View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by The Aphasiology Archive

Examining a Treatment Continuum for Acquired Impairments of Reading and Spelling

The rehabilitation of acquired impairments of language typically involves efforts to strengthen weakened cognitive processes while promoting use of preserved abilities. In the case of written language, there are two complementary procedures or processing routes that support reading and spelling, and they can be differentially impaired by brain damage. Specifically, a dual-route model posits that written words can be processed in a lexical-semantic manner, whereby orthographic word forms are directly linked to their meaning; alternatively, written words may be processed in a sublexical manner that is reliant on the component sound-letter correspondences. In literate adults, both routes typically contribute to reading/spelling in a manner that reflects dynamic interaction of semantic, phonological, and orthographic knowledge. When brain damage degrades lexical-semantic procedures, over-reliance on the sublexical route is common. Conversely, when sublexical procedures are weakened, it results in dependence on lexical-semantic processing. It is logical, then, that rehabilitation of acquired impairments of written language might be directed toward strengthening lexical-semantic procedures, sublexical processing abilities, or both, depending on the nature of the written language profile.

In this study, we sought to determine the nature of the underlying impairment affecting written language processing in individual patients, and to implement suitable treatments to strengthen weakened processes while capitalizing on residual (and re-trained) abilities. Outcomes from previous single-subject research were used to guide the development of the treatment algorithm and procedures examined here in a relatively large, heterogeneous group of individuals with acquired alexia/agraphia. The goal was to test the value of the treatment continuum and the effects of each treatment relative to specific agraphia profiles.[1]

Method

Participants

Twenty individuals with acquired alexia and agraphia due to stroke were included in this study. Extensive behavioral assessment was conducted to characterize semantic, phonological, and orthographic processing abilities, so that a clear understanding of impaired and preserved spoken and written language abilities was established. Reading and spelling performance was assessed using lists of regular and irregular words and nonwords. In the majority of cases, spelling impairment was of greater severity than reading, so treatment decisions were made on the basis of their agraphia profile. As indicated by the decision tree shown in Figure 1, individuals who spelled fewer than 30% correct on our spelling battery were considered to have global agraphia. The responses of those who scored between 30% and 90% correct were evaluated to determine whether there was a lexicality effect (wherein nonword spelling was significantly more impaired than real word spelling) or a regularity effect (wherein spelling of irregularly spelled words was more impaired than regular words). The former fit the profile of phonological/deep agraphia, whereas the latter was consistent with surface agraphia.

Treatment

Depending on the agraphia profile, one of three behavioral interventions was initiated with each participant (see Figure 1). Lexical treatment was the entry level for individuals with global agraphia. The protocol was a copy and recall treatment (CART) designed to strengthen item-specific orthographic representations for single words. Words trained in lexical treatment

were then utilized as "key words" for the subsequent phonological protocol. Phonological treatment was directed toward strengthening sublexical skills in individuals with phonological agraphia, and those with global agraphia who mastered lexical treatment. The final stage, interactive treatment, used a problem-solving approach to promote use of lexical and phonological strategies to improve spelling. This is the entry level of treatment for individuals with surface agraphia, and the final treatment stage for those who progressed from preceding treatments.

With regard to reading, word recognition was facilitated for target words during lexical treatment as an inherent part of spelling training. Phonological treatment specifically included retraining letter-sound correspondences. During interactive spelling treatment, a text-level reading treatment was implemented concurrently. The approach was consistent with multiple oral rereading (MOR) procedures wherein target passages were used for guided, repeated oral reading to achieve improved reading rate and accuracy, with the expectation of generalized improvement to untrained text.

Results

All participants completed one or more treatment protocols and extensive pre-post treatment assessment battery. We will characterize here the treatment response from those who have completed treatment (n = 20), and will amplify these results with the outcomes from those currently completing treatment (n = 6).

Response to Lexical Treatment

Twelve individuals with global agraphia received lexical treatment to retrain spelling for 20 written words. All but one of those individuals achieved mastery of targeted spellings ($\geq$ 80% correct over two sessions). The single-subject multiple baseline data were analyzed for each participant, and an average effect size was calculated to provide a standard index of pre-post treatment outcomes (average d = 3.9, sd = 2.240). A summary of the gains for each set of trained words is shown in Figure 2. As expected, lexical treatment resulted in limited generalization to untrained items, but provided a means for acquisition of written spelling of personally relevant words, as well as the corpus of "key words" to be used for phonological treatment.

