# Effects of Phonomotor Treatment on the Reading Abilities of Individuals with Aphasia and Phonological Alexia

A left hemisphere stroke often results in aphasia characterized by impaired reading (Cherney, 2004; Webb & Love, 1983) and phonological processing abilities (Blumstein, Baker, & Goodglass, 1977; den Ouden & Bastiaanse, 2005). Research has shown that treatment focused at the level of the phoneme improves reading abilities in persons with aphasia (PWA) and phonological alexia (Conway et al., 1998; Kendall et al., 1998; Kendall et al., 2003). These findings are theoretically supported by a connectionist model of phonology (Nadeau, 2001), and a multimodal model of phonological processing and reading (Alexander & Slinger, 2004).

Nadeau's parallel distributed processing (PDP) model of phonology (2001) states that phonologic representations are stored as patterns of connectivity within and between auditory association, articulatory motor, orthographic and semantic/conceptual domains. These connections are strengthened through learning. After stroke, intact phonologic representations and domain connections serve as the foundation for improving reading deficits. Support for this hypothesis comes from language and reading acquisition in children. As children learn to read, they begin to map orthography to established phonologic and semantic knowledge. Well-developed phonological knowledge is believed to help children link written and spoken language (Alexander et al., 1991). If the principles of reading development apply to reading rehabilitation after brain injury, then retraining phonemes and phoneme sequences may improve word reading.

Alexander and Slinger's (2004) model of phonological processing and reading uses a multimodal treatment to develop an individual's explicit awareness of distinct sensorimotor and metalinguistic features of phonemes through association tasks. Alexander (1991) and Torgesen et al. (2001) report multimodal treatment successfully remediates phonological deficits in children with dyslexia. Characteristics of dyslexia (impaired phonological processing and sublexical reading) are seen in PWA and phonological alexia. Therefore, multimodal phonological treatment may be a viable approach to rehabilitate reading deficits associated with this population.

Data presented here were retrospectively analyzed from PWA who participated in a phonological treatment study of anomia (Kendall & Nadeau, VA RR&D Merit Review Grant). Nine participants received reading testing before and after treatment, eight of whom were diagnosed with phonologic alexia.The present study investigated the effects of phonomotor treatment on the reading abilities of PWA with phonological alexia, via the following research questions

In PWAwith phonological alexia, does phonomotor treatment improve:

1. sublexical processing as measured by nonword reading aloud?
2. lexical processing as measured by real word reading aloud?
3. reading comprehension at the single word and passage level?

Additionally,

4. are any treatment effects maintained at 3-months post treatment?

## Methods

Participants: Data from eight PWA with left hemisphere stroke were analyzed. Participants' average age was 61.88 years (SD=15.36), years of education was 15.90 (SD=2.59), and months post-stroke onset was 52.38 (SD=60.47). Participants were premorbidly right-handed, English speakers. Presence of aphasia was determined by performance on the Western Aphasia Battery (WAB; Kertesz, 1982) and Boston Naming Test (BNT; Goodglass et al., 1983). The average WAB AQ for this group was 80.34 (SD=16.19); the average BNT score was 32.13 (SD=17.77). Phonological impairment was determined by performance on the Standard Assessment of Phonology in Aphasia (SAPA; Kendall et al., 2010). The average SAPA score was 103.13/151 (SD=28.27). Phonological alexia was determined by impaired nonword versus real word reading performance on the SAPA and Woodcock Reading Mastery Test-Revised (WRMT-R; Woodcock, 1987).

Design: Data presented here include results of pre-, immediate-post, and three-month post-treatment performance on Subtest 1 of the SAPA, which assesses oral reading of regular, irregular, pseudohomophone and nonwords; as well as performance on four subtests of the WRMT: Word Identification (i.e. real word reading aloud), Word Attack (i.e. nonword reading aloud), Word Comprehension (i.e. antonyms, synonyms, analogies), and Passage Comprehension (i.e. sentence completion).

Treatment: Therapy consisted of 60, one-hour treatment sessions, two sessions/day, five days/week for six weeks. The treatment program consisted of two stages. Stage 1 trained all English phonemes in isolation, and Stage 2 trained one- and two-syllable real and non-words. In Stage 1, each phoneme was trained multimodally by teaching motor descriptions, perceptual discrimination, production, and grapheme to phoneme correspondences. Stage 2 included combinations of phonemic sequences. Training progressed from simple one-syllable to complex one- and two-syllable real and non-words.

