Learning Disorders and Academic Problems

CHAPTER 7

Daniel

Daniel was a nine-year-old boy referred to our clinic because of low academic achievement. Daniel began struggling in school when he was in kindergarten. He had trouble recognizing and writing letters and numbers, answering questions about stories, and following instructions. A medical examination showed that he was healthy. Daniel repeated kindergarten the following year, but his academic problems continued.

In the first grade, Daniel was tested to determine whether he had a learning disability. Daniel's IQ score was 103, indicating average intellectual functioning. His standardized scores on tests of reading (75), writing (78), and mathematics (81) were significantly below most of his peers. However, Daniel's reading, writing, and math test scores were not low enough for him to receive special education services.

At the time of the evaluation, Daniel was attending a regular third-grade classroom. He showed significant trouble in reading. He often confused letters with similar appearances, like P, B, D, and C, and had trouble differentiating similar-looking words such as that, this, those, and these. Daniel could not sound out unknown words; instead, he usually guessed at the pronunciation of words that he did not know. Daniel showed problems with reading comprehension. He would often skip words or whole lines of text while reading and had problems answering questions about what he read.

Daniel hated school. He was especially embarrassed to read aloud in front of the class. He resented the teacher for correcting him when he misread a word. Daniel would often try to avoid schoolwork by averting his eyes in class, volunteering to do chores in the classroom (e.g., clean the blackboards), or "charming" the teacher. At home, Daniel would whine or tantrum when his mother asked him to do his homework.

Daniel explained, “It’s not that I’m dumb or lazy, it’s just that I have a hard time with reading. I look at the page and it’s all jumbled up. If I read a sentence or two, I can’t tell you about it later.”

(Continued)
What Are Learning Disorders?

Learning Disorders (LDs) are serious conditions that can adversely affect children's academic functioning, career attainment, self-concept, and behavior. Although there is disagreement as to the exact definition of LD, most experts agree that LDs are characterized by the following (Loomis, 2006):

1. Children with LDs have marked difficulty learning to read, write, or perform mathematics. These academic skill problems are believed to be due to dysfunction in underlying psychological processes.

2. Genetics often plays a role in LDs. Learning problems run in families and monozygotic twins usually show strong concordance for LDs. Genes are believed to cause subtle abnormalities in brain structure, functioning, perception, memory, and information processing, which, in turn, interfere with learning.

3. Children with LDs show marked deficits in academic achievement. If untreated, these deficits usually persist over time; they do not simply reflect delays in the acquisition of academic skills. Children with LDs are not simply “slow learners” or academic “late bloomers.”

4. Although children's intelligence and academic achievement are correlated, LDs are not caused by low intelligence or Mental Retardation.

5. LDs are not caused by emotional problems (e.g., test anxiety, depression), socioeconomic deprivation (e.g., malnutrition, poverty), or impoverished educational experiences (e.g., low-quality schools). Although these factors can exacerbate children's learning problems, they do not cause LDs.

Current Definition of Learning Disorders

DSM-IV-TR recognizes three main LDs: Reading Disorder, Disorder of Written Expression, and Mathematics Disorder (see Table 7.1). LD is diagnosed when the person's achievement in reading, mathematics, or written expression is “substantially below” the level of achievement expected based on her intelligence. The individual's learning problems must also interfere with her academic performance or her ability to perform tasks that require academic skills (e.g., reading a newspaper, calculating correct change for a dollar, writing a letter). Furthermore, the person's low academic performance cannot be attributed exclusively to Mental Retardation.
or pervasive developmental disorders, visual or hearing impairments, differences in language or cultural background, or impoverished educational experiences.

To diagnose LDs, most psychologists determine whether the individual shows a significant discrepancy between IQ and achievement. First, the clinician administers a norm-referenced IQ test to measure intelligence. Then, he administers a norm-referenced achievement test to measure reading, writing, and/or mathematics achievement. DSM-IV-TR considers a discrepancy of more than two standard deviations between IQ and achievement scores to constitute a significant discrepancy. For example, a person with an IQ score of 100 and a reading achievement score of 70 might qualify for the diagnosis of Reading Disorder.

What Are Learning Disabilities?

The term “learning disabilities” is not used by DSM-IV-TR. The term was coined by Samuel Kirk (1962) to describe children who showed significant delays in the development of reading, writing, math, or oral language. Kirk suggested that these delays interfered with children’s ability to learn and were likely caused by structural abnormalities of the brain. Kirk differentiated learning disabilities from other psychological conditions that often interfere with learning, such as Mental Retardation, blindness, and deafness (Hallahan & Mock, 2003).

In 1975, Congress enacted the Education for All Handicapped Children Act (Public Law 94-142). This law provided free special education services to school-age children with disabilities, including children with learning disabilities. The U.S. Office of Education proposed the following definition of specific learning disabilities, which borrows heavily from Kirk's conceptualization:

The term “specific learning disability” means a disorder in one or more of the psychological processes involved in understanding or in using language . . . which may manifest itself in an inability to listen, speak, read, write, spell, or do mathematical calculations. The term does not include children who have LDs which are primarily the result of visual, hearing, or motor handicaps, or

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<thead>
<tr>
<th>Table 7.1 Diagnostic Criteria for Learning Disorders</th>
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<td>A. Reading, writing, or mathematics achievement, as measured by individually administered standardized tests, is substantially below that expected given the person's chronological age, measured intelligence, and age-appropriate education.</td>
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<td>B. The disturbance significantly interferes with academic achievement or activities of daily living that require reading, writing, or math.</td>
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<td>C. If a sensory deficit is present (i.e., blindness, deafness), the academic difficulties are in excess of those usually associated with it.</td>
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<tr>
<td>1. Reading Disorder is diagnosed in people with reading problems.</td>
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<td>2. Disorder of Written Expression is diagnosed in people with writing problems.</td>
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<td>3. Mathematics Disorder is diagnosed in people with math-related problems.</td>
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Source: Reprinted with permission from the DSM-IV-TR.
mental retardation, or emotional disturbance, or of environmental, cultural, or economic disadvantage (U.S. Department of Education, 1977, p. 65083).

The current definition of learning disabilities is outlined by the Individuals With Disabilities Education Improvement Act (IDEA, 2004), an extension of the Education for All Handicapped Children Act. According to IDEA, children can be classified with learning disabilities if they show problems in any of the following areas:

1. Oral expression
2. Listening comprehension
3. Written expression
4. Basic reading skills
5. Reading fluency skills
6. Reading comprehension
7. Mathematics calculation
8. Mathematics problem solving

Furthermore, children’s low achievement in these areas must not be due to Mental Retardation, emotional problems, other disabling conditions, language differences, or impoverished educational experiences (U.S. Department of Education, 2006).

Many experts have criticized the list of learning disabilities identified in IDEA. Specifically, Fletcher and colleagues (2002) have argued that problems with (1) oral expression and (2) listening comprehension do not reflect academic skill problems. Consequently, children with oral expression or listening comprehension problems should be classified as having speech/language disorders rather than learning disabilities. Indeed, these problems are usually treated by speech and language therapists and not psychologists, counselors, or teachers.

Most medical professionals use the DSM-IV-TR definition of LD to diagnose youths with significant learning problems. In contrast, school districts use the legal definition of “specific learning disability” to determine students’ eligibility for special education services (Samms-Vaughn, 2006).

**Identifying Children With Learning Disabilities**

IDEA does not specify how professionals must identify youths with learning disabilities. Instead, IDEA gives state governments considerable freedom to determine the specific classification criteria they will use. Consequently, different states use different criteria: The stricter the criteria, the fewer children who qualify for special education services. For example, approximately 8% of youth in Rhode Island are classified as having learning disabilities, compared to 2.5% of youth in Kentucky (Reschly, 2006). This variation in classification criteria has caused some cynics to quip: “The best way to help a child overcome his learning disability is to move him to a different state!”
IDEA allows states to use three approaches to identify youths with learning disabilities: (1) IQ-achievement discrepancies, (2) intra-individual discrepancies, and (3) responsiveness to intervention.

**IQ-Achievement Discrepancy**

The IQ-achievement discrepancy method for identifying learning disabilities is the most widely used procedure in public schools. The IQ-achievement discrepancy method is also the procedure specified by *DSM-IV-TR* as a means to diagnose LDs. Professionals who use this procedure compare children's IQ and academic achievement using standardized tests. Significantly low achievement, relative to IQ, can indicate the presence of a learning disability (*DSM-IV-TR*; Reschly, 2004).

Most research indicates that the IQ-achievement discrepancy approach is not a valid method of identifying youths with learning disabilities. The IQ-achievement discrepancy method has at least three weaknesses. First, the IQ-achievement discrepancy approach is often not useful in differentiating youths with and without learning problems. Many young children who show marked delays in reading fall short of the discrepancy needed to be classified as having a learning disability. Although these children (like Daniel) display serious delays in reading, they are often denied special education because they do not meet the discrepancy cutoff identified by the state. Over time, these children often fall further behind their peers.

Second, children identified with learning disabilities using the IQ-achievement method do not show different patterns of cognitive abilities than youths with learning problems who fall short of the IQ-achievement cutoff. For example, youths with reading problems who do and do not show significant discrepancies display similar problems with sounding out words, recognizing letters and words, knowledge of vocabulary, short-term memory, speech and language, and classroom behavior. There is little evidence that youths who meet the IQ-achievement discrepancy process information differently than youths who fall short of this discrepancy (Fletcher et al., 2002; Fletcher, Morris, & Lyon, 2003; Francis, Fletcher, Stuebing, Lyon, Shaywitz, & Shaywitz, 2005).

Third, youths with reading problems who do and do not show significant IQ-achievement discrepancies display similar outcomes. Children in both groups display long-term problems with reading. Youths with reading problems who do and do not have significant IQ-achievement discrepancies respond similarly to treatment. There is little evidence that youths with IQ-achievement discrepancies need to be taught using different methods than other youths with reading problems (Hoskyn & Swanson, 2000; Stuebing, Fletcher, LeDoux, Lyon, Shaywitz, & Shaywitz, 2002; Vellutino, Scanlon, & Lyon, 2000).

