Effects of Phonological Complexity Training on Pseudoword Reading in Acquired Phonological Dyslexia

Introduction

Individuals with acquired *phonological* dyslexia experience specific difficulty associating written letters with their corresponding sounds, especially in the context of pseudowords, and have tremendous difficulty "sounding out" written words. Two predominant theories have attempted to explain this difficulty: *dual-route* theory (Coltheart, Rastle, Perry, & Langdon, 2001) proposes a specific deficit to a pseudoword reading route and *connectionist* theory (Harm & Seidenberg, 1999; Plaut, 1999) proposes a more general deficit in phonological processing. Although evidence can be found for both theories, the strongest evidence supports a general deficit in phonological processing (Crisp & Lambon Ralph, 2006; Harm & Seidenberg, 2001; Rapcsak, et al., 2009). Taking these theories into account, several studies have attempted to improve word reading in this population by training either letter-to-sound correspondence (dePartz, 1986; Nickels, 1992), general phonological skills (Kendall, Conway, Rosenbek, & Gonzalez-Rothi, 2003), or a combination of these approaches (Friedman & Lott, 2002; Yampolsky & Waters, 2002). Although some of these training methods have been moderately successful, their success has generally been limited to trained words. That is, participants have not been able to apply this reading ability to new words.

Training studies with various clinical populations have shown increased generalization when items were manipulated based on linguistic complexity. Sonority, the relative measure of intensity related to openness of the vocal tract (Clements, 1990), is one variable of phonological complexity that has been investigated in aphasic error production (Romani & Calabrese, 1998; Romani & Galluzzi, 2005) and in training phoneme production in children with phonological disorders (Gierut, 1999; Gierut, 2007; Gierut & Champion, 2001). These studies have specifically investigated error and training patterns in the context of the *Sonority Dispersion Principle (SDP),* a principle relating to the overall distribution of sonority across a syllable (Clements, 1990). The *SDP* predicts that syllable onsets with smaller dispersion values are "less complex" than syllable onsets with larger dispersion values. Studies of aphasic error production have found influences of phonological complexity, with some participants demonstrating lower production accuracy for syllables with "more complex" sonority profiles as well as a tendency to change "more complex" syllable targets into "less complex" syllables with respect to sonority (Romani & Calabrese, 1998; Romani & Galluzzi, 2005). Further, in training studies with children, when "more complex" consonant clusters were trained, improvement on trained clusters as well as generalization to "less complex" consonant clusters was noted, but training "less complex" clusters did not result in generalization (Gierut, 1999). To date, however, no treatment studies for acquired phonological dyslexia have systematically manipulated sonority in order to improve reading ability. Therefore, in the present study we examined the effects of this approach, applying principles of phonological complexity to the training of letter-to-sound reading in individuals with acquired phonological dyslexia.

Method

Two individuals with acquired phonological dyslexia participated in a training experiment using phonological complexity as a training variable. This experiment used a single-subject, multiple baseline design across behaviors. For each participant, two consonant clusters were selected for training, one cluster representing a "more complex" onset (e.g., /fl/) and the other representing a "less complex" onset (e.g., /kl/) as predicted by the *SDP*. One participant was trained on the "more complex" cluster and the other was trained on the "less complex" cluster, while tracking oral reading accuracy of both onsets.

Training stimuli consisted of 10 single syllable real words and 10 single syllable pseudowords, each containing the target consonant cluster at the onset of the word. Each participant received training 2 times per week, each session lasting 1 hour. Training involved a combination of letter-sound correspondence and phonological skill instruction. During each trial, participants learned letter-sound relationships of target words in the context of a phoneme segmentation and blending activity. Consonant cluster oral reading accuracy of training and generalization items was measured with weekly probes administered before every other training session. Participants were trained to a criterion of 80% correct over two consecutive probe sessions on trained items.

Results & Discussion

As predicted based on previous studies, Participant 1, who received training in the "more complex" condition demonstrated improved ability to orally read words with the trained cluster onset as well as generalization to words with the untrained, "less complex" onset (Figure 1a). Conversely, Participant 2 who received training in the "less complex" condition demonstrated significant improvement for the trained onset but no generalization to the "more complex" onset (Figure 1b). Although replication of these effects with additional individuals with phonological dyslexia is required to evaluate the validity of these data, the present findings suggest that phonological complexity can be used to improve generalization to untrained phonologically related words in acquired phonological dyslexia.

References

Clements, G. N. (1990). The role of the sonority cycle in core syllabification. In J. Kingston & M. E. Beckman (Eds.), *Papers in Laboratory Phonology I: Between the Grammar and Physics of Speech* (pp. 283–333). New York: Cambridge University Press.

Coltheart, M., Rastle, K., Perry, C., & Langdon, R. (2001). DRC: a dual route cascaded model of visual word recognition and reading aloud. *Psychological Review, 108*(1), 204-256.

Crisp, J., & Lambon Ralph, M. (2006). Unlocking the nature of the phonological-deep dyslexia continuum: The keys to reading aloud are in phonology and semantics. *Journal of Cognitive Neuroscience, 18*(3), 348-362.

