NONVERBAL WORKING MEMORY AS A PREDICTOR OF ANOMIA TREATMENT SUCCESS: PRELIMINARY DATA

Introduction

It has been well established that individuals with aphasia tend to have difficulty with nonverbal working memory (Lang & Quitz, 2012; Maher & Murray, 2012; Wright & Fergadiotis, 2012) that can influence linguistic and nonlinguistic processing. The extent to which these working memory deficits impact recovery from aphasia is still under investigation.

From a clinical standpoint, the relationship between nonverbal working memory and response to aphasia treatment may hold prognostic value in predicting those individuals who will respond best to a particular type of treatment. To obtain this clinical goal, it will be necessary to assess the reliability of working memory tasks in individuals with aphasia (Mayer & Murray, 2012) because of high variability in performance across sessions in this population.

The purpose of the study was threefold; (1) to identify the extent to which nonverbal working memory performance, as measured by the spatial span (SS) task (Wechsler, 1997), was reliable across multiple testing sessions in individuals with aphasia, (2) to determine if Cued Picture Naming Treatment (CPNT) impacted performance on the SS task, and (3) to determine the degree to which nonverbal working memory, as measured by the SS task, predicted response to anomia treatment in individuals with chronic aphasia.

Method

Participants

The study was approved by the local Institutional Review Board before enrolling participants. Eight individuals participated in the study. Participants were six or more months post stroke; achieved a raw score of less than 46 but greater than 3 on the *Boston Naming Test* (*BNT*; Kaplan, Goodglass, & Weintraub, 1983); achieved a score of no less than two standard deviations below norms on the Auditory Verbal section of the *Western Aphasia Battery* (*WAB*; Kertesz, 1982); were pre-morbidly right-handed and native English speakers.

Spatial Span

Nonverbal working memory abilities were assessed using the spatial span (SS) subtest of the *Wechsler Memory Scales* (Wechsler, 1997). This test was given on 21 to 25 occasions over a period of 4 weeks, and one to four times per day with breaks and distraction tasks (picture naming) between administrations.

Participants were asked to touch a series of blocks in the same order as the therapist (forwards) and the reverse order of the therapist (backwards). Administration and scoring occurred according to the SS protocol. None of the participants reached ceiling. Forward and backward scores were summed for the total score, which was the measure of nonverbal working memory utilized in this study.

Anomia Treatment

The aphasia therapy employed in this research was a cued picture naming treatment (CPNT) (Harnish et al., in press) adapted from Kendall et al., 2009, delivered approximately one hour per day, four days per week for two weeks. Fifty pictures were selected for training.

Picture naming probes were delivered by computer throughout baseline, prior to the CPNT treatment session each day, and four times following completion of CPNT. They were scored as correct or incorrect by the treating therapist. Reliability was calculated on 15% of items. Intra-rater reliability was 98.6% and inter-rater reliability was 98.0%.

The SS task was delivered prior to each probe session. Thus, there were the same number of picture naming probe sessions and SS sessions conducted during baseline, treatment, and post-treatment.

Results

Tyron's C-statistic was calculated for all SS sessions for each participant. Results showed that five of the eight participants demonstrated stability across all 21-25 sessions ($p=0.05$). Three participants (s01, s06, and s08) did not show stability across all testing sessions.

SS scores for each participant were plotted across the aphasia treatment baseline, treatment and post treatment phases. The Conservative Dual Criterion (CDC) Method (Fisher, Kelley & Lomas, 2003) was used to objectively analyze the results[1]. Each data set was evaluated for criterion set in the CDC method for minimum number of data points (7 points) above the mean and trend lines to indicate an upward trend (or lack thereof to indicate stability). See Figures 1-8. Results showed all eight participants demonstrated NO effect of aphasia treatment on SS performance.

