Currently, there is increasing empirical and clinical interest in the integrity of nonlinguistic, cognitive processes (e.g., attention, working memory) in aphasia, and the relationship between these processes and aphasic communicative impairments and outcomes (Caspari et al., 1998; Connor et al., 2001). Indeed, recent findings support an emerging conceptualization of aphasia in which deficits in cognitive functions other than language are proposed to generate or intensify linguistic symptoms (McNeil & Doyle, 2000; Murray & Kean, 2004). The purpose of the current study was to specify further this processing or resource model of aphasia by examining interactions between the word retrieval and general cognitive skills of aphasic patients using a dual-task paradigm. Although initial findings suggest that cognitive factors can negatively influence word retrieval in aphasia during phrase completion and discourse tasks (Murray, 2000; Murray et al., 1997), neither of these investigations allowed sufficient examination of whether: (a) material-specific limitations (i.e., verbal fluency during a non-distracting condition, naming test scores), general cognitive abilities (i.e., attention, working memory, nonverbal fluency test scores), or both are important predictors of dual-task outcomes; or, (b) dual-task conditions evoke changes in word retrieval strategy (i.e., error types, number and length of semantic clusters).

Accordingly, this study determined whether word retrieval deficits in aphasia are associated, as least in part, with limitations in other cognitive abilities by having adults with aphasia or no brain damage (NBD) complete a verbal fluency task alone and in competition with a tone discrimination task. A verbal fluency task was chosen because compared to other naming tasks, naming to a category has been associated with greater cognitive demands (e.g., category stimulus provides no delineation of a unique response; output monitoring is necessary to avoid repeating any responses) (e.g., Van Zandvoort et al., 2001). Therefore, a dual-task paradigm is more apt to elicit verbal fluency difficulty in all subjects (including those with very mild aphasia or cognitive impairment), and provide better insight into possible group differences in word retrieval strategy and error types. Based on previous studies of cognitive abilities in aphasia (e.g., Knott et al., 2000) and dual-task performances of adults with aphasia (e.g., Murray et al., 2000), it was predicted that: (a) compared to NBD adults, aphasic adults would exhibit greater dual-task interference, (b) the aphasic adults' dual-task outcomes would be related to both material-specific and general cognitive abilities, and (c) aphasic adults would display quantitative and qualitative changes in their naming strategy as condition complexity increased.

A comparison group of adults with right hemisphere brain damage (RBD) also was included to determine the distinctiveness of the relation between word retrieval and cognitive abilities expected for the aphasic adults. Given that in RBD word retrieval problems are possible, particularly on verbal fluency tasks (Joanette & Goulet, 1986; Stuss et al., 1998), cognitive deficits (including significant attention and working memory impairments) are common (Burrell et al., 1996; Tompkins et al., 1994), and under demanding conditions their linguistic performances correspond more closely to those of aphasic than NBD adults (Arvedson & McNeil, 1986; Murray, 2000), it was predicted that the fluency task performance patterns of RBD adults would be more similar to those of aphasic versus NBD adults.

Methods

Subjects. Currently, the data of 21 aphasic, 11 RBD, and 30 NBD subjects have been examined (Table 1). Additional subjects in each patient group have been evaluated, but their performances have not yet been analyzed. All groups were matched for age and education, and all subjects met inclusionary hearing, vision, and praxis criteria. According to the *Aphasia Diagnostic Profiles*, aphasic subjects had mild to moderate aphasia and represented a variety of aphasia types. On the

MIRBI, RBD subjects varied from mild to severe levels of cognitive-communicative impairment. Test Battery. All subjects completed: (a) *Boston Naming Test,* (b) forward and backward Visual Memory Span, (c) *Ruff Figural Fluency* to assess nonverbal fluency and executive functions such as self-monitoring and flexibility, (d) Tompkins et al.'s (1994) auditory-verbal working memory protocol, and, (e) *Test of Everyday Attention* to establish severity and type of attention disorder. Dual Task Procedures. Subjects completed verbal fluency and tone discrimination tasks under the following listening conditions: (a) *Isolation* - each task completed without distraction, (b) *Focused Attention* - secondary, competing tone stimuli were presented, but subjects completed only the verbal fluency task (only one response required), (c) *Divided Attention #1* - subjects completed both tasks (two responses required) giving priority to the verbal fluency task (i.e., 75% fluency/25% tone priority condition), (d) *Divided Attention #2* - both tasks completed with equal emphasis (50/50% priority condition), and (e) *Divided Attention #3* - both tasks completed giving priority to the tone task (25/75% priority condition).

