CHAPTER 2

READING DISABILITIES

As we drove home down the 405 that summer, I tried to think of all the parts of myself that I was ashamed of, that I thought didn’t fit. I talked too fast, cursed, couldn’t spell, couldn’t sit still, mispronounced words, and interrupted people. I cried for a minute then told myself to stop. I decided, at twelve years old, as dramatic as this sounds, that I would be a soccer player, nothing more. Just be that dumb jock... This was the only way I could envision my life. — Jonathan Mooney, The Short Bus (p. 32)

This chapter provides critical background knowledge about reading disabilities. Reading disability is defined, and statistics on the prevalence of RDs are stated. An overview of the reading process is also provided to better illuminate how traits common to RDs affect the act of reading. The diversity of these traits, both negative and positive, are then described.

1 Definitions and Terminology

Many terms are used to refer to disabilities that affect reading. Dyslexia is perhaps the most well-known, but other terms used over the years include word blindness, phonological processing disorder, strephosymbolia (twisted letters), and visual stress (Edwards, 1994; Wolf & Boulton, 2007). Dyslexia is sometimes broken into different subtypes: auditory, phonological, and orthographic (Evans, 2001). Each term reflects changing scientific perspectives that emphasized or ignored different symptoms and traits (Pollak, 2005, Chapter 1). The meanings have been further shifted in disability legislation and educational policies by politicians and administrators. Popular notions, sometimes wildly inaccurate from what science tells us, have become ingrained in our daily lives (D. Mills, 2005). As each term brings with it a conflux of politics, histories, assumptions, and nuances, they are not interchangeable. Rather than selecting one to use consistently, I choose to use the more general, catchall term reading disability (RD). This choice does not restrict me to any one condition. At times, I will use a more specific term when referring to the work of others or quoting the term used by a person with an RD.
1.1 Defining Reading Disability

Still, defining reading disability is a complicated matter, due in part to a history of changing views as to underlying causes. As originally hypothesized by James Hinshelwood in 1895, a neurological deficit led to “word blindness” in individuals of otherwise fair intelligence. Debate and questions raged as to whether said deficit existed from birth or was the result of trauma (Edwards, 1994; Sandak, Mencl, Frost, & Pugh, 2004; Mooney, 2007). Others suggested that the fault lay in the eyes and other sensory systems (Edwards, 1994; Evans, 2001). Perhaps, voiced another group, RDs are not the result of a defect or problem, but just an extreme learning style or multiple intelligence antagonistic to reading (Powell, Moore, Gray, Finley, & Reaney, 2004; Mooney, 2007) or constructed and exacerbated via social expectations (McDermott, 1993).

Despite the hundred plus years of debate, two elements have always been present in the definition of RDs. First, and perhaps the more essential of the two, the person exhibits profound difficulty in learning and performing the process of reading and related tasks (e.g., writing and spelling). Secondly, the person is provably intelligent but still experiences difficulty with reading even after tutoring and education is provided.

1.1.1 Definition and Diagnosis by Exclusion

Defining a reading disability is often accomplished by explaining what it is not. When a person, often a young student but occasionally an adult, shows marked difficulty with reading, the first course of action is to rule out other potential causes for the difficulty. For example, consider the RD definition used by Dickinson, Gregor, and Newell (2002, p. 97):

A disorder manifested by difficulty in learning to read despite adequate intelligence, and sociocultural opportunity

The first alternative explanation to rule out is the subject’s intelligence. Intelligence testing helps confirm if the cognitive potential is present for engaging in reading. Such testing is typically not limited to just general intelligence measures (i.e., IQ) and will often involve assessments of multiple skills and abilities. For example, the Weschler Intelligence Scale for Children (revised) gives measures of multiple skills, including vocabulary, reading comprehension, arithmetic abilities, memory, and spatial reasoning (Edwards, 1994). Such assessments better identify the person’s areas of difficulty, and it is not uncommon for a person with RD to show inconsistent levels of ability on the different skills. Edwards (1994, p. 5–9) provides an example of a dyslexic student who, despite being significantly below average in some reading and memory skills, scores in the top percentile on abstract reasoning, vocabulary, and judgment skills.

The second alternative explanation to exclude in Dickinson et al.’s RD definition is lack of sociocultural opportunity. By this, they mean that the person should have received at least some initial instruction in the unnatural act of reading. Furthermore, unpracticed skills fade over time. Just as how learning French in high school but not using it until a trip to Paris twenty years later will be problematic, a person’s reading skills and
abilities will grow rusty and inefficient without regular practice. Simply put, a person needs the opportunity and encouragement to practice reading beyond the initial instruction.

The definition used by Dickinson et al. (2002) fails to exclude another potential reason for poor reading performance: poor vision. Many definitions of reading disabilities also recommend ruling out any potential visual impairments before labeling a person as having an RD (Evans, 2001). Being blind or having low vision is a sensory disability, not a reading disability. Additionally, vision problems like nearsightedness, farsightedness, and astigmatism can hinder the reading process by inducing physical strain and exhaustion when reading. Evans, a professor of optometry, has experienced and commented about multiple cases of children struggling with reading showing marked improvement after receiving proper vision care (2001).

1.1.2 Working Definition
Reasonable alternatives are thus always ruled out before diagnosing a reading disability. Although it may seem unscientific to define RD as poor reading performance for reasons not identified, remember that reading disabilities are best thought of as a syndrome of related conditions. Moreover, reading itself is a complex process and problems can manifest at any point or points in that process. Diversity is to be expected. This is why after ruling out other possibilities, additional neuropsychological exams are then administered to better understand the exact nature of the person’s reading disability (Edwards, 1994; Peer, 2001; Ashton, 2001). Thus, the definition of reading disability used in this dissertation reflects both ruling out alternatives and the inherent diversity possible:

A reading disability is a syndrome of multiple conditions in which a person experiences difficulty with one or more aspects of the reading process despite possessing sufficient intelligence, learning, practice, and sensory capability.

1.2 Related Terminology
As shown in Figure 2.1, reading disabilities are a subset of several classes of disability. Although this dissertation focuses on RDs, these other classes occur frequently enough in the literature to warrant a brief coverage here. Working inward, this all begins with the concept of disability. As defined by the Americans with Disabilities Act (ADA) (1990) and the World Health Organization (Sears & Young, 2003), a disability is a physical or mental difference/impairment that negatively impacts one or more major life activities.

One major subclass of disability is cognitive disabilities. Associated with the brain and its functioning, these disabilities affect aspects of learning, memory, emotions, thinking, sensory processing, socialization, and communication (American Psychiatric Association (APA), 2000; Dawe, 2006). They also range in degree of severity: mild, moderate, severe, and profound. Thus, a broad range of conditions are considered cognitive disabilities. Psychological conditions such as obsessive-compulsive disorder and depression are members of
Figure 2.1: Venn diagram showing the nested relationship of reading disability to specific learning disability to learning disability to cognitive disability.

Of particular importance to the topic of this dissertation is the subclass of cognitive disabilities known as learning disabilities (LDs). Typically of mild to moderate severity, a learning disability affects the learning and maintenance of new skills (APA, 2000). LDs are often thought of as being of two types. General learning disabilities affect all areas of learning. Example of this type includes attention-deficit disorder (ADD/HD)\textsuperscript{5} as well as some forms of mental retardation, brain trauma, and autistic spectrum conditions.

