Title: Phonological Neighborhood Density Effects on Treatment of Naming in Aphasia

Summary: Anomia, a difficulty in word retrieval, is one of the most prevalent disturbances in aphasic speech production. Heterogeneity in naming impairments poses a challenge to developing treatment programs for word retrieval difficulties in aphasia. Recent cognitive descriptions of word-finding impairments have been based on a two-step model of word production (Dell, Schwartz, Martin, Saffran, & Gagnon, 1997). Disruptions in accessing one level may result in predominately word substitution or semantic errors, while difficulty with a different level may result in phonological errors, for example responses with only partial phonology and/or incorrect phoneme substitutions. Therefore, considering the error types when planning treatment programs for anomia, may prove to be efficacious by allowing clinicians to target therapy to a specific underlying deficit.

Treatments targeting stage-specific deficits in the word retrieval process have recently been explored to improve word production. For impairments affecting the phonological access stage, therapies have been based on the rationale that repeated productions may re-strengthen the connections between the lexical representation and the phonological form. While this rationale is theoretically sound, most phonological treatments have not been shown to be effective beyond the trained items in the therapy context. Clinicians may need to consider additional aspects of the word retrieval process that may interact with word production.

One of these factors is the role of phonological neighborhoods or collections of words that are phonetically similar to a specific target (Luce & Pisoni, 1998). For example, the words *mat* and *rat* would be neighbors of the word *cat*. Target words with many neighbors are characterized as having high density neighborhoods and promote increased activation during phonological access in word retrieval, while target words from sparse neighborhoods have fewer neighbors and fewer phonological forms become activated (Luce & Pisoni, 1998; Gordon, 2002). Since neighborhood density, like other lexical variables, has been shown to interact with the word retrieval process, it likely influences susceptibility of target words to error in aphasic speech production (Gordon, 2002).

The influence of phonological neighborhoods has been explored extensively in both normal language recognition (Goldinger, Luce & Pisoni, 1989; Goldinger, Luce, Pisoni & Marcario, 1992; Luce & Pisoni, 1998; Vitevich & Luce, 1998) and production (Vitevitch, 1997), but limited evidence exists for how this lexical factor may enhance or hinder word retrieval in aphasic speech production. Generally, the findings indicate that dense phonological neighborhoods may facilitate lexical retrieval in individuals with aphasia and reduce a target's susceptibility to error, which is consistent with the data from normal speech production (Gordon 2002). Therefore, the present study explores if manipulating the phonological neighborhood density of therapy stimulus words has an effect on naming ability, particularly in individuals with predominately phonological-level deficits.

The study used a single-subject basic ABA design with baseline, treatment, and maintenance phases. The treatment protocol was based on a study by Fisher et al. (2009) and used a basic picture naming paradigm. An individual with a primarily phonologically-based impairment, as determined by an extensive test battery, was selected as the participant. Prior to the therapy program a picture naming test consisting of 186 words with high and low phonological neighborhood density values was administered to the participant with aphasia and a control participant three times. The stimuli for the treatment program included target words that were incorrectly produced in two of the three naming tests and either two phonologically related words or two unrelated words, yielding a total of 30 triplet sets. The triplet sets comprise four phonologically related conditions and each had 6 triplet sets: a) Front-matched high density triplets, b) Front-matched low density triplets, c) End-matched high density triplets, d) End-matched low density triplets, and one unrelated set condition. There were also 16 untrained items from high and low density neighborhoods used to probe generalization. The therapy phase consisted of 24 treatment sessions with 8 consecutive sessions that trained triplet sets in each condition: front-matched, end-matched, and unrelated. The therapy protocol involved multiple presentations of pictures representing each of the words in a triplet set under the five conditions. Instructions for each condition were given, e.g. "all three words begin with the same sound", or "all three words end with the same sound(s). Accuracy on training items was recorded for each treatment session. Additionally, all trained and untrained items were probed through a picture naming test for naming accuracy and response time three times during the treatment phase and at one month after the conclusion of the therapy phase to determine maintenance gains.

For the treatment data, effect size values comparing pre- and post-treatment performance were calculated, using a method outlined by Beeson and Robey (2006), for each treatment condition. The front-matched high density condition had a medium treatment effect size, $d = 9.3$, and the front-matched low density condition had a small effect size, $d = 4.6$. The remaining conditions did not show treatment effects. To assess naming performance during the treatment sessions, an analysis of neighborhood density by treatment session was completed by collapsing all treatment conditions into high and low density conditions, independent of front- or end-matched. A two-way repeated ANOVA was conducted to evaluate the independent variables of treatment session (session 1-8) and neighborhood density (high vs. low). Results indicated a significant main effects of treatment session, $F(7,82) = 7.487$, $p < 0.01$, and neighborhood density, $F(1, 88) = 9.022$, $p < 0.01$. Interaction between treatment session and neighborhood density was not significant. A similar analysis was completed in which all treatment conditions were collapsed into front- versus end-matched conditions. There was a significant main effect of treatment session, $F(7, 81) = 5.959$, $p < 0.01$. However, the main effect of matched-condition and the interaction were not significant.

The present study serves as a preliminary investigation into the effect of phonological neighborhood density on naming performance in the treatment of individual with a phonologically-based word-finding impairment. Results suggest that training words from dense phonological neighborhoods may show greater improvements in naming ability. Additionally, training high density words within front-matched triplets may lead to the greatest treatment effect following training. Clinicians should be aware that stimulus parameters, such as phonological neighborhood density, may interact in complex ways with the effectiveness of treatment protocols.