**Intra-Individual Discrepancy**

A second approach to identifying children with learning disabilities is to examine the pattern of strengths and weaknesses that they show on norm-referenced tests of ability and achievement. Children who show significant weaknesses in one ability or achievement area might be classified as having a disability in this domain (Fletcher et al., 2003).
For example, the Woodcock-Johnson III allows clinicians to measure children’s performance in multiple domains of cognitive ability and academic achievement. The clinician obtains a standard score with a mean of 100 and standard deviation of 15 on each of these domains. Then, the clinician examines whether the child’s score on any one of these domains differs significantly from the child’s overall performance. For example, in Table 7.2, we see that the child displays significant relative weaknesses on tests measuring his basic reading skills and phoneme awareness (i.e., the ability to understand the relationship between letters and sounds). These findings indicate that the child might have a specific learning disability in the area of reading. The clinician might hypothesize that the child’s problems with basic reading, such as his difficulty sounding out words, is due to underlying problems with phoneme awareness (Mather & Schrank, 2003; Volker, Lopata, & Cook-Cottone, 2006).

The intra-individual discrepancy approach has several advantages over the IQ-achievement approach. First, emerging data indicate that the intra-individual approach is better than the IQ-achievement approach at differentiating youths with and without learning problems. Consequently, the intra-individual method may possess greater validity as a means to identify children with learning disabilities.

Second, the intra-individual approach often conveys more information to clinicians than the IQ-achievement method. Clinicians who use the intra-individual approach focus on multiple areas of children’s functioning, not just on the magnitude of the difference between their IQ and achievement scores. Indeed, researchers have begun to identify subgroups of children based on their pattern of academic strengths and weaknesses identified by the intra-individual approach (Fletcher et al., 2003; Grigorenko, 2001).

Third, the intra-individual approach can guide clinicians toward appropriate treatments more easily than the IQ-achievement approach. By identifying children based on specific patterns of strengths and weaknesses, clinicians can better understand children’s skills and tailor remediation accordingly. For example, children who show problems in basic reading often respond well to treatments that teach...
phonics skills. Clinicians who use the intra-individual method can more precisely target areas of relative weakness that need remediation while capitalizing on areas of relative strength (Lovett & Barron, 2002).

*Response to Intervention*

A third way of conceptualizing learning disabilities is based on children's educational progress and outcomes (Reschly, 2006). Proponents of the *response to intervention* (RTI) approach believe that youths with learning disabilities can be identified based on their inability to respond to “scientific, research-based” teaching methods (U.S. Department of Education, 2006). Children who are provided with high-quality, empirically based instruction, but who fail to show academic progress, may be classified with learning disabilities.

School systems that use the RTI approach usually rely on a three-phase system to identify children with learning disabilities. In Phase I, all children in a class are evaluated to assess their basic academic skills. Data collected in Phase I are used to evaluate the overall effectiveness of instruction. If most children show adequate progress mastering reading, writing, and math, then the method of instruction is deemed adequate.

In Phase II, youths who showed significant academic deficits during Phase I are provided with additional instruction to help them catch up to their peers. Additional instruction is usually administered in small groups. For example, students who show specific deficits in reading might be provided with 20 minutes of group reading instruction.

In Phase III, students who do not respond to additional group instruction are given intensive individual intervention. For example, a student who continues to show reading deficits despite extra group instruction might receive one-on-one tutoring. Only students who continue to show academic deficits after intensive individual intervention (Phase III) are classified as having learning disabilities (Burns & Senesac, 2005; Gresham, 2006).

The RTI approach places less emphasis on standardized testing and greater focus on children’s actual performance in the classroom. Because RTI is based on observations of children’s performance in class, RTI allows teachers to identify youths’ academic delays much earlier than more traditional discrepancy approaches. The RTI approach also lends itself to treatment. A youth who fails to respond to one scientifically based form of instruction can be provided with other evidence-based teaching methods until she shows improvement (Reschly, Tilly, & Grimes, 1999).

The RTI approach is relatively new. Emerging data indicate that it is effective in identifying young children’s learning problems, preventing future academic skill deficits, and reducing the number of students referred for special education. Furthermore, the approach is beginning to be successfully implemented in school systems across the country (Ardoin, Witt, Connell, & Koenig, 2005; Vellutino, Scanlon, Small, & Fanuele, 2006).

Many experts rely on both standardized testing and RTI approaches to identify children with learning disabilities (Fiorello, Hale, & Snyder, 2006; J. B. Hale,
Kaufman, Naglieri, & Kavale, 2006; Holdnack & Weiss, 2006). For example, IQ testing can predict children’s future academic performance and, possibly, the likelihood that they will respond to academic interventions (Fuchs & Young, 2006).

Epidemiology of Children’s Learning Problems

Prevalence

Overall Prevalence

Approximately 4%–6% of U.S. schoolchildren receive special education services because of a learning disability. However, the actual prevalence of learning problems is probably much higher. Many children remain unidentified and untreated. Other children show marked academic problems but do not quite meet the threshold for LD. In one estimate, as many as 20% of school-age youth show either LDs or significant learning problems that interfere with their performance in school (Silver & Hagin, 2002).

The number of children and adolescents with learning disabilities has increased dramatically in recent years. In 1976, approximately 3.3 million children received special education services. Today, that number has increased to over 6.7 million. The increased prevalence of learning disabilities is largely due to two factors. First, teachers have increased awareness of learning problems in children, making it easier for them to identify at-risk students. Second, government legislation that mandates the identification and remediation of learning disabilities has increased over the past 30 years, causing a corresponding increase in youths classified with learning disabilities (Reschly, 2006).

Reading Disorder (sometimes called “dyslexia”) is the most common LD; as many as 80% of children with LDs have reading problems. The prevalence of writing problems (8%–15%) and mathematics problems (5%–8%) is much lower. Many children with LDs experience trouble in two or more domains. For example, roughly half of all youths with math-related problems also show difficulty reading. Furthermore, children with both mathematics and reading problems show greater impairment in each of these areas than do children with mathematics or reading problems alone (Augustyniak, Murphy, & Phillips, 2006; Loomis, 2006).

Gender

Among children in treatment, learning disabilities are more common among boys than girls. In the areas of reading and writing, boys are two to three times more likely than girls to be classified as having a learning disability. In the domain of mathematics, the gender ratio is smaller, approximately 1.6:1 (McDermott, Goldberg, Watkins, Stanley, & Glutting, 2006).

Among youth in the community, gender ratios are approximately equal. It is likely that boys with learning disabilities are more likely to be referred for treatment
than are girls with learning disabilities because boys often show other disruptive behavior problems that merit intervention. Furthermore, boys with LDs often show more severe academic deficits than do girls with LDs (Loomis, 2006; Young, 2005).

**Ethnicity and Socioeconomic Factors**

Ethnic minority youths are approximately two to three times more likely than non-minority youths to experience significant problems in reading and writing. For example, the prevalence of reading delays is higher among African American (63%) and Hispanic American (58%) children than among non-Hispanic white children (27%; Lyon, Fletcher, Fuchs, & Chhabra, 2006). Interestingly, studies show approximately equal prevalence across ethnicities for mathematics difficulties (McDermott, Goldberg et al., 2006). It is possible that the impoverished learning and educational opportunities often experienced by ethnic minority youth affect reading and writing achievement more than math.

Low-SES children are also at increased risk for LDs. Approximately one-half of youths living in poverty display significant learning problems. Low SES places children at risk for learning problems in at least three ways. First, low-SES parents may be unable to provide enriched early home environments to their children. Children living in poverty may not have the same access to high-quality medical care, nutritious meals, stimulating toys, and educational games as their middle-class counterparts. Second, low-SES parents may be less able to provide high-quality learning experiences to their children. These parents may talk and read to their children less often, place less value on their children’s academic success, and show less involvement in their children’s schooling. Finally, low-SES children often attend less-than-optimal schools. Because most children must attend local public schools, and because schools are largely funded by local taxes, children living in disadvantaged neighborhoods often receive inferior education (Pianta, 2006; Silver & Hagin, 2002).

**Course**

Children with LDs are at risk for long-term academic difficulties. Many youths begin to show learning problems in kindergarten but are not identified until their academic problems worsen. Approximately 70% of children with reading disabilities who are not identified until the third grade continue to show reading problems in adolescence and early adulthood.

Children’s early learning problems place them at risk for academic failure later in life. Children with LDs are more likely than typical learners to earn low grades, to repeat a grade in school, and to drop out of school before graduation. The high school dropout rate for youths with learning disabilities is approximately 37%, compared to an average of 12% nationally (National Center for Educational Statistics, 2003).

The long-term outcomes for children with LDs depend on at least three factors: (1) early intervention, (2) familial support, and (3) the child’s personal resiliency. First, youths who receive high-quality, empirically based interventions, especially
before the third grade, tend to show marked improvement in their academic skills. Consequently, they are less likely to experience long-term achievement problems. Second, youths who receive support from their families are often better able to cope with their learning problems. Parents can emotionally support their children and advocate for their children's educational needs. Third, youths can rely on other, nonacademic skills to compensate for their academic problems. For example, some children develop competence in sports, art, music, or community service and derive self-esteem, motivation, and career interests from these nonacademic accomplishments (Loomis, 2006).

Comorbidity

Self-Concept and Mood

The impact of LDs on children's self-esteem is mixed. Some data indicate that youths with LDs are at risk for developing negative self-concepts because of their academic struggles. However, most recent research indicates that children with LDs show specific deficits in academic self-concept, but they do not show problems with low self-concept overall. Consequently, they may have a dim view of their academic skills but not a negative impression of themselves in general (Lackaye, Margalit, Ziv, & Ziman, 2006; Lipka & Siegel, 2006).

Research regarding the association between LDs and children's mood is also mixed. Some research indicates that youths with learning problems are at risk for a host of negative emotions. These feelings range from self-blame and anger to helplessness and despair (Loomis, 2006). However, other research indicates that depression is equally common among children with and without learning problems (Lipka & Siegel, 2006).

