Can Treatment for Pure Alexia Improve Letter-by-Letter Reading Speed without Sacrificing Accuracy?

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An experimental treatment study designed to improve both the accuracy and the speed of reading was administered to a patient with pure alexia and impaired letter naming. The study focused on the use of letter-by-letter reading. A two-stage approach was employed. The first stage implemented a tactile–kinesthetic strategy to improve accuracy. The second stage concentrated on speed. At the end of the treatment, patient DL was reading both trained and untrained words more accurately and with considerably greater speed than prior to treatment. Accuracy and speed of reading at the sentence level improved as well. © 1999 Academic Press

Pure alexia is an acquired reading disorder characterized by a length effect (shorter words are read faster and/or more accurately than longer ones) and a modality effect (spelling and recognition of orally spelled words are superior to reading). In processing terms, this disorder is believed to be the result of a prelexical impairment somewhere along the route from visual processing to the lexical system. It has been suggested (Friedman & Alexander, 1984) that letters can no longer be identified in parallel, but must be identified sequentially instead. Indeed, patients with pure alexia are frequently observed to read in letter-by-letter fashion. Each letter in the word is named, either aloud or silently, in left to right order before the word can be identified. This sequential reading explains why longer words are more difficult for these patients.

The modality-specific nature of the deficit, i.e., the fact that it exists only for visually presented words, suggests that all lexical representations, including orthographic representations, remain intact. Therefore, orthography is processed normally when accessed through other, nonvisual modalities, such as in spelling and in recognition of words that are orally spelled to the patient.

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A common treatment approach for pure alexia is to capitalize on the natural tendency of many of these patients to read in a letter-by-letter fashion. The patient names each letter of the word in sequence and can then recognize the word s/he has thereby orally spelled to her/himself. This approach can be very effective for improving reading accuracy. For example, Lott, Friedman, and Linebaugh (1994) used a tactile–kinesthetic approach to train their patient to read letter by letter and demonstrated a significant increase in the patient’s reading accuracy. However, reading remained slow and laborious.

The purpose of the current studies was to make letter-by-letter reading more efficient by improving not only accuracy, but speed as well. Experiment 1 is a tactile–kinesthetic treatment that targeted DL’s letter naming accuracy. Experiment 2 is a speeded letter-by-letter reading treatment that focused on improving DL’s letter-by-letter reading speed.

CASE HISTORY

DL is a 67-year-old right-handed man with a Ph.D. in Public Health, who suffered a left hemisphere CVA 4 months prior to our initial evaluation. CT showed evidence of a recent left posterior temporal–occipital lobe infarct, as well as an old infarct in the right frontal–parietal lobe and a small lacune (2–3 mm) in the posterior right basal ganglia region. Language and reading were described as normal prior to the most recent episode.

DL presented with a moderate anomic aphasia and severe pure alexia with poor letter naming. Spontaneous speech was fluent, but mildly anomic. The Boston Diagnostic Aphasia Exam (Goodglass & Kaplan, 1983) was used to further characterize DL’s language profile. Visual confrontation naming was poor and characterized by circumlocution, semantic paraphasias, and increased response time. The Responsive Naming score was reduced mainly by increased response time, but 9/10 responses were accurate. Repetition was quite good. Auditory comprehension was impaired for colors and body part identification and slightly reduced for complex paragraph length material. Basic level reading tasks were performed quite well as was reading comprehension. However, oral reading of single words and sentences was poor; DL’s reading was quite slow and he attempted to read letter by letter. Spelling was well preserved (see Table 1 for scores).

