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It is well known that many adults with aphasia demonstrate concomitant, nonlinguistic cognitive deficits. This has led to resource or processing models of aphasia, by which language-specific deficits are generated or exacerbated by domain-general cognitive impairments. Indeed, researchers have shown that general cognitive stressors can produce aphasic-like language symptoms in non-brain-damaged (NBD) adults (Miyake et al., 1994) and typically-developing children (Hayiou-Thomas et al., 2004), and can worsen the language symptoms of individuals with aphasia (Murray et al., 1997). Despite increasing clinical and empirical attention to general cognitive factors in aphasia, the nature of these deficits and their interaction with language skills remain elusive.

Verbal fluency tasks present a particularly challenging word retrieval situation, in that they require controlled, effortful attention and strategic search for successful completion (Rosen & Engle, 1997), processes with which individuals with aphasia are known to have particular difficulty (Murray et al., 1998). Capacity for controlled attention or working memory has been shown to predict fluency performance in NBD individuals (Rosen & Engle, 1997). Counterintuitively, however, when NBD individuals were exposed to a dual-task paradigm, high- but not low-span subjects were adversely affected (i.e., low spans generated similar numbers of exemplars across single- and dual-task conditions). Together, these findings suggested qualitatively different retrieval processes: High-span subjects employed attention-demanding (i.e., effortful), active search strategies during fluency tasks, while low span subjects relied on passive, associative word retrieval techniques which, while less successful overall (i.e., fewer exemplars retrieved), were more resistant to load effects. This implies that proponents of resource models of aphasia must carefully examine both quantitative and qualitative aspects of task performance in adults with aphasia when distinguishing and explicating linguistic and cognitive factors.

Accordingly, the purpose of this study was to delineate more finely a resource model of aphasia by using a dual task paradigm to examine the word retrieval skills of adults with aphasia, compared to NBD adults and those with right-hemisphere brain damage (RBD). Whereas previous research suggests that increasing cognitive demands should negatively affect patient groups' word retrieval performances (e.g., Murray, 2000), Rosen and Engle's findings (1997) suggest just the opposite: Patients should be *less* affected by the increased demands of a dual-task paradigm if they have capacity limitations, and relatedly are using qualitatively different word retrieval strategies than NBD individuals.

Methods

Subjects. Currently, the data of 24 aphasic, 11 RBD, and 31 NBD subjects have been analyzed (Table 1). All subjects were matched for age and education, and screened for adequate vision, hearing, and absence of limb apraxia prior to inclusion. Subjects with aphasia demonstrated a variety of aphasia types and mild to moderate levels of language impairment according to the *Aphasia Diagnostic Profiles*. RBD subjects presented with mild to severe cognitive-communicative impairments as measured by the *Mini Inventory of Right Brain Injury.*
Test Battery. All subjects completed the following: 1) *Boston Naming Test*, 2) *Visual Memory Span*, 3) *Ruff Figural Fluency* to assess nonverbal fluency and cognitive flexibility, 4) Tompkins et al.'s (1994) working memory protocol, and 5) *Test of Everyday Attention.*

Dual Task Procedures. Subjects completed a verbal fluency task under the following conditions: 1) *Isolation* – the task was administered without distraction, 2) *Focused Attention* – concurrent tone stimuli were presented with instructions to ignore the tones and complete the fluency task only, 3) *Divided Attention #1* – subjects completed both the verbal fluency task and a tone discrimination task, with priority given to the fluency task (75% fluency vs. 25% tone discrimination), 4) *Divided Attention #2* – subjects completed both tasks with equal priority given to each (50% to fluency and to tone discrimination), 5) *Divided Attention #3* – subjects completed both tasks with priority given to tone discrimination (25% fluency vs. 75% tone discrimination).

Categories for the *Verbal Fluency Task* included clothing, items in a school, grocery store items, beverages, and sports. A pilot study (Murray, unpublished data) demonstrated equivalency across these categories with respect to number of responses elicited during a two-minute time period (analyzed in 30-s epochs). The order of categories was randomized across experimental conditions. Subjects were instructed to name as many words as possible in a given category in two minutes, avoiding repetition of items. The *Tone Discrimination Task* required discriminating forty 500 ms pure tones presented randomly at 500 Hz or 2000 Hz. Tone stimuli were prepared and administered using a PowerMac, SoundEdit®, and PsyScope (Cohen et al., 1993) for recording of discrimination accuracy and reaction time.

Data Analyses. Data were examined for changes in verbal fluency accuracy and word frequency across task conditions and over time (i.e., changes in the number or type of responses across each of the four 30 s time periods within a condition). Frequency analyses were completed using a customized program, "WordCat.py," coded by Python programming language and using frequency values by Kucera and Francis (1967). Frequency and accuracy data were submitted to a 3 X 5 (group X condition) repeated measures ANOVA, and time course analyses were completed for each group comparing the first and last 30-s epochs in each condition. Additional analyses of category prototypicality of fluency responses are planned to shed light on the integrity of subjects' semantic categories and their word retrieval strategies. Finally, measures of accuracy, word frequency, and semantic typicality will be submitted to a multiple regression analysis to determine whether subjects' scores on language, working memory, or attention tasks share significant associations with verbal fluency performance.