Peer Interactions

Children with LDs are at risk for peer rejection. At least three factors account for children's increased risk for rejection by classmates. First, children's academic skill deficits and low grades can make them less attractive to classmates. Peers might view them as unintelligent or lazy. Indeed, some data indicate that children with LDs show the same likelihood of peer rejection as children who earn low grades but do not have LDs (Nowicki, 2003).

Second, children with LDs often show other disruptive behavior problems such as hyperactivity and impulsivity. Classmates might find these disruptive behaviors aversive and avoid children with LDs who display them (Samms-Vaughn, 2006).

Third, children with LDs often show deficits in social skills. Children with LDs often prefer younger playmates and display less stable friendships. Some youths with LDs have difficulty understanding other people's emotional expressions and acting appropriately in social situations. They often have low social self-efficacy; that is, they lack confidence in their ability to get along with others. These social deficits and doubts can compromise their peer interactions and friendships (Lackaye et al., 2006; Lipka & Siegel, 2006).
Behavior Problems

ADHD and LDs frequently co-occur. Approximately 15%–40% of youths with LDs have ADHD whereas 25%–50% of youths with ADHD have LDs (Palacios & Semrud-Clikeman, 2005; Silver & Hagin, 2002).

The reason for the high comorbidity between ADHD and LD is not yet known. Some researchers have suggested that children with learning problems display inattention and hyperactivity in the classroom because they are frustrated or bored. However, subsequent research has generally failed to confirm this hypothesis. Instead, most research indicates that ADHD and LD have common genetic causes. For example, twin studies indicate that a common set of genes may predispose children to both disorders. Portions of chromosomes 6 and 16 have been implicated in the development of both ADHD and children’s reading problems (Mayes & Calhoun, 2006; Willcutt, Pennington, Olson, Chhabildas, & Hulslander, 2005).

Several researchers have observed a connection between LDs and the development of children’s conduct problems. Specifically, some youths with LDs show increased likelihood of oppositional-defiant behavior toward adults, aggression, theft, vandalism, robbery, and chronic truancy. Conduct problems are especially likely among children with significant reading problems and below-average intelligence (Palacios & Semrud-Clikeman, 2005).

Two hypotheses have been offered to explain the relationship between LDs and conduct problems. The school failure hypothesis suggests that academic failure mediates the relationship between children’s learning problems and the development of conduct problems. Specifically, children and adolescents with learning problems struggle academically and show less involvement in school-related activities. Consequently, they may associate with deviant peers who model and reinforce delinquent behaviors. Alternatively, the susceptibility hypothesis posits that children with LDs often have other personality and behavioral attributes that place them at risk for conduct problems. For example, youths with LDs often display ADHD symptoms that compromise their decision making and judgment. Consequently, these youths may be prone to disruptive behaviors such as losing their temper, taking risks, and responding aggressively (Lipka & Siegel, 2006).

Genetic Bases for Learning Disorders

Reading and Writing

LDs are heritable conditions. Family studies indicate that 35%–40% of children with Reading or Writing Disorders, compared to only about 5% of the general population, have an immediate family member with at least one LD. Familial concordance seems to be stronger for boys than for girls. Approximately 40% of boys and 18% of girls who have a parent with LDs show serious learning problems themselves. Twin studies provide further evidence that LDs have a genetic component. Concordance rates for monozygotic and dizygotic twins are .85 and .35, respectively (Grigorenko, 2001; Hawke, Wadsworth, & Defries, 2006).
Molecular genetics research indicates that portions of chromosome 15 may contain genes responsible for some cases of Reading Disorder. For example, the DYX1C1 gene seems to underlie certain reading problems. Experts believe that other genes on chromosome 6 and 15 account for other types of reading and writing problems (LoTurco, Wang, & Paramasivam, 2006; Marino & Molteni, 2006).

Mathematics Disorder is also heritable. Mathematics Disorder runs in families; roughly 50% of children with Mathematics Disorder have a sibling with the disorder. Concordance rates for monozygotic and dizygotic twins are .73 and .56, respectively (Butterworth, 2005).

Children with certain X-linked genetic disorders, such as Turner syndrome or fragile X syndrome, often show marked impairment in their mathematical abilities. Turner syndrome is caused by the absence or inactivity of a portion of the X chromosome. Fragile X syndrome usually results from a genetic mutation of the X chromosome. Girls with these disorders display underlying deficits in behavioral inhibition, reasoning, short-term memory, and visual-spatial skills that seem to impair their math performance. The fact that girls with these X-linked disorders show specific deficits in mathematical abilities supports the notion that Mathematics Disorder is partially influenced by one's genotype (Mazzocco & McCloskey, 2005).

Although LDs are believed to have underlying genetic and neuropsychological causes, experience also plays a role in the development and maintenance of learning problems. Recall that the principle of passive gene-environment correlation asserts that parents provide not only their genotypes to their children, but also their early environmental experiences. Parents who have difficulty with reading, writing, and math may be less likely to model and reinforce these academic skills to their children. Indeed, Byrne and colleagues (2006) noticed that parents with reading problems had fewer books and magazines in their home, read to their children less often, and placed less emphasis on literacy than parents with average reading skills. Genetic risk, combined with impoverished early learning experiences, likely underlies many cases of LD.

Reading Disorder: Basic Reading Problems

Reading Disorder is the most common LD. Approximately 80% of children with LDs have Reading Disorder. DSM-IV-TR classifies all significant reading problems under the diagnosis of Reading Disorder. However, IDEA indicates that children can show problems in three separate areas of reading: (1) basic reading skills, (2) reading fluency, and (3) reading comprehension (Lyon et al., 2001, 2006).

Basic Reading Skills

Reading is a complex task that children do not acquire naturally. As children learn to read, they progress along a continuum of reading skills. First, children learn
basic reading skills. These skills include (1) the ability to recognize letters, (2) the awareness of phonemes or the basic sounds of language, (3) an understanding of the connection between letters and the sounds they make, and (4) the capacity to sound out novel words. Consider Alex, a girl with basic reading skill deficits:

Alex

Alex was a 10-year-old girl with a history of low academic achievement, especially in the areas of reading. Alex displayed problems mastering basic phonics skills. Because she could not sound out words, she guessed at their meaning based on their initial letters, length, or context. She often confused words with similar appearance. For example, Alex sometimes read “what” instead of “that” and often mistook “thought” for “though” and “through.” Alex was completely unable to sound out novel words or read stories at her grade level that did not contain pictures or other contextual cues.

Alex had difficulty understanding directions and completing tasks in a timely manner. In school, Alex frequently made mistakes because she did not understand written directions. Alex performed best when her teacher presented instructions orally, demonstrated tasks, and monitored Alex’s progress as she completed her work. Alex admitted that she was frequently confused by assignments at school. “Sometimes, I just guess at what I’m supposed to do because I don’t understand the directions. I also look at the other kids in the class to find out what to do. I have a lot of friends who are willing to help me, so I get by.”

Letter Recognition

Children learn to recognize individual letters by their names and sounds. For example, preschool-age children learn to recognize the letter “s” from a list of printed letters, to name the letter “s,” and to tell a parent that the “s” makes the /s/ sound. Letter recognition is essential to the development of all other reading skills.

After letter recognition, children must develop phoneme awareness. Phonemes are the smallest units of spoken language; they are the sounds that individual letters or combinations of letters make. Examples of phonemes include the /s/ sound, as in sip, or the /sh/ sound, as in ship. There are 41 phonemes in the English language. These phonemes can be combined in many ways to form the English spoken language. Phoneme awareness refers to children’s recognition that spoken language can be broken down into phonemes and that phonemes can be combined to create spoken language (Samms-Vaughn, 2006).

Phoneme Awareness

Phoneme awareness does not come naturally to children. Spoken language is seamless. When we speak, we usually blend sounds together. We usually do not clearly articulate each sound of each word. For example, when we ask a friend, “What do you want to do today?” our question might sound like, “Waddayawanna do today?” Children must learn that these strings of spoken language can be segmented into discrete sounds.
Typically, children need systematic instruction to develop phoneme awareness. Indeed, a considerable percentage of time that children spend in early elementary school is devoted to learning phoneme awareness. Parents and teachers can foster children’s phoneme awareness in several ways.

### Methods to Teach Phoneme Awareness

1. **Phoneme isolation**: Recognizing individual sounds in words
   
   *Tell me the first sound in “paste.”* Answer: /p/

2. **Phoneme identity**: Recognizing a common sound in different words
   
   *Tell me the sound that is the same in “bike,” “boy,” and “bell.”* Answer: /b/

3. **Phoneme categorization**: Recognizing the phoneme that does not belong
   
   *Which word does not belong: bus, bun, rug?* Answer: rug

4. **Phoneme blending**: Listening to separately spoken phonemes and combining them to form a spoken word
   
   *What word is /s/ /k/ /ü/ /l/?* Answer: school

5. **Phoneme segmentation**: Breaking words into sounds by counting phonemes
   
   *How many sounds are in “ship”?* Answer: three (/sh/ /i/ /p/)

6. **Phoneme deletion**: Recognizing the word that remains when a phoneme is deleted
   
   *What is “smile” without the /s/?* Answer: mile

Source: From National Reading Panel (2000). Used with permission.

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**Phonics**

Phoneme awareness is essential for the acquisition of the next basic reading skill: understanding the connection between printed letter combinations and the sounds they make. Specifically, children must learn to translate graphemes into phonemes. **Graphemes** are the units of written language that represent phonemes. For example, the grapheme *ship* represents the three phonemes /sh/ /i/ /p/. Children with adequate phoneme awareness are able to use their understanding of phonemes to decode written words into spoken language.

The ability to decode written words into phonemes depends on children’s phonics skills. **Phonics instruction** emphasizes the correspondence between letters and sounds. Although there are many ways to teach phonics, all phonics-based teaching methods help children see the basic relationship between letter combinations and the sounds letters make (see Image 7.1).
One of the most widely studied methods for teaching phonics is direct instruction. Direct instruction involves the systematic presentation and practice of basic skills in highly structured settings. Skills are broken down into simple steps. Then, each step is introduced, modeled, and practiced. In direct phonics instruction, children are initially taught to convert letters into sounds. Later, they are taught to combine or blend sounds into recognizable words.