Tests of Reading

A battery of reading and reading-related tests was administered to DL. He demonstrated a length effect in which words composed of more letters took longer to read than did words composed of fewer letters (see Fig. 1). He also demonstrated a modality effect: his written spelling and his ability to recognize words that were orally spelled to him were far superior to his oral reading of those same words (see Table 2). There was no effect of part of speech on DL’s oral word reading, nor were there any effects of concreteness.
TABLE 1
DL’s BDAE Scores

<table>
<thead>
<tr>
<th>Subtest</th>
<th>Pretreatment (5 MPO)</th>
<th>Posttreatment (22 MPO)</th>
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</thead>
<tbody>
<tr>
<td>Verbal Expression</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Responsive Naming</td>
<td>24/30</td>
<td>25/30</td>
</tr>
<tr>
<td>Visual Confrontation Naming</td>
<td>50/114</td>
<td>84/114</td>
</tr>
<tr>
<td>Animal Naming</td>
<td>8/min</td>
<td>10/min</td>
</tr>
<tr>
<td>Automatic Sequences</td>
<td>8/8</td>
<td>8/8</td>
</tr>
<tr>
<td>Repetition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repetition of Words</td>
<td>10/10</td>
<td>10/10</td>
</tr>
<tr>
<td>Repetition of High-Probability Phrases</td>
<td>8/8</td>
<td>8/8</td>
</tr>
<tr>
<td>Repetition of Low-Probability Phrases</td>
<td>7/8</td>
<td>6/8</td>
</tr>
<tr>
<td>Auditory Comprehension</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Word Discrimination</td>
<td>56/72</td>
<td>58/72</td>
</tr>
<tr>
<td>Body Part Identification</td>
<td>12.5/20</td>
<td>16.5/20</td>
</tr>
<tr>
<td>Commands</td>
<td>15/15</td>
<td>14/15</td>
</tr>
<tr>
<td>Complex Ideational Material</td>
<td>10/12</td>
<td>10/12</td>
</tr>
<tr>
<td>Reading</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Symbol and Word Discrimination</td>
<td>9/10</td>
<td>10/10</td>
</tr>
<tr>
<td>Word Recognition</td>
<td>8/8</td>
<td>6/8</td>
</tr>
<tr>
<td>Comprehension of Oral Spelling</td>
<td>8/8</td>
<td>8/8</td>
</tr>
<tr>
<td>Word–Picture Matching</td>
<td>6/10</td>
<td>10/10</td>
</tr>
<tr>
<td>Reading Sentences and Paragraphs</td>
<td>8/10</td>
<td>7/10</td>
</tr>
<tr>
<td>Oral Reading</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Word Reading</td>
<td>2/30</td>
<td>16/30</td>
</tr>
<tr>
<td>Oral Sentence Reading</td>
<td>1/10</td>
<td>4/10</td>
</tr>
<tr>
<td>Writing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanics</td>
<td>5/5</td>
<td>5/5</td>
</tr>
<tr>
<td>Serial Writing</td>
<td>42/47</td>
<td>46/47</td>
</tr>
<tr>
<td>Primer-Level Dictation</td>
<td>15/15</td>
<td>15/15</td>
</tr>
<tr>
<td>Spelling to Dictation</td>
<td>8/10</td>
<td>9/10</td>
</tr>
<tr>
<td>Written Confrontation Naming</td>
<td>7/10</td>
<td>6/10</td>
</tr>
<tr>
<td>Written Formulation</td>
<td>4/5</td>
<td>4/5</td>
</tr>
<tr>
<td>Sentences Written to Dictation</td>
<td>12/12</td>
<td>12/12</td>
</tr>
</tbody>
</table>

Note. MPO, months postonset.

(concrete, 7/30; abstract, 3/30) or regularity (regular, 6/20; exception, 9/20). Pseudoword reading was not particularly impaired relative to real words that differ by a single letter (2/20 vs 6/20, respectively).1

Tests of Letter Knowledge

DL was poor at single letter naming (16/26). The data from six letter naming tests, administered on separate days, indicated that the letter naming difficulty was not letter specific: there were only two letters that DL incor-

1 It is possible, however, that some of these effects exist, but are masked by the low test scores.
rectly named each time (h and q), and there were only three letters that he never named incorrectly (o, v, and w). He also had considerable difficulty pointing to letters named by the examiner (19/26). In an upper–lowercase letter matching task, DL successfully rejected pairs that represent different letters (e.g., M–p; 26–26), but he had great difficulty accepting pairs that represent the same letter but are physically dissimilar (e.g., A–a; 7/13). He had intermediate difficulty with letter pairs that represent the same letter and have the same overall shape (e.g., S–s; 10/13). It appears, then, that DL’s difficulty with letters goes beyond letter names; he has difficulty with letter identities as well. However, he still recognizes letter forms as familiar symbols: he correctly identified a letter as being correctly oriented or in mirror image 50 of 52 times.

