Background: Development of effective treatment approaches for language impairments in Wernicke's aphasia have proved challenging because comprehension, production *and* self-monitoring functions are frequently all affected. Often, indirect treatment approaches were selected, including use of gestures and other compensatory strategies (Davis & Wilcox, 1985). Direct approaches emphasized the use of massed repetition that provided intense auditory stimulation, practice in production of words and monitoring of output (Scheull, Jenkins, & Jimenez-Pabon, 1964). Subsequent studies emphasized the importance of incorporating meaningful context into treatment methods, i.e., physical and social contexts, linguistic context, and paralinguistic context (Marshall, 1994; 2008).

It has been recognized for many years that aphasia is not just a 'language' problem, but also involves deficits of other cognitive processes such as attention (McNeil, Odell & Tseng, 1990) and short-term memory (STM) (Saffran, 1990; R.Martin, Shelton & Yaffee, 1994). For example, aspects of the comprehension and monitoring deficits present in Wernicke's aphasia have been attributed to attention difficulties (McNeil et al, 1990), perhaps affecting the ability to ignore extraneous stimuli (La Pointe & Erickson, 1991; Wiener, Connor & Obler, 2004). Martin and Saffran (1997) proposed that word processing deficits are related to the STM impairment invariably present in aphasia. More specifically, they attributed the language processing difficulties in aphasia to an inability to maintain activation of semantic and/or phonological representations of single words and multi-word utterances. In their model, semantic and phonological representations of words are activated, but the activation decays prematurely (too-fast decay) and before a word can be comprehended, produced or repeated. More recently, Martin (2006) reported evidence from a phoneme discrimination task of *slowed* processing of words, a pattern opposite to the too-fast decay problem. These two types of word processing deficits are consistent with the model of Dell and colleagues (e.g., Dell, Schwartz, Martin, Saffran & Gagnon, 1997) that attributes different patterns of naming and repetition errors to two types of 'activation' impairments: increased decay of activation and weak spread of activation.

The recent focus on word activation processes as fundamental to the language impairment in aphasia, and specifically in Wernicke's aphasia, is an important advance with implications for treatment. Treatment entails identifying what language representations to address and what methods to use to facilitate access to those representations. Thus, understanding the interplay of treatment methods and individuals' word processing abilities may contribute to more effective treatment. Recognizing the close link between verbal STM and language processing and their co-occurring impairment in aphasia, researchers are beginning to develop treatment programs that target these STM impairments (Marjerus, Van der Kaa, Renard, Vander Linden, & Poncelet, 2005; Koenig-Bruhin & Studer-Eichenberger, 2007). A novel treatment approach reported here combines linguistic context and massed repetition with a temporal variable to improve endurance of word activation or promote faster activation of words in a participant with Wernicke's aphasia.

Aims: We report a case study of language activation maintenance treatment for an individual with moderate-to-severe Wernicke's aphasia and a severe STM impairment. This novel treatment targets directly the ability to access and maintain activation of

phonological and lexical-semantic representations of words by incorporating varying time intervals between repetition of stimulus and response. By improving this ability to maintain activation of word representations, it was anticipated that there would be improvements on both language and verbal STM tasks and in functional communication.

Methods and Procedures:

Participant: KX was a 69 year old right-handed female who sustained two left CVAs within one year. Her most recent infarct was over six years before she was enrolled in this study. Results of her neuropsychological and language tests are shown on Table 1. As illustrated, KX's profile was consistent with a moderate-severe Wernicke's type aphasia.

Treatment: Treatment involved repetition of single-words from various word lists. Treatment lists contained 10 treated words and were arranged hierarchically based on semantic attributes of imageability and frequency in the following manner: high imageability-high frequency (HI-HF), high imageability-low frequency (HI-LF), low imageability-high frequency (LI-HF), and low imageability-low frequency (LI-LF). Each list was treated under three different interval conditions: 1-second unfilled, 5-second unfilled, and 5-second filled. Criteria for advancing through each word list at each interval were 80% accuracy of the treated words on 2 consecutive trials or completion of 12 treatment sessions. Treatment was initiated with the HI-HF word lists and continued with the HI-LF, LI-HF, and LI-LF lists respectively. If responses were incorrect, a hierarchical cueing procedure with increasingly salient cues was provided to elicit correct responses.

Experimental Design: A single subject, multiple baseline-multiple probe design across behaviors was used to analyze acquisition, generalization, and maintenance of treatment effects. Probes were administered at the beginning of each session and consisted of 10 treated and 10 untreated words for each set. Every fourth session, a probe was administered for all four word lists: HI-HF, HI-LF, LI-HF, and LI-LF.