Image 7.1   A Phonics-Based Reading Program. Texts emphasize the repetition of words with the same phonemes.

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**Direct Instruction**

**Step 1:** The teacher explicitly states the goals for the lesson.

*Today, we are going to learn how to read words that contain the letters “st” and make the sound /st/. By the end of the lesson, you will be able to read words that have /st/ in them.*

**Step 2:** The teacher breaks down material into small steps, giving students the chance to practice each step.

*Here are the letters “st.” What are the letters? (Child answers “st.”)*

*They make the /st/ sound. What sound do they make? (Child answers /st/)*

(Continued)
Almost any skill can be taught by breaking it down into component steps, providing clear instructions and ample practice, immediately correcting mistakes, and liberally reinforcing its appropriate use. Typically, children are first taught very basic tasks that have a high probability of being successfully completed. Then, teachers help children build upon early skills until they demonstrate mastery in more advanced tasks. Advocates of direct instruction believe that children who continue to show learning problems despite average cognitive ability lack adequate instruction; they do not have some underlying disorder that renders them unable to learn (Adams & Carnine, 2003).

Decoding Unfamiliar Words

The final basic reading skill is the ability to read unfamiliar words. New readers can approach novel words in at least two ways. The first method is called phonemic mediation. Readers with adequate phoneme awareness and phonics skills can sound out unfamiliar words, translating them into spoken language. Then they examine whether the word they decode is familiar and makes sense in the sentence. Consider the following sentence: *Cat has a snack.* A beginning reader might know the first three words in the sentence but be unfamiliar with the word *snack.* He might use phonics skills to sound out the word by translating each letter into its corresponding phoneme: /s/ - /n/ - /æ/ - /k/. Then, he examines whether the resulting combination of phonemes corresponds to his existing spoken vocabulary. For example, he might think to himself, “The word sounds like *snack.* I know what a *snack* is. The word *snack* makes sense in the sentence, so the word must be *snack.*”
A second method to decode unfamiliar words relies largely on children’s memories and the use of contextual cues. If children lack phoneme awareness or phonics skills, they may try to infer words based on their appearance, other words in the sentence, or contextual cues (e.g., pictures).

In the sentence *Cat has a snack*, a beginning reader might attempt to guess at the meaning of the word *snack* based on its length or beginning letter. Then, he might use pictures to test whether his inference is correct. In many cases, use of appearance and contextual cues result in successful reading. However, in some cases, these strategies lead to reading errors. For example, a child might incorrectly read the sentence as *Cat has a sack* because he sees a picture of the cat holding a bag of candy.

**Brain Areas Involved in Basic Reading**

Three areas of the brain are important to reading (see Image 7.2). The first area is the **left occipito-temporal cortex**, a brain region located near the boundary of the occipital and temporal lobes. In this region, a small area known as the left fusiform gyrus seems to be critical to our ability to detect words. Functional MRI studies indicate that the left fusiform gyrus helps us recognize familiar printed words. It is likely that this brain region is especially involved in our ability to read rapidly and accurately. Damage to the left fusiform gyrus renders people unable to recognize familiar words. Instead, people with damage to this brain region must sound out even simple, frequently occurring words. Their reading is slow and laborious (L. Cohen, Lehericy, Chochon, Lemer, Rivaud, & Dehaene, 2002; McCandliss, Cohen, & Dehaene, 2003).

**Image 7.2**  Brain Areas Involved in Basic Reading


Note: Printed words are first processed by the left occipito-temporal region, which allows us to recognize and read common words. Uncommon words are processed by the left temporo-parietal cortex, which allows us to sound out novel words. The left inferior frontal regions help us interpret the word’s meaning and context within the sentence.
Two other brain regions are responsible for converting graphemes into phonemes. The first is the \textit{left inferior frontal cortex}, located in a portion of the frontal lobe known as \textit{Broca’s area}. The second is the \textit{left temporo-parietal cortex}. This brain region is located between the temporal and parietal lobes and roughly corresponds to \textit{Wernicke’s area}. These brain regions seem to be responsible for our ability to sound out novel words (Frackowiak, Friston, Frith, Dolan, Price, & Zeki, 2004; Shaywitz & Shaywitz, 2005).

Evidence implicating the left inferior frontal cortex and left temporo-parietal cortex in reading comes from two sources. First, damage to these regions renders people unable to sound out novel words. However, people with damage to these regions are often able to recognize and read familiar words based on their appearance. Second, electrical stimulation of these brain areas disrupts the ability to sound out novel words in healthy individuals. However, electrical stimulation to these regions does not interfere with the ability to recognize familiar words (Cao, Bitan, Chou, Burman, & Booth, 2006).

By measuring activity in the brain, researchers have identified a neurological pathway that underlies our ability to read. Approximately 200 milliseconds after a word is presented, it is processed by the left occipito-temporal regions. These regions are involved in detecting and processing familiar words. Words that require phonological decoding (i.e., unfamiliar words) are further processed by the left temporo-parietal area approximately 150 milliseconds later. This area allows us to sound out novel words. Complex words may also be processed by the left inferior frontal region approximately 100 milliseconds later. The left inferior frontal region helps us understand the word’s meaning and its association with other words in the sentence (Rayner et al., 2001; Simos et al., 2005).

**Basic Reading Problems**

Most children with reading disabilities have underlying deficits in basic reading skills. Children with Reading Disorder often display a lack of phoneme awareness and a deficiency in phonics skills. Instead of using phonics principles to decode words, they often rely on memory, word appearance, and contextual cues to infer word meaning. When reading frequently occurring words, they show few problems. When reading novel words, they are prone to mistakes. Children’s lack of phoneme awareness and phonics skills are especially noticeable when they are asked to read pseudowords, that is, words that follow basic principles of the English language but have no meaning. Examples of pseudowords include \textit{throught}, \textit{plesh}, and \textit{britter}. Children with adequate phoneme awareness and phonics skills are able to sound out these words. Children without adequate phoneme awareness are usually unable to correctly decode pseudowords. Instead, they may mistakenly “read” these words according to their appearance: \textit{thought}, \textit{flesh}, and \textit{bitter}.

**Brain Areas Involved in Reading Disorder**

Abnormal functioning of the left inferior frontal cortex and left temporo-parietal cortex probably underlies Reading Disorder. Children with Reading Disorder show less activity in these brain regions when processing novel words or pseudowords,
compared to youths without reading problems. Decreased activity of these left hemisphere brain regions might explain deficits in phonological awareness among youths with Reading Disorder (Shaywitz & Shaywitz, 2005; Simos et al., 2002).

Instead of relying on the left frontal and temporo-parietal areas to process language, children with Reading Disorder often use other brain areas in the right hemisphere (see Image 7.3). Specifically, many children with Reading Disorder rely on the right frontal cortex, a brain area believed to be responsible for processing visual information. Interestingly, older children with Reading Disorder show greater reliance on right hemisphere brain regions than younger children with Reading Disorder (Cao et al., 2006).

![Image 7.3](image_url)

**Image 7.3** Effects of Phonics Instruction on Brain Activity. Researchers classified kindergarteners into three groups: children who showed normal reading (top row), children who showed initial reading problems but improved following phonics instruction (middle row), and children who showed initial reading problems but did not improve following phonics instruction (bottom row). Normal readers and children who improved their reading learned to rely on left hemisphere brain regions responsible for language processing. Children who continued to have reading problems continued to rely on right hemisphere areas.

Source: From Simos et al. (2005). Used with permission.
These findings indicate that older children with Reading Disorder may learn to compensate for their poor phonics skills in three ways. First, they may rely on the appearance of the word to guess its meaning. Second, they may use the context of the sentence or the story to infer the word's meaning. Third, they may simply memorize words based on their appearance. Although these strategies can be effective for early readers, they are almost always inadequate to read complex material and to read with high comprehension (Shaywitz & Shaywitz, 2005; Simos et al., 2002).

Children with Reading Disorder who receive instruction in phonics show a significant increase in activity in the left frontal and temporo-parietal areas. In several studies, two to eight months of phonics instruction caused significant increases in left hemisphere activity. After instruction, the brain activity of children with and without Reading Disorder was indistinguishable. Phonics instruction may normalize brain activity among children with Reading Disorder, helping these children process words like normal readers (Aylward et al., 2003; Shaywitz et al., 2004).

### Treatment of Basic Reading Problems

**Explicit Instruction in Phoneme Awareness and Phonics**

In 2000, the National Institute for Child Health and Human Development commissioned a group of experts to determine the most effective methods of reading instruction. The group, called the National Reading Panel (NRP), gathered data from numerous studies comparing different methods to teach reading. The panel concluded that methods that provided explicit instruction in letter recognition and phoneme awareness were most effective in helping children learn to read (NRP, 2000).

More recent research has confirmed the importance of systematic instruction in phoneme awareness and phonics skills. Children who receive direct instruction, in particular, show large gains in phoneme awareness, word recognition, and reading comprehension relative to children who do not receive direct instruction. Furthermore, direct instruction is effective in improving the reading skills of children with reading disabilities. The best outcomes are generally attained by children who begin receiving direct instruction in kindergarten and continue to participate in direct instruction through the second or third grade (Adams & Carnine, 2003; Carlson & Francis, 2002).

Figure 7.1 summarizes the NRP findings with respect to phoneme awareness. Explicitly teaching children to recognize and manipulate phonemes had a large and direct effect on their phoneme awareness skills. Explicit training in phoneme awareness was also associated with significant gains in reading and spelling.

Figure 7.2 summarizes the NRP’s (2000) findings regarding the effects of explicit phonics instruction on children’s reading. Overall, children who receive systematic instruction in phonics show significantly greater gains in reading than children who do not receive phonics instruction. Phonics programs that encourage children to convert letters (graphemes) into sounds (phonemes) and combine or blend sounds into recognizable words were associated with the greatest improvement in reading. Systematic phonics instruction is most effective when it is administered...
Phonics-based reading instruction is also associated with gains in children’s reading comprehension (Kerins, 2006).