Testing on the Raven’s Colored Progressive Matrices (RCPM) (Ravens, 1965) and Biber Figure Learning Test (Glosser, Goodglass, & Biber, 1989) revealed no major cognitive impairments. (RCPM 23/36; approx. 50th percentile for his age; Biber Figure Learning Test; all but one subtest within 2 standard deviations for his age).

<table>
<thead>
<tr>
<th>Task</th>
<th>Reading</th>
<th>Spelling</th>
<th>Recognition of oral spelling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Word list</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pseudoword</td>
<td>2/20</td>
<td>18/20</td>
<td>19/20</td>
</tr>
<tr>
<td>Part of speech</td>
<td>8/32</td>
<td>31/32</td>
<td>29/32</td>
</tr>
<tr>
<td>Regularity</td>
<td>15/40</td>
<td>30/40</td>
<td>32/40</td>
</tr>
</tbody>
</table>
EXPERIMENT 1: TACTILE–KINESTHETIC LETTER NAMING TREATMENT

Rationale

DL’s letter naming was quite poor, and, consequently, his letter-by-letter reading was not accurate. The first experiment focused on improving DL’s letter naming accuracy. A tactile–kinesthetic program was administered (Lott et al., 1994). DL was trained to copy each letter onto his left palm using a capped pen and then name the letter. With this method, the sensation of the pen on the left hand produces tactile information, while the movement of the right hand produces kinesthetic information. This multimodal input provides alternate access routes to the letter names.

Pre- and Posttreatment Tests

A variety of external measures were administered in order to compare pre- and posttreatment performance. These tests consisted of The Boston Diagnostic Aphasia Examination (BDAE), The Reading Comprehension Battery for Aphasia (RCBA) (LaPointe & Horner, 1984), a questionnaire regarding various aspects of reading, and various single word reading lists. These tests were administered prior to Experiment 1 and then readministered following Experiment 2, approximately 1 year later.

Method

Stimuli. Stimuli for the tactile–kinesthetic letter naming treatment consisted of the lowercase letters of the alphabet. The letters were divided into three groups, based on DL’s baseline letter naming performance. Set 1 contained the letters that DL named most accurately. Sets 2 and 3 contained letters of intermediate and low accuracy, respectively. The letter sets were divided in this fashion in accordance with standard treatment philosophy that treatment should begin where the patient is successful 60–80% of the time to ensure initial success (Brookshire, 1978).

Design. A single subject, multiple baseline design was used. In this design, there is a baseline phase during which all stimuli are probe tested several times to establish stable, pretreatment performance. Treatment is then conducted in stages. While one set of stimuli are trained, the other sets are not trained, but are probe tested periodically. In the current experiment, Set 1 letters were trained first. Training on the Set 1 letters continued until DL named those letters with 90% accuracy on two consecutive probe tests. Then the Set 2 letters were trained, and finally the Set 3 letters, to the same criterion level. There were three 1-h treatment sessions per week.

Procedure. During the baseline phase, the letters were presented one at a time in random order on a computer screen, via the SuperLab program (Abboud, 1991). At this time we also obtained baseline data for the letter strings and words that would be trained in Experiment 2. DL was instructed to name each letter or word aloud as quickly as possible without making mistakes. DL’s accuracy and response times for naming the letters in isolation and in letter strings, and for reading the words, were obtained.

In each session, treatment was preceded by probe testing. The probe test consisted of the entire alphabet presented one letter at a time in random order on a computer screen. DL was
instructed to name each letter as quickly as possible, without making mistakes. During treatment, DL was instructed to copy each letter onto his left palm, using a capped pen, and then name the letter, again as quickly as possible without making mistakes.