Specific learning disabilities (SpLDs), on the other hand, only affect the learning of a specific set of skills (APA, 2000). A reading disability is an SpLD that impairs reading. Other SpLDs include dyscalculia (mathematical ability), dysgraphia (handwriting and composition), and dyspraxia (motor coordination). For the vast majority of people with SpLDs, their general abilities to think and act are within a range of normal expectations for their age. In fact, as discussed earlier, people with SpLDs typically show inconsistent ability levels on different cognitive tasks. However, if an individual has one SpLD, he or she is likely to also have other specific learning disabilities, though the degree of severity will differ. In particular, 80-90\% of all people with SpLDs have been found to experience significant difficulty with reading (Kavale & Reese, 1992; Eden & Vaidya, 2008).

Not shown in Figure 2.1, RDs, LDs, and some cognitive disabilities are also members of the class of
hidden/invisible disabilities (Cory, 2005). As the name suggests, hidden disabilities are not readily apparent to others. Many disabilities have visual markers of the condition that broadcast their presence: wheelchairs, tics, white canes, hearing aids, etc. When a person with an invisible disability interacts with others, knowledge of the disability will only be made known if the person discloses the disability to somebody. One cannot simply look at a person and know that he or she has a reading disability. Thus, invisible disabilities allow a person to choose to pass as normal thereby avoiding any perceptions or stigmas associated with his or her disability.

Another classification scheme identifies people with print or text access disabilities as group. With these disabilities, the primary issues of access concern written or printed text (Bookshare, 2010b). This disability class includes RDs as well as many visual disabilities. Some motor disabilities may be included if one considers that holding and turning pages of a book are issues of text access.

2 Prevalence of Reading Disabilities

The invisible nature of RDs provides a challenge in determining the number of individuals affected by them. The aforementioned vagaries of definitions and the usage of different terms to label the condition further complicate the task. One particular complication is determining at what point difficulty with reading is severe enough to warrant the label of a reading disability. Another difficulty is that statistics on disabilities may combine reading disabilities with other learning disabilities.

2.1 Statistics

Studies have revealed that upwards of 90% of individuals of all ages with learning disabilities experience significant difficulties with reading (Kavale & Reese, 1992). With these difficulties in mind, current estimates indicate that between 5 and 15% of the world’s population has some form of an RD (Sands & Buchholz, 1997; Evans, 2001). More specific statistics regarding RDs among adults are available from educational institutions. In the 1990s, students with learning disabilities enrolling in U.S. postsecondary institutions were the fastest growing group of students enrolling with reported disabilities. A biennial survey found that the percentage of college freshmen reporting having a learning disability grew from 1% in 1988 to 2.4% in 2000, which represents approximately 27,000 out of 1.1 million undergraduates (Henderson, 2001).

Furthermore, the size of the RD population relative to other disability types is large. According to a 1999 NCES study, students with LDs comprised 46% (195,870 out of 428,280) of students registered with disability services at 2- and 4-year postsecondary institutions in the United States (L. Lewis et al., 1999). The next largest group, mobility disabilities, was one-third the size. However, another NCES study (Horn, Nevill, & Griffith, 2006) that surveyed a sample of 80,000 undergraduates and 11,000 graduate students in the U.S. found that 11.3% of students reported having a disability, of which 7.1% reported having a specific learning disability and 25.3% reported mobility-related disabilities.
The differing findings of the two NCES studies highlight some of the difficulties in gathering statistics on disability prevalence. Foremost is the difference between confirmed disability status used in the 1999 study versus self-reported identification used in the 2006 study. Some of the self-reports may be false, while some disabled students may not self-report. Flaws also exist in considering only students registered with disability services. Disabled students are not required to register; they have complete control over that decision. Thus, the raw numbers in the 1999 study probably undercounted the true number of students with disabilities. Moreover, studies have indicated that students with invisible disabilities, which include LDs and RDs, tend to avoid disclosing their disabilities and often avoid or delay registering with disability services (Henderson, 2001; Cory, 2005). This suggests that students with LDs were unlikely to have been counted accurately in either NCES study. Regardless of the actual numbers, students with RDs/LDs are clearly present in postsecondary education.

2.2 Languages

Variations of reading disabilities occur in all languages, even logographic languages like Japanese (Smythe, Salter, & Everatt, 2004). How the RD manifests, however, is dependent on the language and its complexity. With English and Greek, for example, the languages differ greatly in terms of orthographic depth—the complexity of the phonological mapping between letters and sounds. English has a notoriously complex mapping (e.g. -ough can be pronounced at least six ways), while Greek uses a simpler, regular mapping with very few exceptions (Seymour, Aro, & Erskine, 2003; Protopapas & Skaloumbakas, 2007). Thus, a person with an RD in English is more likely to experience difficulty with identifying and sounding out words due to the inherent difficulty within the language. For Greek individuals with RDs, word identification problems are less common. However, both English and Greek individuals with RDs experience slower reading speeds than the typical population (Protopapas & Skaloumbakas, 2007).

3 The Reading Process

A key to understanding reading disabilities is to understand the actual process of reading—from visual identification of letters on the page to comprehending a text in isolation as well as relative to previously read texts. Figure 2.2 shows a simplified model of reading broken into four component stages. Each stage

Figure 2.2: Diagram of the main stages of the reading process. For clarity, talkback from latter stages to previous stages is not shown.
depends on the outcomes of the previous ones. Thus, errors or difficulties experienced in one stage may lead the reader to return to a previous stage.

3.1 Visual Text Input
With the exception of haptic approaches like Braille, reading begins with the eyes. Light reflects off of the reading surface (page or screen), enters the eye, and triggers a series of chemical reactions that send nerve impulses to the visual cortex. The same events occur when we watch television, gaze at the stars, or look at a pony. Although the underlying sensory process is the same, several aspects make reading a unique visual task. Reading requires attention to a finely detailed scene composed of a series of similar shapes. These shapes are laid out in a regular fashion in what is essentially a two-dimensional format. Thus, reading contrasts sharply with most of the visual tasks we conduct in our daily lives (Everatt et al., 1999; Evans, 2001).

When it comes to how the eye moves during reading, one might think that the eye scans continuously across each line, inputting each character one by one. Eye tracking studies, however, reveal a punctuated process (Tinker, 1965; Rayner, 1983). The reading eye actually operates via repeated sequences of pauses (fixations) and movements (sweeps and saccades).

During a fixa\textemdash\textcircled{tion}, the eye is paused for 100–500 milliseconds, with an average of approximately 250 milliseconds (Rayner, 1983). This pause allows the eye to take in a set of characters—the perceptual span. Quantifying how many characters are found within the perceptual span is complicated. Only 4–5 characters are seen with perfect acuity, but surrounding text is also seen. Although seen with less acuity, some visual processing is applied to this surrounding text (Geiger & Lettvin, 1999). After a fixation, the eye usually moves on to the next text. At the end of a line, a large motion known as a sweep occurs to move the eye to the start of the next line. Otherwise, the eye moves forward an average of 7–9 characters This motion, called a saccade, takes only 20–30 milliseconds (Rayner, 1983). Not all saccades move forward in the text (to the right in English); the eye may engage in a regression to review previously read text. During sweeps and saccades, the visual system runs in a reduced capacity, omitting fine details that would blur due to the eye’s motion (Pepper & Lovegrove, 1999; Evans, 2001).

3.2 Letter and Word Identification
The next stage of reading, as shown in Figure 2.2, begins the deciphering the inputted text via identifying letters and words. The actual process for how this identification occurs has been one of the most debated topics in the reading sciences (Perfetti, Zhang, & Berent, 1992). Multiple models for word identification exist (Harm, McCandliss, & Seidenberg, 2003; Perfetti, Liu, & Tan, 2005; Coltheart, 2006), but discussing and debating their relative merits is beyond the scope of this paper. Instead, only the dual\textemdash\textcircled{route model} is highlighted due in part to its record of empirical support (Perfetti, 1999; Seymour et al., 2003; Coltheart, 2006) and, as shall be shown, its utility in understanding the nature of reading disabilities.
Figure 2.3: The dual-route model of word identification.