We calculated, within subject, the average of all SS scores during baseline, treatment and post- treatment phases. Prior to analysis, the data were screened and all assumptions of linear regression were examined with no obvious violations present. A simple linear regression analysis was conducted to determine if response to aphasia treatment, as measured by effect size, could be predicted from spatial span scores. Effect size was defined as the difference between the mean of the baseline naming probes and the mean of the post-treatment naming probes, divided by the standard deviation of baseline naming probes (Robey & Beeson, 2005). Results showed that the average SS score for each participant was a good predictor of effect size [$F(1,6) = 18.95$, $p<0.005$]. The R^2 for these preliminary data indicates that approximately 76% of the variation in effect size was predicted by average SS scores. The unstandardized slope (.534) and standardized slope (.872) are statistically significantly different from 0 ($t = 4.35$, $df = 8$, $p = .005$). Thus, with every one-point increase in average SS score, effect size for the CPNT treatment increased by approximately one half of one point.

Conclusions

Performance on the SS task remained consistent for 5 of the 8 participants. There were no upward trends on the SS task for any of our participants throughout the aphasia treatment phase despite an increase in naming performance in these participants. These data provide some support that the SS task may be reliable across multiple testing sessions in some individuals with aphasia; however, this claim will need to be substantiated in a larger population. Given the heterogeneity of our population (2 Broca's, 2 Wernicke's, 2 Anomic, 1 Conduction, 1 Transcortical Motor) this task holds promise for measurement of nonverbal working memory for individuals with aphasia.

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[1] Note that the treatment phase began when a stable baseline was achieved on the picture naming probes, not the spatial span. Hence, a stable baseline on the spatial span was not achieved immediately prior to beginning the aphasia treatment for all participants.

The average SS score across all testing sessions for each participant accounted for 76% of the variance of the effect sizes our participants demonstrated after undergoing two weeks of treatment for anomia. This trend with our limited sample size indicates that nonverbal working memory may be a good predictor of how well a person will respond to the CPNT treatment. These data are in line with data acquired during the acute stages of aphasia rehabilitation (Seniow, 2009) that showed that baseline nonverbal visuo-spatial working memory, as demonstrated by the Benton Visual Retention Test, was associated with improvement in naming and comprehension.

References

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Figure 1: Spatial span scores during baseline, treatment, and post-treatment phases with Conservative Dual Criterion (CDC) lines shown for s01

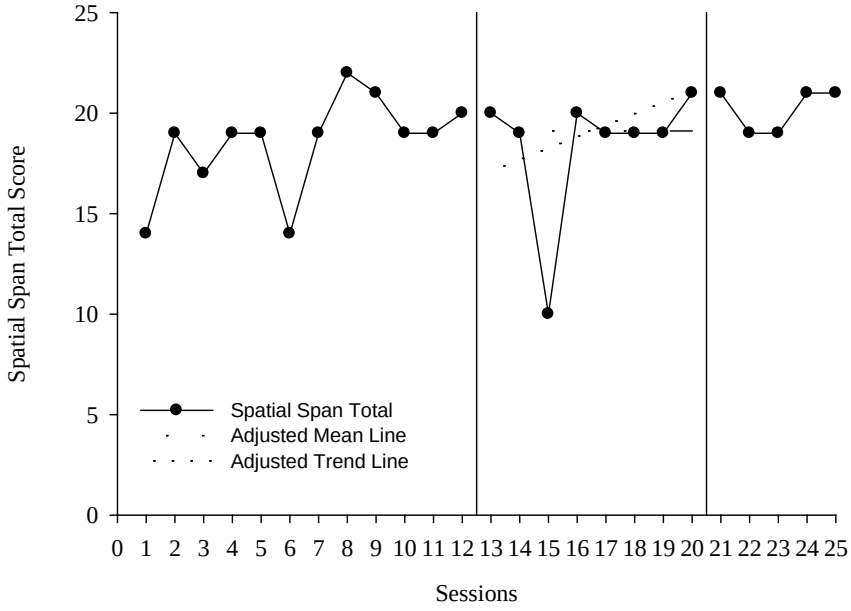

Figure 2: Spatial span scores during baseline, treatment, and post-treatment phases with Conservative Dual Criterion (CDC) lines shown for s02

