Interference and facilitation effects of semantic and phonological contextual priming: A treatment case study

Background.

The language profile of Wernicke's aphasia includes impairments of semantic and phonological input processing and self-monitoring abilities. There are also word and sound retrieval errors in production that are due to or exacerbated by the input processing deficits. Identifying treatment strategies to directly address this combination of language impairments is challenging. Tasks that provide coordinated stimulation of input, output and self-monitoring processes are likely to be most effective (Schuell, Jenkins, & Jiménes-Pabon (1964).

We report a study of a person who initially presented with Wernicke's aphasia, but at the time of treatment fit a profile of Conduction aphasia with some residual deficits of input semantic and phonological processing. The treatment used was 'contextual production priming', a technique adapted from the contextual repetition priming program developed by Martin, Fink and Laine (2004). Contextual repetition priming combines massed repetition with context defined by the linguistic relationship among words being trained (semantic, phonological, unrelated). A production component was added in response to evidence that repetition priming was ineffective when access to semantics was impaired (Martin, Fink, Renvall & Laine, 2006). Studies that have used either approach indicate that its effectiveness depends on the type of word processing impairment (affecting access to semantics and/or phonological representations) as well as the training context. In a report of a person with Wernicke's aphasia, Martin and Laine (2000) found that a phonological context facilitated naming but also stimulated production of more phonological nonword errors than in the semantic and unrelated training contexts. This suggested that a context could have both interfering and facilitative effects, a pattern that has been observed in other contextual priming studies (Martin, Fink, Laine & Renvall, 2004; Fink, Martin & Berkowitz, 2008; Vasseur, Renvall, Martin, & Laine, 2008). Additionally, Martin and Laine (2000) found that rates of phonologically related errors were reduced significantly in the semantic context, suggesting that the semantic context strengthened connections among semantic, lexical and phonological representations of words, resulting in fewer phonological errors. This case study reports several new findings of interest regarding effects of context on learning and error production.

Methods

Participant:
Participant 402, a 64 year old right-handed male, was 5.6 years post-onset of aphasia resulting from a L MCA infarction. Picture naming was moderately impaired, and his error pattern (predominately phonological relative to semantic errors) coupled with his poor repetition and performance on input phonological measures suggests a primary phonological impairment which is complicated by a residual, albeit, milder semantic impairment. Participant testing profile is presented in Table 1.

Design:
We used a single subject, multiple baseline design, tracking acquisition, maintenance and generalization, with follow-up tests 1 month following training. Difficult to name items from a large naming test were used to create two 75 item baseline tests that would correspond with the two treatment modules to be trained. Each baseline test contained 25 items from each of the 3 context conditions (Semantic, Phonologic and unrelated) that comprised a training Module. For each context, 10 items that were difficult to name over repeated presentations were chosen for training and 10 items matched in frequency, length, and difficulty were chosen as control items.

For each context condition (trained one at a time), our participant received 3 treatment sessions per week for nine sessions or until a criterion of 80 percent was achieved across two sessions on all naming probes administered during the treatment session.

When we completed training in all three contexts from Module 1 we repeated the procedure with new relatedness conditions in Module 2, although we shifted the order of training.

Each treatment session consisted of multiple priming trials and naming probes. Production priming of a single word was accomplished by having the participant first identify, then repeat and then name multiple exemplars (several different depictions of a word) of each target. To reduce rehearsal and maximize retrieval opportunities we impose an unfilled and then a filled delay. Training proceeded in four steps, as outlined in Figure 1.

Data analysis
We graphed correct responses on the baseline tests administered at the beginning of each session to track acquisition, maintenance and generalization. The standardized effect size was used to provide a measure of the magnitude of treatment effects (Busk & Serlin,1992). Benchmarks used to determine the magnitude of the effect size were: Small: 2.6; Medium: 3.9; Large: 5.8 (Beeson & Robey, 2006). To further assess differences in context sensitivity, we looked at three types of responses in the naming probe trials during training: 1) correct responses 2) proportion of semantic errors and 3) proportion of phonologically related non-word errors (herein Phonological). Proportions of responses in semantic and phonologic contexts were compared to rates in unrelated contexts using chi-square.

