Introduction

Many aphasic patients have difficulties with the use of syntax to decode messages. Most patients do not have specific deficits affecting syntactic operations or parsing/interpretive operations (Caplan & Waters, 2006; Caplan et al, 2006, 2007; Dede & Caplan, 2006), however, patients who present with a syntactic comprehension deficit on one structure often have abnormal performances affecting other structures, pointing to a source of the disorder beyond the source of deficit (Caplan, 2007). This view of syntactic comprehension deficits is more optimistic about generalization of successful training from one structure to another. Therefore, if therapy impacts the ability to utilize resources that subserve syntactic comprehension, successful training might generalize to all structures or to structures that require the same or fewer resources. Some of the most influential work on treating syntactic deficits in patients with aphasia was published by Schwartz and colleagues, who argued that therapy aimed at the mapping of thematic roles in a sentence onto its syntactic structure achieved better results than traditional repetition-based therapy (Schwartz, Saffran, Fink, Myers, & et al., 1994). Many other therapies that have examined comprehension outcomes require a combination of production and comprehension, making it difficult to determine the extent to which they would be effective for sentence comprehension in patients with production impairments.

In this project, we pilot two new treatments (one based on sentence to picture matching (SPM) and the other based on object manipulation (OM)), that train patients on the relationship between syntactic structure and the meanings of sentences by having them indicate thematic roles on pictures or by manipulating objects. This therapy approach is similar to the mapping therapy approach (Schwartz, et al., 1994) but is modeled after the "treatment of underlying forms" therapy approach (Thompson & Shapiro, 2005). We examined therapy effects for two kinds of syntactic movement structures (NP movement sentences and Wh-movement). We systematically manipulated the trained syntactic structure as well as the treatment schedule (frequency of treatment) to understand the stimulus and treatment parameters that are optimal for promoting improvements in patients with comprehension deficits.

Methods

Fifteen participants with aphasia were identified based on consistently below-chance performance on one or more target sentence types during either the SPM task or the OM task on a screening battery. This battery contained eleven sentence structures, including actives, passives, subject clefts, object clefts, and reflexives in order to assess overall syntactic comprehension ability. A single subject multiple baseline design (Connell & Thompson, 1986; McReynolds & Thompson, 1986) was employed to examine treatment effects. For each participant, one treatment task was used to train comprehension of one affected sentence structure. The treatment protocol utilized either an SPM or an OM task and the treatment stimuli were comprised of two Wh- movement structures (object relatives (OR) and object clefts (OC)) as well as two NP movement structures (passives (PA) and unaccusatives (UNACC)). Four versions of a monitoring battery for each of the SPM and OM tasks with identical structures but different sentences were used to track changes associated with therapy and were administered weekly. In addition to the target structures, an untrained control structure (object

relatives with a complex NP (ORcomplexNP)) and active sentences with three NPs (3NP)) were included in the monitoring batteries.

Treatment protocol

The therapy used a novel approach that explicitly demonstrates the thematic role of each constituent of the sentence. Both the SPM and OM treatments were similar in terms of the number of steps as well as the basic procedures involved, but differed in terms of the nature of thematic role mapping. In the picture matching task, the clinician shows the patient pictures demonstrating the thematic roles in the trained sentence; in the object manipulation task, the participant enacts the thematic roles using paper dolls. For example, the OM-PA(e.g., *the aunt was kissed by the man)* treatment protocol included the following steps: (1) The patient enacted the target sentence using dolls (*aunt, man*) and feedback regarding accuracy was provided; (2) The clinician enacted the sentence using the dolls, modeling the correct thematic roles; (3) The clinician emphasized the agent of the action (e.g., "In this part of the sentence, *the aunt was kissed by* ***the man***, the man is doing the action. Ok, now you show me who is doing the action") and then the theme of the action was emphasized in a similar manner; (4) The patient enacted the sentence with feedback from the clinician. The protocols for OR, OC, PA and UNACC were similar in terms of the basic procedures, but differed in terms of the number of steps to facilitate sentence comprehension.

Results

We trained 15 patients, two on each of the target structures, except OM-UNACC. Only one patient entered into the OM-UNACC treatment condition because several other candidate patients improved on this structure during baseline testing. The structure trained and the frequency of treatment (2 times/week x 2 hours vs. 2 times/week x 1 hour) was counterbalanced across participants. Patients spanned the range of overall ability in syntactic comprehension, ranging from 18.3 % to 88.3% correct on SPM and OM screening tests prior to enrollment in treatment.

All patients received three baseline sessions, up to 10 weeks of treatment (unless they reached ≥80% accuracy on three consecutive monitoring batteries before 10 weeks), and three post treatment probes. The criteria for efficacious treatment was an increase in the level of performance from the pre-treatment baseline probes to post-treatment probes for the treated structure such that accuracy rises from at or below chance to above chance and either a) accuracy on the treated structure rises by 33% or b) the effect size of training on the treated structure is 2.6. Based on these criteria, the success rate for training the target structure was 6/7 patients in the OM condition and 4/8 patients in the SPM condition (effect sizes shown in Table 1). Five of the 15 patients failed to improve, four of them in the SPM treatment condition. In addition, there was a significant difference between pre- and post-treatment performance on the screeners for the trained structure (t (12) = -3.8, $p < .01$), with all but two patients improving subsequent to treatment. Finally, we also examined generalization to untrained, but related structures within the training task for each patient. Results reveal a variable but interesting pattern of generalization between NP and Wh- movement structures across the 15 patients.

Discussion

Results from the study indicate that the object manipulation task is more effective in therapy than the sentence-to-picture matching task. This is an important discovery because, until this point, all syntax training in aphasia has used pictorial or

written materials, not enactment. Additionally, with respect to treatment frequency, two 2-hour sessions per week are superior to two 1-hour sessions in terms of patients' responsiveness to treatment (see Table 1). The outcome of this Phase I treatment efficacy study illustrates the utility of this theoretically-motivated and efficacious treatment for sentence comprehension deficits in patients with aphasia.

Table 1: Treatment effect sizes from 15 patients enrolled in the treatment study.

ES = effect size

	Object Manipulation Task			Sentence Picture Matching Task		
	Patient	**Treatment frequency**	**Treatment outcome**	**Patient**	**Treatment frequency**	**Treatment outcome**
OR	**1**	**2 x 2hrs**	**ES = 30.5**	**8**	**2 x 2hrs**	**ES = 2.6**
OR	**2**	**2 x 1hr**	**ES = 5.0**	**9**	**2 x 1hr**	**Failed criterion**
OC	**3**	**2 x 1hr**	**ES = 1.37**	**10**	**2 x 1hr**	**Failed criterion**
OC	**4**	**2 x 2hrs**	**ES = 4.8**	**11**	**2 x 2hrs**	**ES = 1.99**
PA	**5**	**2 x 2hrs**	**ES = 3.24**	**12**	**2 x 2hrs**	**Failed criterion**
PA	**6**	**2 x 1hr**	**Failed criterion**	**13**	**2 x 1hr**	**ES = 6.34**
UNACC				**14**	**2 x 1hr**	**Failed criterion**
UNACC	**7**	**2 x 1hr**	**ES = 7.5**	**15**	**2 x 2hrs**	**ES = 5.8**

Selected References

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