Figure 2.3 highlights the two key components of the dual-route model of word identification. First, words are identified through an incremental process in which the identification of letters and common letter groupings (e.g., “de-” and “-ing”) build up to word recognition. Second, two parallel processes work in conjunction: a visual channel and an auditory channel. The visual channel uses the shapes of letters and morphemes (groups of letters) to build up a notion of the word. The aural route simultaneously converts the symbols to simple letter sounds and more complex phonemes. For example, the word “greats” could be separated into the phonemes “gr-,” “-ate,” “-eet,” and “-s.” Note that the morpheme “eat” has two common pronunciations, hence the activation of both possibilities. Each morpheme and phoneme is associated with various words, and via the dual-route model, the most likely word is chosen.

Brain scans and studies of people with brain trauma have demonstrated that these channels exist and are processed separately in the brain (Coltheart, 2006). Although separate, the two processes show signs of intercommunication (Perfetti et al., 1992). Reading fluency, the ability to read both accurately and quickly, depends on proper functioning of both channels.

Despite their equal importance, the auditory channel has been shown to be the primary driver of word identification—an unsurprising result given language’s vocal origins (Perfetti et al., 1992). Still, some words are recognized quickly by the visual channel. Known as sight words, these words are those encountered frequently by readers (Ehri, 1997). Examples include articles, words of short length, and common verbs. Other sight words are words that fall outside of the language’s rules for spelling and pronunciation, thus posing a challenge for recognition by the auditory channel. Development of sight words is a necessary trait for becoming a fluent reader (Ehri, 1997).

Although not shown in Figure 2.2, difficulty with identifying the current word may trigger a regression saccade. This then allows for review and error-checking of previous letters and words. For long words in particular, misidentification of earlier letters and word parts will stymie and complicate word identification.
3.3 Word Sense Disambiguation

Reading does not stop with the deciphering of words, though. Reading comprehension begins with the association of meaning to identified words (see Figure 2.2). The challenge here is that in many languages, words often have multiple meanings or senses. Word sense disambiguation is the task of identifying the most relevant interpretation of the word given the context of the surrounding text. Consider the sentence: “The bank was flooded with patrons demanding quarters.” The word “bank” alone has at least eighteen distinct meanings (Table 2.1). Knowledge of grammar automatically rules out eight of the senses, however, as bank is used as a noun and not a verb.

However, grammar alone is not sufficient to completely disambiguate the senses of words. The W. Kintsch (1998) model of sense disambiguation and comprehension during reading consists of two phases: construction and integration. During the construction phase, a mental representation is formed of the text. Word by word, new propositions, sense interpretations, and relations are constructed and added to this representation base on the text and its grammar. At this stage, however, the model may contain inconsistent, contradictory elements due to the presence of multiple sense interpretations. The integration phase addresses these inconsistencies by calling upon the reader’s knowledge and experience relevant to the current understanding of the text. Using this information, the text representation is pruned by rejecting inappropriate parts while maintaining the most consistent and coherent ideas. Construction and integration repeat as more text is read.

Figure 2.4 shows a simplified example of Kintsch’s model in action. Four iterations of the construction-integration process are shown for the sentence: The bank was flooded with patrons demanding quarters. Initially, no distinction can be made of the word “bank.” Two likely senses for bank are conceptualized: side of a river and money institute. It is unlikely that both are simultaneously relevant, but both possibilities are included in the model. Next, the word “flooded” lends support to “side of a river” being the better interpretation given that flooding is more associated with water than an institution involving money. The word “patrons” reverses this support, making either of the two senses likely. Upon reading the word “quarters,” the reader’s mental understands that a large mass of people demanding 5-cent coins have entered the bank building.

An aspect of Kintsch’s model not shown in Figure 2.4 is the key role of memory. Sense disambiguation occurs via personal knowledge and the read text. However, the process is constrained by the limits of working memory. With each word and sentence, parts of the mental representation are shunted off to long-term memory in order to make room for the next piece of text. The few components that remain provide context that is used in the comprehension of the next sentence as well as retrieval cues to the information in long-term memory (W. Kintsch, 1998).

Additionally, Kintsch’s model suggests why sense disambiguation may break down. If an earlier word has been misidentified, the current working understanding of the text may be malformed or misleading. Poor or

<table>
<thead>
<tr>
<th>Noun</th>
<th>Verb</th>
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<tbody>
<tr>
<td>1. sloping land (especially the slope beside a body of water)</td>
<td>1. tip laterally</td>
</tr>
<tr>
<td>2. a financial institution that accepts deposits and channels the money into lending activities</td>
<td>2. enclose with a bank</td>
</tr>
<tr>
<td>3. a long ridge or pile</td>
<td>3. do business with a bank or keep an account at a bank</td>
</tr>
<tr>
<td>4. an arrangement of similar objects in a row or in tiers</td>
<td>4. act as the banker in a game or in gambling</td>
</tr>
<tr>
<td>5. a supply or stock held in reserve for future use (especially in emergencies)</td>
<td>5. be in the banking business</td>
</tr>
<tr>
<td>6. the funds held by a gambling house or the dealer in some gambling games</td>
<td>6. put into a bank account</td>
</tr>
<tr>
<td>7. a slope in the turn of a road or track; the outside is higher than the inside in order to reduce the effects of centrifugal force</td>
<td>7. cover with ashes so to control the rate of burning</td>
</tr>
<tr>
<td>8. a container (usually with a slot in the top) for keeping money at home</td>
<td>8. have confidence or faith in</td>
</tr>
<tr>
<td>9. a building in which the business of banking is transacted</td>
<td></td>
</tr>
<tr>
<td>10. a flight maneuver; aircraft tips laterally about its longitudinal axis (especially in turning)</td>
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Figure 2.4: Mental model (based on W. Kintsch, 1998) held by the reader of the sentence: The bank was flooded with patrons demanding quarters. The reader’s mental model for the word “bank” after the construction and integration phases are shown. For clarity, only senses 1 and 2 from Table 2.1 are shown.
limited working memory may also lead to a poor mental model of the text. Additionally, the reader’s own knowledge background relative to the text is critical. If the knowledge is lacking, the mental representation will not be able to reduce the level of coherency and will result in a larger mental representation to deal with. As more text is read, the size limit of working memory forces large chunks of this representation into long-term memory. Without this context, the interpretation of a word or sentence may become independent of the previous ones. Greater relevant knowledge will lead to the reader having a refined, well-developed text representation that stays in working memory. Such problems with sense disambiguation may lead the reader to reread previous text, thus reengaging the earlier stages of the reading process.

### 3.4 Reading Comprehension

Reading comprehension goes beyond understanding the meaning of individual words, however. Comprehension is not just about making sense of a text but also the ability to predict, summarize, question, and clarify parts or the whole of a text (Palinscar & Brown, 1984). Different reading tasks also demand different types and levels of comprehension. Some tasks concern finding a specific piece of information (Fraser & Schwartz, 1979). Others are about deep interpretation and meaning-seeking, such as in reading poetry (Peskin, 1998). Identifying an author’s motivation and determining his or her credibility are other common tasks (Haas & Flower, 1988; Wineburg, 1991; Britt, Perfetti, Dyke, & Gabrys, 2000). Comprehension can also involve the comparison, contrast, and integration of multiple texts (Wineburg, 1991; Spoehr, 1994; Perfetti, Rouet, & Britt, 1999; Wiley & Voss, 1999).