For home practice, DL was provided with a pen and index cards, each containing one printed letter. The cards containing the letters to be trained in each stage were provided as that stage began.

Results

After learning the procedure for the letters in Set 1, DL was observed using the tactile–kinesthetic method to name the letters in Sets 2 and 3, neither of which was yet trained. His naming of those untrained letters thus improved somewhat; Set 2 improved from 67 to 84% correct and Set 3 improved from 30 to 57% correct.

Training of all three sets of letters was completed in 18 sessions, which lasted approximately 2 months. Figure 2 shows DL’s pre- and post-tactile–kinesthetic letter naming treatment performance on naming letters in isolation, naming letters in nonpronounceable letter strings, and in word reading. Although only letter naming in isolation was trained, DL’s accuracy improved in all three contexts.

Using the tactile–kinesthetic method resulted in slightly increased re-

![Figure 2](image-url)
response times, from 5.8 to 5.9 s/letter in isolation, from 4.9 to 6.3 s/letter for letters in letter strings, and from 29 to 36 s/word. The words ranged from three to seven letters each.

**EXPERIMENT 2: SPEEDED TACTILE-KINESTHETIC LETTER-BY-LETTER READING TREATMENT**

**Rationale**

While Experiment 1 succeeded in improving DL’s letter-by-letter reading accuracy, it also slowed him down a bit. The second experiment focused on improving DL’s letter-by-letter reading speed. A speeded paradigm was employed to automatize the tactile–kinesthetic procedure. DL was instructed to use his tactile–kinesthetic strategy to name letters as quickly and accurately as possible, first in isolation, then in letter strings, and finally in words. DL was provided with feedback regarding his accuracy and average response time.

**Method**

**Stimuli.** The stimuli consisted of all letters of the alphabet, 40 nonpronounceable letter strings (e.g., sdrafpg), and 120 words. Both letter strings and words were divided into sets that were trained (20 strings and 80 words) and sets that were never trained but were regularly probed to assess generalization (20 strings and 40 words). The letter strings ranged from four to seven letters in length. The words ranged from three to seven letters in length. The training and generalization words were matched for letter length and frequency of occurrence based on the Francis and Kucera word count (1982). In addition, the training words were composed of pairs that were matched for orthographic similarity (e.g., plastic and plaster) to eliminate the potential for guessing the word after identifying the first few letters.

**Design.** Again, a single subject multiple baseline design was used. All stimuli were probe tested again, and the treatment proceeded in stages. In this experiment, letters in isolation were trained first. Training continued until DL’s response time reached plateau, defined as 12 consecutive sessions without an appreciable decrease in time. Next, the nonpronounceable letter strings were trained, and last the words were trained, also until DL’s response time reached plateau. The untrained letter strings and words were never trained, but were regularly probed to assess generalization.

**Procedure.** During the baseline phase, the letters, letter strings, and words were blocked and presented one at a time in random order on a computer screen via the SuperLab program (Abboud, 1991). For single letter and letter string blocks, DL was instructed to name each letter (and for word blocks, to read each word) as quickly as possible without making mistakes. DL’s accuracy and response times for naming the letters in isolation and in letter strings, and for reading the words, were obtained.

The first speeded treatment phase targeted letters in isolation. Probe tests were not used during this phase of treatment. Instead, progress was monitored by calculating the average time to name a letter during each treatment session. In each treatment session, two runs were conducted. Each run consisted of three blocks. Each block contained two presentations of each letter, presented one at a time in random order. DL was instructed to name each letter as quickly as possible, without making mistakes. DL’s response time for naming each letter was recorded by a voice-activated relay. At the end of each block, the average time to name a letter was computed. DL was given this feedback, as well as being shown a graph of his
average times over several sessions. DL was also told his percentage correct. Accuracy was not specifically addressed in this stage, but if accuracy dropped below 90% correct, DL was given reminders regarding general use of the tactile–kinesthetic strategy (e.g., be sure to copy the letter exactly as you see it, be sure to copy each letter before naming it, etc.). Training continued until DL’s daily mean letter naming time reached plateau.