Response to Phonological Treatment

Of the 12 individuals receiving phonological treatment, 9 of them successfully mastered relearning of letter-sound and sound-letter correspondences for 20 consonants. As shown in Figure 3a, the individuals with phonological alexia/agraphia demonstrated significant improvement in reading and spelling of nonwords (Wilcoxon signed ranks test[2]; $p<.05$). The individuals with global agraphia who progressed from lexical to phonological treatment made significant improvement in reading and spelling regular words ($p<.05$) and spelling nonwords ($p<.05$). Both groups also showed significant improvements in overall phonological abilities as measured by phonological composite scores ($p<.05$).

Response to Interactive Treatment

Four individuals who had surface agraphia at the outset received interactive spelling treatment, as well as 5 individuals who advanced from phonological treatment. Interactive treatment resulted in improved spelling for words that were not specifically trained, and most

participants achieved near normal spelling levels when allowed to use the electronic spelling device (on which they had been trained). The four individuals with surface agraphia also received MOR treatment and improved reading rate by an average of 18.6 words/minute and accuracy by an average of 1.3 errors/100 words. An example response to treatment is shown in Figure 5. Individuals who advanced to interactive treatment from phonological treatment also showed continued improvement in phonological processing abilities in response to interactive treatment, as shown by improved reading and spelling of nonwords after treatment ($p<.05$) (see Figure 4b).

Conclusions

A treatment continuum including lexical, phonological, and interactive approaches provided appropriate starting points for rehabilitation of written language for individuals with global, phonological/deep, and surface agraphia, respectively. Treatment outcomes suggest that individuals with global agraphia are likely to achieve functional use of written words in response to treatment, and a subset of those individuals are also able to improve phonological abilities in response to the next phase of treatment. Phonological treatment served to strengthen sound-letter and letter-sound correspondences and provided a means to self-cue retrieval of orthography and to generate phonologically plausible spellings. Interactive treatment resulted in increased self-correction of phonologically plausible errors and compensatory use of an external spelling aid as an additional means to accommodate residual weakness. In sum, these outcomes support the value of this treatment continuum across a range of agraphia profiles and levels of severity, and also provide direction for additional alternative treatments to further refine the treatment algorithm.

Notes:

[1] We are also investigating lesion location and extent relative to treatment response, but do not anticipate the ability to discuss these findings in the context of the short presentation format. Lesion overlap maps are included in the figures to provide the interested reviewer with an indication of the lesions in the study participants.

[2] Wilcoxon signed ranks test was used for all pre-post treatment comparisons.

Figure 1. The decision tree used to determine spelling treatment and the number of participants enrolled in each treatment. Arrows indicate advancement to next treatment.

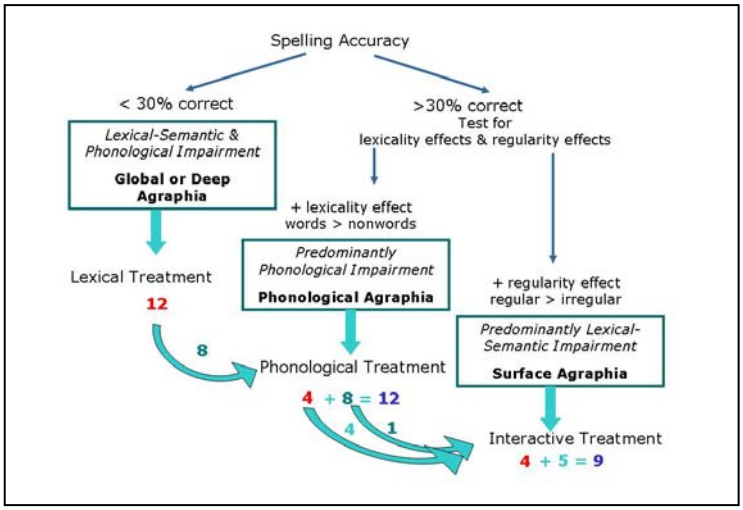

Figure 2. Response to lexical treatment in a group of individuals with left perisylvian damage.

