loop (coupling) between IQ and reading. Individuals who are avid readers usually have enhanced vocabulary and general knowledge gained through their reading which in turn enhances IQ. However, for those who are compensated readers or persistently poor readers, the “Matthew effect” (Stanovich, 1986) takes over, producing an ever widening gap between good and poor readers. Furthermore, poor reading may also negatively impact the development of language and intellectual functioning.

In the primary grades, the most pronounced characteristics of dyslexia are problems of accuracy in decoding skills, however, by adolescence and adulthood, even if decoding accuracy improves, fluency issues (slow and labored reading) become the signature characteristic of dyslexia (Ferrer et al., 2010). Shaywitz and Shaywitz, (2008) suggest that fluency issues justify the need for extra time on “high stakes standardized tests such as the SAT’s, GMAT, GRE” since students with dyslexia are at “a disadvantage compared to nondyslexic peers” in the amount of time required to read and process the written word (p. 1343).

**Dyslexia: Nature and Course**

**Dyslexia: Developmental Characteristics** Prior to developing problems with reading, younger children may experience difficulties with pre-reading skills, such as learning the alphabet, recognizing letters, numbers or shapes, word retrieval problems, and problems with rhyming tasks. As a result, they may not be able to benefit from reading instruction in the primary grades due to an inability to attach the correct sound to a letter, blend sounds together or confusing similar looking words (mirror reading or writing, e.g., saw for was), or having difficulty sequencing letters correctly. Because there are wide variations in skills and abilities due to different levels of exposure to reading materials, some children may demonstrate lags and then
“catch up”, while others continue to fall further and further behind. Although some children may not stand out initially, by third grade, reading problems become more noticeable and in subsequent grades, children with dyslexia will often begin to use avoidance to escape the embarrassment of reading out loud. As reading demands increase, children may become overwhelmed with the pace of reading demonstrated by their peers. If they are able to master decoding and word recognition, they may not be able to read for comprehension due to problems processing information in a way that retains the sequence of information in a meaningful way. Other difficulties that can be exhibited by children with dyslexia include problems following directions, and responding to questions in an organized and timely manner.

Children and adolescents with dyslexia also often exhibit deficits in executive functioning which includes such tasks as the use of: working memory, self monitoring, self regulation (inhibition) and metacognitive skills. The development of successful interventions depends on the ability to identify and target which of the specific executive functions need remediation (Semrud-Clikeman, 2005).

**Dyslexia: Prevalence and Etiology**

**Prevalence:** The prevalence rates for dyslexia range from 5% to 17%, depending on definitions used and populations sampled (Ferrer et al., 2010). The majority of sources report that dyslexia accounts for 80% of all SLD (APA, 2000; Lerner, 1989). However, Mayes and Calhoun (2007) have challenged the assumption that dyslexia is the most common form of SLD. Based on results of their investigations with a clinical population containing 485 children, Mayes and Calhoun (2007) report that 92% of their sample demonstrated SLD in the area of written expression.

**Genetic Influences:** Dyslexia is a highly heritable disorder with at least half (50%) of the variance in the disorder explained by genetics (Olson & Byrne, 2005). Recently, Schumacher and colleagues (2006) have focused specifically on the influence of DCDC2 gene contained on chromosome 6. According to Pennington and Gilger (1996) between 23% to 65% of children with dyslexia have parents with the disorder, while 40% of children with dyslexia will have a sibling with dyslexia. Although more boys are referred and identified, there are a significant number of girls who also are also dyslexic (Flynn & Rahbar, 1994).

**Neurological Systems and Dyslexia:** Several studies have pinpointed deficits in phonological processing in children with dyslexia, and interventions targeting weaknesses in the area have met with good success (Torgesen, 2000). Other cognitive processing deficits associated with
dyslexia, include: expressive and receptive language, processing speed (Flanagan, Ortiz, Alfonso, & Dynda, 2006; Pennington, 2009), and verbal working memory (Swanson, 2009). In their meta-analysis of 32 studies investigating cognitive processes associated with SLD, Johnson, Humphrey, Mellard, Woods & Swanson (2010) suggest that based on the magnitude of effect sizes, future studies should focus on: working memory, processing speed, executive function and receptive and expressive language.

**Neurological Systems and Dyslexia:** Through the use of fMRI technology, Cohen and colleagues (2000) found that normal readers access three areas of the left hemisphere of the brain to accomplish specific tasks: phoneme recognition (anterior system: left frontal gyrus); mapping sound to letter form (posterior system: parietoemporal region); and storage of sight vocabulary for rapid identification in the future (posterior system: occipitotemporal region). The occipitotemporal region, also termed the visual word-form area (VWFA) is an integral component of reading fluency. Researchers have mapped the developmental pathways for reading. Neural pathways mature, developmentally, from the posterior regions (visual perceptual processes, letter and word naming) to the frontal regions (activated in reading comprehension), and from the right hemisphere to the left. However, individuals with dyslexia show low activation of the left posterior systems and compensate by using both the left and right anterior systems, and the right posterior VWFA (Shaywitz & Shaywitz, 2008).

**Attention and Dyslexia:** Depending on the nature of the discrepancy criteria used to define dyslexia, prevalence rates for comorbid ADHD and dyslexia have been reported to be as high as 38% - 45% (Dykman & Ackerman, 1991). In their research, Reynolds and Besner (2006) have focused on the attentional aspects of reading, and they suggest that attention is crucial to the reading process and essential to translating print into speech for fluent reading. The neurological system that maintains attention, particularly the prefrontal cortex, is regulated by the release of catecholamines (dopamine, norepinephrine). Compared to controls, children with ADHD show less activity in the prefrontal and frontal cortex, caudate nucleus, cerebellum and parietal cortex (Casey, Nigg & Durston, 2007; Epstein et al., 2007). The posterior parietal cortex plays a significant role in both the regulation of attention and dyslexia through its connection to the prefrontal cortex. In this way, activation of the prefrontal areas may serve to activate the posterior reading systems. Shaywitz and Shaywitz (2008) suggest that contemporary research has
demonstrated that “attentional mechanisms play a critical role in reading and that disruption of these attentional mechanisms plays a causal role in reading difficulties” (1343).