Whole Language Instruction

Whole language instruction is based on the belief that learning to read is a natural process that occurs through continued exposure to spoken and written language. Advocates of whole language instruction criticize systematic phonics instruction in which teachers carefully introduce, model, and reinforce the relationship between words and sounds. Instead, proponents of whole language argue that children will naturally discover the rules of reading on their own, as long as they are given opportunities to read and they are allowed to direct their own learning (Y. M. Goodman, 1989; K. S. Goodman, 1992).
Whole language approaches to reading instruction are “learner-centered” and designed to increase children's interest in reading. Although instructional approaches vary, teachers who adopt the principles of whole language allow children to select their own reading materials in order to capitalize on their motivation to learn. In some cases, children might dictate stories to the teacher. After the teacher transcribes the stories, children are encouraged to read them. Teachers also encourage students to use contextual cues and pictures to interpret the meaning of the stories they read.

Little research supports the efficacy of whole language instruction. Stahl, McKenna, and Pagnucco (1994) found only 14 studies that included quantitative data investigating the efficacy of whole language approaches to teaching reading. These studies provided some evidence that whole language reading instruction increased children's reading comprehension. However, Stahl and colleagues concluded that there were too few studies to support the adoption of whole language techniques in the classroom.

*Whole Word Instruction*

Whole word instruction is an extension of the whole language approach. Both whole word and whole language approaches emphasize the meaning behind
printed material rather than the ability to sound out words. In whole word instruction, teachers encourage children to process words as wholes, rather than break them down into phonemes. Initially, children learn to recognize a limited number of common words on sight. Then, their reading vocabulary is gradually expanded as teachers introduce new words during the course of reading practice.

In traditional whole word instruction, teachers usually do not provide explicit instruction in phonics. Advocates of the whole word approach believe that breaking words down into phonemes is artificial and not meaningful to students. Instead, teachers might present whole words on flashcards and encourage students to recognize words based on their appearance. This approach is believed to have two chief advantages over phonics-based instruction. First, by learning words as wholes, children may be less likely to be confused by irregular phonemes in the English language. For example, *pint* and *hint* have different pronunciations despite the fact they both end in *int* (Rayner et al., 2001). Second, practitioners of the whole word approach argue that this approach is more meaningful to children than phonics instruction and, consequently, improves children’s motivation to read.

Whole word instruction often relies on **leveled texts** to increase children’s reading vocabulary (see Image 7.4). Leveled texts are short books that are ordered according to a child’s reading level. Each text introduces new words, such as “elephant.” Children are encouraged to use pictures and other contextual cues to derive the meaning of words.

**Image 7.4** Whole Word Instruction. Children read leveled texts, like this one. Each text introduces new words, such as “elephant.” Children are encouraged to use pictures and other contextual cues to derive the meaning of words.
to the difficulty of vocabulary, repetition of words, inclusion of novel words, use of picture cues, and complexity of sentence structure. Children are initially assigned to low-leveled texts, based on the number of sight words they know. Then, teachers gradually present more difficult texts to expand the child’s reading vocabulary.

**Reading Recovery** is one of the most frequently used whole word approaches to reading instruction. Some data indicate that Reading Recovery is effective at reducing reading problems among children with reading delays. Several studies indicate that as many as 81% of children with reading problems show marked improvement in their reading ability following participation in Reading Recovery (Zane, 2005).

On the other hand, much of the research supporting Reading Recovery is flawed (D’Agostino & Murphy, 2004; Zane, 2005). First, in several studies, attrition was very high among children who received Reading Recovery compared to children who received other forms of reading instruction. For example, in one study, more than one-third of youths who participated in Reading Recovery dropped out of the program before completion. Only those children who successfully completed the Reading Recovery program (and who presumably had the best outcomes) were used to evaluate the program’s effectiveness.

Second, teachers who administered Reading Recovery were often better trained than teachers in the comparison groups. In one study, Reading Recovery teachers received two years of training in the program, whereas teachers who administered the comparison treatment received only two weeks of training. The efficacy of Reading Recovery, therefore, may be due to the expertise of teachers rather than the efficacy of treatment.

Finally, Reading Recovery is less efficacious when administered to children with reading disabilities compared to youths without serious reading problems (Elbaum, Vaughn, Hughes, & Moody, 2000). Chapman, Tunmer, and Prochnow (2001) showed that Reading Recovery improved the decoding skills of youths without Reading Disorder, but was largely ineffective for youths with serious reading problems. Reading Recovery, therefore, may be most efficacious for youths least in need of reading remediation.

### Reading Disorder: Fluency and Comprehension Problems

#### The Development of Fluency and Comprehension

**Fluency**

**Reading fluency** refers to the ability to read rapidly, accurately, and with proper expression. Fluent readers recognize words quickly, attend to important words in sentences more than unimportant words, and emphasize critical words so that sentences make sense.

Reading fluency is important. Fluent readers spend less mental energy processing text. Instead, their cognitive resources can be directed at other tasks, like extracting meaning from what they read. Fluent readers also spend less time reading
individual words and sentences. Therefore, they encounter more words and gain relatively greater practice with reading than do disfluent readers. Finally, fluent readers are able to determine where to place emphasis or where to pause so that sentences makes sense. Reading fluency, therefore, allows readers to better interpret and understand text.

Children become fluent readers through extensive practice with reading. Initially, children must sound out almost all words in order to gain familiarity with the irregularities of the English language. Over time, children begin to recognize frequently occurring words on sight. Consequently, their speed and accuracy increases. As children’s reading experience accumulates, they encounter more novel words, which gradually become familiar sight words. Practice allows children to make reading automatic; that is, practice lets children “turn low-frequency words into high-frequency words” (Rayner et al., 2001, p. 40).

**Comprehension**

Reading **comprehension** refers to children’s ability to read text for meaning, to remember information from the text, and to use information to solve problems or share with others. Reading comprehension is an active process in which children construct meaning from what they read. Reading comprehension, therefore, depends on the interaction between the reader and the text. The reader's understanding of the text will depend on her basic reading skills, reading fluency, and prior knowledge.

Reading comprehension depends principally on children’s basic reading skills and reading fluency. In order to understand text, children must be able to recognize words. If children are unable to recognize familiar words or incorrectly decode novel words, their reading comprehension will suffer. Children’s reading comprehension also depends on their ability to read quickly. To understand text, children must be able to combine information from the beginning and end of the passage. Consider the following sentence:

Matt has a fat cat that likes to wear a hat.

A child who must sound out individual words in the sentence might have difficulty remembering information presented early in the sentence by the time he reaches the end of the sentence. For example, a disfluent reader might be able to answer the question, “What does the cat like to wear?” but not “Whose cat likes to wear a hat?”

Reading comprehension also depends on children’s general language skills. Indeed, the correlation between people’s spoken language comprehension and reading comprehension is .90 (Rayner et al., 2001). Many of the same abilities important to reading comprehension are also important to the comprehension of spoken language. First, children must possess adequate information processing skills to comprehend passages. For example, when listening to or reading a passage, children must be able to attend to the most important information, ignore irrelevant information, notice the sequence of events, and pay attention to causal relationships in the story. Second, listening and reading comprehension depends
greatly on children’s working memory. Children must be able to remember information from passages long enough to answer questions. Third, children must also have adequate contextual knowledge about the story in order to make sense of the information that is presented. For example, children who read a story about Vikings will have difficulty comprehending the story if they have never been taught about Vikings before.

Reading comprehension is influenced by practice. Children with greater exposure to stories gain experience understanding passages. Reading experience also increases children’s reading vocabulary, fluency, and general knowledge, which further promote reading comprehension. Ironically, children with adequate basic reading skills are more likely to practice reading and, therefore, develop high levels of reading fluency and comprehension. In contrast, children with basic reading skill deficits are less likely to practice and, consequently, are more likely to show problems with fluency and comprehension (Rayner et al., 2001; Shaywitz, Holford, Holahan, & Fletcher, 1995).

Fluency and Comprehension Problems

Children with reading fluency and comprehension problems often have histories of poor phoneme awareness and word-decoding skills. These children never developed the basic reading skills necessary to sound out novel words. Consequently, their exposure to novel words and practice with reading was limited. Problems reading novel words often leads to an overall reduction in the rate of reading (i.e., fluency) and accuracy with which children can answer questions about the passages they read (i.e., comprehension; Lyon, Fletcher, & Barnes, 2003).

Wolf and Bowers (1999) developed the double-deficit model to explain the relationship between basic reading skills, reading fluency, and reading comprehension. According to this model, children can be grouped into three categories based on the type of reading problems they show. First, some children show problems with basic reading skills. These children have difficulty sounding out words and, consequently, answering questions about what they have read. Lack of phoneme awareness and basic phonics skills often underlies these deficits. Second, some children show adequate basic reading skills but problems with reading fluency. These children have particular difficulty recognizing common words on sight. Consequently, their reading is slow and laborious. Their reading comprehension is also usually impaired. Because their rate of reading is slow, they often have difficulty remembering information from the beginning of the passage by the time they reach the end of the passage. Third, a small group of children show impairments in both basic reading skills and reading fluency. These children show the greatest level of reading problems overall.

It is rare for children to show specific problems with reading comprehension but no deficits in phoneme awareness, decoding, or fluency. Only about 6% of youths with reading problems show difficulty in comprehension alone. Youths with comprehension problems, but not basic reading or fluency problems, tend to have underlying difficulties with oral language and reasoning (Leach, Scarborough, & Rescorla, 2003; Ransby & Swanson, 2003).
Treatment of Fluency and Comprehension Problems

Fluency

Practice is critical to the development of reading fluency. Children who display fluency problems must be given more reading opportunities. Most teachers rely on one of two approaches to provide children with reading practice. One tactic is called guided oral reading. In guided oral reading, the child reads and re-reads a text aloud until she becomes proficient. Teachers or peers listen to the child, provide assistance sounding out words, and correct reading errors. Sometimes, children read along with audiotapes, videos, or computer programs.

