Introduction

This intervention addressed questions regarding the effectiveness of implicit methods to treat verb retrieval errors in aphasia. Implicit techniques have been used previously for rehabilitation of aphasia (Howard, Patterson, Franklin, Orchard-Lisle, & Morton, 1985; Kiran and Thompson, 2001; Davis, Harrington, & Baynes, 2006). Implicit practice is used to describe techniques in which the individual thinks about a task without actual execution. Implicit semantic intervention targeting nouns significantly improved naming and discourse in an individual with fluent aphasia (Davis, et al., 2006).

The use of implicit intervention is based on theoretical models of lexical retrieval that propose that spreading activation of close semantic neighbors is an essential part of the preparation of a lexical item for speech production (Dell & O'Seaghdha, 1992; Humphreys, Riddoch, & Quinlan, 1988). In this intervention, the participant selected one of fours pictures in response to questions about the perceptual, categorical, or associative characteristics of a target word without overt naming. The foils were often the substitutions used by the participant in his attempts to name the action thereby offering more challenge. If selection required activation of the target as well as inhibition of its competitors, particularly close competitors, it was expected that this would provide practice in inhibition of competing targets for overt speech. Production of competing targets such as literal or verbal paraphasias is a common error, we hypothesized that practice in the inhibition of a target's competitors would be useful.

Implicit practice and standard treatment that requires explicit responses have not been compared experimentally. This research was designed to address the following questions:

1. Would implicit treatment result in measurable improvements as tested by 96-verb probes?

2. Would comparable improvements occur after therapy that required explicit response?

Methods and Procedures

Subject selection:

The participant signed a consent form approved by the Institutional Review Board (IRB) of the University of California at Davis. The participant is a 57-year-old right-handed bilingual male (Indonesian and English) who worked for a technology company and spoke English during his recent 20 years in the U.S. He sustained a left MCA ischemic infarction in 2002 while in Singapore on business. He subsequently received acute treatment in Singapore and returned to the U.S. with residual mixed aphasia. He received 6 months of outpatient therapy but was not currently in speech therapy at the time of recruitment. He lives with his wife and independently ambulates in the home and community with residual right hemiparesis.

Pre and post testing:

This individual was administered the Western Aphasia Battery (WAB) and The Boston Naming Test. In addition, his ability to understand semantically reversible active and passive voice sentences and his relative deficits in parts of speech (nouns, verbs, adverbs and adjectives) was measured. He named a list of 96-pictured verbs from a computerized software program *Picture This* (Silver Lining) and his errors on this list were used to select experimental targets.

Pre-test score:

His spontaneous speech was agrammatic with a mean length utterance of 2 words, almost entirely nouns, and often paraphasic. His scores on the WAB were consistent with Broca's aphasia, non-fluent (rated 2 on fluency) with relatively intact comprehension a (8.0/10 Aphasia Quotient). He scored 6/60 on the Boston Naming Test, producing 2 semantically-related errors. He performed best on active sentences (77%) versus passives (42%) combining the written and auditory conditions.

This experiment was a single-subject multiple-baseline ABAC design. In order to strictly adhere to implicit treatment, no probes were collected and outcome was measured only by changes in confrontation naming at pre- and post-treatment. This represents the first half of a more complex design that compares the same treatments when probes were collected. The intervention consisted of 2 training modules counterbalanced with implicit and explicit treatments. The stimuli were ninety-six verbs administered initially and probed at the end of each of each training module. Two lists of 24 verbs balanced by frequency and error rate were selected for this manipulation. Each of those lists was divided into 12 trained and 12 untrained items also balanced in frequency.

This therapist-designed computerized program utilized the DynaVox© system to develop templates that consisted of a single written question at the top, with the option of an auditory presentation of the question, and 4 pictures below, one of the target and three foils. The computerized format allowed us to control for all aspects of the treatment with the independent variable that was manipulated in the implicit and explicit conditions. The only difference between the treatment types was the requirement of an explicit response in condition C.

The subject participated in 12 sessions of implicit therapy followed by 12 sessions of explicit therapy. Sessions were presented 3 times weekly for 1 to 1.5 hours each session. The pre- and post-test included the semantic reversible test and the entire 96 verb lists.

Results:

Non-target responses were classified as semantically–related errors, non-semantic errors, no response or neologisms in an error analysis (see Table 1). Means were calculated for each response type for baseline, post-implicit therapy and post-explicit therapy naming sessions.

