

Developmental Stages of Reading Processes in Children Who Are Blind and Sighted

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Abstract: This article compares the development of print and braille reading in children who are blind and sighted in relation to Chall's stage model of reading development. Chall's model includes a prereading period, in which concepts are developed; middle stages, in which skills that are necessary for decoding text are developed; and later stages, which distinguish skilled readers on the basis of their highly developed schemata and cognitive skills that are necessary for effective comprehension and integration. The relevance of a developmental theory for directing training methods that facilitate braille literacy instruction is discussed.

The process of reading may be said to begin when a sensory modality picks up encoded information from the world. Typically, reading is discussed in relation to the visual and cognitive processing that occurs with printed text. During visual reading, light from the printed page is reflected onto the retinas, where it is transferred to the brain for further processing. The brain applies higher cognitive functions that combine and transform arbitrary symbols into meaningful words and sentences that can represent most concrete and abstract thoughts. Thus, reading is an important cultural invention because it creates an effective medium for sharing information. When vision is not available to readers, information must be accessed using some other sensory modality.

Readers of braille rely on their tactile sense to acquire information

from a body of text. Analogous to vision, information is picked up from the environment via the tactile sensory system and transferred to the brain, where it is processed into meaningful messages. Given the parallel means that readers who are blind and readers who are sighted use to change information from the outside world into representations within the mind, it seems appropriate to compare the two reading protocols. This article discusses the development of reading skills in print-reading individuals who are sighted and compares it to the developmental processes of individuals who are congenitally blind and learn to read using tactile formats.

For children who are sighted, the formal process of learning to read usually begins during the earliest school years; however, before a child enters formal schooling, he or she can learn much about the world that facilitates the process of learning to read (Kupetz, 1993; Lawhon, 2000). The development of active verbal language skills, beginning with the first "real" spoken word at about 10-12 months, culminates in a fast mapping stage in which children are able to learn a large number of words with less exposure (Bjorklund, 2000). The earliest stages of speech acquisition are characterized by semantic overextensions and syntactic errors. Nevertheless, children quickly come to realize that objects, events, and psychological states can be represented with words (Klein, 1981). Bigelow (1990) found evidence of similar language-acquisition processes in children who are congenitally blind. In a study that examined the relationship between children's cognitive and language abilities, Bigelow demonstrated that total blindness does not impede the acquisition of early words in children who are blind, although it may delay the development of the concept of object permanence. (That is, the awareness that objects in the world continue to exist when one is not directly perceiving them.) Representations that children who are blind develop may differ, however, from those of

children who are sighted because of the different experiences that the two groups of children are likely to have had. As a simple example, consider the representation that a child who is sighted may have of an *apple*. An apple can be encoded as a red, semiround, sweet fruit. To a child who is blind, visual representations are not available, so the child must encode and store information about the apple using the representations that he or she has available from other sensory sources and memory. The child may have no conception of what it means to be "red" because he or she may never have experienced the visual sensation of "red." Perhaps, instead, the child encodes the apple as a small, smooth-textured, semispherical, sweet-tasting object. The point is that as children develop the vocabulary that they will use while learning to read, semantic representations may vary widely among them, depending on their experiences.

Models of reading

Numerous theorists have written about how reading development may progress in children who are sighted (see, for example, Gough & Hillinger, 1980; Marsh, Friedman, Welch, & Desberg, 1981). Theories that seek to describe how meaning is extracted from text must necessarily provide a means for decoding characters into meaningful units and for integrating these meaningful units into a knowledge base. As a result, current models of how children learn to read typically emphasize one of two approaches. On the one hand, according to a text-based approach, bottom-up decoding proceeds from a low level of isolated units (such as letters and words) through higher levels of comprehension. On the other hand, the reader-based approach emphasizes top-down mechanisms, in which the context of the message and the reader's knowledge assist the reader in processing letters and words (Paran, 1997).