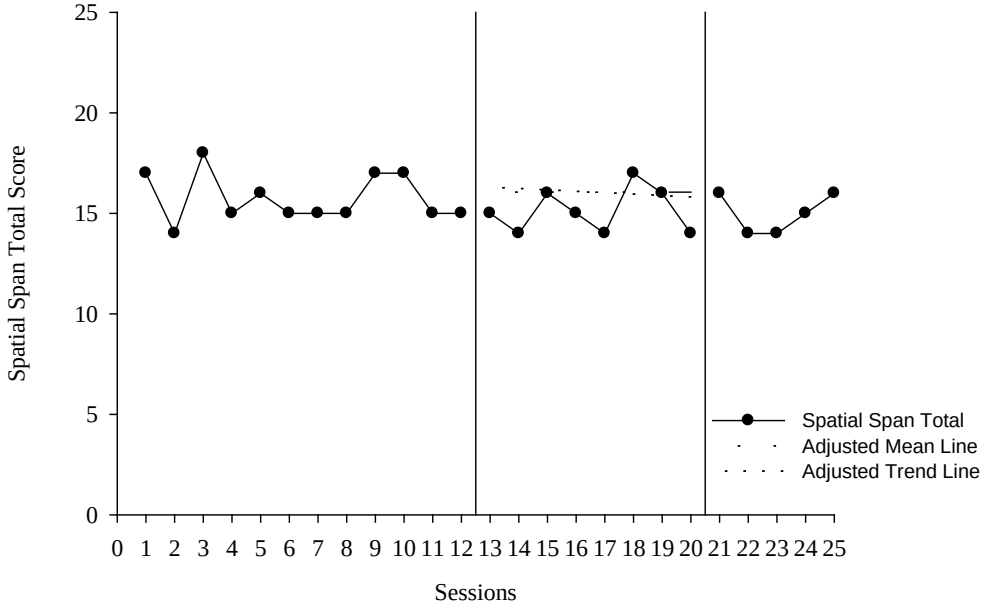

Figure 3: Spatial span scores during baseline, treatment, and post-treatment phases with Conservative Dual Criterion (CDC) lines shown for s03

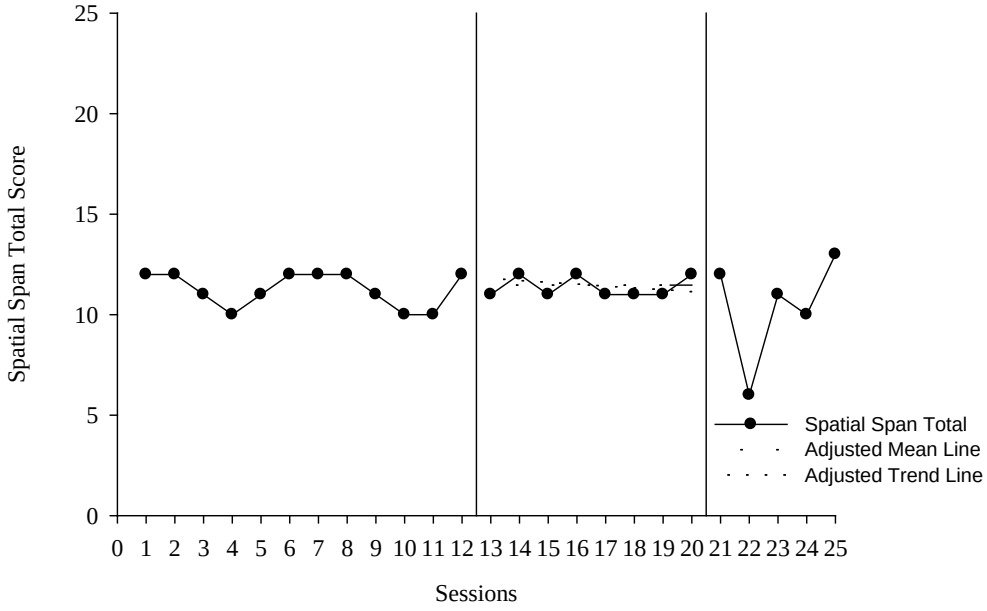

Figure 4: Spatial span scores during baseline, treatment, and post-treatment phases with Conservative Dual Criterion (CDC) lines shown for s04

