Teaching Students With Severe Speech and Physical Impairments a Decoding Strategy Using Internal Speech and Motoric Indicators

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Children who have severe speech and physical impairments often have difficulty acquiring literacy skills. One critical area of literacy instruction involves promoting word identification though the development of decoding strategies that can be implemented by students independently. This study investigated teaching four students who have cerebral palsy and dysarthric speech to internalize the three-step decoding strategy found in the Nonverbal Reading Approach, as demonstrated by motoric indicators (individualized motor movements that parallel the decoding steps). The results of this study indicate that students are able to learn the three-step decoding strategy with the addition of a motoric indicator to identify words in isolation, as well as to apply the strategy independently upon encountering unknown words in connected text.

Keywords: decoding; low incidence disabilities; augmentative and alternative communication; single subject design

Students who have severe speech and physical impairments often encounter difficulty in their acquisition of literacy skills. Literacy levels among students with severe speech and physical impairments are typically lower than those of same-age peers, with phonological processing skills being poorer than what would be expected on the basis of intelligence and education (Foley, 1993; Seidel, Chadwick, & Rutter, 1975; Vanderveld & Siegel, 1999; Wagner et al., 1997). Of particular concern is the difficulty that these students can have in the area of word identification. Students who fail to develop strategies for word identification are at risk of academic failure because of the serious effects that such a deficit has on other reading skills, such as fluency and comprehension (Adams, 1994; Sandberg, 2001). Most word identification strategies that involve decoding rely on students’ saying the word (or parts of the word) and on the teacher’s providing feedback to the students. For students with severe physical and speech impairments, alternate strategies are needed that allow the teacher to provide systematic instruction when the student cannot intelligibly speak the words or the parts of the words. The goal is for teachers to systematically teach students to internalize strategies for decoding and so perform the strategies themselves when encountering unknown words.

Reading Issues Involving Students With Physical and Speech Impairments

The reading difficulties of students with physical and speech impairments are well documented in the literature, with delays and problems found in phonology, morphology, semantics, syntax, and pragmatics (Strum & Clendon, 2004). Some of the factors that may affect performance are specific to the physical disability, such as limited motor movements, fatigue, and other people’s low expectations (Blischak, 1995; Heller, 2005; Koppenhaver, Evans, & Yoder, 1991; Light & Smith, 1993). When students have a severe speech impairment, additional issues arise, such as their having difficulty asking questions that are not programmed into the communication device or their...
not receiving correction on reading errors, owing to an inability to read aloud. Additional factors of concern with students with severe speech and physical impairments include differences in background and reading experiences (Koppenhaver & Yoder, 1993), different communication experiences, phonological processing abilities, and ineffective reading strategies (Browning, 2002; Sturm & Clendon, 2004; Vandervelden & Siegel, 1999).

The background and reading experiences of students with cerebral palsy and complex communication needs may be different than those of typically developing peers. These students may have limited broad experiences, language experiences, and literary experiences because of motor restrictions, mobility issues, decreased time in reading activities (Blischak, 1995; Heller, 2005), and limited ability to interact during reading activities (Koppenhaver et al., 1991; Light & Smith, 1993). A lack of broad experiences owing to mobility issues may interfere with comprehension of literacy activities. Motor disabilities may also result in an inability to retrieve and manipulate books, resulting in less exposure to reading material.

Communication experiences for students with severe speech and physical impairments may also differ from those of their peers because of a lack of speech, a restricted use of picture and symbol selection, and a slow rate of communication (Blockberger & Sutton, 2003; Heller, Fredrick, Tumlin, & Brineman, 2002; Sutton, Soto, & Blockberger, 2002). Literacy experiences are especially affected by severe speech impairments because of an inability to sound out letters, read aloud, ask questions, practice using new words, and participate in certain literacy activities.

Even when augmentative and alternative communication systems are in place, they may not allow for sufficient question asking by the student, particularly if he or she does not have the ability to create a novel message, owing to a lack of literacy skills (Blockberger & Johnston, 2003). In addition, speech limitations may affect the effectiveness of standard reading instruction because of the teacher’s inability to hear the student read aloud. Without this type of feedback, it can be difficult for a teacher to know how to determine the type of reading errors that the student is making, which thus limits the teacher’s ability to provide appropriate intervention.

Many students with severe speech and physical impairments are unable to accurately vocalize letter sounds, words, and the strategy that they are using to identify words. Sandberg (2001), however, found that when examining aspects of oral decoding and phonological processing, the ability to produce speech sounds was helpful but not required for learning to read. This finding supports the work of Foley and Pollastek (1999), who found that adults with anarthria and severe dysarthria are able to decode words. They also found that subvocal rehearsal in combination with working memory allows students without speech to decode words. As such, reading strategies that are useful for students who can talk may be modifiable and thus used for students with physical and speech impairments.