Marsh et al. (1981), for instance, proposed a four-stage text-based

theory in which all readers must pass through the same sequence of stages as they learn to read. In the first stage, children use linguistic guessing strategies that are based on arbitrary characteristics of words, such as their first letter. The second stage builds on the first and is characterized by the ability to discriminate unknown words by matching orthographic similarities and cues, such as the shape, length, and final letter of a word, to those of known words. Readers in the third stage begin to recognize and use rules to decode unfamiliar words. For example, the reader may notice that the *at* in *bat*, *cat*, *hat*, and *mat* is pronounced the same. In the final stage, rules for decoding become more sophisticated and reliant on the context within the word to be decoded. For example, the *a* in the word *cape* has a long sound because the word ends in the silent vowel *e*, and the *a* in *cap* is short because it is followed only by a consonant.

In comparison to Marsh et al.'s (1981) text-based model, in which rules that are related to the bottom-up graphophonemic qualities of to-be-decoded words are primary tools for extracting information, reader-based approaches focus on top-down processes for decoding and comprehending texts. Within the cognitive constructivists' perspective, meaning from a text is actively constructed using "schemata" that are present in emerging readers (Graves, Juel, & Graves, 2001). Schemata are knowledge structures that are created from interrelational concepts about objects or events (Anderson, 1980). On the basis of their current schemata, readers are able to represent and use knowledge in a way that allows new information to become integrated (Rumelhart, 1980). Weaver (2002), for example, believed that meaning from texts arises after a transaction occurs between words on the page and the reader's knowledge structures. When faced with new texts, readers activate appropriate schemata through which meaning may be filtered. Meaning, then, is not a one-to-one transfer from the text to the mind of the reader. Rather, it is a subjective interpretation of the text that is based on

the knowledge that readers bring to the reading task (Graves et al., 2001). The cognitive constructivist perspective differs from text-based theories because it emphasizes the active top-down construction of meaning by using knowledge that readers possess about the world. According to Weaver (2002), existing knowledge structures that are built on experiences and social interactions, as well as intuitive knowledge structures about the nature of language, can offer rich contextual cues that help children to decode textual language.

Text-based and reader-based models are useful for demonstrating how readers may develop the skills and concepts that are necessary for fluent reading; however, a sufficient and comprehensive model will integrate the two perspectives, such that bottom-up and top-down processes work in unison to provide meaning to texts (Graves et al., 2001). A model proposed by Chall (1983) is valuable because it offers insights into the framework for developing skills and shows how higher cognitive processes function to affect the comprehension of text.

Chall's model

Stage 0

Chall's (1983) model consists of six stages of reading development. The earliest stage is called Stage 0 because it is a learning stage that occurs before children begin their formal training in reading. Stage 0 begins at birth and continues until children reach school age. The foundations for literacy are developed early, since children spend this time gaining insights into the nature of words. During this stage, children are able to distinguish letters from letter approximations and may learn to recognize common road signs and brand-name logos. Children in the prereading stage are constantly exposed to text in print, especially when reading is a priority in their homes. They display

their understanding of reading as a concept by engaging in "pretend reading," in which they may hold the book right side up and trace along the letters with a finger while they recite the remembered details of the story. Kupetz (1993) suggested that this stage is especially important because it is the time in which children develop sensory awareness and begin to acquire experiences that reinforce basic concepts about language. In relation to later literacy, the maximal benefits from this stage can be acquired if children have access to many books and are encouraged by adults to enjoy the reading experience.

In the prereading stage especially, children who are blind need to acquire a rich array of experiences that will prepare them to become competent readers. Children who are sighted often learn incidentally through casual observation (Koenig & Farrenkopf, 1997). In contrast, children who are blind must gain experience deliberately, using the sensory mechanisms that are available to them, namely, hearing, touch, smell, and taste. They learn language concepts when adults provide important feedback to them as the children explore the world. Wormsley and D'Andrea (2000, p. 18) emphasized that it is important for parents and teachers to "get inside the children's heads" to imagine what the children are experiencing and to foster the development of concepts through active description. Because children who are blind cannot depend on visual input to extract information, adults need to provide verbal support that corresponds to the children's other available senses. For example, a parent of a child who is holding a teddy bear may encourage the child by saying, "Here is your teddy bear. It's furry and squishy. Listen! It makes a jingly sound when you shake it. That's because there is a bell inside." (Wormsley & D'Andrea, p. 23). Detailed verbal feedback allows the child to match his or her tactile and auditory sensations with rich linguistic descriptions.