Results:
Module 1 (Figure 2). Once treatment was initiated, naming improved and was maintained for treated items in two conditions: Semantic and Unrelated; there was little improvement in the phonological condition or for untrained items. At follow-up, performance was maintained in the semantic condition and to a lesser extent in UR condition.

Module 2 (Figure 3)
Here we see improved naming during treatment in each condition, greater for trained than untrained items. Acquisition and maintenance appears strongest in the Semantic and

Unrelated conditions. Maintenance of gains at follow-up testing were small, but above baseline means in all conditions.

Effect size analysis for both modules is shown in Table 2.

<u>Context sensitivity (Table 3)</u>

Correct responses: We found significantly higher proportions of correct responses in the unrelated condition (.48) compared to phonologic condition (.36), (p <.001) and semantic condition (.38), (p <.001). There was no difference in rates of correct responses between Semantic and phonologic.

Phonological errors: We found significantly higher proportions of phonological errors in the phonological (.28) and unrelated contexts (.27) compared to the semantic context (p =.0001 for each comparison). There was no difference in proportions of phonologic errors in unrelated and phonological conditions.

Semantic errors: Proportions of semantic errors were higher in semantic (.34) and unrelated contexts (.34) compared to the phonological context (.16), (p < .0001 for each comparison). There was no difference in rates of semantic errors in the semantic and unrelated contexts.

Discussion

Semantic and phonological contexts led to significant interference during training. Nevertheless, in the semantic context, acquisition and maintenance were robust with larger effect sizes than the unrelated or phonological contexts. In contrast, the interference observed during training in the phonological context was not followed by better learning. Thus, the pattern of long-term facilitation following short-term interference during training can be specific to one level of word representation. In the unrelated context, there was less interference during training, but the gains made in acquisition (and maintained to some extent) were not as consistently robust as in the semantic context. The semantic and phonological contexts also influenced the types of errors that occurred. More semantic errors occurred in semantic contexts and fewer occurred in phonological contexts. In the phonological context, there were more phonological errors and fewer semantic errors. These patterns indicate that for 402, context has a strong influence on accuracy and the rates and types of errors. We are currently testing the efficacy of this treatment approach with other individuals with similar and different language profiles than 402.

References

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Table 1. Participant background testing scores

Category/Test	
Western Aphasia Battery[1]	
AQ	69.8
Classification	Conduction
Input semantic and phonological processing	
PPVT[2] (standard score)	65
Lexical Comprehension[3] (% correct)	88
Synonymy Triplets[4] (% correct)	
Nouns	80
Verbs	70
Concrete	80
Abstract	70
Phoneme Discrimination[5] (% correct)	
Word pairs, no delay	100
Nonword pairs, no delay	90
Word pairs, 5s filled delay	90
Nonword pairs, 5s filled delay	80
Rhyming Judgments[6] (% correct)	
Word pairs	80
Nonword pairs	35
Output processing	
PNT[7] (Oral Picture Naming) (% correct)	
Correct	70
Semantic	3
Mixed	2
Phonological	17
Formal	4
Description	2
No Response	0
Unrelated	0
Semantic connection weight	.033
Phonological connection weight	.015
PRT[8] (Oral Repetition) (% correct)	67
Word and Nonword Repetition[6] (% correct)	
Words	47
Nonwords	20
Conceptual/lexical-semantic processing	
Pyramids and Palm Trees[9] (% correct)	
Picture version (% correct)	87
Written/spoken word version (% correct)	90

[1]Kertesz (1982). [2]Peabody Picture Vocabulary Test, Form 3A (Dunn & Dunn, 1997). [3]Saffran et al. (1988). [4]Martin & Saffran (1997). [5]Martin & Saffran (1992). [6]Unpublished test. [7]Philadelphia Naming Test (Roach et al., 1996). [8]Philadelphia Repetition Test (Dell et al., 1997). [9]Howard & Patterson (1992).

