Cross-structural priming in sentences with verb particles and verb prepositions: A replication

Introduction

Structural (syntactic) priming (Bock, 1986) is an experimental paradigm used to study sentence processing in non-brain damaged individuals. Repetition of a sentence structure in one or more "prime" trials leads to a tendency to use the same structure in a picture description task. Structural priming treatment for aphasia aims to improve sentence processing in aphasia by increasing accessibility of a syntactic structure, and making it temporarily easier to retrieve. However, this technique's usefulness in treatment depends on the endurance of its effects. Whether structural priming reflects short-term residual activation or short-term learning is a matter of debate (Bock & Griffin, 2000). In treatment studies, this question can be addressed by evaluation of performance at post-treatment assessment.

Priming presumably reduces processing load to facilitate retrieval of a syntactic structure (Kolk & Heeschan, 1992). Processing load can be reduced further by manipulating lexical content and complexity of the semantic and syntactic argument structures of primes and probes in treatment. Benetello, Kohen, Kalinyak-Fliszar & Martin (2012) used a "cross-structural" priming paradigm in which prime and probe sentences were similar superficially but differed in their number of semantic elements and syntactic structure. Verb particle transitives (VPart: *the man is blowing up the balloon)* have fewer semantic elements and less complex syntactic structure than prepositional transitives (VPrep: *the man is blowing on the tea)* and persons with aphasia are better able to repeat VParts than VPreps (Kohen , Milsark & Martin, 2011). Benetello et al. (2012) used VPart-VPrep cross-structural priming to improve sentence

processing in an individual with paragrammatic sentence production. Both VParts and VPreps facilitated sentence production, but effects were more robust for VParts and maintained at follow-up testing 8-weeks post-treatment.

In this replication of Benetello et al.'s, (2012) study, we predict the following:

1- Structural priming will significantly improve repetition of both VPart and VPrep sentence types.
2- VParts will be repeated better than VPreps, because they require fewer processing demands.
3- Cross-structural priming using VParts as primes will result in stronger priming effects than when VPreps are primes, because they will be produced more accurately as primes.
4- Structural priming effects will be evident during post-treatment follow-up assessments.

Method

Participants. TB, a 57-year old right-handed male, experienced a left posterior temporal parietal lobe infarct. He was 72months post onset (MPO) when he participated in this study. DC, a 49 year old right-handed male, sustained a left middle cerebral artery infarct in January, 2010, resulting in a left frontotemporal-parietal craniectomy. He was 23 MPO at the time of his participation.

Pretreatment measures (Table 1). TB's language profile was consistent with a conduction aphasia and profound anomia. Performance on grammaticality judgments and comprehension of reversible sentences was impaired. Repetition of all sentence structure types was impaired. TB's verbal spans (assessed with the *Temple Assessment of*

Language and Short Term Memory in Aphasia (TALSA; Kalinyak-Fliszar, Martin, & Kohen, 2011) were low, especially when the items to be recalled engaged semantic representations (e.g., category membership).

DC's language profile was consistent with a Broca's-Transcortical Motor aphasia. His ability to make grammaticality judgments was mildly impaired. His comprehension of reversible sentences was markedly impaired. Semantic and phonological STM spans were low (Table 1).

Experimental Stimuli. A 72-item test of sentence repetition with VParts (e.g., *the man is backing up the car*) and VPreps (e.g., *the man is backing into the spot*) structures was administered. From these items, four experimental sets were developed, two with 12 VParts; two with 12 VPreps.

Experimental design. A multiple baseline, multiple probe design was used. Cross-structural priming was used for VParts and VPreps for TB. For DC, cross-structural priming was used to prime VPreps, but not VParts because they reached criterion in baseline. Therefore, we examined same-structure priming of VPreps in Set 2. The dependent variable was proportion correct repetition of VPart and VPrep in probes.

Once baselines were stable, treatment was initiated. In acquisition, sentences being primed and same-structure untrained sentences were continuously probed. A reduced probing schedule was followed for sentences in baseline. In maintenance, the schedule was switched so that reduced probing was followed for *these* sentences and continuous probing during acquisition was applied to sentences previously maintained in baseline. Follow-up probes were conducted, 1-, 2-, 4- and 8- (or 11-) weeks after all treatment.