Students with severe speech and physical impairments may lack effective reading strategies, which may be due to (a) a difficulty in understanding the instructional tasks as they apply to someone with complex communication needs, (b) students’ not receiving sufficient repetition to acquire the target skill, and (c) their not being taught effective strategies. Instructional strategies that differ from typical literacy instruction may be necessary for students to master the task (Basil & Reyes, 2003). Systematic sequencing, teacher modeling, drill-repetition-practice-feedback, direct instruction, and modified reading strategies are often needed in addition to typical reading instruction (Swanson, Hoskyn, & Lee, 1999).

Research indicates that the majority of readers who read below grade level have failed to develop accurate and efficient word-recognition skills (Stanovich, 1986, 1992). Bruce and Robinson (1999, 2000) surmised that problems with decoding and word identification may reflect deficiencies in metacognitive strategies used by good readers.

Students may be taught several strategies to internalize and apply word decoding. For example, in a study by Wright and Jacobs (2003), students with reading difficulties were guided through a strategy that instructed them to locate familiar letter combinations (e.g., -at, -og, -ight) and then focus on those combinations when sounding out unfamiliar words. After guided instruction and practice, students were encouraged to internalize the strategy. Internalization involved the use of internal speech to systematically apply the steps of the strategy. In another study, Bruce and Robinson (1999, 2000) used a metacognitive reading program for students who were poor readers. They used reciprocal teaching, which focused on the use of a turn-taking dialogue found in the components of a strategy called the Clever Kid’s Reading Program. After the students became familiar with the strategy, the teachers encouraged them to internalize the process and then use it independently.
Word Identification Strategies

Despite the problems that can interfere with learning to read words, students with physical and speech impairments usually make progress in this area through the use of various reading strategies. Word identification strategies are commonly placed within four major categories: prediction (in which context and letter cues assist in guessing unfamiliar words), analogizing (in which known words are used to help read new words; Goswami, 1986), reading words by sight, and decoding (also referred to as phonological recoding, in which the person sounds out and blends graphemes into phonemes or uses larger chunks or units; Ehri, 2005).

Prediction and analogy approaches are not used with much frequency with students with physical and speech impairments as primary instructional reading strategies. The lack of experiential background, more limited exposure to text, and reading comprehension deficits that are found with this population makes it difficult to use context cues to predict unfamiliar words, which form the basis of the prediction strategy. Reading strategies that use an analogy approach are thought to be built on the awareness of rhyme. Studies have shown that students with physical and speech impairment have lower abilities in regard to making judgments about rhyme similarity through visual rhyme recognition tasks (Card & Dodd, 2006; Vandervelden & Siegel, 2001).

Reading words by sight applies to words to which a person has had exposure and has learned to recognize them automatically. Several strategies are built on recognizing whole words. For instance, one such strategy involves students’ repeated exposure to words presented on a computer screen and voiced through speakers as part of interactive multimedia stories (Hetzrioni & Schanin, 2002). Another such strategy involves pairing pictures with words—specifically, presenting a picture and then fading it to reveal the word (Romski & Sevcik, 1996).

When students learn decoding strategies, they have the ability to decipher words that they have not been directly taught; as such, having decoding abilities makes it easier for them to learn words as sight words (Cunningham, 1993). In addition, rather than learn words only by sight, students who have learned a phonics-based approach will learn how to spell out words that are missing on their communication device, thus allowing literacy to augment communication (Brewster, 2004). Although few in number, some studies have used decoding strategies to teach students with severe speech and physical impairments to identify words. For example, students with speech and physical impairments have been taught to identify the single sounds of the initial sounds of words, to telescope sounds into words, and to read single vowel-consonant and consonant-vowel-consonant words using pictures for assessment (Fallon, Light, McNaughton, Drager, & Hammer, 2004). In another study, students learned word recognition as well as decoding by identifying a grapheme corresponding to a phoneme produced by another person (Smith, 1992). Students have also learned word identification through making words with a set number of letters whose sounds have been learned and by having an augmentative communication device voice the word (Erickson & Koppenhaver, 1997).

Given the strengths of a decoding strategy for this population, this type of strategy seems promising. However, most strategies that teach students a decoding strategy rely on speech to allow teachers to hear the students accurately perform the steps, or they do not systematically teach decoding steps, by having the student rehearse these steps subvocally. One strategy that has shown promise in supporting subvocal rehearsal and teaching students a decoding strategy is the Nonverbal Reading Approach (NRA; Heller et al., 2002; Heller, Fredrick, & Diggs, 1999).

The Nonverbal Reading Approach (NRA)

The NRA is a systematic instructional strategy designed to improve word identification skills for students who have speech difficulties and additional disabilities, such as cerebral palsy. It is used in conjunction with any phonics-based reading curriculum (e.g., reading mastery). The NRA utilizes active participation, internal speech, diagnostic distractor arrays, error analysis, and additional instruction (e.g., word comprehension, spelling, comparing words) in conjunction with adaptations and assistive technology (Heller, 2005).

