Introduction

Impairments in capacity and/or allocation of attentional resources have been proposed as a potential explanatory mechanism for the language performance deficits observed in aphasia (e.g., McNeil, Odell, & Tseng, 1991). Consistent with this general view, language performance differences between normal and aphasic participants are typically magnified under dual-task conditions (e.g., LaPointe & Erickson, 1991; Murray, 2000; Tseng, McNeil, & Milenkovic, 1993). Resource allocation theory has also motivated the study of dual-task language performance in normal individuals, and results suggest that auditory comprehension task demands can affect concurrent visual-manual tracking performance (Granier, Robin, Shapiro, Peach, & Zimba, 2000; McNeil et al., 2004), but that tracking task difficulty has no effect on auditory comprehension performance (McNeil et al., 2004; in press). The present study sought to determine concurrent costs between auditory comprehension and visual-manual tracking in persons with aphasia.

Method

Twelve pre-morbidly literate, right-handed individuals with aphasia due to a single left-hemisphere lesion who met hearing, vision, memory, and language performance criteria participated in the study. Demographic data are presented in Table 1. Participants performed a visual-manual tracking task and a listening task under single and dual-task conditions. The tracking task required participants to operate a joystick with their left hand, manipulating a crosshair in the vertical dimension to keep it centered on a random-appearing waveform that scrolled across the computer monitor. Tracking task difficulty was varied by increasing the frequency of waveform turnarounds. The listening task was the Story Retell Procedure (SRP) (McNeil, Doyle, Fossett, Park, & Goda, 2001). After initial single-task tracking practice, participants 1) performed three two-minute single-task tracking trials at each of two difficulty levels, 2) listened to and retold six stories from the SRP under single-task conditions, and 3) listened to three stories while performing the tracking task at each difficulty level (six story-tracking dual-task trials total). Condition order was counterbalanced across individuals with all participants receiving half of the single-task trials before the dual-task trials and half after.

Following each story, participants retold it in their own words. During dual-task trials, participants were instructed to devote equal effort to both tasks. They tracked only while listening, and not while retelling. Retellings were recorded and scored for percent information units (%IUs) produced. Tracking performance was measured as average root-mean-square error.

Tracking performance was examined using a two-way ANOVA with condition (single-task vs. dual-task) and tracking level (easy vs. difficult) as within-participants factors. SRP performance was analyzed using two one-factor within-participants ANOVAs with three levels: single-task, dual-task/easy tracking, and dual-task/hard tracking.

Results

There was a large effect ($\eta^2 = 0.87$) of difficulty level on tracking performance and significant main effect of difficulty level on tracking performance ($F_{1,11} = 213.13$, $p < 0.0001$),

but no significant difference between tracking performance in the single versus dual-task conditions ($F_{1,11} = 0.09$, $p = 0.77$) and no interaction ($F_{1,11} = 0.336$, $p = 0.574$). The effects of tracking condition (single or dual-task) and difficulty level on tracking performance are shown in Figure 1. Analysis of SRP performance revealed a small estimated effect size ($\eta^2 = 0.011$), and no significant differences between any of the conditions for %IUs ($F_{2,22} = 2.107$, $p = 0.146$). The effects of tracking difficulty on story retell performance are shown in Figure 2.

Given the preliminary nature of this study, inspection of the non-significant differences in the data was justified, and this revealed the expected trend toward more %IUs in the single-task or dual-task/easy tracking conditions and fewer in the dual-task/difficult tracking condition (mean=29.46%IUs, sd=14.90 for single-task; 29.30%IUs, sd=16.06 for dual-task/easy tracking; and 25.86%IUs, sd=13.06 for dual-task/difficult tracking), with nine of twelve participants showing this pattern. A post hoc power analysis revealed low statistical power (0.39). This suggests that the current sample size is insufficient to detect what may be a theoretically, if not practically meaningful difference. Data collection is ongoing in this protocol.

Conclusions

The non-significant findings in the single to dual-tasks and in the effects of tracking difficulty level on story retell performance must be interpreted within the light of low statistical power - suggesting that more participants must be included in order to confidently conclude that the null hypothesis remains tenable. Specifically, the null hypothesis purports that there are no differences between single and dual-task performance and there are no costs to the story retell in the dual-task difficult tracking condition compared to the easy tracking condition. In the case that adequate power is attained, but no difference between single and dual-task conditions is detected, the results could potentially be explained by the natural ramping up of effort and attentional resources during tasks evaluated (unconsciously) to be more difficult (i.e. dual-tasks). Alternatively, the results could be accounted for by the possibility that attentional pools or resource allocation strategies used during the dual-task performance are not used in either of the tasks when performed alone.