The inherent vastness of what reading comprehension entails and requires cannot be discussed in full in the confines of this simple introduction. However, several factors are known to influence comprehension. As shown in the Kintsch model, relevant situational knowledge is a critical aspect for successful comprehension (Perfetti, Marron, & Foltz, 1996; W. Kintsch, 1998). An important aspect for acquiring such knowledge is through texts previously read by the reader. Novice-expert studies of reading skills in specific disciplines have shown that more experienced readers tend to recall and reference texts they are familiar with (Haas & Flower, 1988; Wineburg, 1991; Peskin, 1998).

Proper letter and word recognition skills are also strongly associated with efficient reading comprehension. Holmes (2009) showed in a study of adult readers that rapid and accurate low-level reading processes liberate resources for the crucial higher-level comprehension processing, ultimately resulting in more efficient text comprehension. Similarly, how a text is structured can influence the efficiency of reading as well as recall of the text. Different structures can benefit or hinder different reading tasks such as exam taking (Santos Lonsdale, Dyson, & Reynolds, 2006) and information searching (Fraser & Schwartz, 1979). More generally, as experts tend to organize data by forming conceptual neighborhoods (often hierarchical) of tightly-linked facts and concepts, texts that are structured similarly will tend to support recall (Spoehr, 1994).
Table 2.2: Summary of traits common to reading disabilities. Presence and severity of each trait is likely to significantly differ from individual to individual.

<table>
<thead>
<tr>
<th>TRAIT</th>
<th>DESCRIPTION</th>
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<tbody>
<tr>
<td>Poor lateral masking</td>
<td>Difficulty filtering out surrounding text</td>
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<td>More regression saccades</td>
<td>Repeated rereading of earlier text</td>
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<td></td>
<td>Potentially earlier onset of reading fatigue</td>
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<tr>
<td>Letter and word misidentification</td>
<td>Addition, substitution, or removal of letters</td>
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<td></td>
<td>Rearrangement of letters in a word</td>
</tr>
<tr>
<td>Rapid naming deficit</td>
<td>Slow visual recognition of letters and sight words</td>
</tr>
<tr>
<td>Phonological processing deficit</td>
<td>Slow recognition of phonemes</td>
</tr>
<tr>
<td></td>
<td>Difficulty sounding out words</td>
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<tr>
<td>Comprehension difficulties</td>
<td>Rearrangement of words in sentences</td>
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<td></td>
<td>Difficulty disambiguating senses of individual words</td>
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<td></td>
<td>Fewer cognitive resources available for higher-level comprehension tasks</td>
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<tr>
<td>Memory issues</td>
<td>Less short-term working memory</td>
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<tr>
<td></td>
<td>Slower recall</td>
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<td></td>
<td>Poor visual memory</td>
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<tr>
<td>Poor sequential processing</td>
<td>Difficulty following directions</td>
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<td></td>
<td>Skipping or repeating lines of text</td>
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<td></td>
<td>Problems remembering orderings</td>
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<tr>
<td>Visual stress</td>
<td>Movement and blurring of letters</td>
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<td></td>
<td>Headaches and eye strain</td>
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<tr>
<td></td>
<td>Difficulty sustaining reading efforts</td>
</tr>
<tr>
<td>Writing difficulties</td>
<td>Poor spelling and proofreading skills</td>
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<tr>
<td></td>
<td>Difficulty with logical organization</td>
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<tr>
<td>Attention issues</td>
<td>Increased comorbidity of ADD/HD</td>
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<tr>
<td></td>
<td>Potential for distractibility and increased frustration</td>
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<td></td>
<td>Peripheral distractions when reading</td>
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<td>Motor coordination difficulties</td>
<td>Increased comorbidity of dyspraxia</td>
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<tr>
<td></td>
<td>Weaker fine motor control</td>
</tr>
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<td></td>
<td>Poor body coordination</td>
</tr>
<tr>
<td>Social and psychological issues</td>
<td>Bullying and verbal / emotional abuse from others</td>
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<tr>
<td></td>
<td>Low self-esteem, depression, and poor stress management</td>
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<td></td>
<td>Avoidance of or self-diminished performance with certain tasks</td>
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<tr>
<td>Visiospatial strengths</td>
<td>Strong spatial awareness</td>
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<td></td>
<td>Proficiency in abstract visualization tasks</td>
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<tr>
<td>Creative thinking skills</td>
<td>Increased lateral thinking skills</td>
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<tr>
<td></td>
<td>Talents in art and design</td>
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</table>

4 Characteristics of Reading Disabilities

Now that a basic foundation about the reading process has been established, the specific characteristics of RDs can be discussed. As reading disabilities are a collection of conditions that affect a significant portion
of the population, one can reasonably expect a wide degree of diversity in how RDs manifest (Hammond & Hercules, 2003; Dickinson et al., 2002). A summary of these many traits is provided in Table 2.2, and this section provides coverage of these characteristics. Aspects specific to the reading process are presented first. Additional difficulties common to reading disabilities are also discussed as well as strengths and positive traits often found among people with RDs.

4.1 Difficulties with the Reading Process

The previous section detailed the reading process. This complex series of actions starts with vision and ends in high-level cognitive processing. Reading disabilities can impact every stage of this process. Moreover, each stage influences latter stages. When one reading specific reading challenge occurs, this will more than likely trigger a cascade of further difficulties.

4.1.1 Visual Input Issues

In terms of visual health, people with reading disabilities are very much like the general population (Evans, 2001). There is no evidence that people with RDs experience greater rates of nearsightedness, farsightedness, astigmatisms, etc. Furthermore, despite earlier theories that RDs were a result of a mismatch between handedness and eye dominance (e.g., left-handed by right-eyed), crossed dominance is not more common among people with dyslexia than among the general population. There is, however, some minimal evidence to suggest that people with dyslexia require more physical effort to keep both eyes aligned correctly (binocular stability), which may produce blurry vision that could perhaps potentially negatively impact reading. As the many qualifiers in the previous sentence suggests, binocular instability is not viewed as a major contributing factor to RDs.

One identified difference in visual performance among people with RDs is in the capability to perform lateral masking. Lateral masking is the ability to filter out and ignore visual input outside of the primary region of visual focus. When reading, for example, a small section of text (a word or two) is placed in the foreground and seen in fine detail. The additional text to the left or right of this focus, however, is masked to reduce its clarity and any potential interference with the foreground. Geiger and Lettvin (1999) analyzed readers’ ability to accurately recognize letters in the periphery of their vision. In ordinary readers, accuracy was highest near the center of the reader’s gaze but dropped off quickly further from the center. For readers with dyslexia, though, accuracy remained higher further into the periphery. Thus, dyslexic readers have a reduced ability to mask and ignore surrounding letters when reading. However, this difference may not be an innate aspect of reading disabilities. Additional studies by Geiger and Lettvin (1999) showed that the differences in lateral masking could be influenced by the direction of fatigue and training. Notably, among dyslexic readers of Hebrew (which is read right-to-left), accuracy was maintained further into the left visual periphery than the right. Similarly, the accuracy was maintained further into the left periphery for for dyslexic readers of left-
to-right languages (e.g., English, Italian, and German). Geiger and Lettvin postulated that decreased lateral masking when reading may be an attempt at compensating for decreased reading performance.

Eye-tracking studies have also reported that people with RDs make more regression saccades than non-disabled readers (Rayner, 1983; Pepper & Lovegrove, 1999). These quick movements to previous text on a line have been shown to not be caused by improper eye muscle control, however. Instead, they are likely indicative of a need to reconfirm previously read text (Evans, 2001). Thus, the eyes of a reading-disabled reader engage in more overall movements than the typical reader.

Finally, going behind the eyes, the brains of people with reading disabilities also show some distinctive differences. Neuroimaging studies conclude that the brains of people with RDs more resemble those of beginning readers in that brain activity during reading is less distributed in both groups as compared to the distributed processing seen in more advanced readers (Bilger, Laginess-O’Neill, & Howes, 1998; Sandak et al., 2004). Thus, it is hypothesized that the reading processes in people with RDs use mental resources less effectively and are thereby less efficient at all stages of reading.