**Assessment and Treatment/ Intervention:**

**Assessment:** An initial assessment for dyslexia would include an evaluation of reading achievement in decoding, fluency and reading comprehension. Whether an assessment should include measures of cognitive ability has been a matter of debate between educators, researchers, professionals and policy makers. As emphasized by Johnson and colleagues (2010), the importance of identifying the underlying deficits in cognitive processes is at the basis of the definition and eventual intervention for SLD. In their paper, Johnson and colleagues (2010) emphasized that cognitive assessments should be an integral component in the assessment of a reading disability (RD) in order to detect:

a) normal psychometric intelligence;
b) below-normal achievement in reading;
c) below-normal performance in specific cognitive processes;
d) deficits in isolated cognitive processes that persist despite exposure to evidence-based instruction;
e) that cognitive processing deficits are not directly caused by environmental factors or contingencies (e.g., low SES).

**Intervention:** Although RTI has been suggested as the first line of intervention, there is evidence from meta-analytic sources (Tran, Sanchez, Arellano, & Swanson, 2011) that children with higher IQ scores than reading scores are less responsive to treatment than children whose IQ and achievement scores share the same lower range. Furthermore, research shows that reading difficulties persist and do not subside with time. According to Shaywitz, Morris & Shawitz (2008), this important finding “should put an end to the unsupported, but unfortunately, too widely held notion that reading problems are outgrown or somehow represent a developmental lag” (p. 1343).

Shaywitz and Shaywitz (2008) questioned whether neural systems involved in reading could be malleable and change given the appropriate reading intervention. In an experiment involving dyslexic readers in the 2nd and 3rd grades, the researchers demonstrated that given 50 minutes of daily individual tutoring on phonemes and sound symbol associations, subjects
increased brain activation patterns similar to typical readers. Based on a meta-analysis of empirically supported interventions for reading, the Report of the National Reading Panel (2000) highlights five components that are essential to any reading instruction program, including: phonemic awareness, phonic, fluency, vocabulary and reading comprehension.

**Early Intervention/ Prevention:** Programs that target children in kindergarten and first grade and focus on phonemic awareness, and the meaning of text have been successful in reducing the rates of at-risk students below 5% (Shaywitz et al., 2008). These programs have offered instruction in the classroom (Fuchs & Fuchs, 2005), or pullout programs (Vellutino, Scanlon, Small & Fanuele, 2006) or some combination of the two (Vaughn, Linar-Thompson & Hickman, 2003).

**Later Interventions:** Results with older children and adolescents are not as promising as those for early intervention, and although accuracy may be improved considerably, fluency often remains a serious issue. Programs which have been successful in improving accuracy, include those focusing on direct instruction (phonological analysis) and metacognitive strategies (Lovett, Barron & Benson, 2003).

The majority of programs that address fluency issues use a repeated readings approach (Meyer & Felton, 1999) which involves reading a passage repeatedly, timing the speed of reading and accuracy by recording the reading on tape. Repeated readings with scaffolding (support by peers or teachers) has been successful in improving fluency for children with dyslexia (Kuhn & Stahl, 2003). Comprehension-focused instruction often emphasizes strategies and critical thinking skills related to reading for meaning. Another effective programming intervention for adolescent readers is the SQ3R Method (Martin, 1985). This approach is very helpful for more complex reading materials such as text books. The SQ3R method involves a five step approach to reading which emphasizes five key points in the reading process: *survey, question, read, recite and review*. Students are encouraged to initially, preview or scan the chapter they are going to read, and survey the nature of the content they will be reading. The next step is to turn each heading into a question with the intent of reading the section looking for the answer to the question. This will focus the student on reading for meaning and provide a more in-depth understanding of the material they are learning. After reading the section and answering the question, the next step is to recite what they have read prior to going on to the next section e.g., (summarize what you just read in your own words). Finally, most texts will have review
questions or comments at the end of the chapter. The final step is to answer the review questions to determine what material has been consolidated and what needs to be re-read.

**Disorders of Written Expression (Dysgraphia)**

Compared to the volumes of research conducted on reading disorders, investigation concerning written expression has lagged far behind (Hooper, Swartz, Wakely, deKruif & Montgomery (2002), especially regarding the nature of neurocognitive processes involved in executing written tasks.

**Definition:**

Part of the difficulty in amassing information about problems in written expression is the difficulty in defining and assessing the problem area. According to the DSM-5 (APA, 2013), a disorder of written expression includes “difficulties with spelling (e.g., may add, omit, or substitute vowels or consonants), or difficulties with written expression (e.g., makes multiple grammatical or punctuation errors within sentences; employs poor paragraph organization; written expression of ideas lacks clarity)”( p. 66). The three areas of written expression include: spelling accuracy, grammar and punctuation accuracy and clarity or organization of written expression. Evaluation of written expression also requires the use of information from school reports, curriculum based assessments, work portfolios, as well as, previous or current scores from individual standardized tests of academic achievement.

**Nature and Course:**

Disabilities in written expression may manifest in a number of different errors, including: sentences with punctuation and grammatical errors; poor organizational presentation and delays in initiating written responses. Early warning signs may be evident in poor ability to copy words correctly, or in letter reversals or transpositions, however, identification can be delayed since demands for written work are often minimal in the first grade, and some delays may be due to developmental lags that may remit in some children. Often children with problems in written expression experience reading disorders, mathematics disorders, or both (Mayes & Calhoun, 2007). The process of writing is complex and involves a number of stages and composite skills, including: planning, generating content, organizing the composition, translating content into written language, and revising and improving the writing (Reid & Ortiz Lienemann, 2006). In their study of the writing process, Berninger and Rutberg (1992) found that young children’s early fine motor planning and control were related to success or lack of it in later written
expression. Other neurological factors and executive functions that have been implicated in the writing process, include: memory, attention, graphomotor output, sequential processing, and higher order verbal and visual-spatial functions (Hooper et al., 2002).