Preliminary Results

Preliminary analyses demonstrated significant differences in both accuracy and word frequency across groups, conditions, and time (Figures 1-2). Specifically, NBD subjects produced significantly more correct responses across conditions than both aphasic and RBD subjects, who did not differ significantly from one another. Average overall word frequency did not differ across groups. NBD subjects, however, demonstrated no significant changes in word frequency within or across conditions, whereas time-course analyses indicated that both aphasic and RBD subjects produced significantly more high-frequency words at the beginning of each condition. Aphasic subjects also demonstrated significantly more variability in word frequency across conditions compared to NBD and RBD subjects. A pattern of interaction between word frequency and accuracy emerged across groups and conditions, such that larger differences in word frequency from simpler to more complex conditions corresponded with smaller decrements in accuracy, and vice versa. That is, NBD subjects demonstrated the least variation in word frequency across conditions and epochs, but experienced significantly decreased accuracy as

attentional demands increased. RBD subjects, on the other hand, demonstrated significant changes in word frequency across conditions without a corresponding decrement in accuracy levels. Aphasic subjects fell between these two extremes.

Summary and Clinical Implications

These preliminary data demonstrate qualitative differences in verbal fluency performance between normal subjects and patients with aphasia or RBD, driven by general cognitive factors such as attention and strategic task completion. That RBD subjects, known to exhibit attentional and working memory problems (Tompkins et al., 1994), performed more similarly to aphasic than NBD subjects in a verbal task supports the high attentional demands of the task and the attentional component of the aphasic subjects' impaired performance. Findings from this study will not only emphasize the importance of fine-grained analyses in interpreting dual-task data, but also have implications for resource theories of aphasia and clinical management of acquired linguistic and cognitive impairments.

Selected References

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Table 1. Preliminary Group Characteristics and Select Test Data

Variable		Aphasic (n = 24)	RBD (n = 11)	NBD (n = 31)
Age (years)	M	59.5	58.6	62.1
	SD	13.7	17.2	14.2
	Range	32-83	31-87	30-82
Education (years)	M	14.6	14.2	14.6
	SD	1.9	1.8	2.1
	Range	12-16	12-16	8-16
Time Post Stroke* (months)	M	54.0	27.9	
	SD	52.7	27.8	
	Range	6-204	6-103	
Boston Naming Test	M	44.6	52.5	57.8
	SD	14.8	7.5	2.2
	Range	17-60	29-58	52-60
Auditory-Verbal Working Memory (# recall errors)	M	21.6	11.9	7.1
	SD	10.8	6.8	4.4
	Range	6-40	3-26	0-14
Ruff Figural Fluency Test (%ile for # unique designs)	M	26.9	23.0	64.8
	SD	30.5	30.8	14.8
	Range	1-100	1-99	43-99

*As an inclusionary criterion, all aphasic and RBD subjects were required to be at least 6 months post-stroke onset.