The number of correct responses did not increase significantly after implicit training ($z=1.31$, binomial p, n.s.), but did increase after explicit treatment relative to implicit ($z=2.47$, binomial $p=.013$, two-tailed). Of note, the number of semantically-related errors rose after implicit treatment, from 9% to 22% of the total responses ($z=2.53$, $p=.01$, two-tailed and declined after explicit treatment from 22% to 11% ($z=2.08$, binomial $p=.038$, two-tailed). Treatment was effective in decreasing "no response" trials. The participant moved from 30% to 3% response failures after implicit treatment ($z=5.41$, binomial $p<.001$). Because multiple differences were tested for statistical significance, acceptable significance was calculated to be .008 to adjust for experimenter-wise error rate. From this perspective only the decrease in response failures reached significance. However, there was trend to increased number of correct responses following explicit treatment. Implicit treatment had its greatest impact in decreasing the number of response failures and increasing the number of semantically-related errors. This pattern suggests that implicit treatment may have helped the participant overcome a reluctance to respond. This change, in turn, may have contributed to the excellent response to explicit therapy in this participant. Graphic representation of responses is shown in Figure 1.

Conclusions:

Both the implicit and explicit treatment conditions revealed changes in speech production as tested on confrontational naming tasks. Although implicit treatment did not increase naming success to as great a degree as it has in previous studies, it did improve the response rate significantly. This may have provided a readiness to respond that contributed to success in the explicit condition. Implicit semantic training has increased accurate naming in a fluent participant without the use of probes (Davis et al, 2006) and implicit phonological training has improved naming in a non-fluent participant when probes were employed (Davis et al, under review). The current design cannot determine if patient variables, lack of probe stimuli to provide at least some explicit response opportunities, or word class of the targets may have lessened the effectiveness of the implicit intervention. It remains clear that implicit intervention did change the nature of the responses. Continued investigation will be required to help understand under what conditions this occurs.

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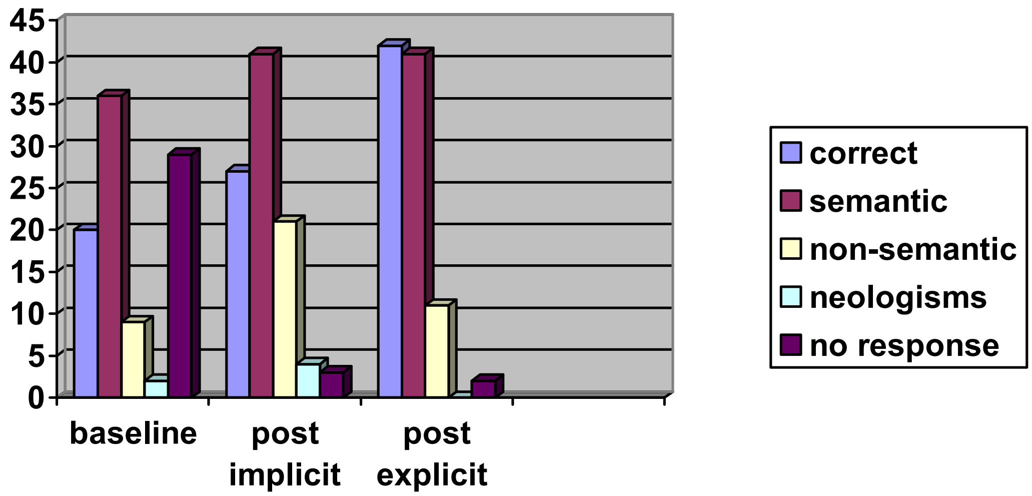
Table 1.

Summary of error analysis

	Baseline	Post-implicit therapy	Post-explicit therapy
Correct	20	27	42
Semantically related errors	36	41	41
Non-semantically related errors	9	21	11
No response	29	3	2
Neologisms	2	4	0
Totals	96	96	96

Figure 1. Graphic depiction of responses over treatment type



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.

Dell, G. S., & O'Seaghdha, P. G. (1992). Stages of lexical access in language production. *Cognition, 42*(1-3), 287-314.

DynaVox Windows Sunrise Medical.

Howard, D., Patterson, K. E., Franklin, S., Orchard-Lisle, V., & Morton, J. (1985). The facilitation of picture naming in aphasia. *Cognitive Neuropsychology, 2*, 49-80.

Humphreys, G., Riddoch, M., & Quinlan, P., (1988). Cascade processes in picture identification. *Cognitive Neuropsychology* 5, pp. 67–104.

Kiran, S., & Thompson, C.K. (2001). Effect of exemplar typicality on naming deficits in fluent aphasia. Paper presented at the 31st *Annual Clinical Aphasiology Conference*, Santa Fe, NM.

Picture This Silver Lining.