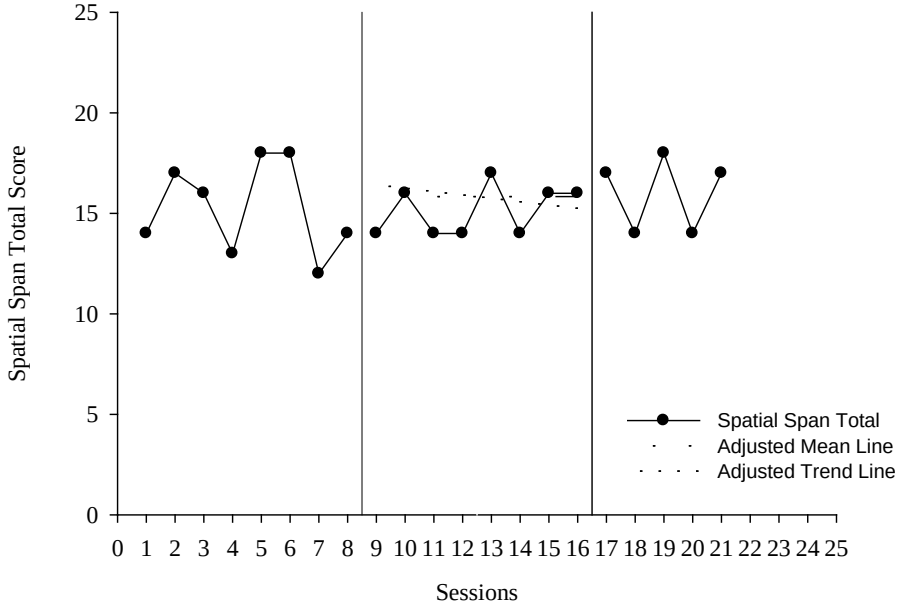

Figure 5: Spatial span scores during baseline, treatment, and post-treatment phases with Conservative Dual Criterion (CDC) lines shown for s05

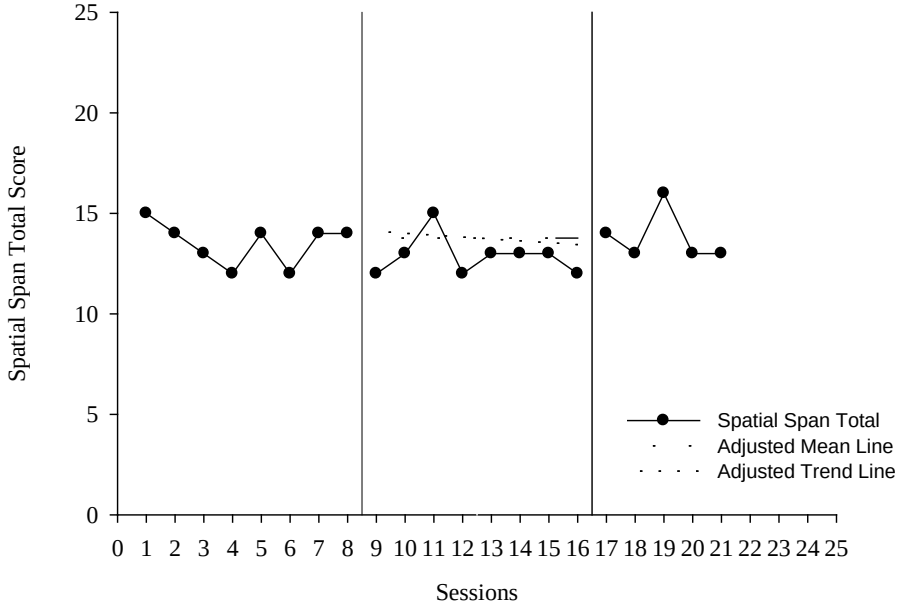

Figure 6: Spatial span scores during baseline, treatment, and post-treatment phases with Conservative Dual Criterion (CDC) lines shown for s06