Braille readiness activities for children who are blind are also

stressed during the prereading stage and may include instruction in the concept of spatial representation and tactile sensitivity training. Curricula, such as *Patterns Prebraille Program* (American Printing House for the Blind, 1987), are designed to address the need for a child to develop auditory, tactile, conceptual, and language abilities before he or she learns to read. Lessons are designed to teach prereaders who are blind skills that will be important in bottom-up decoding (such as to follow a raised line physically on a page), as well as important concepts that the children will use to build their knowledge structures (about foods, school, and their communities, to name just a few). Because in the prereading stage, children who are blind are less likely to have the same incidental exposure to braille words as children who are sighted have to printed words (Craig, 1996; Rex, Koenig, Wormsley, & Baker, 1995), the associations between the graphemic combinations and the concepts that they represent may be less clearly defined for children who are blind as they begin their formal training in reading. For example, before they start school, children who are sighted are likely to see the orthographic form *airplane* associated with a rich array of pictures, stories, and real-life experiences having to do with travel on airplanes. The frequency of these experiences will strengthen the children's associations between printed words and the objects that they represent.

In contrast, school-aged children who are blind must associate a relatively vague concept of an airplane as something big that you ride in through the air at high speeds with a new two-dimensional representation on the page (braille or tactile graphic). Unlike their counterparts who are sighted, who learn language associations implicitly, prereading children who are blind require a larger amount of directed stimuli to establish accurate representations of the world. They can learn about the qualities of textual language by being exposed to braille wherever it occurs in the real world, however limited, and by having frequent exposure to braille

books. Most important, in the prereading stage, both children who are blind and children who are sighted can benefit greatly by being read *to*, even before they are able to read themselves (see Craig, 1996). Using books with both print and braille on the pages allows parents and siblings who are sighted to read with children who are blind and allow the children to explore the text tactilely.

Stage 1

Stage 1 of Chall's (1983) model marks the beginning of children's formal skills training in reading. The stage is characterized by children's ability to decode formerly arbitrary letter shapes into the sounds that are used in spoken language. During this stage, children begin to associate the shapes of letters with phonetic patterns. Simple graphemes (letters) and combinations of graphemes are associated with sounds that can be joined and blended to decode unfamiliar words (Breech & Pedley, 1994). Rules are memorized that enable the reader to know when sounds vary, depending on what combinations of letters appear. According to Chall (1983), children in Stage 1 typically direct their attention to the medium, rather than to the message. In other words, Stage 1 print readers use bottom-up qualities of the text (such as phonetic rules), rather than contextual knowledge, to decode texts.

In a similar manner, beginning braille readers must learn to distinguish words on the basis of the tactile qualities of the braille characters. Beginning braille readers are not likely to have had great prior exposure to the braille alphabet in comparison to children who are sighted, whose pretraining experience with print may be extensive (Rex et al., 1995). As a result, children who are blind may require additional learning steps to distinguish individual letters and to identify combinations of letters as representations for specific concepts. In addition, braille readers have more symbols to master, since published braille materials

use a system of contracted symbols and abbreviations. Even if all the extra symbols are not introduced in the earliest stages of reading development, their introduction at a later time may, at least temporarily, return a reader to a mode of progression that is similar to Stage 1 until the entire character set can be assimilated into memory as a complete set of patterns.