The next phase of speeded treatment targeted letters in nonpronounceable letter strings. Each week, treatment was preceded by probe testing of both the trained and the untrained letter strings. During each treatment session, two to four runs were conducted. A run consisted of the entire set of trained letter strings presented one at a time in random order. DL was instructed to name every letter as quickly as possible, without making mistakes. Letter strings were trained as a precursor to words in order to stress the importance of naming every letter. Again, after each run, the average time to name a letter and the percentage correct were computed and reported to DL. Training continued until DL’s daily mean letter naming time reached plateau.

The final phase of treatment targeted letter-by-letter word reading. Once per week, treatment was preceded by probe testing of all the trained and untrained words. On each of the other two sessions that week, treatment was preceded by probe testing of a subset of the trained and untrained words. During each treatment session, two to four runs were conducted. A run consisted of the entire set of trained words presented one at a time and in random order. DL was instructed to name every letter, and then to read the word aloud, as quickly as possible without making mistakes. At the end of each block, the average time to read a word and the percentage correct were computed and reported to DL. Training continued until DL’s daily mean word reading time reached plateau.

For home practice, DL was provided with index cards, each containing a printed training letter string or word. The cards containing the stimuli to be trained in each stage were provided at that stage began.

Results

1. Speeded naming of letters in isolation. DL’s time to name letters and read words following this phase of treatment was compared with that following Experiment 1. Training was discontinued after 14 treatment sessions because no measurable improvement in DL’s speed of naming letters in isolation was observed. However, DL’s speed of naming letters in letter strings and his speed of word reading, neither of which was yet trained, did improve. DL’s mean response time for naming letters in letter strings decreased from 6.3 to 5.6 s per letter. DL’s mean response time for reading words decreased from 36.0 to 23.6 s per word. DL’s accuracy in naming letters in isolation continued to improve during this stage, from 90 to 96% correct. Accuracy in naming letters in letter strings remained the same, at 89–90% correct. Accuracy in word reading, however, dropped from 94 to 72% correct.

2. Speeded naming of letters in nonpronounceable letter strings. Following an additional 37 sessions, the last 12 of which represented plateaued performance, DL’s mean letter naming time for trained letter strings decreased from 5.9 to 2.0 s per letter. His mean letter naming time for untrained letter strings decreased from 5.3 to 2.3 s per letter. His mean reading time for words, which still were not yet trained, decreased from 23.6 to 13.2 s per word. Accuracy of naming letters in trained letter strings improved from
89 to 95% correct and remained at 92% correct for untrained strings. Word reading accuracy improved from 72 to 95% correct, returning to a level comparable to that recorded prior to the beginning of the speeded letter treatment.

3. Speeded letter-by-letter word reading. After an additional 40 sessions, DL’s mean reading time for both trained and untrained words decreased from 13.1 to 7.0 s per trained word and from 13.3 to 7.2 s per untrained word. Accuracy remained 96% correct for trained words and improved from 93 to 98% correct for untrained words.

The training in Experiment 2 lasted approximately 9 months.

PRE- AND POST-TREATMENT TESTING

DL’s performance before the initiation of any treatment was compared with his performance following the entire treatment program. Figure 3 illustrates DL’s improvement in reading both trained and untrained words, measured before the tactile–kinesthetic treatment and after the speeded treatment. DL read both groups of words faster and more accurately after treatment.

Several external measures were assessed only twice: once pre-tactile–kinesthetic treatment and once post-speeded treatment. The first of these

![Graph showing speed and accuracy of reading trained and untrained words before and after treatment.]

**FIG. 3.** DL’s speed and accuracy of reading trained and untrained words before treatment vs after treatment.
measures consisted of single word reading lists. One single word reading list contained 50 short words (three to five letters) of varying parts of speech, all with a high frequency of occurrence. A second single word reading list contained 50 longer words (four to eight letters), all with a low frequency of occurrence. Figure 4 shows that DL read these words both faster and more accurately after treatment.

