## Introduction

An "implicit" intervention which focused on semantic decisions rather than effortful verbal responses is compared with a standard method of treatment that required explicit verbal response. This implicit intervention is hypothesized to stimulate the neural semantic networks in an individual who exhibited mostly semantic paraphasic errors. In previous work, this type of intervention, applied intensively, significantly improved naming and discourse in a patient with fluent aphasia (Davis, Harrington & Baynes, 2006). Additionally these results were accompanied by increased activation of the left inferior frontal cortex during verb production as measured by functional magnetic resonance imaging (Davis, Harrington et al. 2006). The use of a similar implicit intervention using phoneme manipulation to treat apraxia of speech and co-occurring aphasia improved speech sound production at the word level (Davis, Farias, & Baynes, 2008). These studies suggest that implicit interventions, such as these, practiced without overt speech, can improve verbal output, hypothetically through activation of the neural semantic and phonological networks known to support speech production.

The benefits of implicit methods have not been compared experimentally with standard explicit methods. In this experiment we compared the treatment effects of an implicit intervention with an identical method that required overt speech in an individual diagnosed with Broca's aphasia from a traumatic brain injury. We sought to answer the following questions:

1. Would **implicit** semantic training improve production of trained verbs in an individual with Broca's aphasia?
    1a. Would **implicit** semantic training generalize to untrained verbs in the same individual?

2. Would **explicit** semantic training improve production of trained verbs in an individual with Broca's aphasia?
    2a. Would **explicit** semantic training generalize to untrained verbs in the same individual?

## Methods:

### Subject:

The experimental subject was a 25 year-old female who sustained a traumatic brain injury from a pedestrian versus auto accident 6 month prior to this intervention. She had a left-sided subdural hematoma and a partial parietal anterior temporal lobectomy. Her current MRI scan revealed a mild communicating hydrocephalus and left frontal-temporal encephalomalacia. Her scores on the Western Aphasia Battery were consistent with a diagnosis of Broca's aphasia; Spontaneous speech 4/10, Comprehension 6.5/10, Repetition 6/10, Naming 7.75/10. The Boston Naming Test documented a severe word retrieval deficit with a raw score of 13/60. Relatively intact semantic knowledge, required for this method to be successful was demonstrated on 2 subtests of the Pyramids and Palm Trees Test with a raw score of 45 for object semantics and 45 for word semantics.

### Procedures:

The stimuli for implicit and explicit interventions were two lists of 24 verbs, 12 trained and 12 untrained in each. The verbs in each list A and B, trained and untrained, were of comparable frequency. The treatments were presented identically in both methods, except that in the explicit intervention the participant overtly practiced the probe verbs during training and in the implicit treatment overt practice was discouraged.

In both methods the stimuli were presented on a computer screen. The participant selected one of four pictures in response to questions about the perceptual, categorical, or associative characteristics of the target verb. The computerized templates were individualized so that the foils were often the substitutions used by the participant in attempts to name the action, thereby offering greater challenge. For example, a picture representing the action of "brushing" hair (target) was presented with a picture representing "combing" hair (foil) which was often her substitution for the target. The foils varied in semantic distance to the target. We hypothesized that this practice during training required activation of the target, as well as inhibition of its competitors. Only the requirement of speech during the explicit training varied. Probe sessions were also identical during both training methods and required the participant to name all trained and untrained verbs from both lists every other treatment session for a maximum of 16 sessions (8 probe sessions). Treatment was terminated when 11 of the 12 trained verbs were named correctly over two consecutive probe sessions or when 16 treatment sessions were completed.

**Results**

Figure 1 illustrates the results. List A was trained explicitly and subsequently list B was trained implicitly. List A was trained for the maximum of 16 sessions (8 probe sessions); however, list B met the accuracy criterion after 4 probe sessions. Visual inspection of Figure 1 shows gradual treatment effects during explicit training for the trained items on list A. The d statistic for the trained verbs on list A was 7.57 which is equivalent to medium effect size. When compared to the d statistic for the untrained list A verbs, 1.85, the difference in effect size supports greater training effects for the treated verbs on list A. These gains were maintained throughout the list B training and after treatment cessation at the 6-week follow up.

Response to implicit treatment for trained items on list B was demonstrated on visual inspection and substantiated with a d statistic of 6.22. Visual inspection suggests some generalization to untrained items. However the d statistic of 1.07 was unconvincing. Visual inspection shows a steeper learning curve and more efficient learning of the list B verbs during the implicit method as the 90% criteria over two sessions was met after 8 treatment sessions (4 probe sessions). However, it is uncertain if these results reflect the cumulative effects of previous training.

**Conclusions**

Both methods resulted in improved verb production and maintenance of gains, although the implicit intervention resulted in more rapid acquisition of the trained verbs. These results, verified by visual inspection and by d statistic size effects, support the use of implicit methods for delivery of speech therapy to improve verb production. One

confound during the implicit method was the necessity of overt production during probe sessions to document the effects of treatment. A second confound was the lack of control for order effects. Additional experiments with a cross-over design to address order effects are planned.