There have been three studies published so far utilizing the NRA. In the first study (Heller et al., 1999), students with severe speech and physical impairments were taught reading using the NRA in conjunction with direct instruction curricula over an academic year. The students made considerable gains in their reading levels. This study also used a reversal design that showed the positive effect of using diagnostic...
distractor arrays to assess student learning, as opposed to using nondiagnostic dissimilar word arrays. The second study (Heller et al., 2002) used a multiple-probe design to show the effectiveness of the NRA in teaching students to decode words and to generalize to decoding unknown words. The data indicate that the students were able to learn the targeted words, with one student generalizing the ability to decode unknown words with similar phoneme sequences and with the other students being able to learn the new words more quickly. In the third study (Coleman-Martin, Heller, Cihak, & Irvine, 2005), students with physical disabilities and autism were taught words via the NRA, as presented by a teacher and as presented by a computer with PowerPoint presentation and voice output. The study showed that the students were able to learn the target words when instruction was delivered by the computer using the NRA script, as well as when it was delivered by the teachers. Using the computer for delivery of instruction had the advantage of allowing the students to learn the words independently while giving the teachers the flexibility to assist other students.

For a strategy to be useful to the student, he or she should internalize the strategy and use it when encountering unknown words. Documentation is limited regarding students’ independent use of the NRA to decode unknown words. In one study (Heller et al., 1999), a student demonstrated the internalization process by moving a card under the letters of each word as she subvocally decoded the word. In a study evaluating the use of computer-aided instruction with the NRA (Coleman-Martin et al., 2005), one student moved the cursor under each word on the screen in unison with the sound being pronounced by the computer program. Although both these instances indicate that the students internalized and applied the decoding strategy taught in the NRA, this finding would normally be missed unless the students engaged in some type of motor movement when decoding a word subvocally.

To help determine when students are using the decoding process of the NRA, they could make some type of motor movement. Motor movements are used to verify that students are attending to a word, such as by touching a word card (Cohen, Heller, Alberto, & Fredick, in press) or by tracing letters via multisensory reading programs (Mercer & Mercer, 2005). In this case, designated motor movements that are simultaneously engaged with each step of the decoding strategy may be used to provide an observable behavior and to help the student remember the decoding steps. In the present study, these designated motor movements are called motoric indicators. For example, if a student with athetoid cerebral palsy can easily swing his arm back and forth, he could have a motoric indicator of swinging his arm back and forth at various rates—that is, slow as each phoneme (or unit) is said subvocally, a little faster upon subvocally blending the sounds together, and faster yet when saying the word as pronounced when reading. However, it is unknown whether the addition of a motoric indicator interferes with students’ attention, concentration, and ability to effectively decode words.

The purpose of this study was to examine the use of the three-step decoding strategy and the addition of a motoric indicator with students with severe speech and physical impairments. Specifically, it examined whether students could learn the decoding strategy with a motoric indicator as they receive instruction on targeted words in isolation and if they would independently use the strategy upon encountering unknown words in connected text in the naturalistic classroom setting.

Method

Participants

To be selected for this study, the student had to meet the Georgia requirements for an orthopedic impairment (OI), which refers to students with mild intellectual disabilities to those with above-average intelligence who have a physical disability that interferes with educational performance; they had to receive services through an OI special education program; they had to have dysarthric or anarthric speech requiring the use of augmentative and alternative communication; they had to have letter-sound correspondence for the majority of letters of the alphabet; they had to have the ability to see print; and they had to be a candidate for conventional (academic) literacy instruction. Only four students met these criteria in two schools, and all four had cerebral palsy and severe dysarthric speech (see Table 1).

Alice was an 8-year-old student with severe spastic quadriplegic cerebral palsy who received instruction in a self-contained OI classroom. She had learned letter-sound correspondence for all the letters but was not receiving instruction in word identification and decoding. Most literacy activities consisted of books being read to her. She had used a communication device for 3 years (DynaVox 3100, DynaVox Technologies,
The communication device was accessed with a toggle switch placed at her right cheek, and it utilized a linear scanning pattern. Alice’s accuracy rate with this method was approximately 85%, with errors primarily being caused by activating the switch too early in anticipation of the desired choice. Because of these motor-planning errors, her most reliable means of response involved vocalizing yes when asked yes/no and multiple-choice questions. Alice was able to verbalize a few one-syllable words that could be uttered during her exhaling of breath. Respiratory strength and oral motor difficulties prevented Alice from being able to expand her verbal vocabulary as well as improve her poor speech intelligibility.

Beth was a 7-year-old student with severe spastic quadriplegic cerebral palsy. She received instruction in a self-contained OI classroom. She had also learned letter-sound correspondence for all the letters. But she was not currently receiving instruction in word identification and decoding, and she participated only in literacy activities by having books read to her. The classroom teacher had the opinion that Beth wanted to learn to read because she frequently chose a book when given a choice of activities for free time; however, the teacher was unsure with how to proceed with reading instruction. In the area of communication, Beth had recently begun to use a communication device (DynaVox 3100) with visual and auditory scanning capabilities. Because she was still learning to use the device proficiently, Beth’s most reliable means of communication was eye gaze. She could accurately answer questions by looking at her choice from an array of items (e.g., objects, pictures, symbols).