A second strategy to improve fluency is independent silent reading. For example, teachers who use the Sustained Silent Reading (SSR) or Drop Everything and Read (DEAR) programs devote 15–30 minutes of class time each day to independent silent reading. Students are allowed to select their own reading material, and they do not receive systematic help and correction from teachers or peers.

The NRP (2000) reviewed the effect of guided oral reading and independent silent reading on children's reading fluency and comprehension (see Figure 7.3). Children who participated in guided oral reading showed increased reading accuracy, reading speed, and reading comprehension compared to children who did not

![Figure 7.3 Effects of Guided Oral Reading](image)

**Figure 7.3** Effects of Guided Oral Reading

Source: Based on National Reading Panel (2000).

Note: Guided oral reading is associated with increases in children's fluency and comprehension.
receive opportunities for guided oral reading. Guided oral reading is effective for normal readers and children with reading disabilities (Chard, Vaughn, & Tyler, 2003; Kuhn & Stahl, 2003).

The NRP (2000) was unable to draw firm conclusions regarding the merits of independent silent reading. Too few studies were conducted to adequately evaluate these programs. However, most of the research that had been conducted indicated that these programs were not associated with increases in reading fluency.

**Comprehension**

Most teachers recognize that reading comprehension skills must be systematically introduced and modeled in the classroom. Children who are provided with systematic training in reading comprehension show significant improvements compared to youths who do not receive explicit instruction (Rosenshine, Meister, & Chapman, 1996).

At least seven techniques have been shown to improve children's reading comprehension (NRP, 2000):

1. **Cooperative learning**: Children read and discuss text with peers. Peers help each other understand material. This technique is associated with increased comprehension and more advanced strategies for analyzing text.

2. **Graphic organizers**: Children represent material from the text using charts, graphs, or pictures. Students might underline or highlight key terms or connect ideas with arrows. This strategy is often used in science and social studies classes. It is associated with improved memory for text.

3. **Question answering**: Children answer teachers' questions about the text. This technique is effective in improving children's recall of important ideas or themes.

4. **Question generation**: Children generate their own questions while reading. Readers might ask themselves *who*, *what*, *when*, *where*, and *why*. This method increases reading comprehension among youth in first through twelfth grades.

5. **Story structure**: Children learn to identify elements of stories, such as the main characters, the plot, and the timeline of events. This technique is particularly effective with younger readers and readers who have comprehension problems.

6. **Summarization**: Children identify the main idea of a passage and connect information in the text to the main idea. This technique is especially effective for older children.

7. **Multiple strategy instruction**: Teachers combine two or more of the above strategies in flexible ways. For example, a teacher might have students read a story, generate questions, summarize the main points, and draw a timeline of events. The use of multiple strategies is generally more effective than the use of single techniques.
Recent research has identified two other approaches that seem to increase reading comprehension (Kim, Vaughn, Wanzek, & Wei, 2004). These approaches are particularly relevant for children with Reading Disorder:

1. **Activating background knowledge**: Teachers encourage students to recall information relevant to the passage before reading. For example, before reading a passage about Vikings, teachers might ask students to tell all that they know about Vikings.

2. **Explicit teaching of vocabulary**: Teachers provide students with systematic instruction on word meaning to make sure they understand individual words in the text.

Systematic comprehension instruction is associated with increases in children’s memory for information, speed of reading, understanding, and ability to apply information to answer questions or solve problems (NRP, 2000; Rosenshine et al., 1996; Therrien, Wickstrom, & Jones, 2006).

## Disorder of Written Expression

### Writing in Normal Children

Writing is a complex task that takes years to master. For most children, the writing process involves three steps: planning, translating, and reviewing (Hayes & Flower, 1980). First, children plan the writing task. Planning involves determining the purpose of the writing, generating a main topic and supporting ideas, and organizing these ideas so that they make sense.

Imagine that a teacher asks students to write a report on sharks. Most children would begin the writing process by identifying the purpose of the writing assignment and an appropriate format for the paper. An essay on shark behavior would be written differently than a creative story about a fictional shark. Then, children might gather information about sharks, identify the most important information that they want to include in their essays, and discard irrelevant information. Finally, children would likely spend time organizing their thoughts generated from the information they gathered. Some children might outline their essays, whereas others might use diagrams or flowcharts.

Second, children translate their ideas into written text. Translation depends on children's phoneme awareness, their knowledge of vocabulary and spelling, and the mechanics of writing (e.g., how they hold a pencil).

Third, children review their writing. Reviewing involves rereading their stories, identifying mistakes, and making changes. Mistakes can be at the level of individual words (e.g., illegible handwriting, misspellings), sentences (e.g., missing subject, predicate), or paragraphs (e.g., no topic sentence). Editing can also involve analyzing the composition's grammar and punctuation (e.g., Are singular and plural verbs used correctly?) or theme (e.g., Does the sentence make sense?).
Children With Writing Problems

Planning

Children with writing disabilities spend far less time and effort planning assignments than their classmates (Graham & Harris, 2000). Specifically, children with writing disabilities do not think about their goals for writing, do not generate much information about the topic, and do not organize their thoughts before sitting down to write. Instead, most youths with writing disabilities begin writing about the first relevant concept that comes into their minds. Then, they add information that is prompted by their first sentence. For example, a child without writing problems might write the following topic sentence:

Sharks are some of the most dangerous animals in the ocean.

Then, she might follow up with additional sentences supporting her topic:

Sharks have hundreds of teeth that are as sharp as knives.

An adult shark can eat 100 pounds of fish each day.

Sharks have been known to eat fish, seals, and even other sharks!

In contrast, a child with writing difficulties might begin his essay in the same way:

Sharks are some of the most dangerous animals in the ocean.

Sharks have hundreds of teeth that are as sharp as knives.

Then, he might follow up with a series of sentences that are prompted by the sentence that immediately precedes it. The result is a list of ideas that strays from the topic:

If one cuts you, you will be in a lot of trouble.

You will need to swim to shore and see a doctor.

The doctor will tell you not to go out into the ocean again.

You might swim in swimming pools.

This lack of planning, often shown by children with writing problems, has two adverse consequences. First, the stories of children with writing disabilities tend to be disjointed and difficult to follow. In the above example, the reader expects that the paragraph will be about shark’s teeth or the fact that they are dangerous, but the actual text conveys a story about a swimmer. Second, the stories of children with disabilities tend to be brief. Indeed, children with writing disabilities tend to generate
stories approximately two-thirds shorter than those of their classmates. Because children with disabilities do not plan and organize their writing before they begin, they run out of ideas earlier than their peers (Graham, Harris, MacArthur, & Schwartz, 1991).

**Translation**

Children with writing disabilities often show problems translating their thoughts onto paper. Spelling errors and poor handwriting are extremely common among children with writing problems. Indeed, spelling errors and illegible handwriting account for 41% and 66% of the variance in children's overall quality of writing, respectively (Graham, Harris, & MacArthur, 2004). Spelling problems and poor handwriting interfere with writing by slowing the writing process. Children who struggle with spelling devote cognitive resources to spelling individual words, rather than focusing on sentence quality or paragraph coherence. Children who have difficulty with mechanics may write too slowly to keep up with the thoughts they want to convey. Consequently, their writing may be disorganized or illogical.

**Reviewing**

Children with writing disabilities review and edit their work differently than their classmates. When most children review their writing, they attend to all aspects of the text, including whether individual sentences make sense and whether paragraphs are organized into a coherent story.

In contrast, children with writing disabilities focus primarily on low-level writing mistakes when editing. Low-level mistakes include errors in capitalization, mistakes in punctuation, and illegible handwriting. A child with writing disabilities might write, “The boy and the girl is going to the party.” However, he might edit the sentence by changing the order of the boy and the girl in the sentence, altering the punctuation, or rewriting the sentence so that it is more legible. In one study, approximately 70% of the revisions made by youths with writing problems involved surface-level changes that did not correct substantive errors (De La Paz, Swanson, & Graham, 1998; MacArthur, Graham, & Schwartz, 1991).

**Treatment of Writing Problems**

**Improving Planning and Reviewing**

Self-Regulated Strategy Development (SRSD; Graham, 2006) is a method for systematically teaching children how to plan and review their writing. In SRSD, children are explicitly taught to think about the goals of their writing, to generate and organize ideas, and to elaborate on the sentences that they produce. In elementary school classes, teachers might use the POW acronym to help students recall the steps to effective pre-writing: (1) Pick my idea, (2) Organize my notes, and (3) Write and say more. First, teachers describe each of the POW steps. Then, they model the use of each step in front of the class while thinking aloud. Next, they
encourage students to memorize and use the steps. Finally, teachers monitor their students as they use the steps on their own (Graham & Harris, 2003).

Teachers also encourage children to review their writing during the writing process (see Image 7.5). For example, young children are taught to analyze stories using the following questions:

- Who is the main character?
- When does the story take place?
- Where does the story take place?
- What does the main character (and other characters) do or want to do?
- What happens then?
- How does the story end?
- How does the main character (and other characters) feel?

Empirical studies have investigated the efficacy of SRSD for children with and without writing problems (see Figure 7.4). Four aspects of children's writing have been evaluated: (1) writing quality, the overall value of the composition; (2) writing elements, such as identification of main characters, location, time frame, and conclusion; (3) grammar; and (4) length.

Overall, children who participate in SRSD show increased writing skills in all four areas compared to youths who receive other forms of writing instruction. SRSD is associated with improvements in the writing skills of youths with writing disabilities and typically developing children. Furthermore, the benefits of SRSD are maintained

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Albert the Fish

On a warm, sunny day two years ago (When), there was a big gray fish named Albert (Who). He lived in a big icy pond near the edge of town (Where). Albert was swimming around the pond when he spotted a big juicy worm on top of the water. Albert knew how good worms tasted and wanted to eat this one for dinner (What He Wanted To Do). So he swam very close to the worm and bit into him. Suddenly, Albert was pulled through the water into a boat (What Happened). He had been caught by a fisherman (Ending). Albert felt sad (Feelings) and wished he had been more careful.