Table 2. Effect sizes

Module 1	*Baseline*			*Treatment*				*Maintenance*				*Follow-up*			
	n	Mean	SD	n	Mean	SD	Effect Size	n	Mean	SD	Effect Size	n	Mean	SD	Effect Size
S-T	15	.10	.10	8	.51	.17	**4.13**	18	.71	.12	**6.06**	3	.63	.21	**5.33**
S-UT	15	.11	.11	8	.20	.08	0.85	18	.39	.11	**2.62**	3	.30	.10	1.76
U-T	24	.16	.11	8	.54	.17	**3.58**	9	.63	.05	**4.48**	3	.60	.10	**4.17**
U-UT	24	.20	.14	8	.40	.09	1.38	9	.40	.07	1.38	3	.37	.12	1.15
P-T	33	.09	.08	8	.26	.12	2.24	-	-	-	-	3	.33	.06	**3.14**
P-UT	33	.15	.09	8	.24	.05	0.95	-	-	-	-	3	.20	.00	0.54

Module 2	*Baseline*			*Treatment*				*Maintenance*				*Follow-up*			
	n	Mean	SD	n	Mean	SD	Effect Size	n	Mean	SD	Effect Size	n	Mean	SD	Effect Size
S-T	27	.20	.11	8	.50	.14	**2.72**	4	.58	.05	**3.40**	4	.45	.17	2.26
S-UT	27	.16	.12	8	.23	.07	0.53	4	.20	.08	0.31	4	.20	.00	0.31
U-T	18	.37	.13	8	.61	.06	1.92	13	.64	.08	2.12	4	.65	.06	2.21
U-UT	18	.34	.12	8	.46	.07	1.03	13	.49	.05	1.28	4	.43	.05	0.72
P-T	9	.24	.05	8	.45	.15	**3.90**	22	.39	.07	**2.69**	4	.38	.05	2.48
P-UT	9	.26	.11	8	.33	.09	0.61	22	.33	.07	0.67	4	.33	.13	0.61

Note. All effect sizes are calculated in comparison to the baseline using calculations from Busk and Serlin (1992). Benchmarks for effect sizes (Beeson and Robey, 2006): small, 2.6; medium, 3.9; large, 5.8.

Table 3. Context sensitivity comparison (results of chi-square analysis)

	Context Comparison		
<u>*Response Type*</u>	Semantic vs. Phonological	Semantic vs. Unrelated	Phonological vs. Unrelated
Correct	S = P	U > S (*p* < .001)	U > P (*p* < .001)
Semantic	S > P (*p* < .0001)	U = S	U > P (*p* < .0001)
Phonological	P > S (*p* < .0001)	U > S (*p* < .0001)	U = P

