A novel approach to training verbs in two individuals with chronic aphasia

Introduction

A novel intervention for the rehabilitation of verb naming disorders was applied to two individuals with chronic aphasia. This intervention examined the effectiveness of intensive implicit semantic training for improving verb production. This was done without the requirement of an overt response. Implicit interventions, such as these, practiced without overt speech, can improve verbal output, hypothetically through activation of the interrelated semantic, lexical and phonological networks known to underlie word production. For the individuals with aphasia and apraxia of speech, implicit therapy has the advantage of reducing production error and the associated effects of reinforcing the neural circuits that are activated while producing errors. Prior work has shown that error-reducing training can improve naming and discourse and these results were accompanied by increased activation of the left inferior frontal cortex during verb generation tasks as measured by fMRI (Davis, Harrington & Baynes, 2006). The use of a similar approach, implicit phoneme manipulation to treat apraxia of speech, also improved speech production at the word level (Davis, Farias, & Baynes, 2008).

This implicit intervention was compared to an identical training method that did require an explicit verbal response.
We address the follow questions:

1. Would implicit semantic training improve production of trained verbs as measured in probe production in two individuals with aphasia?
2. Would implicit semantic training of trained verbs generalize to untrained verbs?
3. Would the identical treatment requiring an explicit response improve production of trained verbs and generalize to untrained verbs?
4. Would these interventions be comparable on visual inspection and on d statistic size effects?
5. Would order effects be observed?

Methods

Subjects

Both participants had mild initial strokes and subsequently more severe strokes that resulted in aphasia. RL is a 72 year-old left-handed male with evidence from MRI (05/2010) of infarcts in the left middle cerebral artery (MCA) including the basal ganglion and posterior insular cortex on the left. Our second participant is DD a 57 year-old right-handed male with multiple infarcts in the left MCA and right thalamic territory sustained from 2005 through 2009. Both individuals have advanced degrees, DD a PhD and RL a MBA.

Pre-test scores

RL's Aphasia Quotient (AQ) score of 77.8 on the Western Aphasia Battery (WAB) was consistent with a diagnosis of anomic aphasia. His subtest scores are as follows:

Spontaneous speech 7/10, Comprehension 9.5/10, Repetition 6.5/10, Naming 7.9/10. Relatively intact semantic knowledge, required for this method to be successful, was demonstrated on 2 subtests of the Pyramids and Palm Trees Test (PPTT) with a raw score of 49/52 for object semantics and 48/52 for word semantics. His aphasia was complicated by dysarthria and apraxia of speech (AOS) with a deterioration score of .9 on the Apraxia Battery for Adults.
DD's AQ score of 60.8 on the WAB was consistent with Broca's aphasia. His subtest scores are as follows: Spontaneous speech 4/10, Comprehension 8.3/10, Repetition 6.1/10, Naming 4/10. His score on PPTT was 48/52 for object semantics however due to his severe alexia he was unable to take the word version. He exhibited no dysarthria or AOS.

Procedures:

This was an ABBA cross over design. The stimuli consisted of four lists of verbs in the gerund form (ing form) obtained from a list of 221 verbs which were used to assess production errors. Three baselines were obtained to determine initial variability in pre-treatment naming. Each of the four lists contained 11 trained and 11 untrained verbs matched for frequency (totaling 44 trained and 44 untrained verbs). The intervention formats were presented identically beginning with the explicit format requiring verbal responses during the intervention (A) and then implicit in which verbal responses during the intervention were discouraged (B).

In both interventions the stimuli were presented on a computer screen. Pictures were used from web-based images and formatted onto Microsoft Power Point© slides. The participant selected one or more of the four pictures in response to questions written above the template about the perceptual, categorical, or associative characteristics of the target verb. The computerized templates were individualized so that the foils were close competitors to the target. For example, a picture representing the action of sneezing was presented with 3 pictures representing "coughing" "blowing nose" and "smelling." We hypothesized that this practice during training required activation of the target, as well as inhibition of its close semantic neighbors.

Probe sessions were identical and required the participant to name all trained and untrained verbs from the lists during that phase. The probe stimuli were pictures representing the verbs. Probes were obtained every other treatment session for a maximum of 12 sessions (6 probe sessions). Treatment was terminated when 10 of the 11 currently trained verbs were named correctly over two consecutive probe sessions or when 6 probe sessions were completed.

Results
Figure 1 illustrates the results. RL responded to both approaches however a steeper response to treatment was observed on implicit when compared to explicit training. On both implicit verb lists RL met the ceiling criteria before six probe sessions. Size effects were 2.8 and 2.6 for explicit training and 4.2 and 6.66 for implicit training. Visual

inspection suggests some generalization to untrained items. However the d statistics were unconvincing (d=1.8, 0, 1.94 and 1.4).

DD responded to both explicit and implicit training with a d statistic of 6.49 and 5.5, medium size effects on implicit training, compared to 1.6 and 7.0 (small and large respectively) training effects on explicit training. The untrained lists showed no treatment generalization (d=.08, 0, 1.33 and .9). The difference in size effects support greater training effects for the treated verbs compared to untreated verbs.

Visual inspection of Figure 1 reflects that both participants responded to treatment which appears to be cumulative. DD's smallest size effect, 1.6, was observed on the first treatment phase. His largest size effect, 7.0, was observed on the final fourth session. RL clearly responded to the implicit training over the explicit with size effects of 4.1 and 6.66 compared to 2.8 and 2.6. However as each new verb list was introduced he required fewer probe session to meet criteria until the final fourth session where he obtained a ceiling in the first 2 probe sessions.