Similar to investigations of dyslexia, executive functions associated with the prefrontal cortex have also been of increased interest to researchers investigating written expression. Given this direction, it is not surprising to see a number of studies that have investigated written expression in children with ADHD which is primarily a disorder of executive function. Children with ADHD have been found to have significantly more problems in transcription skills (handwriting, copying) and spelling than their non-disabled peers (Imhof, 2004; MTA Cooperative Group, 1999).

Prevalence Rates and Etiology:
According to Mayes & Calhoun (2007), prevalence rates for problems of written expression have been underestimated, especially in clinical populations where written problems were the most prevalent form of learning disability. Developmentally, prevalence rates for problems of written expression escalate from 1.3% to 2.7% in primary-grade children (Berninger & Hart, 1992), to between 6% to 22% of middle school children (Hooper et al., 2002). Although research into the root causes of dyslexia has been prolific, there are few studies that have explored the etiology of disabilities in written expression, and as a result, little is known about potential causes of the disorder.

Assessment and Intervention:
Assessment: Identification of written expression problems can depend on the assessment instrument used. Mayes, Calhoun & Lane (2005) compared results from the Woodcock-Johnson (1989) Written Language Subtests (measuring achievement for production of single words and single sentences) with results from the Wechsler Individual Achievement Test (WIAT; The Psychological Corp., 1992) Written Expression Subtest (which assesses compositional writing skills). While the Woodcock-Johnson identified 35% of children as having significant writing problems, the WIAT identified 78% of the sample as having significant problems in written expression. The authors suggest that compositional writing is a more complex task and should be assessed in determining whether an individual has significant problems in written expression.

Intervention: Direct instruction in writing strategy (planning) using prompts and mnemonics with guided feedback and self-regulatory procedures can improve the quality of writing for
students with writing disabilities (Vaughn, Gersten, & Chard, 2000; Graham, Harris, & Larsen, 2001). In students with ADHD and comorbid writing disabilities, Reid and Ortiz Lienemann, (2006) found that the use of a Self-Regulated Strategy Development (SRSD) model, stressing goal setting, and self monitoring was instrumental in increasing the amount and quality of written work produced by children with ADHD who had comorbid writing problems. Accommodations that circumvent the writing process can also be beneficial for children with severe writing problems and who would otherwise not be able to disseminate their ideas. For these students, dictated passages have been found to be superior to written essays (Graham, et al., 2001) and students may also benefit from using speech recognition software (Reid & Ortiz Lienemann, 2006), or keyboards and word processors (Graham, et al., 2001; MacArthur, 2000). Accommodations such as, providing access to class notes, use of a scribe, study guides, outlines and modified test taking through increased time, or reduced written content (fill in blanks, multiple choice, oral exams) can also increase the student’s opportunities for academic success (Reid & Ortiz Lienemann, 2006).

**Specific Mathematics Disability/ Mathematics Learning Disability (MLD)**

*Definition:* Children with dyscalculia have limitations in mathematical areas involving “number sense”, problem solving, and fluency in retrieving math facts (Geary, Brown, & Samaranayake, 1991). Although research into cognitive processing deficits that influence performance in mathematics is not as prevalent as studies on cognitive processing in dyslexia, deficits have been suggested in a number of areas associated with executive functions, including: visual and verbal working memory, processing speed and attention (Fuchs, et al., 2005; Geary, 2004; Swanson & Jerman, 2006).

*Nature and Course:* Geary, Hamson, and Hoard (2000) suggest that problems in charting the course and in the identification of MLD are compounded by variability in performance depending on the nature of the mathematical operation required and the types of assessment instruments used. For example, some students may show low achievement levels in one grade but average in another. The variability, may be related to the specific concept taught (e.g., some may struggle with division, others with fractions), or other extraneous factors that may influence performance (e.g., emotional difficulties). Furthermore, instruments that use composite scores for evaluating math
performance may not be sensitive to severe gaps and weaknesses in specific areas. However, compared to those with intermittent performance, children who have MLD experience math problems as a result of cognitive or memory deficits, which are usually persistent regardless of the math concept required, and are often treatment resistant. These problems are evident in deficits in calculation fluency (Gersten, Jordan, & Flojo, 2005) and early acquisition of number sense (ability to estimate, judge quantity and sequence).

Prevalence and Etiology:
Researchers have estimated that between 5% and 10% of children will meet criteria for MLD during their educational history (Barbaresi, Katusic, Colligan, Weaver, & Jacobsen, 2005; Shalev, Manor, & Gross-Tur, 2005). According to Mazzocco, Feigenson & Jalberda (2011), there are two approaches to understanding specific mathematical disabilities: a domain-general approach, and a domain specific approach. Individuals who use a domain-general approach to enhance their understanding of MLD seek to answer questions about how and why some children develop MLD. The focus of this inquiry is on cognitive systems and executive functions, such as phonological skills, working memory, long-term memory, visuospatial processing (Geary, 1993) and genetic predispositions to MLD (Plomin & Kovacs, 2005). Researchers who concentrate on specific processing deficits, such as number processing skills or “number sense” attempt to answer questions regarding how these skills relate to MLD (Dehaene, et al., 2003; Mazzocco, Geigenson, & Jalberda, 2011).

Findings from domain-general research: Heritability rates for general mathematics disability (43%) and reading disability (47%) suggest that heredity plays a stronger role in the development of these disabilities than environmental influences (Kovas, et al., 2007). Plomin and Kovas (2005) have suggested a “Generalist Genes Hypothesis” of learning abilities and disabilities based on twin studies that have revealed high genetic correlations (averaging .68) between reading and mathematics ability, suggesting extensive genetic overlap. However, since the correlation is not perfect, Kovas, Harlaar, Petrill and Plomin (2005) estimate that approximately a third of the genetic variance in mathematics is independent of reading and general intelligence (g).