4.1.2 Letter and Word Misidentification

Misidentification of letters and words, often considered to be the hallmark trait of reading disabilities, can take many forms (Peer, 2001). Letters can be added or dropped from a word. Letter or words with similar shapes may be interchanged. Letters may be rearranged. These misidentifications significantly impact all of the reading process as word identification is an early and crucial stage of the process. Research into reading disabilities has largely focused on this stage of reading, and in doing so, two common performance deficits have been identified: a rapid naming deficit and a phonological processing deficit (Wolf & Bowers, 2000; Wolf et al., 2002). For many clinical definitions, a person with dyslexia is said to have one or both of these deficit (Wolf et al., 2002).

The rapid naming deficit refers to difficulty in the ability to quickly visually identify and name basic information signs such as letters or numbers. This deficit is most pronounced in the early stages of the dual-route model in Figure 2.3 (Letter Sound and Letter Form specifically). Despite its early place in the word identification process, this deficit does not intrinsically lead to misidentification due to calling a ‘b’ a ‘d’ or a ‘6’ a ‘5’. The rapid naming deficit is primarily about the speed of reading.

To illustrate this distinction, Deeney, Wolf, and O’Rourke profiled a young boy with a rapid naming deficit but no other discernible reading disability. This nine year-old boy showed strong verbal skills and a well-formed vocabulary for his age. He would show remarkable slowness but high accuracy when reading—a distinct lack of fluency and automaticity. His awareness of being a slow reader would at time cause him to push himself to read faster, thus introducing more reading errors (misidentifying or skipping words). Thus, the rapid naming deficit is primarily about the efficiency of reading. It primarily impacts the recognition of
low-level elements of text (i.e., letters), but it can also limit the ability to achieve reading fluency due to the lack of acquiring sight words.

The **phonological processing deficit**, however, is more about processing than identification issues. Phonological processing is the ability to understand and manipulate the sound components of language. In reading, this includes translating individual morphemes into phonemes (see the dual-route model in Figure 2.3) as well as the ability to combine said phonemes into complete words. An individual with a phonological processing deficit experiences noticeable difficulty in performing these tasks in both speed and accuracy. Essentially, such an individual fails to develop the automaticity or fluency seen in average readers when it comes to sounding out words. Sarah Entine, a filmmaker with dyslexia, notes that as a child, the concept of letters making sounds was an alien notion to her and still is a difficult concept for her to grasp (Entine, 2009).

As mentioned earlier in Section 2.2, the phonological mapping between letters and sounds does have some regular structure, though the complexity of the mapping does vary among languages. Readers with phonological processing deficits can thus develop strategies and rule sets to help with word identification. Unfortunately, words with irregular phonetic structures, of which there are many in English, can pose particular challenges. For example, the phoneme/morpheme “-eat” is usually pronounced with a long ē as in “eat” and “meat”. However, the word “great” is pronounced with a long ā even though the rules would suggest otherwise. Thus, a reader with a phonological processing deficit may misidentify the word as ‘greet’ instead.

Misidentification is also associated with a common misconception about reading disabilities—reversals. In English and many other orthographies, some characters can be flipped, rotated, or inverted to resemble other characters. A ‘b’ can become a ‘d’ through horizontal flipping, and either can become a ‘p’ or ‘q’ through a vertical transformation. Such reversals are often purported to be the main feature/cause of dyslexia: seeing letters backwards and/or upside-down (Harman, 1982; Gregor, Dickinson, Macaffer, & Andreasen, 2003; Entine, 2009). However, this reasoning is quite flawed. As Harman (1982) questions, why would the eyes of a dyslexic person only occasionally flip some characters and nothing else?

The far simpler explanation is that reversals are a symptom, not a cause, of reading disabilities like dyslexia. Every reader has reversed letters at some point in their lives, and reversals are quite common in those learning to read. Even experienced readers may reverse a letter while reading, becoming more common when tired or rushing through a text (Harman, 1982). Most importantly, reversals occur during the process of word identification. A letter reversal will only occur if it results in an actual word. Quite simply, “bad” may become “dad,” but “different” will never be read as “bifferent.”

### 4.1.3 Word Sense Ambiguity

As previously discussed in Section 3.3, reading comprehension begins with determining the specific meaning or sense of the words. Moreover, word sense disambiguation can break down in multiple ways. An immediate
and obvious detriment is when a word is misidentified. An incorrect word essentially pollutes the working text model. Mental resources are wasted attempting to disambiguate the misidentified word. The invalid word also introduces irrelevant associations during the integration phase, further muddying the process. Unfortunately, recognizing that a word was misidentified does not instantly rectify the situation. Fragments of the erroneous word may persist in the reader’s working model, falsely strengthening some concepts over others. Similar problems may occur when a word is accidentally skipped.

A person with an RD may experience further difficulties with sense disambiguation due to memory issues. Some people with RD report difficulties with memory and organizational skills, including the movement of short-term memory to long-term storage (Edwards, 1994; Raskind & Higgins, 1998; Mooney & Cole, 2000; Dickinson et al., 2002; Hammond & Hercules, 2003). Recall that Kintsch’s model of sense disambiguation is constrained by the reader’s working memory (W. Kintsch, 1998). Poor memory performance will hinder the reader’s ability to maintain relevant information from previously read text, thus hindering the sense disambiguation process.

Furthermore, the sense disambiguation process is in part driven by the reader’s knowledge relevant to the text. The more well read a reader is, the more efficient and effective the integration process will be (W. Kintsch, 1998). However, we know from longitudinal studies of reading behaviors, children who read less often than their peers continue to read less and less often relative to their peers as they reach adulthood (Cunningham & Stanovich, 1997). The struggles with early reading experienced by a child with an RD may very well lead to an aversion to reading and subsequent poor sense disambiguation. However, not all people with RDs become averse to reading. Jonathan Mooney, for example, was diagnosed with dyslexia in early childhood and graduated with honors in English literature from Brown University (Mooney, 2007).

4.1.4 Reading Miscomprehension

Misidentification and difficulty making sense of words in a text undoubtedly complicate and negatively impact reading comprehension in terms of both speed and accuracy. Venable (2003) identifies numerous ways in which word confusion can complicate understanding, including difficulties with metaphors, pronouns, sentence complexity, and inferring meaning from context. Memory issues may also influence comprehension, particularly in the recall of earlier sections in a large text or maintaining awareness of distinct components (i.e. characters or plot threads). Background knowledge and contextual information may also be lacking due to a hesitancy to engage in reading (although these can be gained through means other than reading).

However, recall that specific skills are needed for expert reading in a discipline (Haas & Flower, 1988; Wineburg, 1991; Peskin, 1998). How a reading disability may impact these higher-level skills, unfortunately, has not yet to be studied in detail. However, circumstances have enabled some critical issues to come to light. Due to disability education legislation in Britain, schools are required to include students with disabilities in
the general classroom (Peer & Reid, 2001). In high school courses, however, a certain phenomenon started to be observed: a decline in the academic performance of students with dyslexia who had performed well previously (equivalent to their non-dyslexic peers) with the aid of accommodations. Cory (2005) noted that some American college students similarly experienced a drop in their performance despite believing that they had successfully addressed their learning disabilities in high school.

One potential explanation may be understood in terms of available cognitive energy and resources. With accommodations, the dyslexic students were able to perform the same as their peers but were also applying nearly the whole of their available cognitive resources to doing so. When new reading tasks arose in the more difficult high school courses, they lacked the spare resources possessed by their peers to engage in the new activities. Time and practice may help streamline the resources to better address these difficulties. Different forms of accommodations may also help. Still, the full impact of RDs on higher-level reading comprehension activities is an open question.