Categories for the *Verbal Fluency Task* (i.e., clothing, items in a school, grocery store items, beverages, and sports) were first piloted to assure across-category equivalency (e.g., elicit similar number of responses overall and across 30 s time epochs). Categories were randomized across experimental conditions, assuring that each category was presented during each speaking condition to an equal number of subjects in each group. For each condition, subjects named as many words as possible in two minutes, avoiding the repetition of any item. The *Tone Discrimination Task* required discriminating forty 500 ms pure tones (20 at 500 Hz, 20 at 2000 Hz) presented in a random order; during dual-task conditions, a larger number of tone stimuli were presented so that this competing task was completed over the entire duration of the verbal fluency task. Tone stimuli were prepared and administered using a PowerMac, SoundEdit®, and PsyScope (Cohen et al., 1993) which allowed on-line computation of tone discrimination accuracy and reaction time (RT). A *Baseline RT Task* also was administered so that baseline RTs could be considered when interpreting dual-task data.

Data Analyses. Verbal fluency responses will be analyzed for accuracy and the following error types: (a) repetition - response previously given during that condition; (b) intrusion - response that was a target during a previous condition; (c) unrelated - response that bears no apparent relationship to the target category; and, (d) non-word or unintelligible response. Naming strategy will be investigated by examining the number and mean size of semantic clusters (Troyer et al., 1997; Varley, 1995), and by comparing the number of acceptable responses across each 30 s period (Joanette et al., 1988). Verbal fluency and tone accuracy and tone RT data will be analyzed via group X condition ANOVAs (ANCOVA if baseline RTs have a significant relationship to experimental task performances).

Preliminary Results and Summary

Preliminary analyses indicate that the dual task conditions, while difficult for all groups (Figure 1), affected most negatively the patient groups' performances, particularly in the proportion of correct verbal fluency items that they generated (Figure 2) and their tone discrimination accuracy (Table 2). Completion of data collection and further statistical analyses will determine whether: (a) material specific limitations, general cognitive impairments, or both predict dual-task decrements, and (b) subjects in any group displayed changes in verbal fluency error types and naming strategy across time epochs within as well as across conditions. Regardless of final outcomes, the findings from this study will inform resource models of aphasia by further delineating interactions between word retrieval and general cognitive abilities in both patient and normal populations.

Table 1. Preliminary Group Characteristics and Select Test Data

Variable		Aphasic (n = 21)	RBD (n = 11)	NBD (n = 30)
Age	M	59.5	58.6	62.1
(years)	SD	13.7	17.2	14.2
	Range	32-83	31-87	30-82
Education	M	14.6	14.2	14.6
(years)	SD	1.9	1.8	2.1
	Range	12-16	12-16	8-16
Time Post Stroke*	M	54.0	27.9	
(months)	SD	52.7	27.8	
	Range	6-204	6-103	
Gender (Male:Female)		15:6	6:4	10:20
Boston Naming	M	44.6	52.5	57.8
Test	SD	14.8	7.5	2.2
	Range	17-60	29-58	52-60
Auditory-Verbal	M	21.6	11,9	7.1
Working Memory	SD	10.8	6.8	4.4
(# recall errors)	Range	6-40	3-26	0-14
Ruff Figural Fluency	M	26.9	23.0	64.8
Test (%ile for #	SD	30.5	30.8	14.8
unique designs)	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.

Table 2. Preliminary Accuracy (% Correct) and Reaction Time (msec) Group Means, Standard Deviations, and Ranges for the Competing, Tone Discrimination Task.

			GROUP		
Data Type	Condition		Aphasic	RBD	NBD
Accuracy	isolation	M	95.0	97.5	96.6
		SD	4.7	2.6	3.1
		Range	83-100	93-100	88-100
	divided attention #1	M	76.6	81.3	93.8
		SD	16. 4	9.7	6.0
		Range	50-100	68-100	77-100
	divided attention #2	M	81.7	80.6	94.2
		SD	14.3	12.7	5.0
		Range	48-100	57-100	83-100
	divided attention #3	M	81.6	86.1	94.8
		SD	17.6	10.9	3.9
		Range	36-100	60-100	83-100
Reaction Time	isolation	M	741	726	559
		SD	208	235	169
		Range	392-1055	400-1130	324-1130
	divided attention #1	M	1579	1733	1462
		SD	441	452	450
		Range	899-2286	1135-2600	518-2642
	divided attention #2	M	1693	1799	1527
		SD	543	774	464
		Range	722-2537	595-2930	640-2318
	divided attention #3	M	1614	1566	1466
		SD	489	456	464
		Range	992-2545	837-2198	511-2290