Stimuli: Stimuli were comprised of all English phonemes in isolation, and phonotactically legal one- and two-syllable real and nonwords with low phonotactic probability and high neighborhood density.

Analysis: Paired t-tests were used to compare pre- and post-treatment scores and pre- and 3-month treatment scores on specific subtests of the SAPA and WRMT.

## Results

See Figures for illustration of results.

RQ 1 addressed nonword oral reading abilities, as measured by WRMT Word Attack and SAPA pseudohomophone and nonword reading (i.e., sublexical reading) at one week post-treatment. Results showed significantly improved performance immediately post-therapy on Word Attack ($p=.014$). Nonword reading performance was not significantly improved on SAPA sublexical reading.

RQ 2 addressed real word oral reading abilities, as measured by WRMT Word Identification and on SAPA regular and irregular word (i.e. lexical) reading at one-week post-treatment. Results showed significantly improved performance immediately post-treatment on Word Identification ($p=.023$). Real word reading performance was not significantly improved on SAPA lexical reading.

RQ 3 addressed reading comprehension abilities at the single word level, as measured by WRMT Word Comprehension, and at the passage level, as measured by WRMT Passage Comprehension one-week post-treatment. Results showed no significant improvement for these measures.

RQ 4 addressed maintenance of treatment effects three-months post-treatment. Reading performance on WRMT Word Attack and WRMT Word Identification remained significantly improved three-months later ($p= 0.019$, $p=0.003$, respectively). No other measures demonstrated a significant maintenance effect.

## Discussion

The results indicate that multimodal phonomotor treatment improves real and nonword oral reading abilities in PWA with phonological alexia, and effects of treatment are maintained three-months later. This overall improvement provides evidence that once an adequate repertoire of phonological sequence knowledge is achieved, PWA continue to build upon existing connections between orthography and phonology. This finding is consistent with prior research (Conway, 1998; Kendall; 2003), specifically, strengthened phonologic representations yield improved grapheme-to-phoneme correspondence, leading to improved reading ability.

Treatment was not found to improve reading comprehension at the word or sentence level. We interpret these findings to be attributed to the tasks employed. The WRMT Word Comprehension and Passage Comprehension subtests require individuals to produce a verbal response after silent reading, engaging lexical retrieval mechanisms in addition to text comprehension. Thus, pervasive word retrieval deficits in this sample may have masked reading comprehension improvement. Although these tasks required both comprehension and production, the group showed trends toward continued improvement immediate post- and three-month post-treatment for both word and passage comprehension. This provides further support for the hypothesis that phonologic and orthographic connections will continue to strengthen when applying trained knowledge to everyday experiences.