4.2 Other Common Difficulties

Not all difficulties associated with RDs are specific to reading, however. Various other elements of cognition, physical ability, and social interaction may also be affected.

4.2.1 Memory Issues

As previously reported, many individuals with RDs report memory difficulties (Raskind & Higgins, 1998; Dickinson et al., 2002; Hammond & Hercules, 2003). Short-term memory is particularly affected, meaning people with RDs tend to keep less in short-term memory and thereby slowing recall. Visual memory can also be affected, with some individuals reporting getting lost in a text and having difficulty finding one’s place after looking away for only a short instance (Dickinson et al., 2002; Newell, Carmichael, Gregor, & Alm, 2003). These short-term and visual memory issues also have an impact on interface design. Users with RDs have reported getting disoriented by complex menu systems and having difficulties recalling the locations of commands (Keates, 2002).

4.2.2 Writing Difficulties

Given writing’s intimate ties to reading, people with RDs unsurprisingly also experience many challenges in writing (Edwards, 1994; Raskind & Higgins, 1998; Peer, 2001; Hammond & Hercules, 2003). Studies have shown that spelling errors made by people with RDs are notably different from those made by the general population (Pedler, 2001; Bourassa & Treiman, 2003). Errors are often based more in phonological confusion than the accidental transposition of letters due to typing mistakes. Examples of such errors due to the phonological processing deficit (mentioned in Section 4.1.2) include “jerney” for “journey” and “clene” for “clean.” Additionally, Bourassa and Treiman (2003) found that dyslexic writers often exhibit a lexicality
effect in which real words are preferred over non-words. For example, while a non-dyslexic writer might misspell “severe” with the typo “seveer,” the lexicality effect would lead to a dyslexic writer using the real word “server.” Another example of the lexicality effect would be writing “secede” for “succeed.”

Proofreading itself can thus be problematic for those with RDs. Despite their designed intention to aid writers, spellcheckers are often not helpful. A spellchecker will suggest several potential corrections, requiring that the user to not only identify similarly spelled words but to also interpret what they mean. Both tasks may be of significant difficulty to a person with a reading disability. Pedler (2001) has detailed the many shortcomings of spellcheckers when it comes to spelling errors atypical of those made by people without RDs.

The writing composition process is another area of potential difficulty for people with RDs. Organizational skills are commonly reported to be poor among people with RDs, and this can carry over into arranging arguments in writing (Raskind & Higgins, 1998; Hammond & Hercules, 2003). The linearity of written prose has often been suggested as particularly daunting (Hammond & Hercules, 2003; Entine, 2009).

### 4.2.3 Sequential Processing

More generally, sequential and linear processing difficulties have also been reported among people with RDs (Raskind & Higgins, 1998; Peer, 2001; Hammond & Hercules, 2003). Sequential processing takes place with tasks involving a specified order. Thus, a person with an RD may find it difficult to follow a list of directions such as a recipe. Accidentally skipping or repeating lines of text when reading can also occur.

Remembering the relative positions of list elements may also pose a challenge. For example, while a person with an RD may recall all seven parts of biological classification (kingdom, phylum, class, order, family, genus, and species), she may not be able to remember if class comes before or after family. Similar difficulties with the alphabet and its order are also common.

### 4.2.4 Visual Stress

Although RDs are viewed primarily as being neurological in origin, some visual difficulties are associated with RD (A. J. Wilkins, Jeanes, Pumfrey, & Laskier, 1996; Jeanes et al., 1997; Evans, 2001; A. Wilkins, Huang, & Cao, 2004). Among these is the notion of visual stress (also referred to as Meares-Irlen syndrome and scotopic sensitivity syndrome). During reading, some readers report perceptual effects such as color, movement, and blurring of letters. Prolonged reading usually acerbates these effects and can lead to headaches and difficulty in sustaining reading.

In general, visual stress is diagnosed by ophthalmologists or optometrists (Evans, 2001), although both a screening questionnaire (Singleton & Trotter, 2005) and computerized assessments (Singleton & Henderson, 2007) are being developed. Studies suggest that an estimated 20–30% of the general population experience visual stress to some degree, although there is some evidence that visual stress is more common among people with RDs (Kriss & Evans, 2005; Singleton & Trotter, 2005). Thus, a growing view is that visual stress is a
separate condition but one that strongly influences reading disabilities.\(^8\)

The biological underpinnings of visual stress, however, are still not understood. Neither is it understood why certain color overlays (see Chapter 3, Section 1.3) appear to successfully accommodate those with the condition (Jeanes et al., 1997; Evans, 2001; A. Wilkins et al., 2004). However, several theories have been proposed (Evans, 2001, see Appendix 7 for a review). One theory regarding the cause of visual stress is that some people are sensitive to the pattern glare formed by regularly-spaced lines of black-on-white text. The sharp contrast between black and white is viewed as a primary factor, but some studies have found that simply ameliorating contrast does not account for all visual stress (Jeanes et al., 1997). Irlen proposed a scotopic sensitivity disorder as an explanation, although critics note that the scotopic visual syndrome is specific to low-light vision and not visual functions associated with reading (Irlen, 1991; Evans, 2001). Deficits in the magnocellular visual system are another potential explanation. This visual system is about transient vision such as detecting changes in peripheral vision, gathering coarse details, and detecting flicker. The rapid movements of the eyes during reading rely on the magnocellular system to help clear away any previous image and determine the current span of text to read. As noted by Evans (2001), studies suggest that upwards of two-thirds of all people with dyslexia show magnocellular deficits, and dyslexia is considered synonymous with magnocellular deficits by some. However, the magnocellular deficit does not detect color and thereby does not explain why color overlays reduce visual stress.

This lack of a clear biological explanation has unsurprisingly helped lead to dissent regarding the legitimacy of visual stress as an actual condition. For example, at the Third World Congress on Dyslexia in 1987, the plenary speaker, Isabelle Liberman, made the statement that “Vision has nothing to do with developmental dyslexia,” although she specified no evidence to support such an extreme position (Cornelissen, 2005). The American Optometric Association has even issued a statement of caution regarding the diagnosis and treatment of visual stress and suggests that it is actually due to various already known visual disorders (G. J. Williams, Kitchener, Press, Scheiman, & Steele, 2004). However, the results of an earlier literature review by Evans (2001) contradicts with this viewpoint. As this controversy is ongoing and unlikely to be resolved in the near future, I choose to consider visual stress and its potential accommodations (see Chapter 3, Section 1.3) as elements to be relevant to reading disability and technology usage.

### 4.2.5 Attention

If an individual has one type of learning disability (specific or general), then one is statistically more likely to have one or more additional LDs as well (Semrud-Clikeman et al., 1992). One particularly common disability class comorbid to reading disabilities are the various attention deficit disorders. Although some estimates have placed the co-occurrence rate as high as 90%, more recent estimates suggest that among people with RDs, 15–30% or 25–40% also have some form of ADD/HD (Willcutt & Pennington, 2000; Eden & Vaidya, 2008). The
prevalence rate of ADD/HD in the general population is only 3-17% (Eden & Vaidya, 2008).

People with ADD/HD have varying degrees of difficulty with impulsivity, hyperactivity, and attention in their daily activities (Mooney, 2007; Eden & Vaidya, 2008). For example, a person with impulse issues may decide to take on an action without consideration of the consequences. Avoidance of reading tasks until near a deadline may be one result of impulsivity (Mooney & Cole, 2000). Hyperactivity can also lead to strong emotional reactions and, in the case of RDs, may increase feelings of frustration with one’s reading ability. Finally, attention issues may result in distractions during reading, leading to repeated scanning of the same text. Frequent breaks during reading may hinder complete comprehension of the text due to memory decay.