Carl was a 6-year-old student with athetoid cerebral palsy who received reading and language arts instruction in an OI resource room and instruction for the rest of his subjects in general education. According to the Georgia Kindergarten Assessment Program–Revised, Carl had name recognition, general understanding of positioning and page turning when looking through books, and an ability to convey thoughts. Reading instruction was provided daily by a teacher of students with OI, using Reading Mastery–Level 1. He used a communication device (DynaVox 3100) by using the thumb of his right hand directly on the pictures or letters. Carl was able to verbalize approximately 20 words that could be understood by people familiar with his dysarthric speech. His most reliable means of communication was through the use of his DynaVox 3100.

Dave was a 12-year-old student with mixed cerebral palsy (spastic quadriplegia with frequent athetoid movements in the upper body) who received instruction in reading and language arts in the OI resource room. The rest of his day was spent in the fifth-grade classroom. His reading curriculum was Trophies

### Table 1

Overview of Participant Characteristics and Their Motoric Indicators

<table>
<thead>
<tr>
<th>Student</th>
<th>Age</th>
<th>Disability and Placement</th>
<th>Reading</th>
<th>AAC</th>
<th>Motoric Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alice</td>
<td>8</td>
<td>Spastic cerebral palsy</td>
<td>Kindergarten&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Verbally says yes&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Sounds and blending steps: Move head forward. Say word fast: Blinks.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OI self-contained</td>
<td>Letter-sound correspondence</td>
<td>DynaVox with linear scanning and toggle switch at right cheek</td>
<td></td>
</tr>
<tr>
<td>Beth</td>
<td>7</td>
<td>Spastic cerebral palsy</td>
<td>Kindergarten&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Eye gaze&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Sounds and blending steps: Lean forward from waist. Say word fast: Jump shoulders forward.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OI self-contained</td>
<td>Letter-sound correspondence</td>
<td>DynaVox with linear scanning with pressure switch for right hand</td>
<td></td>
</tr>
<tr>
<td>Carl</td>
<td>6</td>
<td>Athetoid cerebral palsy</td>
<td>Kindergarten&lt;sup&gt;a&lt;/sup&gt;</td>
<td>DynaVox with direct selection&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Right thumb moves left to right under the word with increasing speed for each step.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OI resource</td>
<td></td>
<td>Verbalize 20 words with dysarthric speech</td>
<td></td>
</tr>
<tr>
<td>Dave</td>
<td>12</td>
<td>Mixed cerebral palsy</td>
<td>Fifth-grade level&lt;sup&gt;c&lt;/sup&gt;</td>
<td>Pathfinder with direct select&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Right index finger moves left to right (or up and down) near the word with increasing speed with each step.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OI resource</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: AAC = augmentative and alternative communication; OI = orthopedic impairment.

<sup>a</sup> Georgia Kindergarten Assessment Program–Revised.

<sup>b</sup> Reliable means of response.

<sup>c</sup> Criterion-Referenced Curriculum Test.
(Harcourt School), which is the reading and language arts textbook used by the fifth-grade general education classes. Before this study, Dave had received instruction in the NRA. Dave’s Criterion-Referenced Curriculum Test scores from the previous year showed him to be on level in the areas of reading and language arts (i.e., scoring 300 or higher, placing him in the category of meets or exceeds the standards). He communicated with using a communication device (Pathfinder AXS1600, Prentke Romich Company, Wooster, OH) for approximately 5 years, which he accessed by direct select, using the index finger of his right hand. His most reliable means of response was direct select with the Pathfinder.

**Procedure**

**Word selection and presentation.** Before beginning the study, all students received a pretest on graded word lists to determine which words they already knew. During the pretest, each word was presented three times over three sessions. If the word was not identified correctly during any of the three presentations, it was included in the list of words to be taught. Thirty words were initially presented to compile a collection of 10 words for each student. Three of the students had words at the kindergarten level, whereas Dave had words at a fifth-grade level. Each word was presented on a 3.5 inch × 5.0 inch index card. The words were printed in 72-point Arial font. Instruction took place in a 1:1 format within the classroom environment. At this time, the other students in the classroom were actively engaged in academic activities with the paraprofessional. Ten words were selected for each student from the results of the pretest. Words that were irregular and words that could not be easily decoded were eliminated. The teachers verified that the targeted words had not been taught and would not be taught in their reading and language arts class during the study.

**Teaching the decoding strategy used in the NRA.** The NRA is a systematic method for teaching word identification to students with speech and communication impairments and additional disabilities, such as cerebral palsy (Heller et al., 1999). This approach consists of guided practice and evaluation (see Table 2). The guided-practice component teaches students the targeted words and a three-step decoding strategy. The three steps consist of teaching the student to use internal speech to subvocalize the smaller units of the word (which are typically phonemes for small words), to bring the smaller units (or sounds) together without stopping between them, and to say the smaller units together fast, thus making a word. In each step of the guided-practice component, the teacher models the steps of the decoding strategy and says aloud the sounds and word that is being targeted, and the student learns and performs the steps using internal speech.