The BDAE was also presented only at pre- and posttreatment intervals. DL improved on three of the seven reading subtests (see Table 1). With the exception of increased speed on the Visual Confrontation Naming subtest, there were no significant changes on any of the other subtests.

The RCBA was also presented before and after treatment. DL’s accuracy and speed improved on two of the five sentence and paragraph length subtests administered (see Table 3).

A questionnaire containing 11 questions eliciting subjective evaluations of various aspects of reading was administered before and then again after treatment. After treatment, DL rated himself higher in four aspects, including how frequently he now reads and how well he comprehends single words, sentences, and paragraphs. His wife rated him higher in 9 of the 11 areas, including how much he enjoys reading, how quickly and how frequently he
now reads, how well he reads words aloud, and how well he comprehends single words, sentences, signs, labels, and newspapers.

**EXPERIMENT 3: READING WITH AND WITHOUT THE STRATEGY**

**Rationale**

The results reported above show that, following treatment, DL read more quickly and accurately. In order to support our claim that his improvement can be attributed to the treatment, and not to spontaneous recovery, an additional experiment was conducted. DL’s reading performance was compared under two conditions: (1) when allowed to use the speeded tactile–kinesthetic strategy and (2) when he was not allowed to use it.

**Method**

*Stimuli.* The stimuli consisted of a list of 40 words ranging from four to six letters in length. Each word was paired with another that was matched for frequency and orthographic similarity (same first three letters).

*Design.* The list was read under two conditions: in condition 1 DL was allowed to use his tactile–kinesthetic strategy and in condition 2 he was not allowed to use it. During one session, half of the list was administered under condition 1 and the other half under condition 2. During a different session, the words were presented in the same order, but the conditions were reversed.

*Procedure.* The words were presented one at a time in random order on a computer screen. In condition 1, DL was instructed to use what he had learned to read the words aloud as quickly and accurately as possible. In condition 2, he was instructed to sit on his hands, so that he could not inadvertently use the strategy.

**Results**

When DL was not allowed to use the strategy, he was 68% correct and took an average of 12.5 s/word. When he was using the strategy he was 85% correct and took an average of 10.8 s/word.
SUMMARY

DL’s reading of trained words was both more accurate and faster after treatment. In addition, both the patient and his wife rated his posttreatment reading performance as improved in several aspects of reading.

DL’s improvement can be attributed to the treatment rather than to spontaneous recovery: DL was faster and more accurate when using the tactile–kinesthetic strategy than when not allowed to use it, indicating that the improvement was strategy specific. Posttreatment testing on the BDAE demonstrated improvement on some reading subtests, but not on subtests assessing other aspects of language processing (with one exception), suggesting that DL’s improvement was not due to general language recovery.

The treatment effect generalized to untrained stimuli. DL’s reading of words that were untrained, both those that were regularly probed and those that were tested only before and after treatment, showed improvement. Improvement in reading words that were tested only before and after treatment indicates that the generalization seen on the untrained words was not simply due to repeated exposure to those words. Improvement on the BDAE and RCBA showed that the effect also generalized to sentence length reading material (improved reading of more lengthy material was not demonstrated).

DISCUSSION

The goal of the typical language therapy program for improving the reading of patients with acquired alexia is to facilitate the patient’s accuracy in reading words and sentences. The tactile–kinesthetic technique is one such approach. This technique has been shown to produce the desired results (Lott et al., 1994). For many patients with pure alexia, however, the accurate decoding of words is not the main problem that they experience when attempting to read. For patients who have no difficulty identifying letters, or for those who have been taught to use tactile–kinesthetic letter identification, most words can be accurately decoded. Yet these patients still complain about their poor reading skills. Their reading is so slow and laborious that they often quit in frustration. The current therapy addressed both aspects of letter-by-letter reading in pure alexia and was successful at improving both accuracy and speed of word reading.