Vision during reading may be complicated due to ADD/HD as well (Klein & D’Entremont, 1999; Pollatsek, Rayner, Fischer, & Reichle, 1999; Evans, 2001). As mentioned earlier in Section 4.1.1, dyslexic readers show a reduced ability to ignore letters in periphery. More generally, the ability to control what is being attended to during a fixation while reading may be more difficult for poor readers (Klein & D’Entremont, 1999). The presence of ADD/HD will likely further exacerbate this situation. As noted by Evans (2001), the surrounding text may even distract the eye enough during saccades that the eyes are led to focus on the wrong section of text.

4.2.6 Motor Coordination

Clumsiness and poor fine-motor control are also common among people with reading and learning disabilities (Dickinson et al., 2002; Peer, 2001). If poor coordination is severe enough to significantly impact a person’s daily life, the person is said to have the specific learning disability known as developmental dyspraxia. Among people with specific learning disabilities (such as RDs), dyspraxia has a comorbidity of 50% (Smits-Engelsman, Wilson, Westenberg, & Duysens, 2003). Thus, about half of all people with RD will have some degree of fine motor control or body coordination issues. During reading, dyspraxia may increase the difficulty of certain small physical tasks such as turning the thin pages of a book or using a hand / pointer to follow along a line of text.

Dyspraxia may also impact computer usage. Fitts’s Law is a predictive model from motor psychology that describes the time necessary to move a pointer to a target based upon the target’s size and the distance to the target (MacKenzie, 2003). This law is often used to model the use of a mouse or digital pen on a computer. Smits-Engelsman et al. (2003) compared the performance of children with and without developmental dyspraxia on a Fitts’s Law-based task. Participants used a digital pen to perform a series of target acquisition tasks for various target sizes (22, 44, and 88 mm). The observed movement patterns of both the control and experimental groups (32 children each) were accurately modeled by Fitts’s Law. However, significant differences in certain task behaviors were identified. For example, the children with dyspraxia undershot or overshot the target more frequently than the control group. This missing occurred more often
as well with the smaller targets. The experimental group was also found to exert greater and more variable pressure on the pen’s tip.

An additional impact of dyspraxia is its visible nature. Unlike most of the other aspects associated with RDs, clumsiness and awkward movements are readily visible to others. Involvement in sports and other physical activities may be impaired. Peer (2001) suggests that this lack of physical finesse may mark dyspraxic students as targets for bullying and mockery.

4.2.7 Social and Psychological Issues

Peer’s suggestion goes beyond bullying, however. The impact of a reading disability is not limited to how and how well the individual performs various tasks; having an RD can impact an individual’s emotions, self-image, and interactions with others. In her case studies of young men with dyslexia, Edwards (1994) found that having dyslexia elicited additional burdens beyond academic difficulties. In struggling with reading while others appear to have little or no difficulty, the students experienced severe amounts of self-doubt, low-confidence, and feelings of isolation. Many of them reacted to these troubles in negative ways: behavioral problems, extreme sensitivity to criticism, and psychosomatic pain. A more recent study by Alexander-Passe (2006) confirms how low self-esteem, depression, patterns of avoidance, and stress management issues negatively impact the lives of teenagers with dyslexia. Reading-related tasks are likely to trigger anxiety, although may be attenuated by the audience and expectations placed on the reader (Tsovili, 2004). Riddick (1995) additionally argues that these social and psychological issues are secondary characteristics that arise as the person ages and interacts with society.

More generally, interactions with others can be troublesome for people with RDs. Due to misconceptions about what a learning disability is, some people doubt the existence of LDs or assume that the person is merely lazy or unintelligent. Edwards (1994) notes that many of the students in her study had been teased or ridiculed by their peers. In interviews with college students with learning disabilities, Cory (2005) found that when several of them told professors of their disability, the students were informed that such disabilities do not really exist and that they needed to just try harder. This attitude may not be uncommon; articles in the Chronicle of Higher Education have been written by professors questioning the legitimacy of requests for accommodations by students with LDs (W. M. Williams & Ceci, 1999; Zirkel, 2000).

The knowledge that a person has a learning or reading disability can also lead people to lower their expectations for that person. In a case study of an individual child with LD across several learning environments, McDermott (1993) found that the child’s ability to perform various tasks was directly affected by the expectations of the people around him. When people around him expected him to read poorly, he did. Otherwise, he still struggled but performed much better. As McDermott describes it, only when a proper unsupportive environment was present would the learning disability “acquire” the child into being disabled.
Given these negative associations of having a reading disability, it is of no surprise that some individuals avoid acquiring the RD label (Edwards, 1994; Cory, 2005). As the body shows no outwardly visible evidence of the person having this disability, an RD (as well as any LD) is considered to be an invisible or hidden disability. This allows a person with an RD to potentially pass as “normal,” thereby avoiding the stigmas associated with the disability. However, passing as “normal” does come with some costs. Studies of success for people with LD have found that acceptance and recognition of one’s disability is correlated highly with achievement (Spekman, Goldberg, & Herman, 1992; Gerber, Ginsberg, & Reiff, 1992). If hiding one’s disability reflects not accepting its reality, then one’s chances for future success could be limited. Furthermore, seeking out support and help from others requires disclosing about the disability to others. In studying the experiences of college students with invisible disabilities, Cory (2005), found that students with hidden disabilities are very strategic in choosing when and to whom they come out in regards to their disability. Many, due to past negative experiences, will delay registering with disability services until a crisis necessitates it. Unfortunately, this is often too late to avoid poor or failing grades for that academic term.

### 4.3 Strengths Associated with Reading Disabilities

After the long list of difficulties associated with reading disabilities presented above, one may conclude that having an RD is an all-out negative experience. However, positive aspects may arise from having a disability as well, such as enhanced peripheral vision among many of the congenitally deaf (Bavelier, Dye, & Hauser, 2006). Acknowledging strengths may provide opportunities for compensating and accommodating the negative aspects of a reading disability.

Many individuals with RDs show prowess with tasks involving spatial awareness and visualization skills (Dickinson et al., 2002; Cottrell, 2003). Some also show particular strength with creativity and lateral thinking (West, 1997, 2001; Cottrell, 2003; Powell, Moore, Gray, Finley, & Reaney, 2004) as well as in art and music (Edwards, 1994; West, 1997, 2001). In fact, the prevalence of students with dyslexia and other RDs in design schools and art programs has led some to directly associate creativity, artistry, and visual thinking as universal strengths among individuals with RDs.

For example, Thomas West (1995, 1997) argues that many great minds (e.g., Leonardo da Vinci and Albert Einstein) throughout history have had undiagnosed learning disabilities and this different neurology enabled them to visualize information through innovative means, transcend common forms of thought. Although he does cite some neurological evidence that visual talents are associated with verbal difficulties, West has the advantage of cherry picking his historical examples to confirm what he wants to include. Moreover, the accuracy of RD diagnoses in historical figures is questionable. Although Einstein is often popularly considered to have had dyslexia, biographical studies do not support this position (Pais, 2005). Similarly, the diagnosis of Leonardo da Vinci as dyslexic is derived only from his surviving writings, and writing samples alone are not
considered enough for making a diagnosis of RDs (Edwards, 1994).

Although many with RDs are drawn to artistic or other creative careers, one should be careful about drawing any causation. While it may be that individuals with RDs have natural talent in the arts, it might also be that said fields emphasize verbal tasks to a lesser degree, thereby posing less frustration and difficulty for those with RDs. Moreover, it is risky to place expectations of superior performance on an entire population. In fact, specific studies of visual abilities among people with dyslexia (Winner et al., 2001) found that not only did the RD population not show superior visual skills, a significant portion showed deficient performance compared to the general population. A more moderate perspective to take is offered by Powell, Moore, Gray, Finley, and Reaney (2004): while a person with an RD may not show savant-like visual abilities relative to the general population, said abilities may be a relative strength in regards to all of his or her abilities.