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Image 7.5  Improving Children's Writing. Students are taught to identify the parts of their story to determine whether it makes sense. Children focus chiefly on errors in grammar, sentence structure, and logical organization rather than on low-level mistakes.

Source: Based on the National Center on Accelerated Student Learning (http://kc.vanderbilt.edu).
over time and generalize to other types of writing assignments. For example, children who are initially taught to write essays also show improvement in writing book reports or short stories. The benefits of SRSD are attributed to the fact that teachers systematically introduce and model planning and reviewing strategies and encourage students to actively participate in the writing process (Graham & Harris, 2003). Similar results have been obtained by other writing instruction techniques that explicitly teach planning, organizing, and editing (Graham, 2006; Wong, 1997).

**Improving Translation: Handwriting and Spelling**

Some children show writing problems because they have difficulty with mechanics (Monroe & Troia, 2006). Techniques that improve handwriting and
spelling often lead to improvements in the overall quality and length of children’s stories (Graham, Harris, & Fink, 2002).

The goal of handwriting instruction is to help students write legibly and quickly. Students must also be able to write automatically, so that they can direct their attention to the quality of their composition rather than to the mechanics of writing. One method of handwriting instruction consists of four steps:

1. Alphabet Warm-up: Students learn to name and identify letters.

2. Alphabet Practice: Three lower-case letters with similar shapes are presented (e.g., l, i, t). First, the teacher models how to write each letter. Students practice writing the letters with guidance from the teacher. Students practice writing words containing the letters.

3. Alphabet Rockets: Children rapidly copy sentences with words that contain the previously introduced letters.

4. Alphabet Fun: Children are taught to write the letters in a creative way (e.g., making the “t” into a tomahawk; Graham, Harris, & Fink, 2000).

Spelling instruction involves three components (Graham et al., 2004). First, teachers help students learn to spell frequently occurring words. Teachers might use “word banks” or flashcards to familiarize children with the correct spelling of common words. Repeated exposure to commonly misspelled words is important to help children learn about spelling irregularities in the English language. Graham and colleagues (2002) recommend using a word sorting activity in which children are asked to sort common words based on similar phonemes (e.g., made, laid, and say belong in the same group). Students might also engage in games designed to reward spelling improvement. For example, in a game called Spelling Road Race, students move tokens around a game board when they correctly spell words.

A second component of spelling instruction involves teaching children to spell novel words by analogy. For example, a child who is able to spell ought might be able to use this knowledge to spell words such as bought, brought, and thought. Students might also be taught word-building activities. For example, teachers might encourage students to generate as many words as they can that end with “oy.”

A final component of spelling instruction involves proofreading. Children are taught to review their own writing and identify and correct spelling mistakes. In some cases, students review each other’s compositions and correct misspellings.

Handwriting and spelling instruction is associated with improvements in the quality of children’s overall writing. Effective instruction seems to have two components. First, effective instruction is explicit; teachers introduce, model, and reinforce children as they engage in each activity. Second, effective instruction is repeated. Children are given opportunities to practice new skills until they demonstrate proficiency.
Mathematics Disorder

Mathematics Development in Normal Children

Numerosity

Some experts have argued that children are biologically predisposed to understand and process mathematics information. Infants may have an appreciation for numerosity, that is, the understanding that a group of stimuli can be understood in terms of their number. Numerosity allows us to differentiate 12 pieces of candy from 6 pieces of candy or differentiate 12 chimes on a clock from 6 chimes on a clock.

Starkey and Cooper (1980) examined whether four- through seven-month-old infants could differentiate groups of dots presented in different numbers. First, infants were presented with a group of three dots. When infants became habituated, or no longer responded to the dots, the researchers changed the number of dots in the display. Infants who habituated to three dots showed renewed interest when presented with only two dots. Starkey and Cooper’s findings indicate that young infants appreciate simple numerosities. More recent research has shown that young infants can also discriminate between sounds of different numbers (Lipton & Spelke, 2003).

Other data indicate that infants may have a basic appreciation for number. Karen Wynn (1992) examined whether five-month-olds could discriminate between a correct numerical expression (1 + 1 = 2) and an incorrect expression (1 + 1 = 1). First, infants saw a case containing a doll. Then, the case was obscured by a screen. Next, infants saw a hand apparently place a second doll behind the screen. Finally, the screen was removed and infants were shown either a correct display (i.e., two dolls) or an incorrect display (i.e., one doll). Infants looked at the incorrect display significantly longer than the correct display, suggesting that they had an appreciation for simple numerosities.

Recent research indicates that six-month-olds show activation of the middle-frontal areas of the brain when they encounter these unexpected mathematical events. This brain region also becomes active when adults observe mathematical irregularities (Berger, Tzur, & Posner, 2006). This finding indicates that the brain mechanisms involved in our appreciation for number may be present at birth and active from a very early age. Although not all researchers agree (Mix, Huttenlocher, & Levine, 2002), these data indicate that infants may be hard-wired to understand and process numbers.

Counting

Children’s ability to count develops between the ages of two through five years. Young children seem to obey certain rules of counting that follow a fixed sequence (Gelman & Gallistel, 1978):

1. One-to-one correspondence: One number is assigned to each object.
2. Stable order: Numbers are counted in a specific order.
3. Cardinality: The last number stated reflects the quantity of the items counted.

4. Abstraction: Objects of any kind can be grouped and counted.

5. Order irrelevance: Objects can be counted in any order.

Children’s counting skills increase with experience. However, children universally progress through similar stages of counting, suggesting that counting is mediated by brain maturation.

**Arithmetic Computation**

Beginning in elementary school, children’s math skills become more complex, as children transition from simple counting to arithmetic. Addition depends greatly on children’s counting abilities. For example, young children use fairly immature strategies to add numbers. Initially, they might count on their fingers to solve addition problems. Later, addition is performed verbally or mentally.

Young children also use less efficient strategies to add. For example, when young children are asked to add $7 + 4$, they usually first count from 1 to 7 and then count four more numbers until they arrive at the correct answer. Later, children use the counting-on strategy; they begin with the largest number (i.e., 7) and then count four more digits until they arrive at the answer. Similar shortcuts are used for subtraction and other mathematical operations (Augustyniak et al., 2006).

With experience, children learn to store math facts in long-term memory. For example, children simply recall that $7 + 4 = 11$; they no longer need to count to arrive at the correct answer. Direct retrieval from long-term memory permits more automatic math computations. Children can direct their attention to conceptualizing the arithmetic problems rather than to counting. Direct retrieval also frees short-term memory, allowing children to perform more complex calculations in their heads (Geary & Hoard, 2005).

**Math Reasoning and Problem Solving**

By late childhood, children begin to develop more complex math problem-solving skills. These skills include the ability to solve story problems, to draw information from charts and graphs, and to perform mathematical operations with complex sets of numbers (i.e., borrowing, long division, fractions). These higher-order math skills depend on a number of underlying cognitive abilities.

Children’s ability to solve story problems depends on their verbal reasoning skills, attention, and concentration. First, children must be able to read and understand the story problem. Second, they must attend to important parts of the story problem and ignore irrelevant information.

Children’s abilities to use charts and graphs depend on their visuospatial reasoning skills and attention/concentration. First, they must appreciate the relationship between visually presented information in the chart or graph and the quantities these illustrations represent. Second, they must identify important elements of the chart or graph and ignore extraneous details. Children’s abilities to
perform complex mathematical calculations, like adding three-digit numbers or performing long division, also depend on their visuospatial skills. Children must line up numbers properly to ensure that they perform calculations using the correct digits (Geary & Hoard, 2005).

Adolescents who have entered the stage of formal operations are able to think more abstractly and flexibly about mathematical concepts. Formal operational thinking allows adolescents to learn algebra, geometry, and other mathematical disciplines that are not directly tied to concrete objects. Adolescents’ abilities to solve equations, geometric proofs, or rate-of-change problems depend on their foundational math skills as well as their ability to reason abstractly.

Development of Mathematics Disorder

Children with Mathematics Disorder develop math skills in the same progression as youths who do not show math problems. However, children with Mathematics Disorder often display difficulties mastering basic counting and computational skills that serve as the foundation for higher-order mathematical reasoning.

First, youths with Mathematics Disorder frequently have difficulty remembering math facts. Whereas most fourth graders can effortlessly recall $4 + 5 = 9$, children with Mathematics Disorder often need to perform this mathematical computation to recall the correct answer. Consequently, children with Mathematics Disorder spend greater cognitive resources performing basic calculations and fewer resources conceptualizing the problem itself (Geary & Hoard, 2001).

Second, youths with Mathematics Disorder often show problems remembering math procedures. For example, when presented with a problem such as $41 - 29 = ?$, children with Mathematics Disorder may forget how to “borrow” (Temple & Sherwood, 2002).

Because of their difficulty retrieving math facts and procedures, youths with Mathematics Disorder often rely on immature strategies to solve math problems. For example, many first graders count on their fingers to solve addition problems. However, children with Mathematics Disorder often continue to rely on this immature tactic into the third and fourth grades. Furthermore, when young children with Mathematics Disorder count, they often count all digits rather than rely on more advanced “add-on” strategies. These immature strategies result in slow, error-prone calculations (Butterworth, 1999; Geary & Hoard, 2005; Jordan, Hanich, & Kaplan, 2003).

Problems remembering math facts, difficulty performing math computations, and reliance on immature problem-solving strategies interfere with children’s abilities to solve higher-order math problems. By the time they reach early adolescence, youths with Mathematics Disorder may have difficulty performing simple arithmetic problems quickly and accurately and not understand higher-level math procedures (e.g., graph interpretation, long division).