Outcome and Results: Word repetition abilities improved for the treated words, especially in the 1-second and 5-second unfilled conditions. Improvement during the 5-second filled conditions was not as robust. See Figures 1 through 4. Criteria were reached for HI-HF words and HI-LF words in the 1-second unfilled condition and for the HI-LF words in the 5-second unfilled and 5-second filled interval conditions. Criteria were often reached within 3 treatment sessions and sometimes even met during baseline as treatment progressed. Additionally, in the untreated words, small but consistent improvement was noted across all conditions.

Effect sizes (ES) were calculated (Beeson & Robey, 2006). Effect sizes for the HI-HF words during the 1-second unfilled condition were small immediately after treatment (5.0) and large during the maintenance phase (12.4); during the 5-second unfilled condition they were medium immediately after treatment and during maintenance (range = 6.60-8.00). Effect sizes for the HI-LF words at the 1-second-unfilled and 5-second unfilled conditions were small immediately after treatment and during maintenance (range = 3.62 – 4.38). Criteria were met in baseline for the LI-HF word lists for the 1-second unfilled condition. A similar trend was noted for the LI-LF

words. Untreated words yielded consistently positive, small effect sizes (range = 1.16-4.20). These preliminary results indicate a favorable outcome for this treatment approach.

Positive results of therapy were also noted during conversation, functional activities, and post-test measures. These results will be reported. The participant began to attempt to self-correct her utterances, a novel behavior that was not observed previously. Anecdotal comments describing the participant's increased communication skills were numerous. Most importantly, the participant herself noted an improvement in her ability to "say and hear the words".

Conclusion: This study demonstrates a novel and effective treatment approach for a person with Wernicke's aphasia that targets the ability to access and maintain activation of phonological and lexical-semantic representations of words, using varying time intervals between stimulus and response during repetition. Effects seem to reflect improvement in the ability to maintain activation of word representations to allow successful processing of words. In fact, the robust response to the treatment indicates great potential of this approach with someone who has difficulty with semantic and phonological processing of words.

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TABLE 1
Pretreatment test results for participant KX

Task	Results		
Western Aphasia Battery	Subtest	Score	AQ
	Spontaneous Speech	13/20	13
	Comprehension	39/60	3.6
	Repetition	57/100	5.7
	Naming	6/60	1.4
	Aphasia Quotient		47.3
Lexical comprehension	1-sec unfilled: .88 5-sec unfilled: 1.0 5-sec filled: .56		
Boston Naming Test	Raw Score: 2		
Philadelphia Naming Test (30 item version)	Raw Score: 0		
Word repetition span (closed word set)	In serial order: 1.8 In any order: 1.8		
Word repetition span (controlled for imageability and frequency)	HI-HF: 1.4 HI-LF: 0.0 LI-HF: 1.0 LI-LF: 0.4		
Word-Nonword repetition span (open set)	Word span: 1.4 (in serial order) Nonword span: .4 (in serial order)		
Probe test of identity, semantic, and phonological span	Identity: 1.0 Semantic: 1.93 Phonological: .27		
Word and nonword repetition test with varying intervals	Words 1-sec unfilled: .6 5-sec unfilled: .07 5-sec filled: .5	Nonwords 1-sec unfilled: .3 5-sec unfilled: 0.0 5-sec-filled: 0.0	