Nevertheless, the process of learning to read braille seems to proceed in a progression that is similar to print reading after the characters have been learned. Early stages of braille reading are dependent on phonological skills and require the development of the same graphemic knowledge that is used by readers who are sighted to learn sound-symbol relationships (Wormsley & D'Andrea, 2000). Gillon and Young (2002) tested children who were blind on several tasks that measured phonological awareness and found a profound relationship between phonetic abilities and performance on reading tests. Evidence by Pring (1994) suggested a degree of phonetic competence in early readers who are congenitally blind that mirrors that of readers who are sighted. The importance of Stage 1 processes is further underscored by the literature on reading by adults who are blind. Millar (1997) tested the hypothesis that the dependence on phonological decoding changes with proficiency in braille. By presenting expert and beginning braille readers with sentences containing inappropriate homophones (such as *He through the ball*) and then counting the number of acceptance errors made by the two groups, Millar demonstrated a greater dependence on phonetic coding among beginning braille readers. It seems, then, that braille readers may also pass through an early stage that is similar to that proposed by Chall (1983), in which the bottom-up qualities of the words that are related to phonetic patterns are primary in decoding texts. As print and braille readers become more practiced, the use of phonetics in decoding words decreases; however, psycholinguists have shown that adult readers may continue to use sound and spelling relationships to decode unfamiliar or low-frequency

words (see, for example, Millar, 1997; Waters, Seidenberg, & Bruck, 1984).

Stage 2

Children continue to learn phonetic patterns well into Stage 2 of Chall's (1983) model. However, the progression between Stage 1 and Stage 2 is marked by a developmental shift in which children begin to use visual whole-word patterns in addition to phonetic cues to access words from their lexicons (Rayner & Pollatsek, 1989). In this stage, fluency develops from experience that releases beginning readers from the bonds of phonetic decoding. Still, readers in Stage 2 are heavily dependent on the familiar appearance of words for decoding, while meaning is secondary. Texts in this stage are intended not for gaining knowledge, but for acquiring reading experience and practice. Reading materials should be familiar and children should know the content, so they can concentrate on word and sentence structures. The repetition of familiar words and word patterns spawns a degree of automatic decoding skills.

Similarly, for children who have been exposed to contracted braille in the initial reading stages, reading materials should be chosen that reinforce braille contractions. These materials should encourage automatic decoding by emphasizing symbols for common combinations of letters, such as *ar* and *er*; whole-word contractions, such as *for* and *the*; and single-letter contractions that are used as words, such as *c* for *can* and *h* for *have*. For example, Wormsley and D'Andrea (2000) recommended the use of braille flash cards to help students recognize common characters accurately and to encourage proper reading mechanics. Other appropriate content for facilitating word recognition may include simple stories that rhyme and that are rhythmically predictable to develop a child's sense of how language sounds and to allow the child to use contextual relationships between words

for decoding.

Achieving automatic decoding may take longer for readers who are blind than for readers who are sighted because of different cognitive demands during decoding. For instance, in adult print readers, the perceptual span (that is, the amount of information that can be acquired during one eye fixation) is estimated to be between 10 and 20 characters (Rayner & Pollatsek, 1989). With fluent reading skills, print readers can process multiple characters (such as whole words) in parallel during a single fixation. In contrast, Nolan and Kederis (1969) concluded that reading whole words is less common among beginning braille readers. By evaluating word-recognition times as a function of the length of a stimulus, they concluded that braille word recognition among inexperienced readers likely proceeds serially, one braille cell at a time.

Given these results, cognitive demands may be greater for braille readers, who must store the beginnings of words in memory until later letters are decoded. In many cases, tactile linear reading methods may increase the amount of time it takes for braille readers to achieve automatic decoding and may decrease efficiency during this stage. According to Wormsley and D'Andrea (2000), inefficient braille readers are more prone to "scrubbing" and "backtracking." When readers scrub, they run their fingers continuously over a character to establish its identity; this type of behavior indicates the lack of automatic letter recognition. Backtracking, on the other hand, occurs when readers go back to search for words or characters that they encountered previously; this behavior suggests that the reader has inadequately integrated information. Wormsley and D'Andrea suggested that braille reading should be considered automatic when students are able to read passages aloud with expression, can tell another person what they have read, and when their listening comprehension and oral reading comprehension demonstrate

equal recall.