Treatment. Three unique prime sentences were presented for repetition followed by repetition of a probe sentence that was either the same structure or the superficially similar structure. Treatment sessions consisted of random presentation of 36 prime sentences and 12 probe sentences with feedback for primed sentences only. Treatment continued until $\geq$ .80 correct was achieved for two consecutive probe sessions or until 12 treatment sessions were completed.

Results

Acquisition, maintenance and follow-up data are shown in Figures 1 (TB) and 2 (DC) with Shewart chart trend-lines (Robey, Schultz, Crawford & Sinner, 1999) to assist in visual interpretation of data.

TB. Acquisition and maintenance.

Set 1(VPrep-*prime*-VPart). Probe performance for VParts met Shewart chart trend-line criterion for significant change from baseline to treatment (and maintenance). There was limited generalization to untrained VPreps or VParts in Set 2 (but the latter continued to rise during cross-structural training of VPreps). Performance on VPreps improved in acquisition and stayed above baseline levels in maintenance.

Set 2 (VPart-*prime*-VPrep). Behavioral criterion was not met, but the Shewart trend-line indicated a significant change from baseline through treatment. Repetition of VParts showed an upward trend but then began to decline.

Follow-up. Repetition performance was above baseline levels for VPart and VPreps especially at probes 1- and 11-weeks post-treatment.

DC. Acquisition and maintenance.

Set 1 (VPart-*prime*-VPrep). Repetition of primed VPreps probes met Shewart trend-line criterion for significant change from baseline, but not behavioral criterion; VPart probes reached criterion quickly. Generalization to untrained VParts and VPreps (Set 2) was observed in baseline. In maintenance, VPrep probes improved beyond acquisition levels and continued to rise during Set 2 training.

Set 2 (Same-structure priming of VPreps). Behavioral criterion was met for VPreps in acquisition quickly but not for Shewart trend-line criterion .

Follow-up. High levels of repetition performance for VParts and VPreps were maintained at 1-, 2-, 4-, and 8-weeks.

Chi square comparisons of performance from baseline to followup.

TB. Improvement on VParts and VPreps was significant from baseline to 11-weeks follow-up ($p = .026$).

DC. Improvement on VPreps was significant from baseline to follow-up ($p = .009$) and approached significance for VParts ($p = .066$).

Discussion

This study replicates some findings of Benetello et al. (2012). We showed that cross-structural priming effectively improves sentence processing if the prime and probe structures share similar surface structures and lexical content. Benetello et al. (2012) also showed that cross-structural priming was more effective when an easier structure (semantic or syntactic) was the prime. This pattern was not fully realized in the current study.

We also observed generalization to untrained VPart and VPrep structures in one

case (DC), suggesting that structural priming effects are not just item-specific but impact a basic process that mediates access to syntactic structures.

Finally, structural priming effects observed in this study lasted as long as 11 weeks post-treatment, consistent with the idea that these effects reflect short-term learning.

References.

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Table 1. Pre- and post-treatment testing: Laboratory-developed and *TALSA* measures.

Measure		TB *Pre*	TB *Post*	DC *Pre*	DC *Post*
GRAMMATICALITY JUDGMENTS					
	Good (n=30)	0.80	1.00	0.90	0.90
	Bad (n=30)	0.50	0.37	0.67	0.70
SENTENCE COMPREHENSION					
	Lexical (n=60)	0.87	0.83	0.85	0.86
	Reversible (n=60)	0.65	0.57	0.62	0.67
SENTENCE REPETITION					
	Active (n=6)	0.50	0.00	0.83	1.00
	Passive (n=6)	0.00	0.50	0.17	0.33
	Prepositional datives(n=6)	0.17	0.33	0.17	0.33
	Double object datives (n=6)	0.00	0.00	0.00	0.33
	Compound noun phrases (n=6)	0.00	0.17	0.33	0.50
	Subject relatives (n=6)	0.00	0.00	0.00	0.00
	Object relatives(n=6)	0.00	0.00	0.00	0.00
	Prepositional phrases (n=6)	0.33	0.17	0.00	0.17
	Verb particles (n=6)	0.17	0.33	0.33	0.67
	TOTAL (n=54)	0.13	0.17	0.20	0.37
SENTENCE REPETITION (*TALSA*)					
	1-sec UF				
	Unpadded	0.42	0.44	0.74	0.90
	Padded	0.3	0.33	0.47	0.54
	5-sec UF				
	Unpadded	0.24	0.34	0.74	0.76
	Padded	0.23	0.16	0.39	0.44
	5-sec F				
	Unpadded	NA	NA	0.42	0.26
	Padded	NA	NA	0.20	0.17
DIGIT SPAN (ISO)					
	Pointing	2.80	3.40	1.60	1.80
	Repetition	3.40	3.80	3.00	3.40
WORD SPAN (ISO)					
	Pointing	2.60	2.80	1.60	2.40
	Repetition	2.80	3.20	2.80	2.80
PROBE MEMORY SPAN* (*TALSA*)					
Semantic	Semantic	3.55	4.00	2.00	>3.00
Phonological	Phonological	5.38	3.44	3.22	2.93
* Maximum string length= 7 items					