5 Chapter Summary

This chapter has provided a comprehensive overview of reading disabilities. As has been demonstrated, reading disability is not a single condition but a cluster of related issues that impact reading ability. RDs impact individuals in varied and diverse ways and, importantly, can involve and affect more than just the act of reading. Moreover, scholarly debate and study about what RDs are and what causes them is ongoing.
This debate as to whether reading disabilities are present from birth or acquired later is essentially moot nowadays. Both types are generally recognized now: developmental (from birth) and acquired (Edwards, 1994; Elkind et al., 1996). Distinguishing between the two can be difficult given that reading abilities are not identifiable at birth, usually only being diagnosed in the school years. Generally, an RD is considered acquired when a noticeable change in reading ability follows a recent brain injury (e.g., stroke, infection, or trauma).

In this dissertation, the RDs under consideration are almost always developmental though not necessarily identified in childhood. Instances of acquired RDs are explicitly noted.

Given the ubiquitous nature of reading in our lives, it is easy to forget that reading is not a natural, innate aspect of humanity. Early hominids evolved language as a means of more expressive communication for coordinating tasks such as hunting, gathering, and communal living. Such utterances, either through sounds or gestures, were ephemeral in nature. Only millennia later did humans begin to record and reuse their words in a more permanent fashion (M. J. Adams, 1990; Wolf & Kennedy, 2003). How this recording was accomplished has also evolved from pictograms to logographs and orthographic symbols mapped to syllables and sounds.

Additionally, what we mean by literacy today is very different from what it was over a century ago. At the beginning of the twentieth century, basic literacy in the United States consisted of knowing one’s ABCs and being able to read certain chosen pieces of literature, like the Gettysburg Address, the Preamble to the U.S. Constitution, essentially from memory. Reading comprehension was not an aspect of literacy and was not emphasized until mechanization in World War I necessitated the need for people to be able to read instructions and apply them (Bransford, Brown, & Cocking, 2000, p. 133) This reading for a purpose has further evolved into reading for meaning, identifying symbolism, and other various forms of interpretation.

Simply put, written language and the act of reading it are both constructs of human civilization. These constructs are in-progress and constantly evolving.

The reader may wonder if it is possible for a person to be both blind and have a reading disability? This is a definite possibility, as injury or disease could lead to a born-seeing individual with RD becoming legally or functionally blind. Whether a congenitally blind person could also be reading-disabled is more difficult to answer. Part of the difficulty lies in that reading is typically defined as the process of decoding the meaning of an established set of visual symbols (e.g., letters in English, logographs in Japanese, musical notation). If we adjust the definition to non-auditory symbols, then we can ask if
readers of tactile languages like Braille can experience difficulties due to having a reading disability.

The literature on this topic is sparse but reveals that some struggling Braille learners show signs of developmental dyslexia. Early work by Arter (1998) provided evidence that cognitive impairments similar to dyslexia led to slowed learning of Braille among some students. She hesitated to make a definite conclusion given her perception of a lack of a consistent definition of dyslexia. Further study by Greaney and Reason (1999) found evidence of a phonological processing deficit in a struggling reader of Braille. As of this writing, I am aware of two studies beginning to explore the presence of dyslexia among some of the congenitally blind (Coppins & Barlow-Brown, 2006; Anneli & Pol, 2009).

Although the evidence is preliminary, it does seem possible for a person to be born both blind and reading-disabled. Remember, however, the latter of the two disabilities will only become present when learning or interpreting a non-visual language like Braille. When it comes to challenges in interpreting a visual language, a blind person is not reading-disabled; the problem is the inaccessibility of the text.

What necessarily constitutes a major life activity is an area of much debate and legislation (ADA, 1990; ADA Amendments Act (ADAAA), 2008). Certain tasks, such as taking care of basic health needs, receiving an education, and being able to work are generally considered to be major life activities. Still, debate can and does occur. Does this mean that all jobs must be achievable for any person regardless of (dis)ability? Is participation in sports and hobbies a major life activity?

These questions are beyond the scope of this dissertation and have been debated and discussed deeply by many others. For my work, I take a simple perspective and consider any major life activity to be an activity a person wants to do. I do keep an element of pragmatism and expect some level of within reason in these desires. Strawmen such as inclusive design meaning the blind should be able to drive cars (Newell & Gregor, 2000) distract from the goals of providing access and opportunity.

The classification of ADD/HD as a general learning disability is an example of the vague boundaries between disability classes. ADD/HD definitely impacts learning, especially in rigorously structured classrooms (Mooney & Cole, 2000; Mooney, 2007). However, the condition also affects aspects of life beyond learning. In various discussions with other disability scholars, I have found mixed opinions on whether ADD/HD is an LD or not. As the condition is not a primary focus of my work, I choose not to enter into this debate and note that my choice to list it here as a general learning disability is not hard and fast. The bottom line is that ADD/HD is a cognitive disability that can and does affect learning.

In her film Read Me Differently, Entine demonstrates her ongoing struggles with phonological processing by reading a Dr. Seuss book aloud to her niece and nephew. Seuss’s rhyming prose invariably
contains many nonsense words that must be properly decoded to fit the intended rhythm and rhyme scheme. Although the works of Dr. Seuss are much beloved by many (including myself), one has to wonder about the experiences of a child with a reading disability attempting to read *Green Eggs and Ham* or *The Cat in the Hat*. Although such books are targetted for children’s reading levels, they do require advanced phonological processing skills.

When I started looking at ATs for dyslexia, I originally thought that dyslexia was all about letter reversals. This misconception was quickly corrected once I began to read about dyslexia and related conditions. My earlier misconception is shared by many others in society, which raises the question as to why reversals have become so strongly tied to dyslexia in the public’s eye. The line of reasoning offered by Harman (1982) is clean, direct, and, in hindsight, quite obvious. However, this argument has not penetrated the public sphere.

Although I have no evidence for as to why the public conception of dyslexia has evolved as such, I can hypothesize a few potential reasons. First, the image of a backwards letter is entrenched in our popular culture as the scrawls of someone of limited writing ability, be they a young child or an uneducated buffoon. Struggling with reading is similarly associated with youth or lack of education.

Second, reversals are relatable. Unlike most other disabilities, it is difficult to empathize with people with RDs. Although the experiences are not the same, a “normal” person can wear a blindfold to emulate blindness, sit in a wheelchair to experience physical barriers, etc. To struggle with reading, however, is fairly alien. One may read articles from a highly-specified field or a foreign language they are barely fluent in, but these reading acts may be overcome through study and effort. They lack the sense of the self being at fault. Reversals, though, can at least offer a phenomenon to relate to.

These two hypotheses are just that—hypotheses. Understanding why reversals are the public conception of reading disabilities requires not only following the history of popular depictions of dyslexia and other RDs in media and public discourse but also popular conceptions of disability, reading, literacy, and likely much much more. That is another dissertation in itself.

Acknowledging visual stress as a component to reading disability does introduce some complications to the working definition of reading disability in Section 1.1.2. As discussed earlier, ruling out vision problems is a key aspect to the exclusionary diagnosis process. Visual stress is a vision problem that can hinder reading, so it should not be considered as part of the RD umbrella. However, given that visual stress has been strongly associated with RDs both historically and in the current day, the legacy is worth continuing. Its inclusion is just as important as understanding other comorbid conditions, such as ADD/HD and dyspraxia.