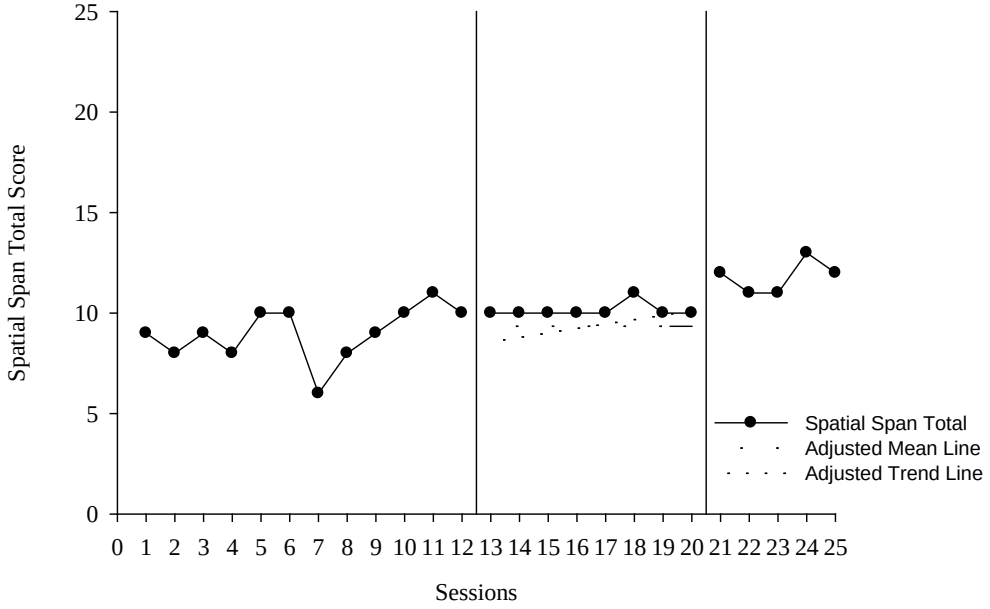

Figure 7: Spatial span scores during baseline, treatment, and post-treatment phases with Conservative Dual Criterion (CDC) lines shown for s07

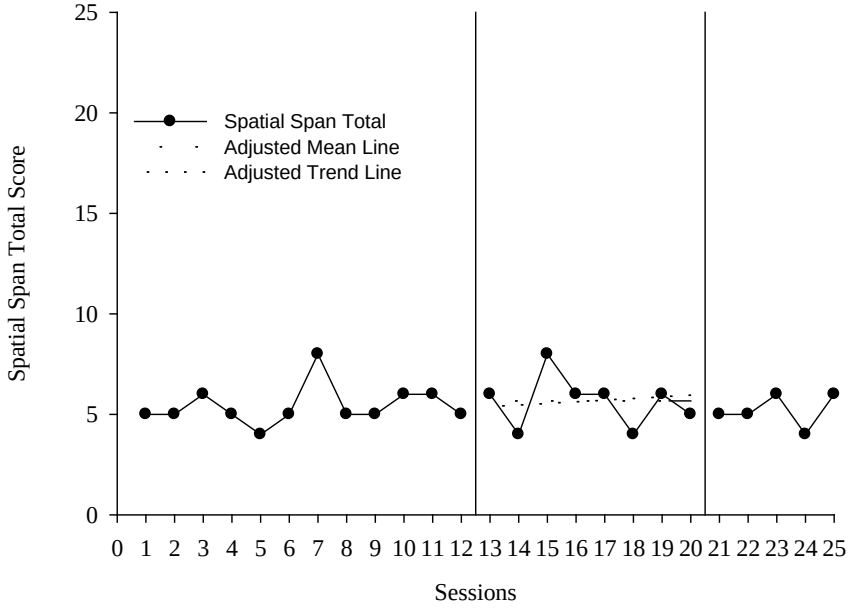

Figure 8: Spatial span scores during baseline, treatment, and post-treatment phases with Conservative Dual Criterion (CDC) lines shown for s08