For consistency, the same procedure was followed for each targeted word: The teacher would start by saying, “Let’s look at this word. Let’s sound it out together. I’ll say the sounds slowly while you say it with me in your head.” The teacher would uncover the letter or letters, the phoneme, or the unit of the word and then give the first step of the decoding strategy: “Say in your head this sound.” The teacher would then model the sound. For example, the teacher might hold up a card printed with the word man. The teacher would cover all but the letter m, say the first step of the decoding strategy, and say mmm while the student said the sound in his or her head. The teacher would then uncover the letter a, give the verbal cue, and say aaa. Next, the teacher would uncover the last n, give the verbal cue, and say nnn. For the second step, the teacher would give another verbal cue: “In your head, say it all together without stopping between the sounds.” Then the teacher would provide a model. For example, the teacher would move her hand across the word, saying mmmmaaannn. The third step consisted of stating, “Say it in your head fast”; that is, the teacher said the word out loud as it would be pronounced when reading text. For example, the teacher would say man.

**Selection and instruction of motoric indicators.** As a way of monitoring whether students were performing the three-step decoding strategy, each student had a specific movement referred to as a motoric indicator. Students were taught to use their motoric indicators with each step of the decoding strategy. During the evaluation component of the NRA, the teachers would tell each student to decode the word; then the teacher would observe for the presence of the student’s motoric indicator. Presence of the movement served as an indicator that the student was using internal speech to go through the decoding steps.

Each motoric indicator involved movements that were neither fatiguing nor difficult for the student to perform. Because Alice and Beth had the most severe cerebral palsy, their motor indicators were more subtle. Alice would lean her head slightly forward when decoding the phonemes and blending them slowly. When it came time to read the word quickly, she...
demonstrated a pronounced blink after finishing the word. Beth’s motoric indicator consisted of her leaning forward from her waist in her wheelchair as she was decoding each phoneme of a word and blending the phonemes together. The movement was slow and deliberate as she decoded. When it was time to read the word fast without stopping between the sounds, she would jerk or jump her shoulders forward with little movement from the waist.

Carl and Dave had similar motoric indicators. Carl used the thumb of his right hand to track under the word being decoded. His thumb was consistently under the target word, and he would track slowly when decoding and track quickly when reading the word without stopping between the sounds. He often moved his thumb so quickly when reading the word quickly that it lost contact with the book or paper. Dave used the index finger of his right hand to track. However, his finger was seldom placed directly under the target word because of motor limitations. Depending on his motor function at the time, his finger might be located above the word, below the word, or even off to the side of the target word. Additionally, because of his athetoid movements, he often appeared as if he were tracking up and down as well as left to right. However, he always demonstrated a pronounced slow movement during the first step of decoding and increased movement speed for each following step.

Evaluating word identification and decoding strategy use. After a guided practice session, each student engaged in other school activities for a minimum of 2 hours. Each student was then tested on his or her own words. Performance was recorded, as was whether the student used the motoric indicator. If the student answered any of the target words incorrectly, the word was retaught by taking the student through the decoding strategy using guided practice. This procedure deviated from other studies using the NRA, which continued to guide the students through the decoding process by telling them the steps to perform without giving them the sounds. This divergent procedure was used, given that the focus of the present study was to promote the student’s learning and using the decoding strategy independently and having it generalize to independent use in the classroom when encountering unknown words in connected text.

The evaluation component of the NRA consisted of using diagnostic distractor arrays and error analysis to determine if the student correctly identified the word. In the diagnostic distractor array, four words were presented. One word in the array was the target word.
whereas the other three were predetermined distractor words similar to the target word.

Distractors were carefully selected to help determine the type of errors that the students made (e.g., vowel confusion, not reading out the ending sounds, confusing specific consonants). Each distractor array also contained a dissimilar word to help determine if the student was guessing or not decoding at all. To perform an error analysis, the teacher recorded the student’s selection for later review and analysis. For example, presenting the words *bog*, *dig*, and *doc* with the target word *dig* would allow the teacher to determine whether the student was sounding out words correctly. If the student chose the word *bog*, he or she might be confusing the *b* and *d* sounds. Selection of the word *dig* might indicate a need for more practice with medial vowel sounds. Selection of the word *doc* might indicate that the student is not decoding the entire word. Error analysis allowed the teacher to examine the student’s selections and look for patterns or similarities in the errors (Heller et al., 1999). If an error pattern was detected, additional corrective instruction was given to target the specific errors.

During the evaluation component of the NRA, the distractor array could be changed to reflect a student’s error pattern. For example, if a student frequently confused the *a* and *i* sound, other target words that contain these vowel sounds should have their distractor words changed to contain the vowel that was incorrectly selected. Modifying the distractor arrays to contain past errors assists the teacher to determine whether the student learned from additional, corrective instruction. In this study, either there were no error patterns, or the errors did not persist over enough sessions; so, no additional instruction was given, and the distractor arrays were not changed.