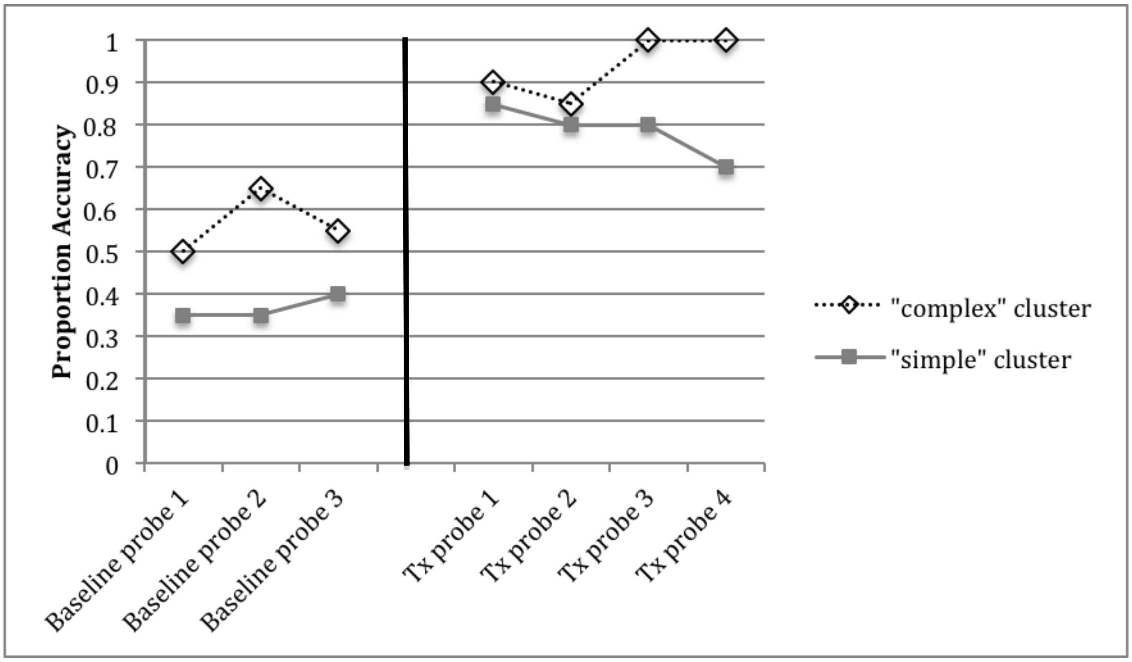
dePartz, M.-P. (1986). Re-education of a deep dyslexic patient: Rationale of the method and results. *Cognitive Neuropsychology, 3*(2), 149-177.

Friedman, R. B., & Lott, S. N. (2002). Successful blending in a phonological reading treatment for deep alexia. *Aphasiology, 16*(3), 355-372.

Gierut, J. (1999). Syllable onsets: Clusters and adjuncts in acquisition. *Journal of Speech, Language and Hearing Research, 42*(3), 708-726.
Gierut, J. (2007). Phonological complexity and language learnability. *American Journal of Speech-Language Pathology, 16*, 6-17.
Gierut, J., & Champion, A. H. (2001). Syllable onsets II: Three-element clusters in phonological treatment. *Journal of Speech, Language and Hearing Research, 44*, 886-904.
Harm, M., & Seidenberg, M. (1999). Phonology, reading acquisition, and dyslexia: Insights from connectionist models. *Psychological Review, 106*(3), 491-528.
Harm, M. W., & Seidenberg, M. S. (2001). Are there orthographic impairments in phonological dyslexia? *Cognitive Neuropsychology, 18*(1), 71-92.
Kendall, D. L., Conway, T., Rosenbek, J., & Gonzalez-Rothi, L. (2003). Phonological rehabilitation of acquired phonologic alexia. *Aphasiology, 11*, 1073-1095.
Nickels, L. (1992). The autocue? Self-generated phonemic cues in the treatment of a disorder of reading and naming. *Cognitive Neuropsychology, 9*(2), 155-182.
Plaut, D. (1999). A connectionist approach to word reading and acquired dyslexia: Extension to sequential processing. *Cognitive Science, 23*(4), 543-568.
Rapcsak, S., Beeson, P., Henry, M., Leyden, A., Kim, E., Rising, K., et al. (2009). Phonological dyslexia and dysgraphia: Cognitive mechanisms and neural substrates. *Cortex, 45*(5), 575-591.
Romani, C., & Calabrese, A. (1998). Syllabic constraints in the phonological errors of an aphasic patient. *Brain and Language, 64*(1), 83-121.
Romani, C., & Galluzzi, C. (2005). Effects of syllabic complexity in predicting accuracy of repetition and direction of errors in patients with articulatory and phonological difficulties. *Cognitive Neuropsychology, 22*(7), 817-850.
Yampolsky, S., & Waters, G. (2002). Treatment of single word oral reading in an individual with deep dyslexia. *Aphasiology, 16*, 455-471.

Figure 1.
Oral reading accuracy of pseudowords with “more complex” versus “less complex initial consonant clusters for (a) Participant 1, who received training on a “more complex” consonant cluster, and (b) Participant 2, who received training on a “less complex” consonant cluster.

a)



b)