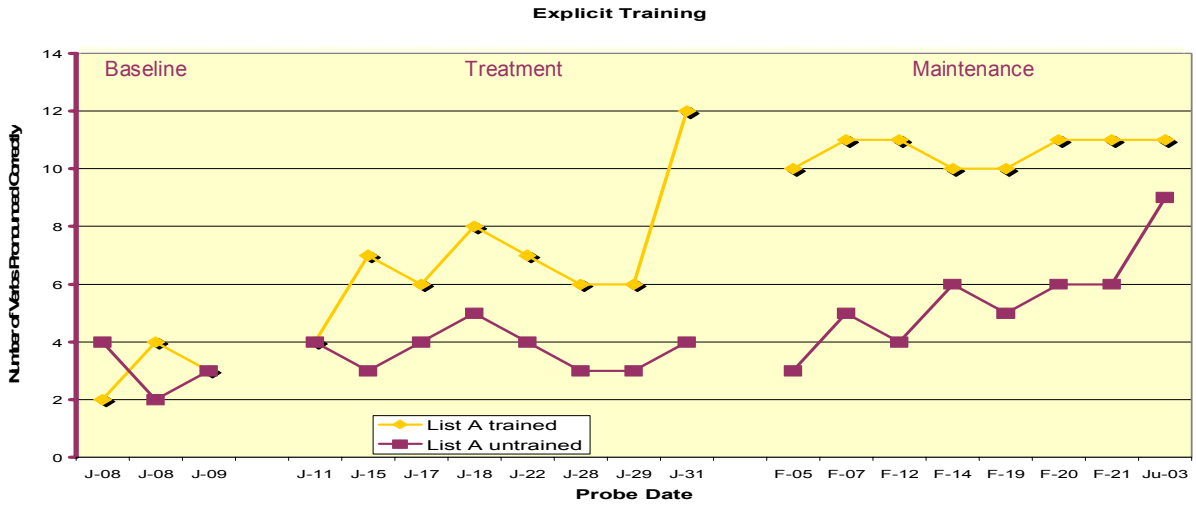
Successful development of implicit computerized training based on these assumptions may offer an economical method of delivering speech therapy to individuals whose authorization for therapy has expired or who would benefit from more intensive therapy than permitted by their insurance.

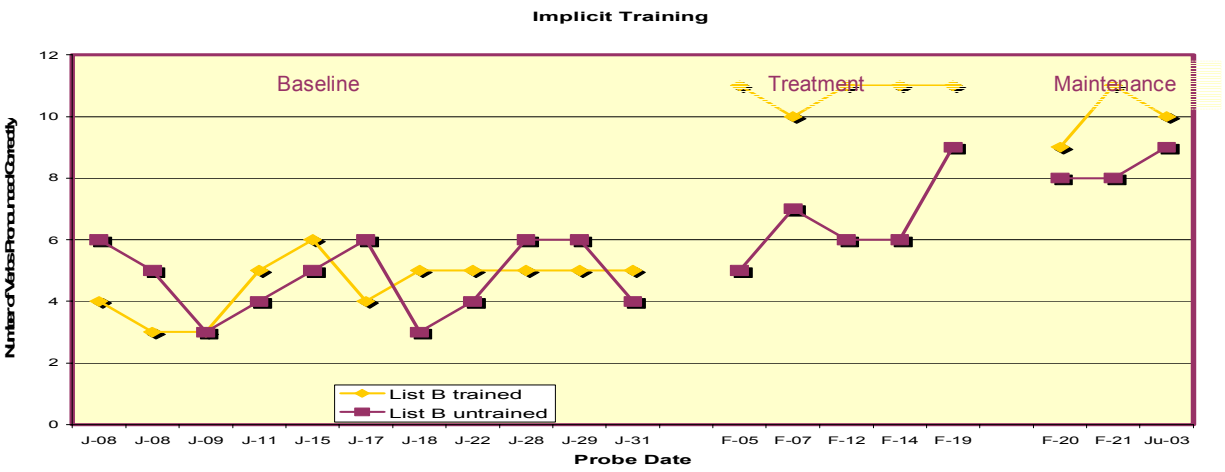
## References


Davis, C., Harrington, G., Baynes, K. (2006). 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, iFirst Article, doi: 10.1080/02687030802368913,* 1-26.


**Figure 1 Comparison of implicit with standard (explicit) methods of treatment**




Implicit Training
Baseline
Treatment
Maintenance
List B trained
List B untrained
Number of Words Pronounced Correctly
Probe Date
0
2
4
6
8
10
12
J-08
J-08
J-09
J-11
J-15
J-17
J-18
J-22
J-28
J-29
J-31
F-05
F-07
F-12
F-14
F-19
F-20
F-21
Ju-03