References

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Figures and Graphs

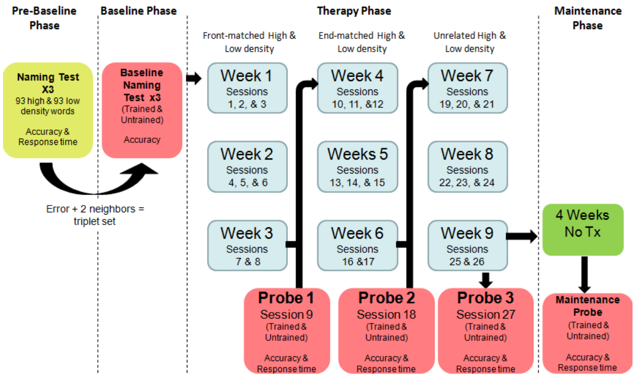

Figure 1: Therapy Program Design

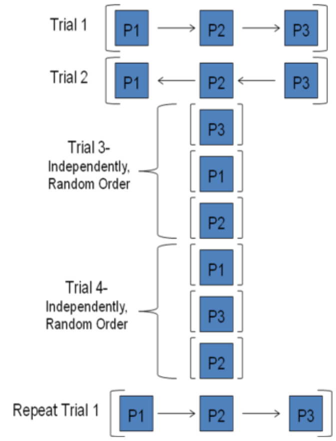

Figure 2: Treatment Protocol for each Triplet
P1, P2, P3- three pictures representing each word within the triplet set. The brackets indicated what was visually presented on a PowerPoint slide. The arrows show naming order.

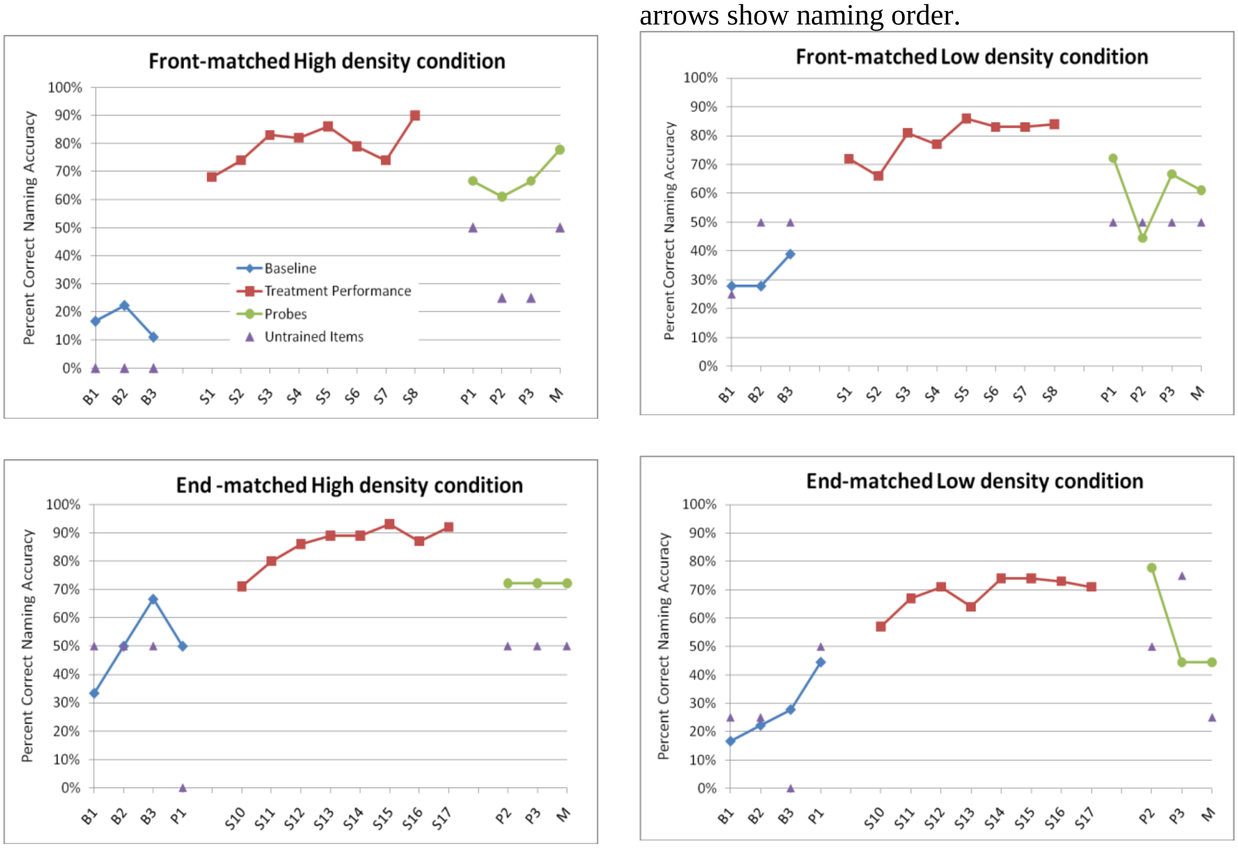

Figure 3: Graphs of percent correct naming accuracy during treatment sessions (S) and for baseline (B) and probe naming tests (P) for each condition. Baseline and probe sessions consisted of a randomized naming test of treatment items and the treatment protocol involved naming pictures in triplet set.