As generalization is a significant part of new learning, it is important to examine the aspects of our treatment program that did and did not result in generalized improvement and to attempt to understand what determines when generalization is seen. The first part of our program, the tactile–kinesthetic therapy, teaches a new strategy for identifying letters. Following training on some letters, DL was observed to be using the tactile–kinesthetic strategy to identify other letters, with some degree of success. The learning of a specific method or procedure, then, generalized to use with other items of a similar nature. In addition, once the patient learned to use the technique
for all single letters of the alphabet, generalization to other contexts was observed: word reading accuracy improved substantially, before words were explicitly trained.

Following 14 sessions of speeded single letter naming training, individual letter naming speed did not increase. However, speed of naming letters in letter strings and speed of word reading did increase. There are two possible explanations for these results. The first is that any increase in single letter naming speed was too small to be detected, given the inconsistencies in measurement inherent in paradigms employing computer screen presentations. These small increases were magnified when measurement was summed over entire letter strings and words. The second possibility is that the probe tests themselves, although infrequent, may have provided sufficient practice with longer strings to allow for some improvement with these items.

Speeded single letter naming training also had an interesting effect on DL’s accuracy. His accuracy in naming letter strings remained high, but his accuracy in word reading dropped. The difference between letter string and word accuracy may be attributed to effects of guessing. Because DL now had to respond as quickly as possible, when reading words he would frequently make “educated guesses” after identifying only the first few letters. Such guessing, of course, frequently led to inaccurate reading. In contrast, to name letters in a letter string, every letter must be identified; there is no rationale for guessing in this context.

When letter strings were trained, further improvement on both letter strings and words was seen, suggesting that context plays an important role here: naming letters in words places cognitive processing demands on the patient in addition to those that are present when single letters are being named. To read a whole word using the tactile–kinesthetic approach, the reader must segment the word into letters, come up with the identity and name of each letter, store the name of each letter in memory, keep track of which letter in the string is to be named next, and put all the letter names together to come up with the word. These cognitive processes are not likely to improve with practice that consists solely of the naming of single letters. Some of those processes are involved in naming letters in letter strings, consistent with improved performance on words following training with the letter strings. The additional improvement seen following training with words is attributed to the processing steps that are unique to the word stimuli.

Of particular interest is the finding of Experiment 3, that subsequent to our therapy, both DL’s reading accuracy and his reading speed were enhanced by his use of the tactile–kinesthetic speeded letter naming technique. One might have expected to see a speed–accuracy trade-off with the use of this strategy: certainly the additional input about letter identities from other modalities should improve accuracy, but the additional act of tracing each letter requires an appreciable amount of time, which should increase the overall time required to read the word. Indeed, speed of naming letters in
letter strings and of reading words following tactile–kinesthetic training did decrease somewhat over pretreatment letter naming. However, following the speeded letter naming treatment, the speed increased considerably. While we certainly predicted that speed would increase following the therapy designed to increase speed, we did not necessarily predict that the speed of word reading with tactile–kinesthetic input would actually surpass that of reading without implementation of this technique. Yet DL read words faster when allowed to use the tactile–kinesthetic strategy than he did when he was prevented from using it. What does this suggest?

One possibility is that DL’s impaired ability to decode letters using the visual modality results in his spending more time attempting to decode each letter when the use of the tactile–kinesthetic technique is precluded. That is, DL’s attempts to name letters strictly using visual input is not merely inaccurate, but also slower than when he uses the tactile–kinesthetic strategy. Another possibility is that the improved accuracy of letter naming with the tactile–kinesthetic strategy contributes to the increased speed of word naming by allowing for better use of top–down strategies in decoding the letters of the word. That is, if the first few letters of a word are identified accurately, then the top–down processes that generate possible letter choices for the end of the word will be more effective.

This study demonstrates that when both accuracy and speed are targeted for improvement in pure alexia, that result is likely to be an improvement in reading that is more efficient and less frustrating for the patient.

REFERENCES