Students were evaluated by presenting a target word in written format, pausing for the student to use the three-step decoding strategy, and then orally providing the distractor arrays for that word. First, students were presented with each word on a written card. Next, they were to decode the target word using the three-step decoding strategy with their motoric indicators. Students were then presented with four oral choices from which they indicated the correct choice (based on their decoding the written word). Presenting the target word in written format and decoding the word was thought to more closely emulate what happens when a student is reading connected text and encounters an unknown word and tries to decode it. Students were not presented with four written words and given the target word orally, given that the student would have to decode the four written choices or match auditory input to visual information without necessarily decoding the entire word.

The students indicated their selection from the distractor array using their most reliable means of response. Alice was given the four choices orally, and she would say *yes* when she heard the word that she wanted to select. Because Beth’s most reliable means of response was eye gaze, she would focus her eyes on a *YES* card upon hearing the word that she wanted to choose. Carl and Dave would say *yes* or *no* on their respective augmentative and alternative communication devices to make their selections. Care was taken that the teacher did not unintentionally cue the student when choices were provided orally. To ensure that there was no unintentional cueing, part of the procedural fidelity procedure included observing for this very aspect.

When told to sound out the word, students were observed for the presence of their motoric indicators, as well as for other behaviors indicating that they were decoding the word (e.g., attending to the word, eye movements). If the student did not appear to be using the decoding strategy to sound out the target word, the student was corrected and told to sound out the word. Data were taken if this correction was necessary.

**Generalization and independent use of the decoding strategy and motoric indicators**. After the students had received criteria on all 10 of their words, their teachers continued to use the NRA with their reading instruction. Teachers also explained to the students that they should use the decoding strategy whenever they encountered words that they did not know. Students were observed for any independent use of the three-step decoding strategy when they were reading connected text. Observing a student independently perform a motoric indicator while reading indicated that the student had internalized the process and had generalized this skill to reading connected text. This portion of the study continued until students were observed independently using the decoding strategy with a motoric indicator on unknown words in connected text.

**Design**

**Word identification**. A changing-criterion design was used to ascertain whether the students were learning the words as they used the decoding strategy and performed their motoric indicators. The benefit of a
changing-criterion design is that it systematically and consistently alters the number of target words to which the students receive instruction (Kazdin, 1998). The dependent variable in this study was the number of words read correctly. The independent variable was the use of the NRA with motoric indicators. Students served as their own controls, with the number of words read correctly compared to their performance in the baseline condition.

The first phase of a changing-criterion design involves the baseline, which in this case consists of the words selected from each student’s pretest. During the pretest, only words that were identified incorrectly each session were selected for the study. As such, baseline consisted of three sessions. No instruction occurred during this time.

The second phase of the design involves the intervention phase, which is composed of a series of subphases in which each has an interim criterion. Interim criteria can be set on the basis of a professional estimate of the student’s ability (Alberto & Troutman, 2006). With this guideline, the interim criteria were set at an increasing increment of two words for each subphase. A functional criterion is established when each student is assessed on all the words in each subphase and when the student’s performance level matches the continuing changing criteria for performance (Kazdin, 1998). In this design, each subphase served as the baseline of the increased criterion of the next subphase (Alberto & Troutman, 2006; Kazdin, 1998).

In accordance with this design, the first subphase systematically taught the students to sound out two of their words using the three-step decoding strategy with the performance of the motoric indicators. At the beginning of each session, each target word was presented five times using the guided practice component of the NRA. The number of times was selected to facilitate learning the three-step decoding strategy with the motoric indicator to promote internalization of the process so that it could be used independently when given the words to decode. Later in the day, data were collected on the number of words identified correctly.

The criterion for changing subphases involved reaching 100% accuracy on all the targeted words that were taught in the current phase (and taught in the preceding phases). In addition, each intervention sub-phase consisted of a minimum of five sessions to have sufficient practice in using the decoding strategy with the motoric indicator to encourage independent use of the strategy when encountering unknown words when reading connected text. If the students did not reach the interim criteria in five sessions, the session would continue until they were reached. After reaching the first intervention subphase criteria of correctly identifying the two targeted words for that phase (at 100% accuracy), the next subphase would involve teaching the student the next 2 targeted words, and the student would need to identify all 4 targeted words correctly to change to the next subphase (with a five-session minimum in each phase). Two additional words would be taught during each subphase until all 10 words had been taught. The terminal goal was to correctly read 10 out of 10 words (100% accuracy). Data were also taken on the presence of their motoric indicators and the type of errors the students were making with each word.