Note. Divided Attention #1 = 75/25% condition in which subjects are asked to allot 75% of their attentional capacity to the fluency task and 25% to the tone task; Divided Attention #2 = 50/50% priority condition in which subjects are asked to distribute equally their attention to both tasks; Divided Attention #3 = 25/75% condition in which subjects instructed to allot 25% of their attentional capacity to the fluency task and 75% to the tone task.

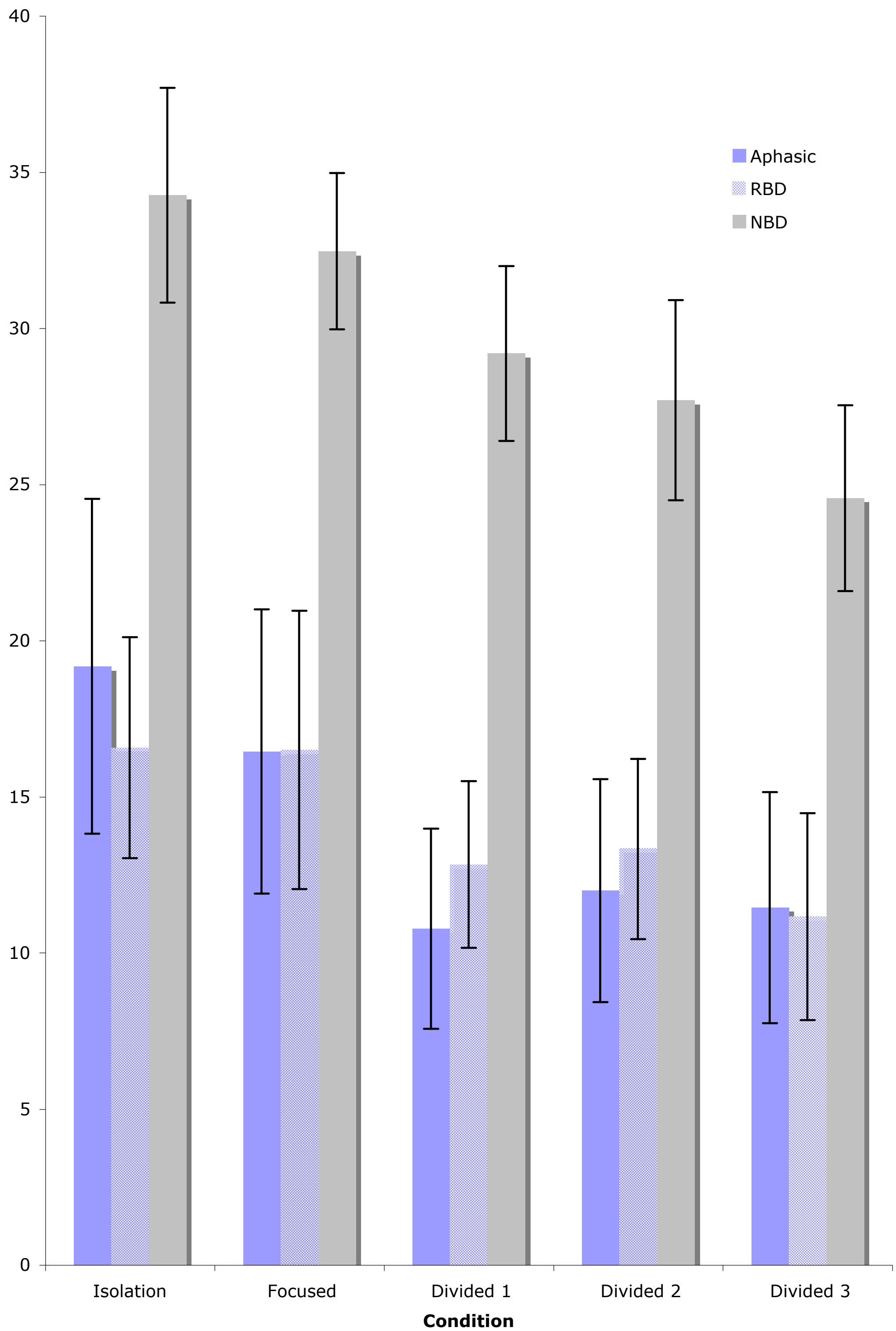

Figure 1. Total number of correct verbal fluency responses generated by each group across each condition.