Inherent in MLD are processing problems, such as problems of executive functions (attention, short term memory) and deficits in visual/spatial functioning that may contribute to poor alignment of numbers or faulty understanding of place value systems, or charts and maps.
According to Geary (2000), children who repeatedly use their fingers for counting may be using this strategy to compensate for deficits in their working memory.

**Findings from domain-specific research:** Mazzocco et al. (2011) investigated deficits in the Approximate Number System (ANS) in 71 ninth graders. The ANS is an implicit system that is universally evident at an early age in normally developing children. This system involves the use of “number sense” in making judgments about the relative size or quantity of one array compared to another. In their paper describing the process, Mazzocco et al. (2011) use the example of “selecting a checkout line” in a store based on the number of people lined-up. Results from their study suggest that children with MLD demonstrated significantly poorer ANS acuity compared to peers without MLD, even when controlling for more general cognitive abilities.

**Assessment and Intervention/ Prevention:**

There has been a conscientious effort to develop and research a valid early screening measure for math proficiency (Gersten et al., 2005). The *Number Knowledge Test* (Okamoto & Case, 1999) is a screening device that provides good predictive validity for early skills in basic math concepts, operations, number sense and counting.

Because mathematics is a cumulative body of knowledge emphasis has focused on early identification and prevention. Morgan, Farkas and Wu (2011) recently studied a large sample of children (7,400) comprised of children diagnosed with SLD (reading or mathematics), SLI (speech and language impairment) and controls. The researchers looked at the learning trajectories of the children in this sample from kindergarten through grade 5 and found that Matthew effects (poor get poorer) were evident for children with MLD but not those with reading disabilities, suggesting the importance of early intervention/ prevention in the MLD population.

Results from early intervention programs and prevention initiatives have found that significant time and practice must be devoted to strengthening math concepts. For example, one study found that small-group intervention for first grade students, provided for four days per week for 15 minutes per session over the course of 18 weeks yielded no significant effect on math ability for students in the program (Bryant, Bryant, Gersten, Scammacca & Chavez (2008a). However, in a follow-up study, extending the time to 20 minute sessions, 4 days per week over the course of 23 weeks did reveal a significant positive effect (Bryant and colleagues, 2008b). Other studies have had mixed results. For example Fuchs et al (2006) found that their
computer fact retrieval system increased student facility for addition facts, but not subtraction. In their review of intervention programs, Gersten and colleagues (2005) stress the importance of assessment and intervention in areas of discrimination of quantity (e.g., using number lines), and identification of numbers.

**Nonverbal Learning Disabilities (NLD):**

*Definition:*

Rourke and colleagues (1982, 2000; Rourke, Hayman-Abello & Collins, 2003) distinguished a type of learning disability which is distinct from other learning disabilities due to an emphasis on the nonverbal aspects of information processing, compared to problems resulting from a **basic phonological processing disorder (BPPD)** associated reading and writing disabilities. As a result, children with a **nonverbal learning disability (NLD)** will evidence right hemisphere dysfunction (Mattson, Sheer & Fletcher, 1992) and problems in visual/spatial processing, compared to those with BPPD who demonstrate deficits in the left hemisphere. The syndrome is characterized by:

- significant primary deficits in some dimensions of tactile perception, visual perception, complex psychomotor skills and in dealing with novel circumstances (Rourke et al., 2002, p. 311).

The disability has also been referred to in the literature as **developmental right-hemisphere syndrome** (Gross-Tsur, Shalev, Manor, & Amir, 1995) and **visuospatial learning disability** (Cornoldi, Venneri, Marconato, Molin & Moninari, 2003).

*Nature and Course:*

Characteristics of children with NLD may include clumsiness, being poorly coordinated and having a poor sense of spatial awareness, especially, of their body in space and social/personal space. In their study of children with NLD, Gross-Tsur and colleagues (1995) found the vast majority experienced problems with slow processing speed for both cognitive and motor tasks (80%), graphomotor impairment (90%) and dyscalculia (67%). Visual memory deficits, including immediate memory for faces was also impaired for children with NLD (Liddell & Rasmussen, 2005). In their study of measures of social perception, Semrud-Clikeman, Walkowiat, Wilkinson & Minne (2010) found that children with NLD and Asperger’s disorder evidenced impairment in reading social and emotional cues and were more likely to exhibit sadness and social withdrawal compared to controls. Studies have demonstrated that children
with NLD experience many deficits in social functioning, including poor ability to understand social rules, pragmatic language, weak eye contact and facial expressions (Gross-Tsur et al., 1995). Reluctance to engage in novel situations or tasks, and social withdrawal can have negative long term outcomes for individuals with NLD resulting in increased risk for depression and suicide (Rourke, 1995). Comorbid ADHD is not uncommon in those with NLD.

**Prevalence and Etiology:**
NLD is rare (0.1%) however many cases may remain undiagnosed or misdiagnosed (Asperger’s) due to the lack of understanding or familiarity with of this type of learning disability. Unlike other learning disabilities, the male to female ratio is equal for NLD. While other forms of learning disabilities have a strong genetic component, NLD is related more to brain structure and function.

**The White Matter Model:**
According to Rourke (1982, 1995) etiology of NLD is best explained by deficits (destruction or dysfunction) in the white matter that impairs the ability to access the right hemisphere to integrate information cross modally.

**Assessment and Treatment/Intervention:**
Given the neurological basis for NLD, a neuropsychological examination is recommended in order to evaluate functioning in a wide range of areas tapping motor and psychomotor functions, including: grip strength, eye tracking, visual spatial organization, and other neuropsychological functions. Additional assessments are also recommended to investigate functioning in areas of: cognitive ability, problem solving and set shifting (category test), as well as, academic performance and behavior. Cornoldi, et al., (2003) have developed a visuospatial questionnaire to assist in the identification of students with visuospatial disabilities which may also be of value in identifying NLD.