The non-significant difference in story retell performance in the dual-task conditions between the easy and difficult tracking conditions might be accounted for by an insensitivity of the story retell metric (%IUs) to detect an actual cost in comprehension and retelling due to the differential demands of the concurrent tracking task demands. In addition, the "off-line" nature of the story retell task may offer the opportunity to reformulate that which was interfered with during the concurrent comprehension and tracking dual-tasks. The off-line story retell task may also provide the opportunity to exercise top-down knowledge of story structure and generate equivalent %IUs in spite of actual dual-task costs to comprehension.

If the trend observed in SRP performance across competing task conditions is confirmed in the final sample, it will provide further evidence to support the view that impairments in attention (capacity or allocation) may be related to the language performance deficits in aphasia. Future studies are planned to examine the reciprocal effects of tracking and language task difficulty in persons with aphasia, and to compare them to those found in individuals with intact language function.

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Table 1. Participant demographic and clinical characteristics.

Subject	Gender	Age	MPO	55-Item RTT[1] %ile	SPICA[2] %ile	ABCD[3] Story Recall Delayed/Immediate Ratio	Lesion Site	Lesion Type[4]
1	M	53	37	53	72	0.86	unspecified left	1
2	M	51	9	6	71	1.08	temporoparietal	2
3	M	86	27	90	75	0.93	unspecified left	3
4	M	73	141	10	44	1.00	frontoparietal	1
5	F	55	2	89	92	0.86	parieto-occipital	2
6	M	45	22	18	71	1.20	MCA	1
7	M	44	15	51	76	1.00	Parietal	2
8	M	55	4	89	85	1.10	Parietal	1
9	F	46	40	88	88	1.08	frontotemporal	1
10	F	50	55	85	90	1.06	frontotemporal, basal ganglia	2
11	F	70	4	70	97	1.16	Unspecified left	3
12	F	77	69	89	84	1.20	Temporoparietal	1
Mean		58.8	35.4	61.5	78.8	1.04		
SD		14.1	39.5	33.3	14.1	0.12		

[1]55-Item Revised Token Test (Arvedson, McNeil, & West, 1986)
[2]Shortened Porch Index of Communication Ability (DiSimoni, Keith, & Darley, 1980)
[3]Arizona Battery for Communication Disorders of Dementia (Bayles & Tomoeda, 1993).
[4] 1 = ischemic, 2 = hemorrhagic, 3 = unknown

Figure 1. Single and dual-task tracking performance by tracking difficulty.

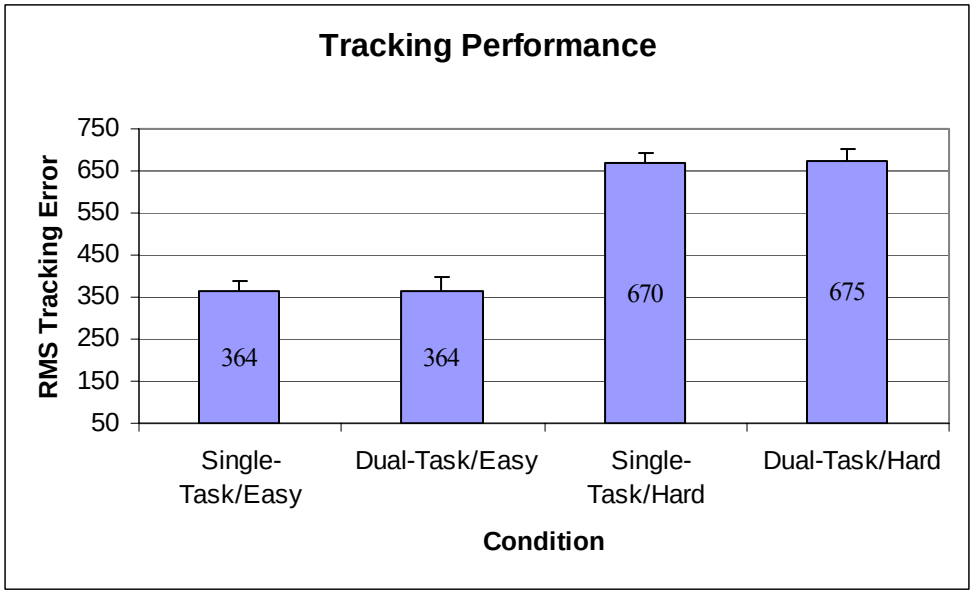

Figure 2. Single and dual-task story retell performance by tracking condition and tracking difficulty level.