**References**


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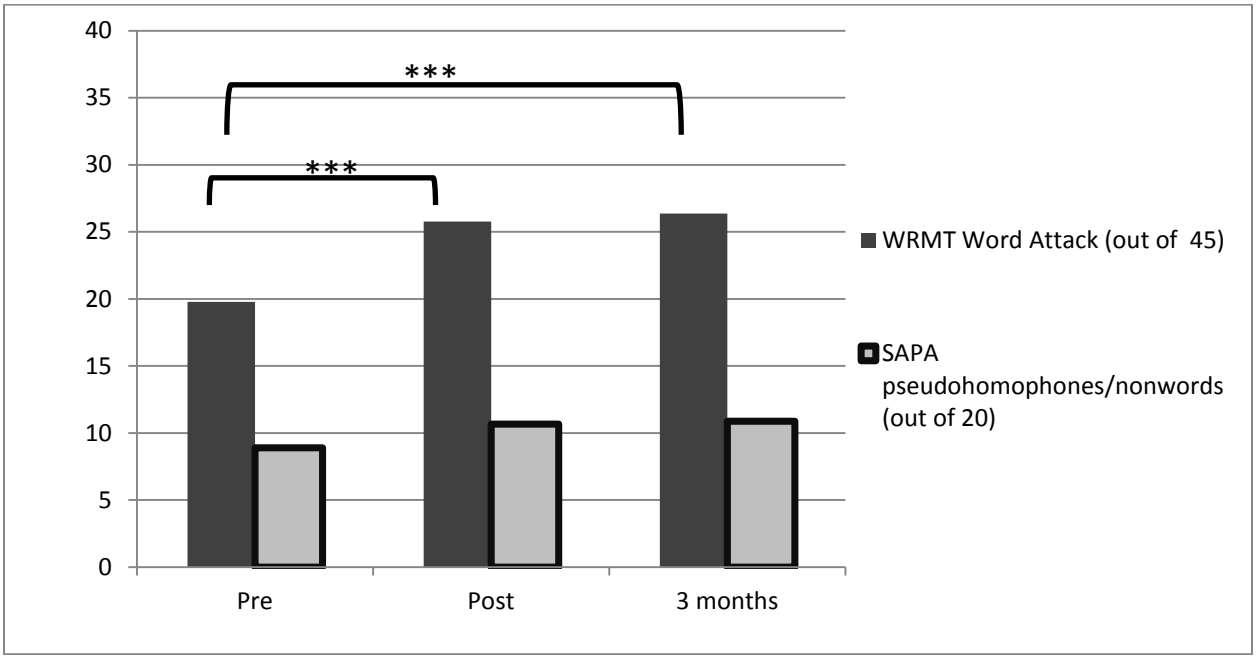
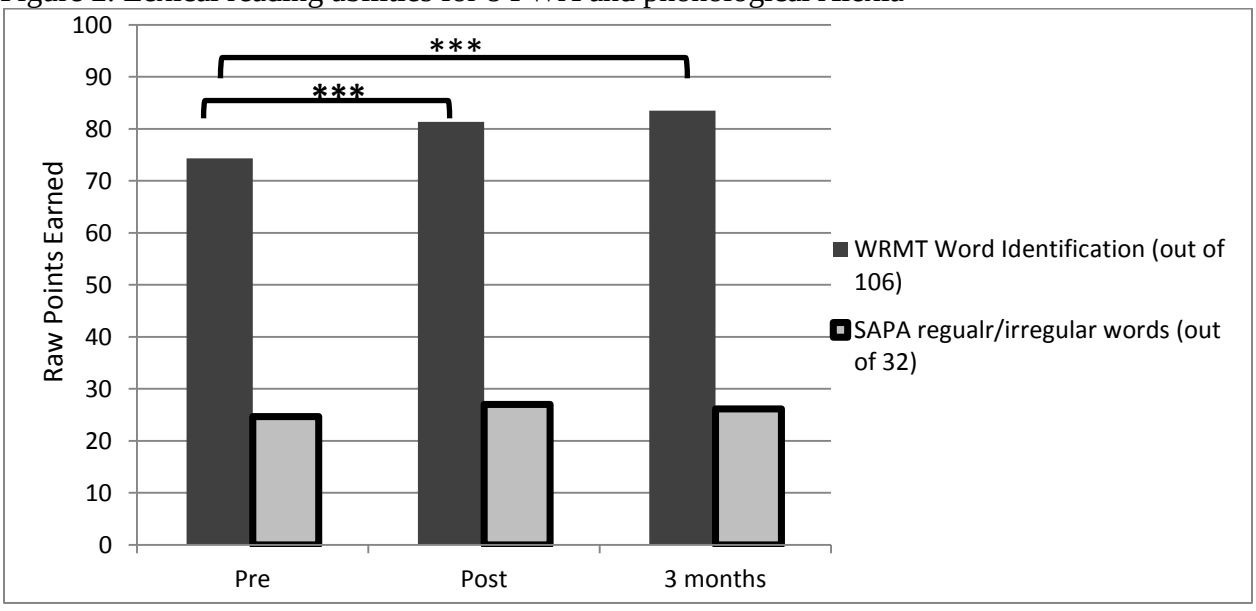
Figure 1. Sublexical reading abilites for 8 PWA and phonological alexia




*** p < .025 (after multiple comparison correction)

Figure 2. Lexical reading abilities for 8 PWA and phonological Alexia




*** p < .025 (after multiple comparison correction)

Figure 3. Reading comprehension abilities for 8 PWA and phonological Alexia