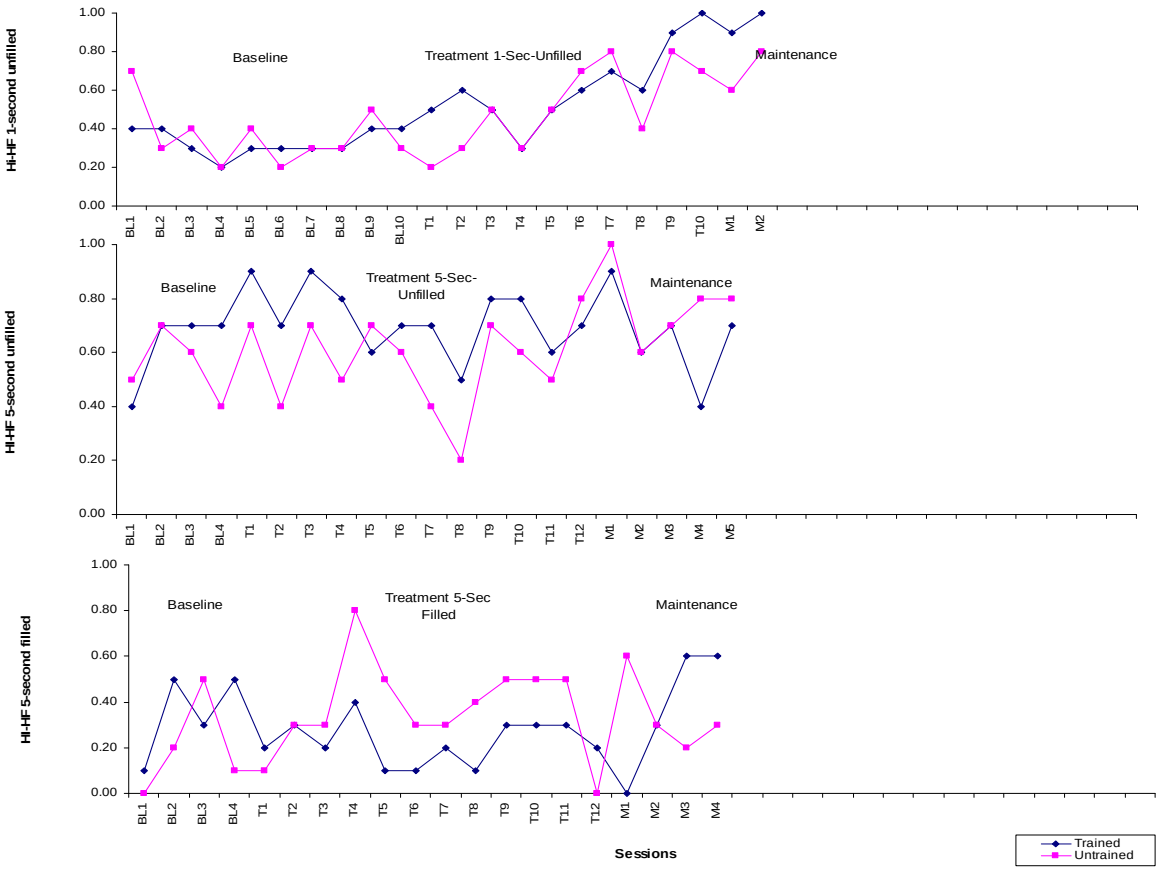

Figure 1. KX treatment Hi-HF all intervals

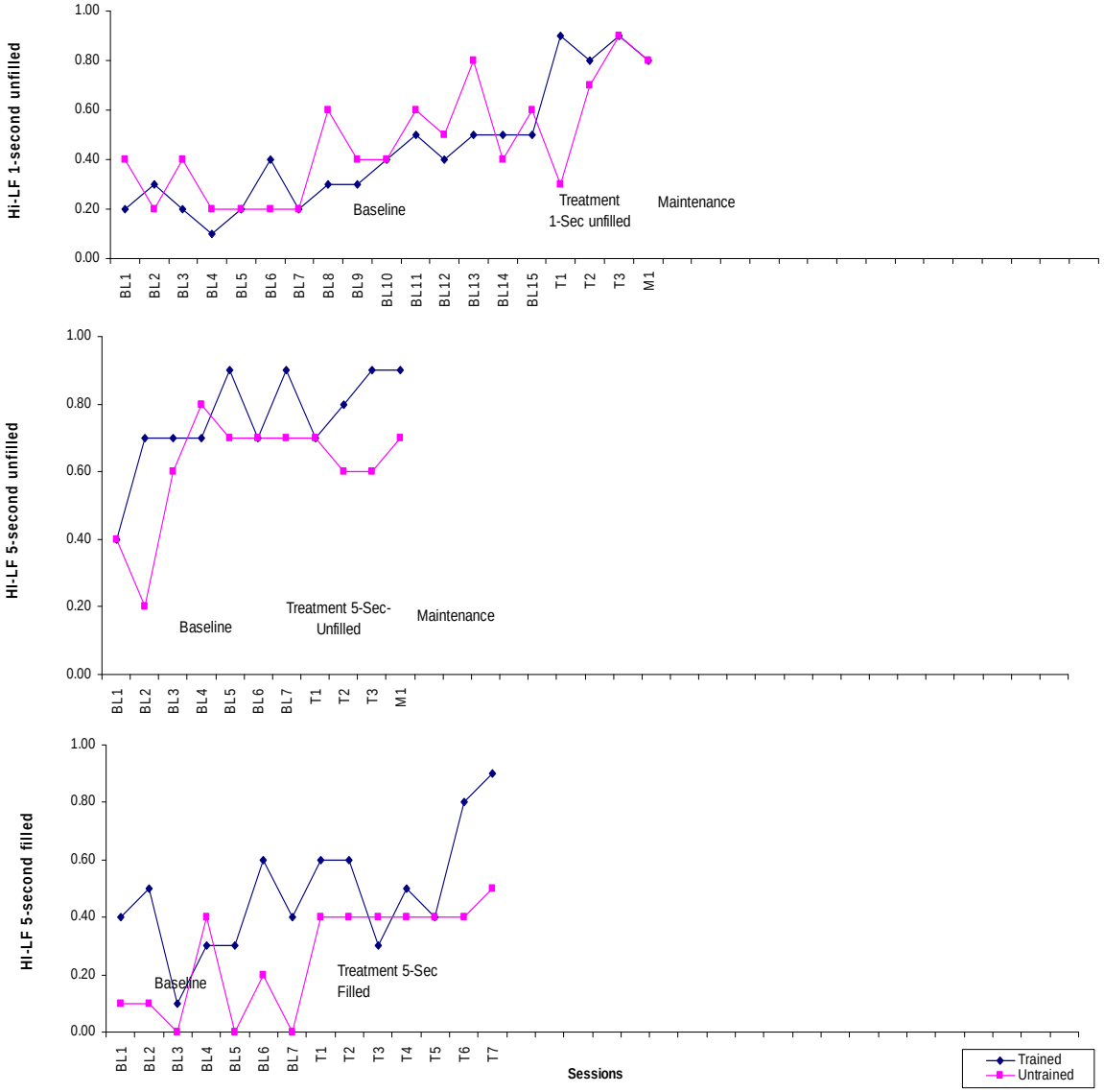