Independent use of decoding strategy and motoric indicators. A generalization phase of the study was conducted to determine whether the students would independently use the NRA’s decoding strategy with motoric indicators when reading connected text. After the students learned the 10 words, they continued to receive instruction on the decoding strategy with motoric indicator use on their vocabulary words. They also were given connected text to read as part of their literacy instruction. Students were observed for use of their motoric indicators upon encountering unknown words (or if they asked for help or if they just continued reading). Students were rechecked for these behaviors at the end of the school year, as well as 6 months after the completion of the study.

Results

The purpose of this study was to evaluate whether students with severe speech and physical impairments would be able to use a decoding strategy with a motoric indicator to identify 10 words and to independently use that strategy when encountering unknown words in connected text during typical classroom reading. A changing-criterion design was used to determine whether the students could effectively identify words using the decoding strategy and motoric indicator. As seen in Figures 1 and 2, a functional relationship between the number of words read correctly and the use of the NRA was demonstrated for all four students by matching the students’ performance levels with the continually changing criteria for performance.

Figure 1 illustrates Alice’s and Beth’s performances per session. Although Alice did not have a consistent
error pattern, many of her errors tended to involve confusing vowel sounds. When the incorrect words were retaught using guided practice, special emphasis was placed on the vowel sounds. As such, she consistently performed her motoric indicator while decoding each word. In comparison, the errors that Beth tended to make involved failure to attend to the final letter in a word, such as choosing the distractor word plan when the target word was play. When the words were retaught using guided practice, special emphasis was given on the final sounds. Consequently, Beth consistently performed her targeted movement while decoding each word.

Figure 2 illustrates the data for the Carl and Dave. Carl had no discernable pattern of errors. He consistently performed his targeted movement while decoding each of the words. In comparison, Dave made no errors while decoding, and he consistently demonstrated his targeted motor movement as he decoded the targeted words.

Independent use of the decoding strategy. Within 2 weeks of learning the 10 target words, Dave’s teacher observed Dave using his motoric indicator without prompting while reading a book for the Accelerated Reader program used in his school. She observed him read a sentence, return to the beginning of the sentence (as indicated with a sweep of the right index finger back to the first word in the sentence), track along the sentence, and stop at a particular word. He subsequently initiated the same motor movements that he used in this study when decoding a word; then he returned to the beginning of the sentence and reread the sentence. His actions indicated that he was independently applying the decoding strategy used in the NRA to an unknown word when reading connected text in a naturalistic setting. When asked what he was doing, he wrote a message using his communication device that said that he was sounding out a word that he did not know. To be sure, the teacher verified that he successfully identified the word. At this time, the other students did not show any independent use of the three-step decoding strategy.

Six months after the students had been taught to use the decoding strategy and motoric indicators, their teachers were continuing to teach reading using the components of the NRA along with their regular curriculum. By that time, all three remaining students
had been observed using their motoric indicators when encountering unfamiliar words in connected text. (It should be noted that this involved approximately 4 months of instruction after the targeted words were mastered, owing to summer break.)

**Interobserver Reliability and Procedural Fidelity**

Interobserver reliability was measured for 25% of the sessions for each participant. Trained classroom teachers conducted the interventions and were the primary observers, and the researcher served as the secondary observer and collected interrater reliability and procedural fidelity. Observers independently and simultaneously recorded the number of words read correctly on the last trial of each session and observed the presence of the motoric indicators. Interobserver agreement was calculated by dividing the number of agreements by the number of disagreements and multiplying by 100. Interobserver agreement was 100% for each occasion. Presence of decoding behaviors, including the presence of a motoric indicator, was also noted by the two observers.

Procedural fidelity was assessed through the use of an intervention checklist. The checklist contained each step of the NRA script. As the teachers instructed students to use the strategy, the observer made a checkmark next to each step in the checklist. Procedural fidelity was 100% for each occasion.

**Social Validity**

To determine the students’ and teachers’ impressions of the methodology used in this study and their attitudes toward reading, a questionnaire was administered after intervention. A 5-point Likert-type scale was used, and the teachers’ and the participants’ answers ranged from 4 (agree) to 5 (strongly agree) on all questions: On Question 1, “Students with severe speech and physical disabilities can learn to read,” the mean was 5.0. Questions 2 and 3, “Reading is important” and “The NRA is effective,” had a mean of 4.5. Questions 4 and 5, “The NRA is easy to use” and “Internal speech helps with decoding,” had a mean of 5.0. Comments from the teacher included the following: “This method works,” and “I always knew they could read if we knew how to teach them.” Dave commented on his communication device: “Finally, someone knows a way to teach me to read.” Carl used his communication device to say, “Show people smart me.”

**Discussion**

The purpose of this study was to evaluate whether the three-step decoding strategy used in the NRA with a motoric indicator would be used independently by students upon their encountering unknown words while reading connected text, after being taught to use the strategy on 10 targeted words. Prior studies (Coleman-Martin et al., 2005; Heller et al., 1999; Heller et al., 2002) focused on the use of the NRA as an instructional strategy in which the teacher or computer program guided the student through the decoding process. This study focused on teaching the student to internalize the three-step decoding strategy and apply it to connected text.