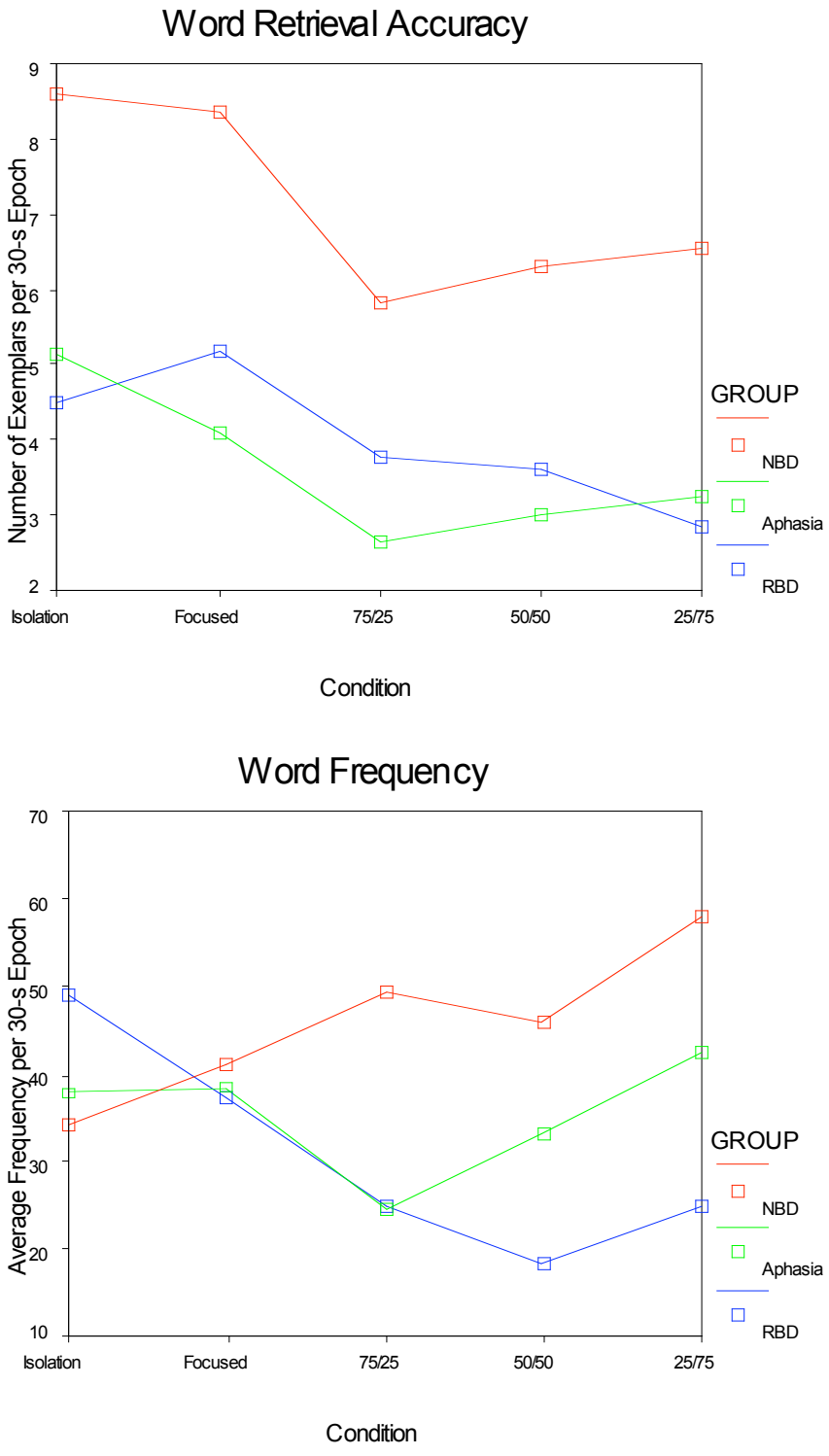
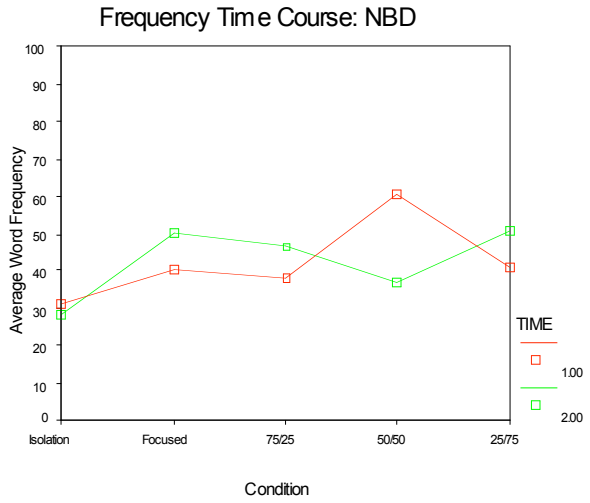
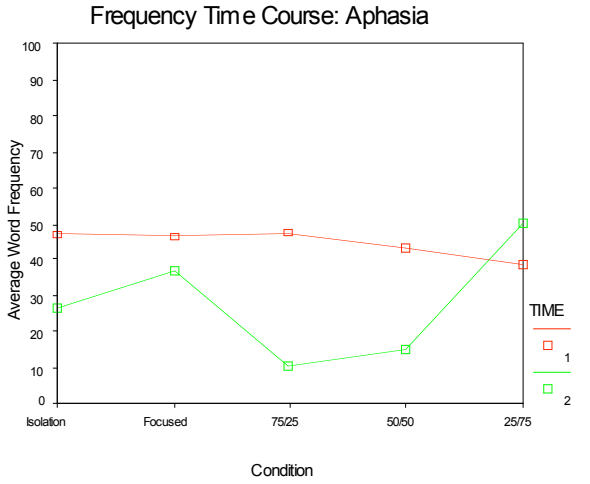


Figure 1. Word retrieval accuracy and average word frequency across each group and each condition.





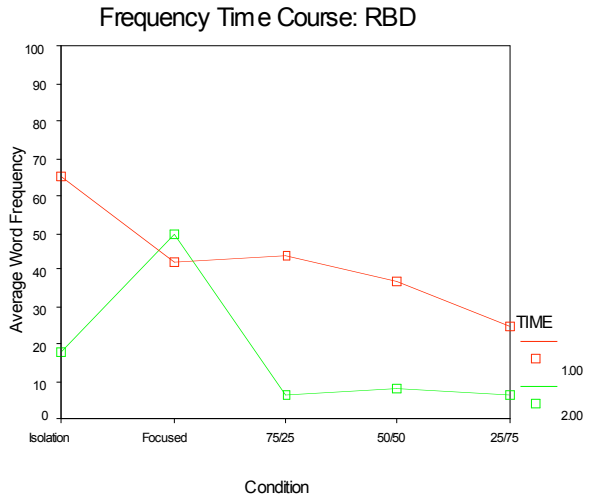


Figure 2. Time course analyses: Changes in word frequency across each group and condition from the first to last 30-s epoch.