Although the processes described throughout the first three stages of Chall's (1983) model were primarily text-driven, bottom-up processes, this is not to suggest that early readers do not use context to decode and decipher texts. Weaver (2002) described an interesting method that was used to provide evidence that even young readers use context-derived predictions about what should come next in the text. By analyzing oral miscues--that is, by monitoring the discrepancies between what the reader says and what is actually written in the text--it is possible to infer the strategies that readers use for decoding. For instance, in the sentence "She heard (*had*) the children singing," where the word *had* is miscued for *heard*, the child's use of context can be inferred because the miscue fits with the syntax that preceded it. A child who made this miscue may have matched the first letter, *h*, and then recognized the need for a verb to make the syntax read sensibly. In relation to Chall's (1983) model, the use of context in Stage 2 may still be thought to be driven by bottom-up text-based processes. The use of top-down context becomes more useful in later stages, not only for decoding text, but for integrating knowledge and inferring meaning from texts.

Stage 3

After Stage 2 of Chall's (1983) model, the remaining stages have one major point in common. Foremost, in Stages 3-5, the purpose of reading is to acquire new information--to comprehend meaning. In these later stages, the focus becomes the message, rather than the medium. After automatic decoding is achieved in Stage 2, readers begin to use reading as a tool with which to add to their knowledge base. Readers in Stage 3 are still limited in their knowledge, thoughts, and experiences, so learning proceeds best when texts are clear, are limited in technical complexity, and express ideas through one point of view. During this early

knowledge-gathering stage, accurate concepts and word meanings become important as readers learn to integrate meaning into their own limited knowledge base. From a Piagetian (1952) perspective, children acquire a new supertool for assimilating knowledge about the world into their own schematic worldview.

Kintsch (1994) examined how learning from texts varies by the degree of overlap of content between the text and sighted readers' knowledge. If a text is to be effective for learning, some degree of overlap of content is a necessary condition. Recall that in Stage 2, optimal texts were those in which the content was highly familiar to the reader. Because readers did not have to struggle with new concepts, they were able to focus on the words themselves, thus acquiring fluency by repetition in decoding exercises. In contrast, the goal of Stage 3 is to integrate new knowledge into an existent knowledge base. According to Kintsch, there is an optimal learning zone for readers in which the overlap of content with the reader's knowledge base is finely balanced. Optimal texts will provide a gap in coherence that is neither too large for the reader to overcome nor too small to stimulate the reader. Instead, readers should have enough knowledge to fill in the gaps while actively constructing their own memory representations.

Notice that the focus has changed from the decoding of characters to comprehending the information that the characters represent. There is no reason to believe that readers who are blind perform any differently from sighted readers once fluent decoding is achieved if they have sufficient life experience to provide a reliable context in which to assimilate the newly acquired information--a condition that is required of all readers, regardless of whether they are blind or sighted. Nevertheless, as fluency increases, so should the complexity of the content that students who are blind have available to remain within Kintsch's (1994) optimal zone of learning.

Stage 4

Once readers have reached Stage 4 of Chall's (1983) model, they are ready to begin to build cognitive representations of the world using multiple points of view. This stage builds directly on Stage 3. In Stage 3, elementary readers began learning facts about the world from simple single-perspective texts. In contrast, Stage 4 readers encounter a greater depth of coverage of topics through multiple perspectives. In this stage, texts require readers to integrate and add layers to the information they acquired during Stage 3 reading. The qualitative change that occurs during this stage is that readers become able to interconnect related knowledge from various perspectives to construct a new mental representation. According to Kintsch (1998), readers use the text base, as well as their own knowledge about the language and the world in general, to actively construct a situation model. In doing so, they are able to make inferences that are not explicitly mentioned in the text base.