The results of this study indicate that the three-step decoding strategy with motoric indicators can be used to teach word identification and that it can be internalized for students to use independently. All four students in this study were able to learn their target words using this approach. Alice and Beth, who were the furthest behind in reading, took longer to reach acquisition in most intervention phases. Dave, being the most experienced reader who was also at grade level, was able to immediately reach acquisition in each intervention phase and demonstrate the ability to use the strategy independently much faster than the other students were capable of doing. The finding regarding the ability to identify words after decoding instruction was consistent with that of other studies in the literature that used decoding with this population of students (Erickson & Koppenhaver, 1997; Fallon et al., 2004; Smith, 1992).

When teaching the decoding strategy using guided practice, each student appeared to decode the targeted word, as observed through their use of motoric indicators and additional behaviors. During the evaluation phase, each student demonstrated his or her targeted motor movement, which appeared to parallel the three steps of the decoding strategy. Students demonstrated their motor movements each time they decoded one of the targeted words, and no reminders or further instruction was needed. The motoric indicators ranged from subtle head movement and blinking to moving an index finger in a left-to-right motion near the word. The successful use of motoric indicators in this study is consistent with other reading methods that have successfully used movements as a part of the instruction on word identification (Cohen et al., in press; Fernald, 1988; Gillingham & Stillman, 1970).
A limitation of the study is that the use of a motoric indicator does not guarantee that the student is performing each step of the decoding strategy using internal speech as the motor movement is being made or that he or she is decoding. This is a similar problem with any internalized strategy, except that students who have speech can verbally demonstrate that they are using the technique. However, in this study, the student’s accuracy and behavior of attending to the word, intently looking at the word while making a motor movement, and making the motor movement correctly for each of the steps indicate that the students were actively using the decoding strategy and decoding the words.

During the 6-month follow-up period, the students were found to stop reading their connected text upon encountering an unknown word, to independently perform their motoric indicators, and to arrive at the correct word. This finding further indicates that the students had learned the decoding strategy and were using the strategy to decode unknown words. It is interesting to note that when each student incorrectly identified a word, he or she made the same type of error—for example, confusing vowel sounds and end sounds, which are common decoding errors (McCandliss, Beck, Sandak, & Perfetti, 2003). The students’ ability to internalize the three-step decoding process used in the NRA is consistent with the findings in the literature in which students are able to learn strategies and apply them to the reading process (Bruce & Robinson, 1999, 2000; Wright & Jacobs, 2003).

When students are unable to verbalize, a motoric indicator may help signify that the students are engaging in the steps of the procedure. Care should be taken that the motor movement is easy to produce. When there are multiple steps, the motor movement may need to vary between steps. In this study, the speed of the motor movement increased between each step for some students, whereas for other students, a different motor movement indicated the last step. In this study, each student chose the motor movements that accompanied the three-step decoding strategy, which ensured that the movement was one that the student had control over and could independently and voluntarily produce.

An extension of this study would be to add the next step of the NRA, in which students are presented with a target word in written form and are taught to ask themselves if they know the word. If the student does not know the word, then he or she continues with the internalized three-step decoding strategy. If the student indicates that he or she knows the word, the teacher can immediately evaluate the student using a diagnostic distractor array. In this study, students were being taught the three-step decoding strategy and were using it before making a selection, which provided them with sufficient practice to internalize the strategy. However, students should reach automaticity with each targeted word and be able to identify the target word without decoding it. It is possible that students may have reached automaticity on some of their targeted words and could eventually identify them by sight, but because the emphasis was on learning the decoding strategy, they were encouraged to continue to decode the words to learn the strategy and be able to apply it later (i.e., at the 6-month follow-up). However, in future studies, having students learn to ask themselves whether they know the word and having them determine whether they need to use the decoding strategy will aid them in efficient word identification. Future studies can include this next step of teaching students when they need to use the decoding strategy as part of the procedure once the participants have had enough experience using the three-step decoding strategy.

Another limitation of this study was that it involved only four students who, according to the definition of OI in the state of Georgia, had cognitive levels of mild intellectual disability, normal intelligence, or gifted ability. As a result, the students who participated in this study were able to successfully internalize the use of the decoding strategy with the motoric indicator. Future studies are needed to examine the use of the strategy with a larger variety of students with a wider range of cognitive abilities and across different instructional settings (e.g., general education classrooms). Students who require more support to learn the three-step decoding strategy could have it programmed in their communication devices. Students could access their communication devices to remind them of what to do when encountering an unknown word. The strategy could also be used as an intermediate step between guided instruction given by the teacher and its independent use.

Future studies should examine whether the motoric indicator should be taught with the decoding strategy or at a later time. Students with varying physical abilities may require additional attention, concentration, or effort to perform a motoric indicator, even when one has been selected that appears easy for a student to execute. Although this was not found to be the case in this study, performing the motoric indicator while remembering the steps of the decoding strategy upon encountering a new word may be too difficult for


References


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