Figure 2. KX treatment Hi-LF all intervals

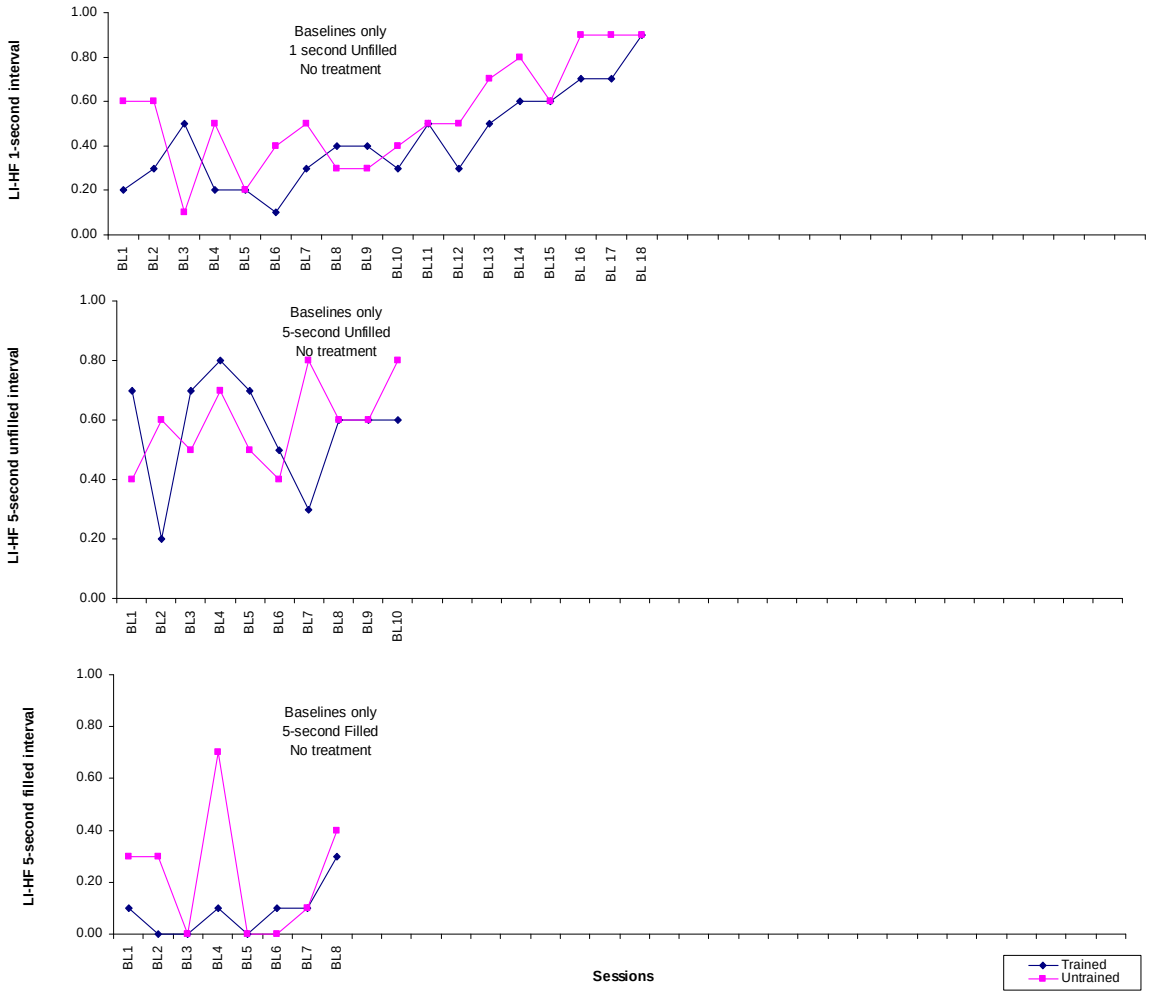