What explains the deficits shown by youths with Mathematics Disorder? Brian Butterworth (2005) has developed the defective number module hypothesis to explain the cause of certain Mathematics Disorders. According to this hypothesis, the neurological system that is believed to underlie infants’ appreciation for
numerosity does not develop properly. This neurological system involves many brain areas, especially portions of the parietal lobes known as the right intraparietal sulci (IPS). The right IPS seems to play an important role in estimating numerosity for small sets of stimuli, a capacity displayed by infants and young children. The left IPS seems to be important for more complex numerical processing and arithmetic calculations shown by older children. Problems in the development of either right or left IPS would affect mathematical ability. Indeed, neuroimaging studies indicate that some youths with Mathematics Disorder show abnormalities in these brain regions (Dehaene, Piazza, Pinel, & Cohen, 2003; Piazza, Giacomini, Le Bihan, & Dehaene, 2003).

David Geary and Mary Hoard (2005) have suggested an alternative developmental model for Mathematics Disorder (see Figure 7.5). According to their developmental model for Mathematics Disorder, children’s math skills depend on underlying neuropsychological abilities, including their (1) language abilities, (2) visuospatial abilities, and (3) executive functioning.

Children’s language skills enable them to understand the correspondence between spoken numbers (e.g., “twenty-two”) and written numbers (e.g., 22). Language skills also help children listen to and understand orally presented math problems and to read/formulate math story problems. Some youths with mathematics disabilities may have underlying verbal deficits that interfere with their math skills.

Figure 7.5 A Developmental Model for Mathematics Disorder

Note: According to Geary and Hoard (2005), problems in language, visuospatial abilities, and executive functioning underlie mathematics disabilities.
Children’s visuospatial skills allow them to represent numerical values along a continuum (i.e., a “number line”), to organize and correctly line up numbers for multidigit calculation, and to draw information from charts and graphs. Some youths with Mathematics Disorder have visuospatial deficits that compromise these abilities. For example, many youths with Mathematics Disorder have difficulty representing digits on a number line; consequently, they often have trouble determining which values are “greater than” or “less than” other values. These children also misalign multidigit problems, causing computational errors (Zorzi, Priftis, & Umilta, 2002).

Children’s executive functioning allows them to attend to important information in mathematics problems, ignore unimportant details, retrieve math facts from long-term memory, and perform mathematic operations in short-term memory. Some data indicate that youths with Mathematics Disorder have difficulty with all four tasks. Youths with Mathematics Disorder often have difficulty recognizing important elements of story problems and are easily distracted by extraneous information. They may also be unable to inhibit irrelevant mathematical operations when presented with math problems. For example, when they see the problem $6 \times 4 = \ ?$, children with Mathematics Disorder might answer “10” because of their failure to inhibit the use of addition. Children with Mathematics Disorder also have difficulty retrieving math facts and, consequently, rely on immature strategies (e.g., counting) to solve math problems. As a result, their short-term memories are often overly taxed, and they are unable to devote sufficient resources to understanding and effectively framing math problems (Barrouillet, Fayol, & Lathuliere, 1997; Geary & Hoard, 2005).

Luke

Luke was a 10-year-old African American boy who was referred to our clinic because of behavior and academic problems. Luke earned below-average grades in most subjects, but he performed poorest in math. As a fifth grader, Luke could add and subtract simple numbers, but he had great difficulty with multiplication, division, and computations involving “borrowing” or “remainders.” His teacher recommended that he be “held back” next year so that he could get “extra practice” before progressing to junior high school.

Dr. Ideran observed Luke as he completed some math problems in her office. She noticed that Luke often arrived at the correct answer for addition, subtraction, and simple multiplication problems. However, he was largely unable to divide and his progress was extremely slow and effortful.

“You got a lot of them right,” she said, “but it takes you a long time, doesn’t it?” Luke replied, “Yeah. I’m not too fast.” Dr. Ideran asked, “So, how do you go about solving a problem like $4 \times 7$?” Luke was reluctant to answer. After a long pause and sigh, tears rolled down his cheeks. Embarrassed, Luke said, “I just start with four . . . and keep counting up by fours . . . until I get to the answer.” Dr. Ideran said, “Yes. That takes a lot of work and energy doesn’t it? Do you want to learn a better way?”
Treatment of Mathematics Disorder

Targets of Instruction

To treat Mathematics Disorder, therapists can target three areas: (1) preparatory arithmetic skills, (2) basic math computation skills, and (3) math problem solving (Kroesbergen & VanLuit, 2003). Interventions designed to teach preparatory arithmetic skills are usually directed toward very young children and youths with developmental delays. These interventions help children develop an appreciation for numerosity, the ability to recognize numerals, and basic counting skills.

Interventions designed to teach basic computational skills are directed at elementary school-age children with Mathematics Disorder. These interventions focus primarily on addition, subtraction, multiplication, and division. Often, interventions address more complex mathematical operations, such as operations involving three-digit numbers, long division, fractions, and decimals. These interventions help children acquire and automatize math facts and procedures.

Interventions that focus on math problem solving are usually reserved for older children who show adequate computational skills. These interventions provide children with training in understanding story problems and applying math facts and procedures.

Methods of Instruction

Clinicians generally rely on one of three methods for math instruction: (1) direct instruction, (2) self-instruction, or (3) mediated/assisted instruction (Goldman, 1989). Direct mathematics instruction involves the systematic presentation of math knowledge and skills. In direct instruction, the teacher introduces and demonstrates the skill following a carefully designed script. Then the skill is broken down into specific steps, which children perform. Teachers provide help and feedback regarding children’s performance, correcting children’s mistakes (see Table 7.3). Gradually, teacher assistance is faded as children gain mastery of the skill. Children are given repeated opportunities to practice the skill and extend it to new problems.

Self-instruction is a second method to improve children’s math skills. In self-instruction, teachers systematically present a series of verbal steps or “prompts” that children can use to solve math problems. Teachers model the use of these prompts as they complete problems on the blackboard in front of the class. Then, children are encouraged to use the prompts when solving their own problems, while the teacher monitors their use. Initially, teachers provide careful assistance to children in using the prompts. Eventually, teacher assistance is faded until children can use the prompts to solve problems on their own.

Teachers who use mediated/assisted instruction begin with the student’s understanding of the mathematical problem. Then they offer assistance and guidance to the child to help him solve the problem correctly. Mediated/assisted instruction does not involve the use of a script (as direct instruction) or a series of steps (as self-instruction). Instead, the teacher offers increasingly detailed hints at solving the math problem until the child is able to complete the problem successfully. In this
Table 7.3 Three Methods for Teaching Mathematics Skills

**Problem:** Anne had 9 apples. She gave 4 apples to her friend. How many apples does Anne have left?

**Direct Instruction**a

**Step A**
Read the problem with me. *Teacher reads the problem.*
What kind of problem is it? *Answer: Subtraction*

**Step B**
Good. It’s subtraction. Is the big number given? *Answer: Yes.*

**Step C**
Let’s read the problem again. *Teacher reads the problem again.*
Is 9 the big number or the small number? *Answer: The big number.*
What kind of number is 4? *Answer: The small number.*

**Step D**
Good. Now let’s take 9 and subtract 4. Watch me. Nine minus four is five.
Now you say “Nine minus four is five.” *Child repeats.*
Good. What is the answer? *Answer: Five*

**Step E**
Good. Now let’s read the next problem.

**Self-Instruction**b

Teacher introduces and demonstrates the following steps to solve story problems. Teacher encourages children to use the steps (first aloud, then silently) as she monitors.

**What are you asked?**
*How many apples does Anne have left?*

**What numbers do you have?**
9 and 4

**What number(s) do you need to know?**
*How many left?*

**What must you do?**
*Subtract, 9 – 4*

**What is the answer?**
5

**Check your answer.**
4 + 5 = 9, so it checks out!

**Mediated/Assisted Instruction**c

Teacher provides a structured sequence of hints to help the child complete the problem. Hints become gradually more specific and content-related until the child is able to arrive at the correct answer.

**Hint Strategy**

**Example**

**Simple negative feedback:**
Teacher asks child to check answer.
Your answer is not quite right. Try again.

**Working memory refresher:**
Teacher reminds child of important parts of the problem.
Remember, she has 9 and gives away 4.

**Numerals as memory aids:**
Teacher asks child to write down important parts of problem.
Let’s write it down in numbers: 9 – 4.

**Enumeration:**
Teacher uses a series of verbal instructions and numbers to guide child.
Nine apples [points to nine] minus four apples [points to four] is what?

**Complete demonstration:**
Teacher completes problems for child, giving rationale.
See. Nine minus four is five.

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b. Based on Fleischner and Manheimer (1997).
c. Based on Goldman (1989).
way, children are encouraged to derive their own way of solving math problems, rather than rely on a formal set of rules provided by the teacher.

**Efficacy**

Treatment techniques vary in their efficacy (see Figure 7.6). Interventions that use direct instruction tend to be most effective in improving children's basic computational skills. Self-instruction appears to be most effective at teaching higher-level math problem solving. Across all categories, mediated/assisted instruction is least effective. These results indicate that interventions that provide direct, systematic instruction should be incorporated into remediation programs for Mathematics Disorder (Kroesbergen & VanLuit, 2003).

![Figure 7.6 Effects of Mathematics Instruction](image)

Source: Based on Kroesbergen and VanLuit (2003).

Note: Youths who receive self-instruction show the greatest improvement in math skills. However, direct instruction was particularly effective in improving children's computational skills.

**Update: Daniel and Luke**

Dr. Butler administered the WISC-IV and the Woodcock-Johnson III Tests of Achievement to Daniel. Daniel's intellectual functioning (IQ = 101) fell within the average range. However, his standard scores on measures of reading (64) indicated significant deficits. Dr. Butler also noticed that Daniel's reading
Critical Thinking Exercises

1. What is the difference between Learning Disorders and learning disabilities?

2. Explain and critique the three main techniques used to identify children with learning disabilities.

3. Why might ethnic minority children or youth from low-income families be at increased risk for academic problems? How might state governments and local school districts prevent or alleviate learning disabilities among these at-risk children?

4. Compare and contrast phonics-based direct instruction with whole word approaches to treating reading disabilities. Which treatment strategy seems to have greater empirical support for young children with reading problems?

5. Develop an intervention program for (a) a 12-year-old boy with difficulty writing research papers in his seventh-grade history class and (b) a 10-year-old girl who has difficulty with math story problems.