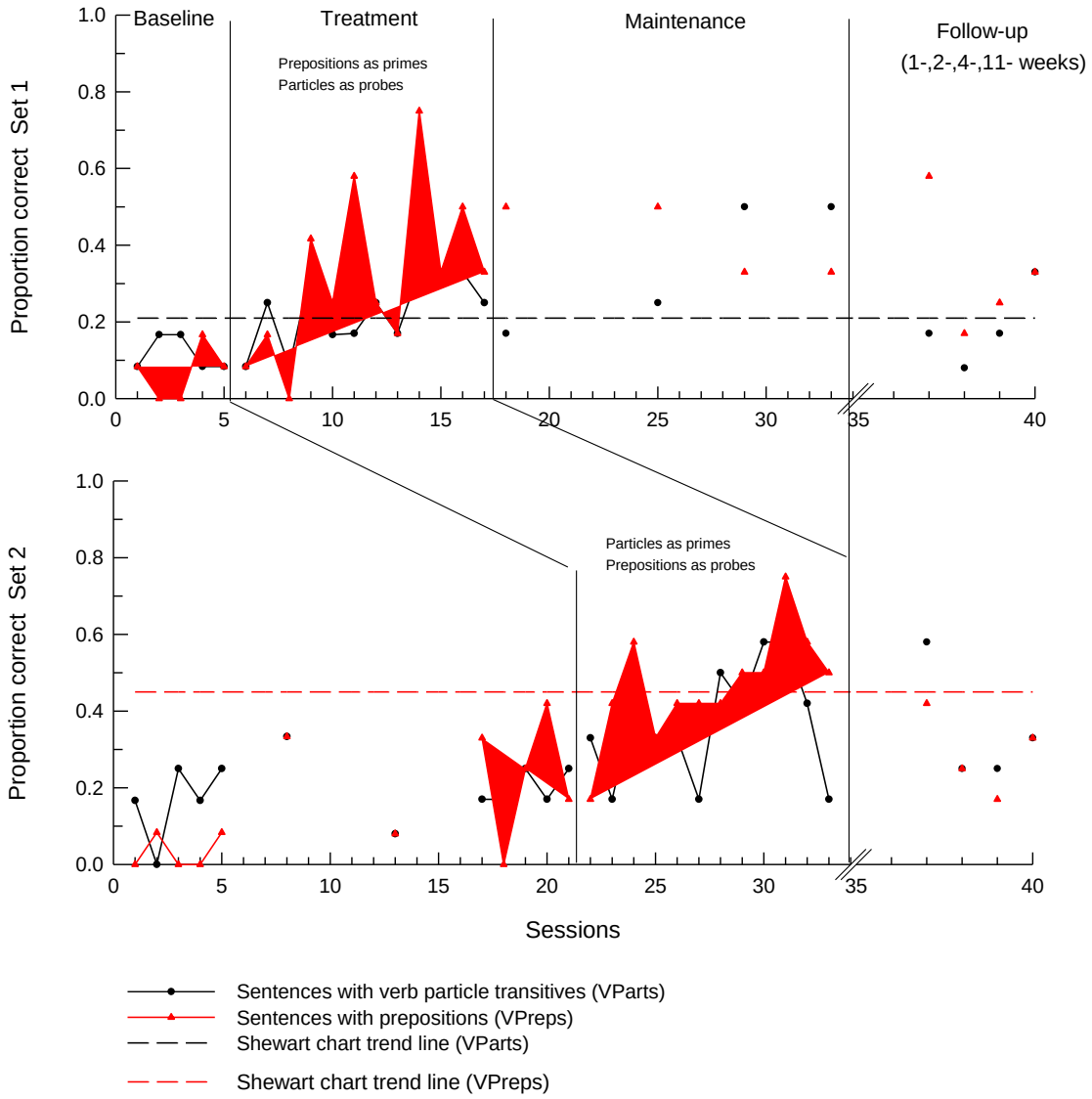

Figure 1. TB proportion correct sentences with verb particle transitives (VParts) and verb prepositional transitives (VPreps) in probes.