It is important for intervention programs to target weak academic areas (especially math skills) as well as social challenges facing children with NLD. Direct instruction in social pragmatics (social skills, social communication, emotion recognition) can assist children to improve social competence. The majority of children with NLD (72%) will experience
significant math difficulties both in calculation and problem solving (Rourke, 1995, 2000), and many will need practice to improve handwriting skills.

**Dyspraxia (Developmental Coordination Disorder)**

*Definition:*
Dyspraxia and developmental coordination disorder (DCD) are terms that have been used interchangeably to refer to problems children experience with posture, movement and coordination. While dyspraxia is more commonly used in the UK, in the United States, DCD is the term most frequently used.

Historically, several terms have been used to describe children who exhibit *movement difficulties*, such as “congenital clumsiness”, “child or developmental dyspraxia”, (Vaivre-Douret et al., 2011), or *developmental coordination disorder (DCD)*. The term DCD was introduced in the DSM-III-R (APA, 1987) and is the only version that is supported by diagnostic criteria. Overall, it is the most widely used term (Sugden, Kirby & Dunford, 2008). The DSM-5 considers DCD as a neurodevelopmental motor disorder where “the acquisition and execution of coordinated motor skills is substantially below that expected given the individual’s chronological age and opportunity for skill learning and use. Difficulties are manifested as clumsiness (e.g., dropping or bumping into objects) as well as slowness and inaccuracy of performance of motor skills (e.g., catching an object, using scissors or cutlery, handwriting, riding a bike, or participating in sports).” (APA, 2013, p. 74). The disorder interferes with activities of daily living and academic success. The DSM also stipulates that motor deficits cannot be better attributed to having an intellectual disability (or intellectual developmental disorder) and must not be the result of visual impairment or due to another neurological condition, such as cerebral palsy, muscular dystrophy, or degenerative disorder.

Disturbances of motor coordination may include: delay in motor milestones (crawling, walking), tendency to drop items, general “clumsiness”, and poor performance in athletics or academics due to poor handwriting. There are high rates of comorbidity among children with DCD and developmental dyslexia, ADHD, SLI and ASD (Sugden et al., 2008). After conducting a substantive review of the research concerning dyspraxia and DCD, Gibbs, Appleton & Appleton (2006) state that: “the terminology of coordination disorders has been confused but in practice dypraxia and DCD should be regarded as synonymous” (p. 537).
Currently, the DSM does not consider DCD as a learning disorder, per se, but as a motor skills disorder and states that when considering disorders of written expression, if poor handwriting is due to impairment in motor coordination, a diagnosis of DCD should be considered. However, given the impact of the disorder on learning and achievement, for purposes of this paper, DCD is discussed along with the other learning disorders.

**Dyspraxia versus apraxia:**

While the term dyspraxia refers to the failure to develop the ability to perform age-appropriate fine or gross motor skills, the term apraxia is used in adult populations to refer to the loss of previously acquired functions (e.g., loss of movement through stroke).

**Nature & Course**

Children with DCD have difficulties planning, controlling and coordinating motor activities in the absence of any neurological or physical condition (Bowens & Smith, 1999). Recent investigations have found that in children with ADHD, comorbidity rates with DCD can be as high as 50% (Kadesjo & Gillberg, 1998). This high rate of comorbidity has lead some to suggest the existence of a combined disorder, Atypical Brain Disorder (Gilger & Kaplan, 2001), or Deficits in Attention, Motor Control and Perception (DAMP; Gillberg, 1992). However, recent investigation of cognitive profiles of children with ADHD and comorbid ADHD and DCD reveal that while those with ADHD alone do not demonstrate deficits in visuo-spatial ability, those with DCD performed significantly weaker on the Perceptual Reasoning Index of the WISC-IV compared to individuals with ADHD, alone, leading researchers to suggest that the two disorders have different etiology (Loh, Piek & Barrett, 2011).

Developmentally, children with DCD often demonstrate a history of delayed motor milestones, poor ability to dress themselves (buttons and shoe laces), poor ability to catch or throw a ball, and immaturities in art work (cutting, coloring). In primary school, motor skills will continue to be delayed with slow and labored attempts at handwriting and copying from the board.
Prevalence and Etiology:
It has been estimated that as many as 6% of children (5 to 11 years of age) may meet criteria for DCD (APA, 2000). The exact cause of DCD is not known but several suggestions have been made to account for central nervous system dysfunction, including: premature birth, impairment in the dominant cerebral hemisphere, sensory integration disorder, or birth complications, such as anoxia or hyponoxia (Vaivre-Douret et al., 2011). Pinpointing the origins is further complicated due to bidirectional influences from biological, cognitive and behavioral facets of the disorder (Barnett, 2008). Although DCD has been associated with the development of internalizing behaviors in older children and adolescents (Cantell & Kooistra, 2002), more recent reports suggest that signs of internalizing problems in this population may be evident as early as 3 and 4 years of age (Piek, Bradbury, Eysley and Tate, 2008). Sequences of genetic codes for dopamine receptors DRD1-DRD5, and dopamine transporter DAT1 that have been identified in children with ADHD have also been uncovered in those who have comorbid ADHD and DCD. Piek and colleagues (2008) found that individuals with comorbid ADHD and DCD had significantly higher depression scores that those with either disorder in isolation. Furthermore, studies of students in college and university with motor difficulties have found that 50% reported continued handwriting difficulties as a major source of difficulty for them, while 52% also reported problems in areas of executive functioning, such as organizational skills, time management and decision-making (Kirby, Sugden, Beveridge, and Edwards, 2008).