Figure 3. KX baselines LI-HF all intervals

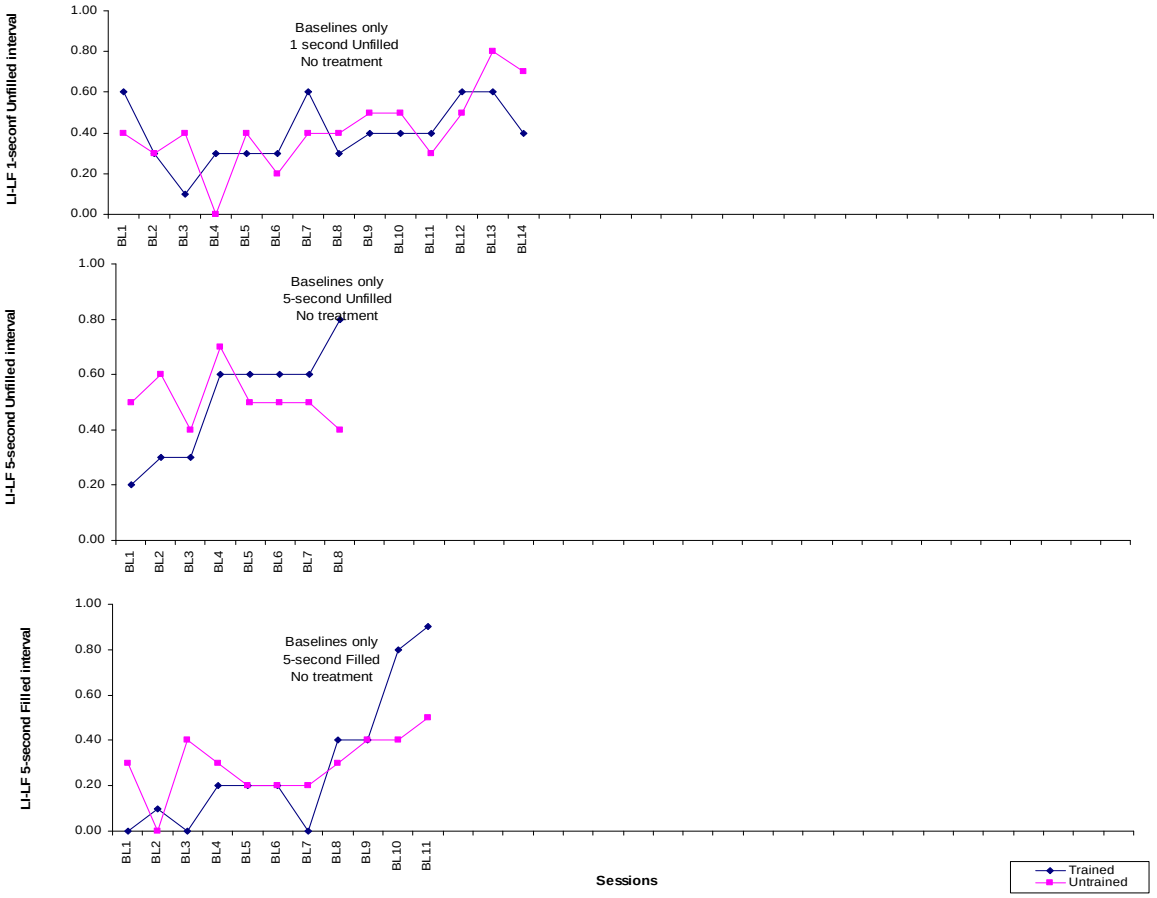

Figure 4. KX baselines LI-LF all intervals