Clearly, this level of reading requires that the individual have certain cognitive structures that allow him or her to interrelate abstract concepts and to glean information through deductive reasoning. From a Piagetian (1952) standpoint, this stage seems to coincide with the development of formal operations. Individuals who have acquired formal operations are able to use hypothetical-deductive reasoning and reflective abstraction to construct mental models of how the world operates (Wadsworth, 1996).

Similarly, braille readers in later stages of reading development bring large amounts of knowledge to the reading task. Compared to beginners, more-experienced braille readers have a larger vocabulary and wider knowledge for understanding stories and texts (Millar, 1997). Millar distinguished between linguistic competence and general knowledge when discussing the cognitive characteristics of later braille readers. Reading complex

braille passages requires not only cognitive speed and efficiency in retrieving knowledge, but the knowledge of how and when to apply previously gained knowledge to new scenarios. This qualitative advance represents skills that are analogous to Kintsch's (1998) active construction of a situational model. Braille readers integrate multiple perspectives using prior knowledge to infer new information that is not explicitly written into the text.

Stage 5

Stage 5 of Chall's (1983) model represents the most mature stage in reading development. In this stage, both braille and print readers have reached a degree of expertise in a domain, such that reading becomes a process of judgment, analysis, and synthesis. Readers judge what is important, analyze how it fits with current knowledge, and then synthesize new knowledge on the basis of a high level of abstraction. The domain specificity of the stage is important. Readers at Stage 5 may regress to Stage 4 when they read complex materials on an unfamiliar topic. Within his or her domain, a reader decides what to read and at what level of detail to fulfill his or her purposes. Kintsch (1998) described highly skilled readers as those who read selectively, making decisions about where to spend cognitive resources on the basis of a highly developed set of schemata. Skilled braille and print readers scan the content of the page for certain words that trigger their attention, reading nonsequentially sections that fit their purpose.

Finally, reading in Stage 5 is similar in many ways to reading at Chall's (1983) Stage 0. Both require the reader to use his or her own perceptions of the world to determine what is interesting in the text. At both stages, readers are divorced from the text itself. Prereaders do not rely on the text because their concept of what text is has not yet fully developed. As a result, they depend on memory and their knowledge of the world to derive meaning.

Advanced readers, on the other hand, do not dwell word for word because their knowledge structure for the content is well developed. In both cases, the readers are able to concentrate on the important ideas within the text and to synthesize new ideas from the old.

Concluding thoughts

Currently, there is no developmental model that directly addresses the issue of braille literacy and development. Nevertheless, this review of Chall's (1983) model of reading development suggests that readers of both print and braille text formats may progress through similar stages. In the prereading stage, the seeds of literacy are sewn as children acquire knowledge about elements of the world and the nature of language. The role of parents is pertinent in guiding the children's exploration of the environment and the development of concepts. Parents and teachers of children who are congenitally blind have an even greater responsibility to expose the children to varieties of learning experiences because the children cannot pick up information incidentally using visual resources.

During Stages 1 and 2, readers acquire necessary information about the elements from which texts are made and become fluent in their use and knowledgeable about their interrelationships. At this critical stage, fluency can be fostered by providing beginning readers with abundant reading materials that are written at an appropriate level. Appropriate materials need to be simple, rhythmic, and repetitious, so that the children can focus on the sounds of the words themselves and not struggle to decode strange words.

In Stages 3-5, readers use texts that are written at various levels of complexity and expertise to integrate new information into their knowledge structures. Readers in all three stages use domain

knowledge to fill in informational gaps in the text. Because of their advanced knowledge, readers who are expert in a domain are prone to skip large sections of text and to read only what is pertinent to their needs.

Future research should strive to test this stage model empirically as a viable framework for understanding the development of braille reading skills. Teachers, parents, and readers of braille can benefit by understanding the processes that occur while reading from texts that are encoded from a tactile medium. This framework may also serve to identify the role of other sensory modalities in the development of braille reading skills and lead to new teaching methods.

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