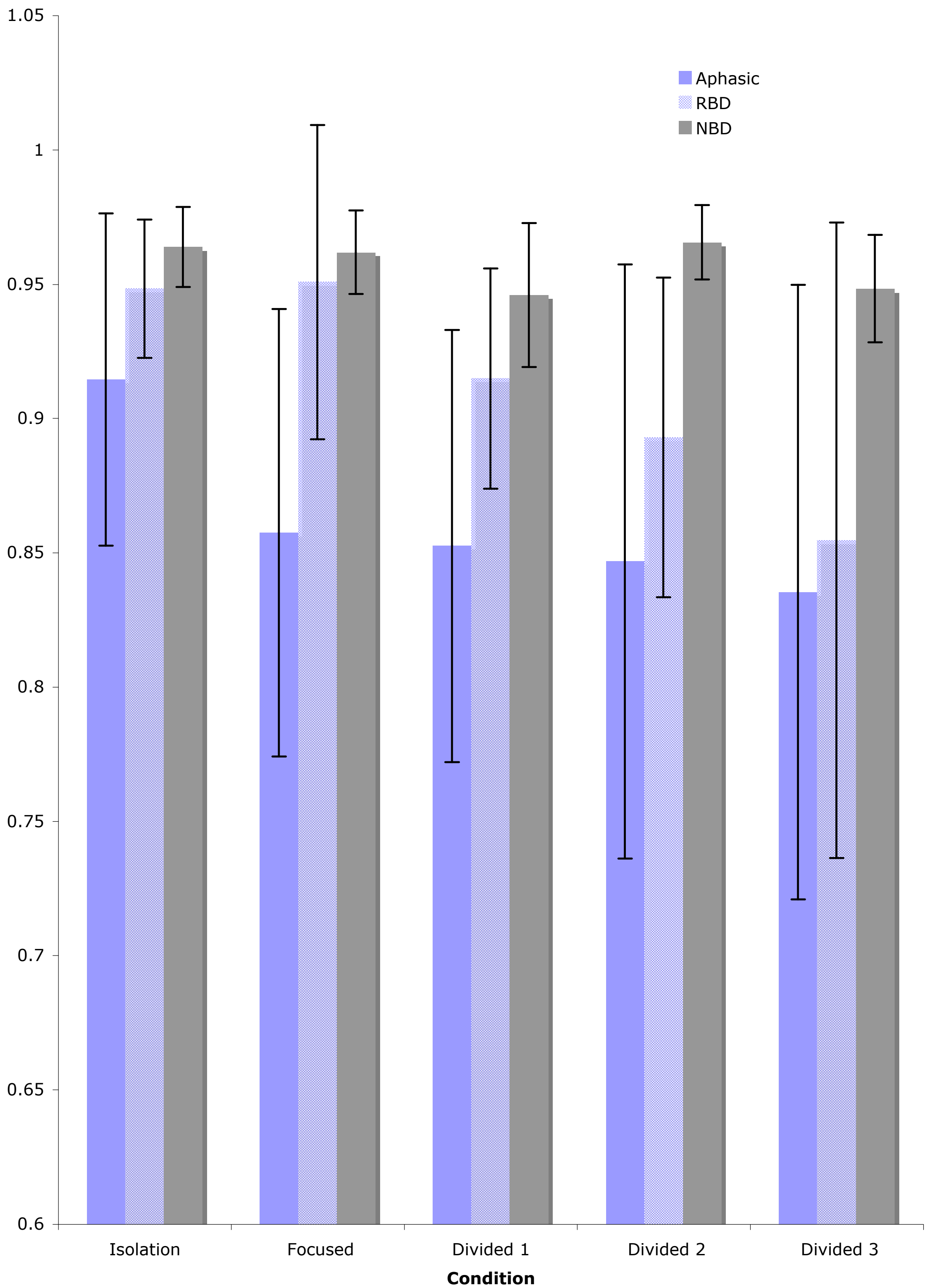

Figure 2. Proportion of correct verbal fluency responses generated by each group across each condition.