Assessment and Treatment:
Although it is beyond the goals of this paper to provide a review of potential assessment and treatment techniques that can be applied to DCD, interested readers are urged to read Barnett’s (2008) article which provides an excellent summary of screening and assessment tools for DCD. According to Sugden et al., (2008) challenges for the future will be to investigate the needs of adolescents and adults who are attending higher education and how to appropriately assess DCD in these populations who may require disability services in order to be successful, academically. Since a diagnosis of DCD requires the assessment of motor skill deficits, the overall goals of occupational therapists are often centered on targeting areas of sensorimotor impairment for intervention. However, Sugden and colleagues (2008) emphasize the importance of targeting “participation” as an overall goal for children with CDC, within a more ecological framework, engaging students in areas of schoolwork, recreational activities, and self care tasks.
PROBLEMS OF IMPULSIVITY, HYPERACTIVITY AND INATTENTION

**Attention Deficit Hyperactivity Disorder**

**Definition:**
There is global consensus that extreme forms of impulsivity, overactivity and inattention constitute features of a disorder which can cause significant impairment in functioning (International Consensus Statement on ADHD, 2002). However, while the ICD-10 (WHO, 1993) defines the syndrome of hyperkinetic disorder (HKD) using a narrow set of parameters, the DSM (APA, 2013) classifies attention deficit/hyperactivity disorder (ADHD) as a more broadly defined disorder with three variations:

- Primarily Inattentive Presentation
- Primarily Hyperactive-Impulsive Presentation
- Combined Presentation (APA, 2013).

Both systems of classification require symptoms to be pervasive (evident in two different situations, e.g., home or school), although for the ICD-10, full criteria must be met in both situations. The disorder is persistent with onset usually prior to five (ICD-10). Onset was previously states as prior to 7 years of age (DSM-IV), however the DSM-5 now recognizes onset for ADHD prior to 12 years of age.

There have been two major changes to the way the DSM-5 conceptualizes ADHD compared to how it was previously conceptualized. In the DSM-IV-TR, ADHD was placed in a section entitled “ADHD and The Disruptive Behavior Disorders” (Conduct Disorder and Oppositional Defiant Disorder). The juxtaposition of ADHD with the Disruptive Behavior Disorders was unfortunate, since many considered ADHD to be one of the disruptive behavior disorders. Although the hyperactive-impulsive type and combined presentation could be comorbid with behavior difficulties (e.g., ADHD and ODD can often appear together), the inattentive type of ADHD is not often associated with comorbid behavior problems. Currently, the DSM-5 has relocated ADHD to the chapter on Neurodevelopmental Disorders which is a far more appropriate placement.
Although symptoms are similar for both classification systems, differences in criteria have resulted in variations in prevalence rates. Furthermore, the ICD-10 discourages comorbidity of HKD, other than within the confines of hyperkinetic conduct disorder, while the DSM emphasizes that high rates of comorbidity exist for ADHD with other disorders (ODD, CD, anxiety and mood disorders and DCD).

The DSM-5 has made some changes to the number of symptoms that must be present for a diagnosis for individuals over 17 years of age. For individuals under 17 years of age, the criteria remain unchanged. The list of ADHD symptoms is presented below. Symptoms are divided into categories for inattentive and hyperactive-impulsive symptoms. Individuals must have 6 symptoms from a list of 9 potential symptoms in order to be identified as ADHD-primarily inattentive, from the inattentive list (see below) or 6 symptoms from the list of ADHD –primarily hyperactive-impulsive symptoms (see list below). In order to be diagnosed with ADHD-combined presentation, individuals must meet criteria for both inattentive and hyperactive-impulsive presentations (e.g., need 12 symptoms for a diagnosis of the combined type, six from each list). However, after 17 years of age, only 5 symptoms are required for a diagnosis of the inattentive or hyperactive-impulsive type (or a total of 10 symptoms for the combined type).

Characteristics of symptoms and examples are presented below.

**Symptoms for ADHD-Primarily Inattentive Presentation:**

- Careless attention to details
- Problems sustaining attention over time
- Doesn’t appear to listen
- Poor follow-through (homework, assignments)
- Poorly organized

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**Conceptual differences between the ICD-10 and DSM**

The major conceptual difference between these two classification systems is that the ICD-10 does not recognize the inattentive subtype or the hyperactive-impulsive subtype. The combined subtype is closest to HKD, however full criteria do not have to be met across two different situations.
• Poor ability to sustain mental attention (school work, homework)
• Loses necessary materials (e.g., pencils, notebooks)
• Easily distracted
• Forgetful

**Symptoms for ADHD-Primarily Hyperactive-Impulsive Presentation**

**Hyperactivity:**

• Fidgety or squirmy behavior
• Problems remaining seated
• Excessive motion
• Problems engaging in quiet play
• Constantly on the go
• Incessant talking

**Impulsivity:**

• Blurts out answers, comments
• Is impatient, has problems with turn taking
• Is intrusive to others.

**Historical Perspective on ADHD:**
The history of our understanding of ADHD is an important part of the process of comprehending where we are today. Over the course of time, the disorder has been referred to as: hyperkinetic syndrome, minimal brain dysfunction (MBD), attention deficit disorder with or without hyperactivity (ADD), attention deficit hyperactivity disorder (ADHD), and currently, attention deficit/hyperactivity disorder (AD/HD). In the 80’s with the advent of the DSM-III (1980), attention deficit disorder (ADD) was considered to exist as a single attentional disorder that could present with or without accompanying symptoms of hyperactivity and impulsivity. The DSM-III listed 5 possible symptoms of inattention, impulsivity or hyperactivity and 3 symptoms were required from either category to make a diagnosis. However, controversy over this conceptualization and lack of research support, resulted in the DSM-III-R (1987) reverting back to their previous position of a single symptom list with the criterion of 8 of 14 symptoms.
required for a diagnosis. However, with the publication of the DSM-IV (1994), the consensus was that there were three variants possible of the disorder known as AD/HD: predominantly inattentive type (6 of 9 symptoms); predominantly impulsive/hyperactive type (6 of possible 9 symptoms) or combined type (meet criteria for each variant with 6 symptoms from each for a total of 12 symptoms). The current DSM criteria (DSM-5) remain the same, although the number of symptoms required has been reduced (5 symptoms instead of 6) for individuals over 17 years of age. So over the course of time, we have remained relatively stable in our conceptualization of the disorder over the past 20 years, with the exception of increasing our awareness that the disorder can persist into adulthood for many individuals. However, while lack of self control (disinhibition) associated with the hyperactive and combined types of ADHD is likely to improve with age, problems with focusing and inattention remain relatively stable over time (Hart, Lahey, Loeber, Applegate & Frick, 1995). It has been estimated that one-third to two-thirds of children with ADHD will demonstrate characteristics associated with the disorder throughout their lifetime (Wender, Wolf & Wasserstein, 2001), with between 2% and 6% of the adult population meeting criteria for diagnosis (Wender, 1995).