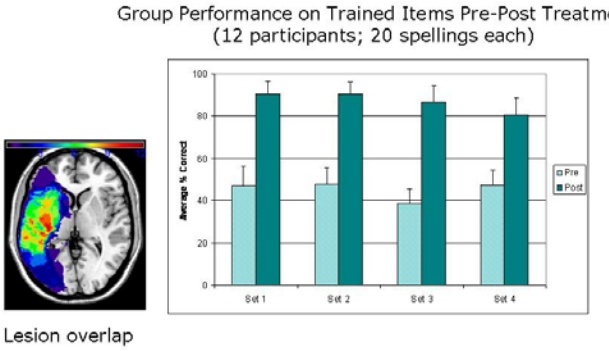

Figure 3. Response to phonological treatment (generalization to untrained items) in a group of individuals with phonological alexia/agraphia (Figure 3a.), and a group of individuals who had global agraphia and previously received lexical treatment (Figure 3b.).

a. b.

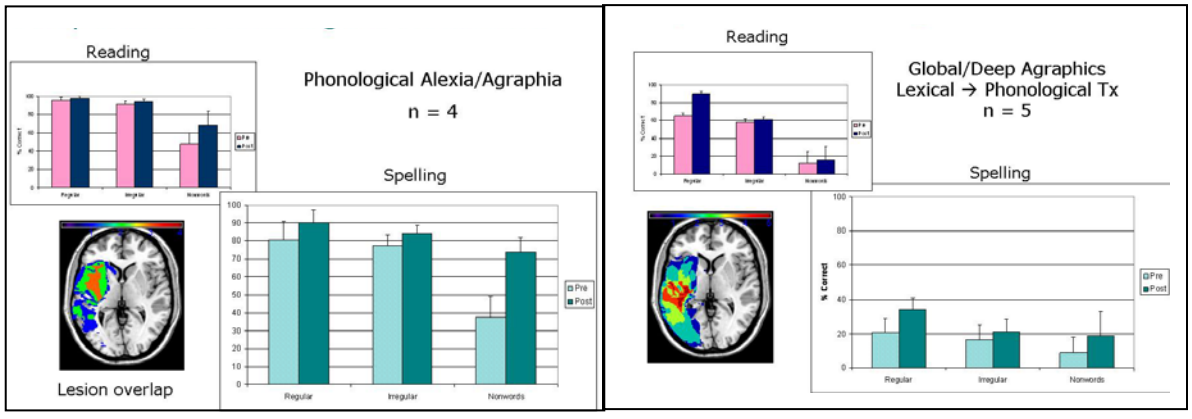

Figure 4. Response to interactive spelling treatment (reading/spelling of untrained items) in a group of individuals with surface agraphia associated with left PCA stroke (n=4) (Figure 4a.), and a group of individuals with left MCA damage who previously received phonological treatment (Figure 4b.).

a. b.

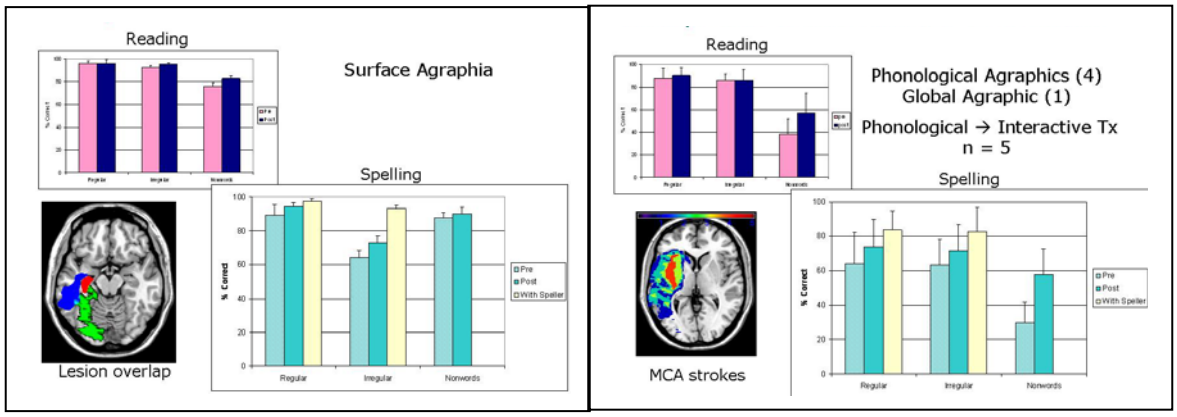

Figure 5. Example response to multiple oral re-reading treatment administered concomitantly with interactive spelling treatment. Oral reading rate in words per minute (upper line) and accuracy in errors per 100 words (lower line) for text that was not trained (i.e., generalization).