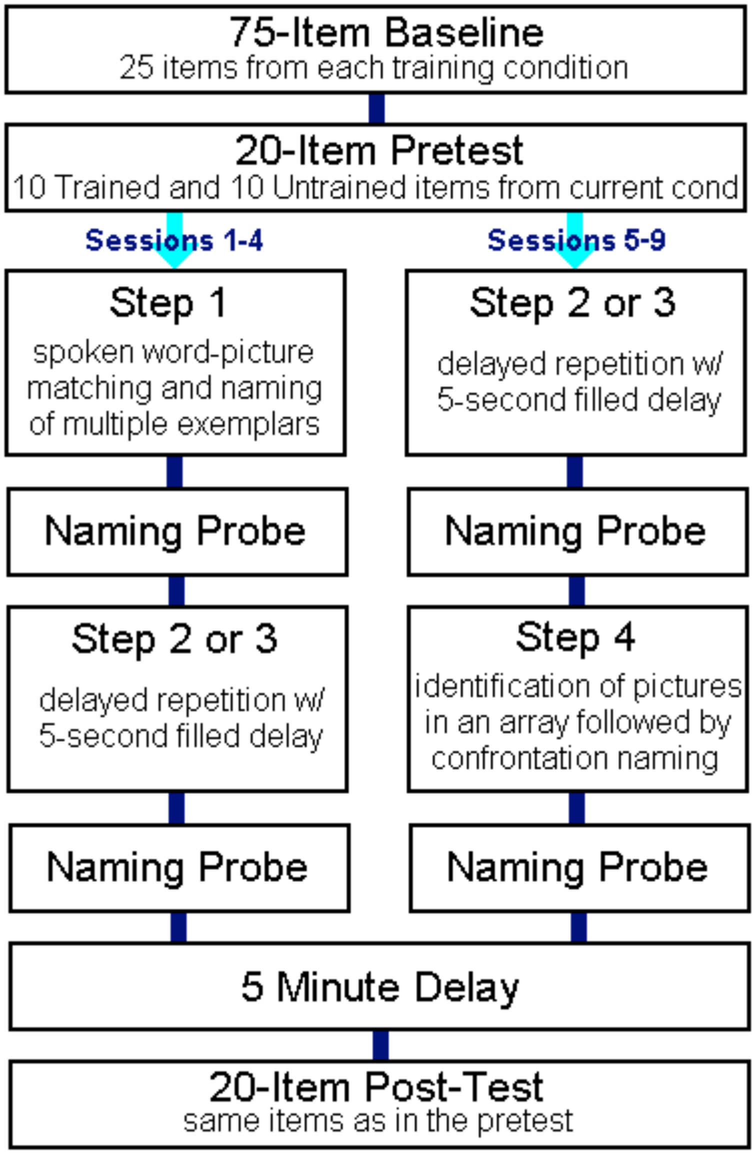

Figure 1. Treatment session.

Figure 2. Results for treatment module 1.

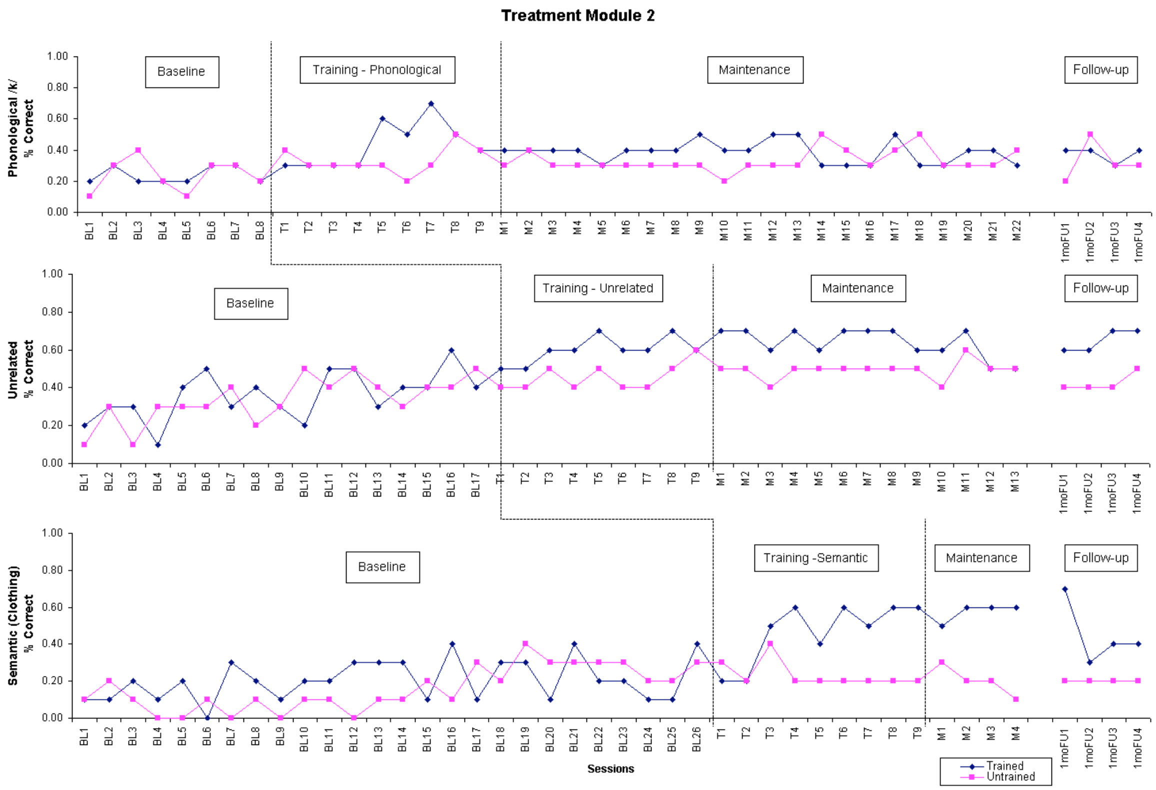

Figure 3. Results from treatment module 2.