*Nature and Course:*

**Birth to Toddler Period:** Parent reports of early patterns of excessive activity, poor sleep habits, irritability and difficult to soothe (Barkley, 1998) during the toddler period have been associated with increased risk for ADHD. However, diagnosis is difficult during this age span because toddlers commonly demonstrate high levels of activity and impulsivity and lower levels of self control, at this stage of development.

**Preschool age (3 to 6 years):** By three years of age, children who do not regulate behavior and emotions as expected are seen as more demanding and stressful than peers. As a result, they evidence increased problems in unsupervised situations (Altepeter & Breen, 1992), and in relationships with peers, preschool teachers and parents (Campbell & Ewing, 1990). It is during this period, that parents (and preschool / early school teachers) may become increasingly concerned that a child is not developing skills in the area of adequate self control or inhibiting impulsive responses.

**School-age (6-10 years of age):** Difficulties are more evident as children face increased academic and social demands. Problems of inattention, distractibility, organization and task
completion place children at greater risk for academic problems. Socially, overactive and impulsive behaviors, intrusive behaviors, excessive talking and noisy play can be disruptive in social circles. Risk of accidental injury at this stage is evident in bicycle accidents, pedestrian injuries and head injuries (Barkley, 1998).

**Adolescence:**
Adolescents with ADHD are more likely to evidence the lingering effects of inattention, evident in ease of distractibility and poor ability to sustain their focus at a time when the educational setting is becoming more complex (multiple teachers), is more demanding (increased workload) and requires more self-discipline and organization.

Although individuals with ADHD are at a disadvantage for graduating from high school (Barkley, Fischer, Edelbrock, & Smallish, 1990), increased recognition of the potential impact of ADHD on academic performance over the past thirty years has resulted in improvements in support services and modifications to programming for children and youth with disabilities. As a result, there has been an increase in the number of students with “hidden disabilities”, such as ADHD and learning disabilities, who are now seeking admission to colleges across the United States (Wolf, 2001) and the enrollment of college students with ADHD is steadily increasing (Shaw-Zirt, Popali-Lehane, Chaplin, & Bergman, 2005). It has been estimated that between 2% and 4% of the college student population would meet criteria for diagnosis as ADHD (DuPaul et al., 2001; Weyandt, Linyerman, & Rice, 1995). College students with ADHD represent 20% of students in college who have disabilities and one quarter of those receiving support services (Guthrie, 2002; Henderson, 1999).

Adolescents and adults with ADHD are at risk for lower educational achievement, increased unemployment or underemployment, problematic interpersonal relationships, less stability of residence, and a higher incidence of psychiatric disorders, substance use disorders, and antisocial behavior (Grenwald-Mayes, 2002). In adolescence, lack of academic success and concomitant social problems can lead to a host of comorbid externalizing and internalizing problems (Biederman, Faraone, & Lapey, 1992). One of the major tasks of adolescents is identity formation and the development of a positive self concept based on peer acceptance, gained through increasingly refined social skills. However, adolescents with ADHD often experience low self concept, poor acceptance from peers and are vulnerable to bouts of depression.
Mannuzza and Klein (2000) found that children who demonstrate deficits in social skills and self esteem continue to experience difficulties in these areas throughout adolescence and adulthood.

**Stimulant medication and future risk:**

Although parents often express concern that stimulant medication can be a “gateway drug” leading to the abuse of other substances, research finds the opposite to be true. Adults with ADHD who did not have the benefit of stimulant medication are at greater risk for later substance abuse than those whose ADHD was successfully managed, medically (Biederman, Wilens, Mick, Spencer, & Faraone, 1999).

**Prevalence and Etiology:**

**Prevalence:** Due to the narrower criteria, the ICD-10 identifies less individuals with HKD, while the broader criteria of the DSM leads to the identification of more individuals with ADHD (Foreman, Foreman, Predergast & Minty, 2001). Lee and colleagues (2008) compared the predictive validity of the two systems and found only 11% out of the 419 cases that met criteria for ADHD also met criteria for HKD due to the more rigid criteria of pervasiveness in the ICD-10 (requiring the full criteria be met in more than one situation). The authors support previous results (Lahey et al., 2006) suggesting that the ICD-10 criteria under-identify those with significant impairment. However, a study conducted by the UK Office of National Statistics reported that ADHD was the most common referral to specialist child and adolescent mental health services (CAMHS) across the UK (Meltzer, Gatward, Goodman, & Ford, 2000), while in the United States, it is reported that approximately 30-50% of referrals involve children with ADHD (Barkley, 1998).