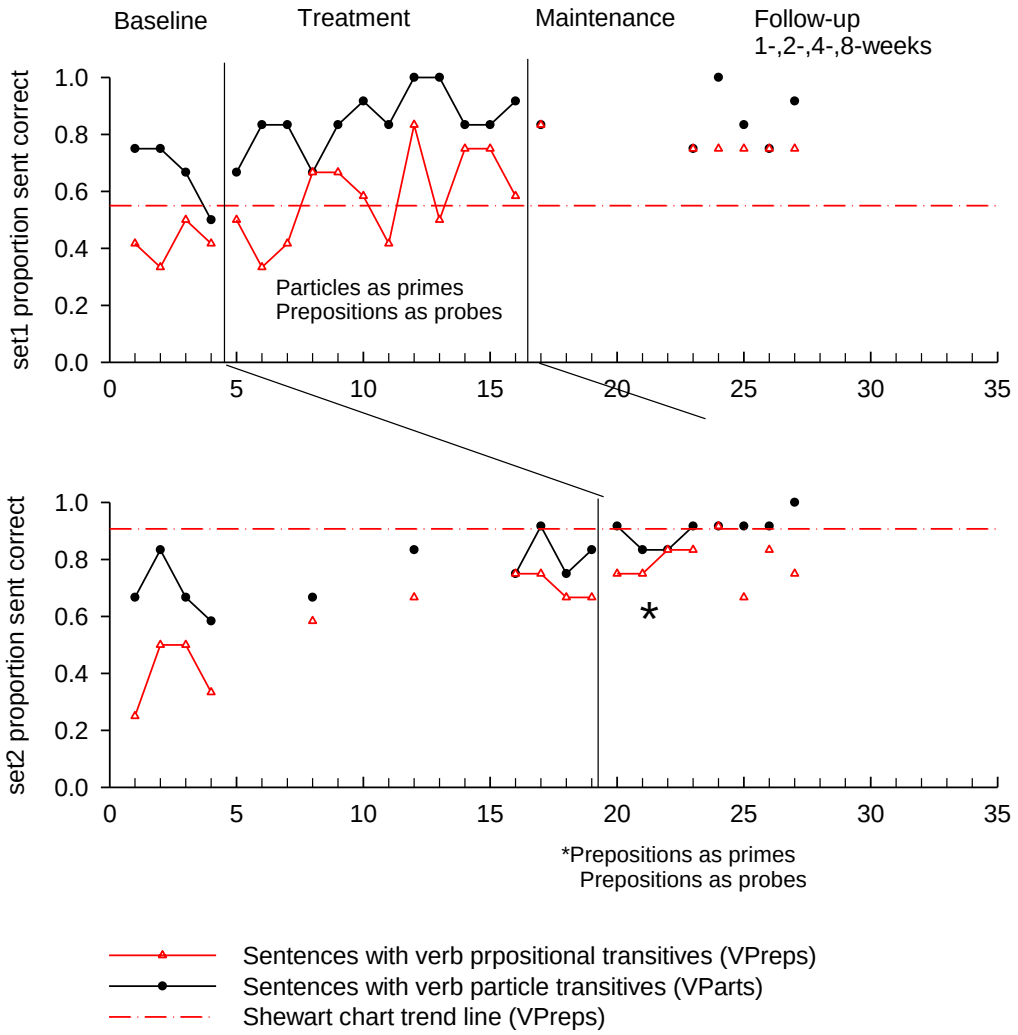

Figure 2. DC proportion correct sentences with verb prepositional transitives (VPreps) in probes.