Order effects were not observed. On error analysis both DD and RL produced a greater number of semantically-related errors on verb naming of the untrained lists as the result of training.

Conclusions

These results reflect that the benefits of implicit intervention were comparable to explicit for improving verb production. Generalization to untrained verbs was not significant but training did result in an increase in semantically-related responses. These responses may have been the result of semantic training and the associated spread of activation in the semantic network.

RL's aphasia was complicated by dysarthria and apraxia of speech and therefore he may have profited from the implicit training more so than DD. Our conjecture is that his focus during training was primarily on selection of the verb rather than effortful production. In contrast DD profited from exposure to both implicit and explicit training in a cumulative fashion. His d statistic increased over each phase of the training.

These results, verified by visual inspection and by d statistic size effects, support the use of implicit methods to improve verb production in individuals with chronic aphasia. Successful development of implicit computerized training may offer an economical method of delivering speech therapy to individuals whose authorization for therapy has expired or who would benefit from more intensive therapy than permitted by their insurance.

References

Davis, C., Harrington, G., Baynes, K. (2006). Case Study: Intensive semantic intervention in fluent aphasia: A pilot study with fMRI. *Aphasiology*, *20*(1), 59-83.

Davis, C, Farias, D, Baynes, K. (2008). Implicit phoneme manipulation for the treatment of apraxia of speech and co-occurring aphasia. *Aphasiology, i First Article, 1-26.*

Figure 1

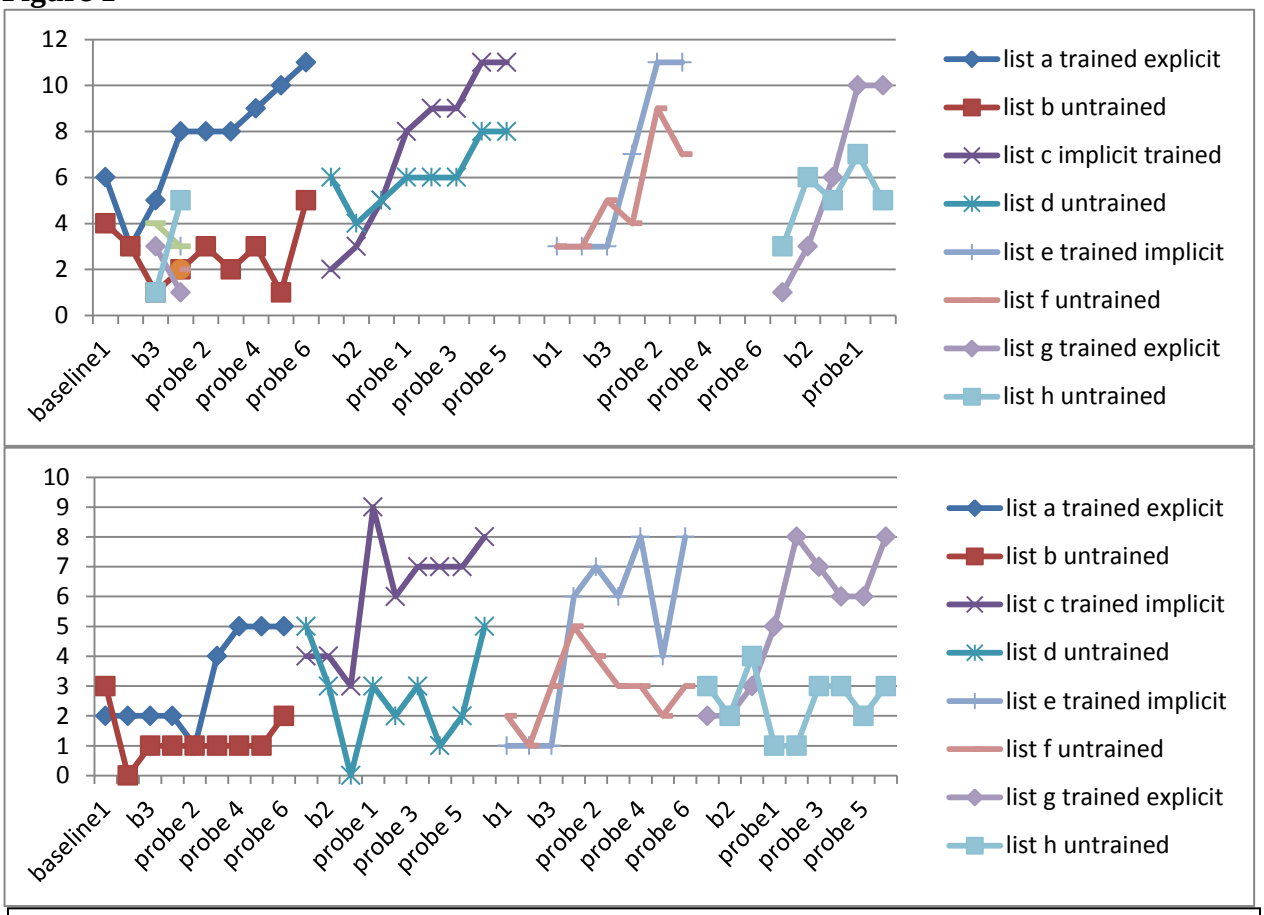

Figure 1 Comparison of implicit with explicit methods of treatment for rehabilitation of verbs ABBA design, A=explicit and B=implicit training. Top figure RL results, bottom figure DD results.