Although the majority of children who are diagnosed with ADHD (90%) will have the more obvious forms of the disorder (hyperactive-impulsive or combined hyperactive/impulsive – inattentive type), children with the inattentive type are likely to be identified much later, or remain undiagnosed. While lack of self control (disinhibition) associated with hyperactive-impulsive and combined types is likely to improve with age, inattention remains relatively stable over time (Hart, Lahey, Loeber, Applegate & Frick, 1995).
The disorder is more frequent in males than females with ratios ranging from 2:1 to 9:1 (DSM-IV-TR, p. 90), however, research suggests that females with ADHD are significantly more impaired than males with ADHD and controls in areas of psychosocial social functioning, including: depression, anxiety, self-esteem and overall stress levels (Rucklidge & Tannock, 2001). Since 90% of those diagnosed with ADHD have either the impulsive/hyperactive or combined type, it is possible that gender differences among children may represent differences in type. Whether there are male/ female differences in the subtypes of ADHD symptoms continues to be an area of debate. At least one study, found females were twice as likely to have the inattentive type (Biederman, Mick & Faraone, 2002), although research with college students has demonstrated significantly less gender disparity (Weyandt et al., 1995).

It is estimated that between one–third and two-thirds of children with ADHD will continue to demonstrate ADHD symptoms throughout their lifetime (Wender, Wolf & Wasserstein, 2001), while approximately 2% to 6% of the adult population will meet criteria for diagnosis (Wender, 1995).

**Etiology:** Complex interactions between biological factors and environmental factors are at the core of ADHD. There is high heritability with 50% of parents with ADHD having a child with the disorder (Biederman et al., 1995). One study demonstrated that if children and parents shared high ADHD symptoms, the children demonstrated no improvement in the program, suggesting that it may be necessary to treat the parent prior to intervention, in cases such as these (Songu-Barke, Daley, Thompson, Laver-Bredbury, & Weeks, 2001).

**Brain structures and brain function:**

Modern technology, positron emission tomography (PET), magnetic resonance imaging (MRI), functional resonance imaging (fMRI), and SPECT brain scans have focused on three sites relevant to ADHD: **prefrontal cortex** *(executive functions, planning ability)*, **cingulated gyrus** *(focusing of attention and response selection)* and **basal ganglia** *(time perception).*
**Neurotransmitters:** The catecholamines (dopamine, norepinephrine, epinephrine) are neurotransmitters that have been associated with attention and motor activity. Medications that have been successful in treating the disorder, such as Dexedrine (dextramphetamine), Ritalin (methylphenidate) and Cylert (pemoline) work to increase the number of catecholamines in the brain (Barkley, 1998).

According to Barkley (1997) **behavioural inhibition** (the ability to inhibit a response, interrupt a current response or block a distractor) is an essential step that allows sufficient time for higher functioning (executive functions) to take place. This delay allows the necessary time to process information in four major areas: **working memory** (*planning skills*), **internalize speech** (*analysis*), **self regulation of affect** (*goal direction and sustained attention*) and **reconstitution** (synthesis). Individuals with ADHD, especially the hyperactive-impulsive variant, evidence poor behavioral inhibition.

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**Video games versus homework:**

Why is it that children with ADHD can play video or computer games for hours, yet cannot do homework? Barkley (1997) addresses the issue by distinguishing between **sustained attention** (effortful attention in a low interest task, e.g., homework) versus **contingency based attention** (focusing on a task that is inherently rewarding, e.g., video game). Children with ADHD have problems sustaining goal directed behavior for low interest tasks that are not rewarding.

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**Assessment and Treatment/ Intervention:**

Assessment for ADHD can involve a number of different procedures depending on the professional involved. A family physician can diagnose the disorder based on an evaluation of symptoms and medical/ developmental history. A psychologist may observe the child in the classroom, have parents, teachers complete a number of behavioral questionnaires, and have older children complete a number of self report measures. The psychologist may also administer a battery of individual tests (cognitive ability, executive functions, and academic achievement). There are two computerized assessment instruments that can be administered to obtain
information on whether the child or adolescent has significant problems with inattention, sustained attention, vigilance or impulsivity. The *Conners Continuous Performance Test* (CPT3; Conners, 2014) evaluates attention-related problems for visual information in individuals 8 years of age and older. This task requires the child to respond to each letter that appears on the screen, by clicking the mouse, except when a letter X appears. The *Conners Auditory Test of Attention* (CATA; Conners) assesses auditory processing and attention-related problems in individuals 8 year of age and older. Individuals are required to listen to different tone patterns and to click on the mouse when the target pattern is presented (high tone preceded by a low tone). Each test takes 14 minutes to administer. There is a separate version of the test for younger children (4 to 7 years), the *Conners Kiddie Continuous Performance Test* (K-CPT2; 2014) which is very similar to the CP3, but is normed on the younger population and requires half the administration time.

Treatment will vary based on the nature and severity of the problem, and the child’s developmental level. Determining the correct type of medication and dosage may be difficult and frustrating. In addition to stimulant medications that target the catecholamines, *Strattera*, a selective norpinephrine reuptake inhibitor (SSRI), has recently been found effective in the treatment of ADHD. However, unlike the quick turnover of the stimulant medications which are usually out of the system in 12 hours, Strattera requires four to six weeks to stabilize and is continuously present in the system.

Although medication is often the treatment of choice, there are times when medication is either ineffective or produces unwanted side effects. Alternative treatment methods, such as behavior management programs can be devised through observations at school and at home and conducting a functional behavioral assessment to target behaviors for intervention (e.g., increase on task behavior). Other classroom interventions that have been successful have included peer tutoring and computer assisted instruction (DuPaul & Eckert, 1998; Hoffman & DuPaul, 2000). Parent training programs can also improve parent management; help reduce parent stress and increase positive behaviors (Barkley, 1997, Forehand and McMahon, 1981).

Recent investigations of ADHD coaching have produced positive results. Prevatt & Yelland (2013) evaluated the success of a coaching program that combined cognitive behavioral therapy and psychoeducational techniques over a 5-year period involving 148 college students. Students who participated in the 8-week coaching program showed significant improvement in all areas
assessed, including: learning strategies, self-esteem, reduction of symptoms and increase in satisfaction with school and work.

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