INTRODUCTION

In a recent review of anomia management, Maher & Raymer state that 30% of aphasia intervention research from 1946 to 2001 focused on naming; however, "despite this proliferation of case reports and small group studies, there is still no clear agreement on how best to manage these deficits" (Maher & Raymer, 2004, p. 13). The inconsistency of acquisition, maintenance, and generalization effects observed across participants and types of treatment protocols is likely to stem from an inadequate knowledge base about how subject and treatment variables influence learning.

One treatment variable that has received intermittent attention is *dosage* or *treatment intensity* (Basso, 2005; Basso, Capitani, & Vignolo, 1979; Bhogal, Teasell, & Speechley, 2003; Bhogal, Teasell, Foley, & Speechley, 2003; Brindley, Copeland, Demain, & Martyn, 1989; de Pedro-Cuesta, Widen-Holmqvist, & Bach-y-Rita, 1992; Denes, Perazzolo, Piani, & Piccione, 1996; Hinckley & Craig, 1998; Pulvermuller, Neininger, Elbert, Mohr, Rockstroh, Koebbel, & Taub, 2001; Robey, 1998). Bhogal, Teasell & Speechley (2003) suggest that intensity of treatment is likely to emerge as the variable that contributes most to the inconsistency of acquisition, maintenance and generalization effects across studies.

Principles of neurobiological learning across both animal (Squire, 1992) and human research (Poldrack & Gabrieli, 2001) suggest that the intensity of treatment is a significant factor for learning; further research addressing neural plasticity involved in memory and learning indicates that a large number of trials are required to elicit change (Squire, 1992). Despite a considerable amount of literature examining overall treatment intensity, data are not available regarding the frequency (i.e., stimulus dosage) of treatment at which individuals with aphasia will maximally benefit (see table 1). Systematic dosage manipulations are necessary to provide evidence for optimal intervention rates for patients with anomia. Specifically, the number of presentations of a given stimulus required to yield consistent improvement of naming accuracy and latency has not been investigated, despite the fact that repeated verbal practice of picture-naming is inherent to nearly all anomia treatment protocols.

RESERCH DESIGN AND METHODS

A single subject design was used to investigate the acquisition and maintenance of trained stimuli, and generalization to untrained stimuli during a repetition priming protocol among individuals with chronic aphasia. Independent variables included: stimulus dosage (2 vs. 5 presentations); training variables (trained vs. untrained stimuli; alternate exemplars), and lexical variables (word frequency; syllable length). Dependent variables included response latency and accuracy.

Participants

This paper discusses the findings associated with two individuals with chronic aphasia, F.P. and L.G. Pilot data previously obtained from two individuals with chronic aphasia and two healthy controls lead to the refinement of protocol procedures and inclusionary criteria.

Participants had a medically-documented, single cardiovascular accident to the left hemisphere of the brain at least six months prior to enrolling in the study. The participants had no other previous or concomitant neurological, psychiatric, or substance abuse disorders. Hearing and vision were corrected to normal.

Participants presented with mild-to-moderately severe symptoms of expressive language impairment, with no evidence of a concomitant severe-to-profound apraxia of speech or severe-to-profound dysarthria. Individuals with pronounced cognitive and/or memory impairments were excluded. See table 2 for a summary of the participants' profiles.

Procedures

Participants were administered four baseline probes to assess pre-training picture-naming performance. Participants attended training sessions 2-3 times per week until they reached 80% accuracy or for a maximum of 14 training sessions. Participants returned three times following the last training session to assess maintenance performance.

Probe Sessions

Baseline Probes Baseline probes consisted of 60 pictures (40 trained and 20 untrained). Target pictures were presented randomly.

Training Probes Training probes were administered immediately after every third training session and immediately before every fourth training session. Training probes assessed naming performance of all 40 trained items and 20 randomly selected untrained items.

Generalization Probes Stimulus generalization probes, during which participants were asked to name alternate exemplars of the trained stimuli, were administered after every training probe session. Twenty alternate exemplars were presented randomly each session.

Maintenance Probes Three maintenance probes (40 trained and 20 randomly selected untrained items) were administered between 3 and 6 weeks after the last training probe.

Training Sessions

Forty target pictures were randomly selected as trained stimuli. Target items were presented either 2 or 5 times during each session to assess differential effects of stimulus dosage. A total of 100 pictures were presented randomly during each session (20 presented 2 times, 20 presented 5 times). Intervals between presentations were not controlled.

For each trial, the participant first attempted to name the picture without support; the picture then reappeared, accompanied by both the auditory presentation of the name of the target and the orthographic form; the participant then attempted to name the picture again.

Data Collection and Analysis

Accuracy Data
Responses were transcribed on-line. Experimenters reviewed 100% of the recorded data to ensure accurate transcription of participants' responses. Experimenters then coded the transcribed responses for accuracy. An error coding taxonomy was created to categorize response types (see table 3). Similar to the scoring system for the Philadelphia Naming Test, three portions of the entire utterance were assigned a code (Roach, Schwartz, Martin, Grewal, & Brecher, 1996). The error code was assigned to the first complete response, excluding initial attempts that may have preceded the response. Once the first complete response was identified, each was assigned a description of accurate or erred. Errors were then assigned a code, providing detailed information regarding the nature of the error. Error rates/descriptions were calculated and categorized by lexical variables and stimulus dosage across probe sessions.

Reaction Time Data
Response latencies were detected and recorded by E-Prime during all sessions. Incorrect responses were not included in data analysis. Descriptive statistics were calculated for the remaining latencies for each subject across probe sessions.

RESULTS

Participant #1: F.P.

Accuracy Data
During baseline probes, F.P. averaged 39% accuracy for trained items; by the end of training, F.P. averaged 67% accuracy. This increased accuracy persisted throughout the maintenance phase. Untrained items remained consistent throughout all phases of the investigation. See figure 1.

Pictures presented five times in the training sessions steadily increased in accuracy with time and persisted throughout the maintenance phase. Accuracy for items presented twice fluctuated over time with a decrease in accuracy observed during the maintenance phase. See figure 2.

As expected, high frequency words were produced accurately more often than low frequency words across trained and untrained items. Similarly, one-syllable words were produced accurately more often than 2-syllable words across trained and untrained items.

Error Analysis
F.P.'s errors were primarily semantic or phonologic in nature. The percentage of phonologic errors remained stable during training and decreased during the maintenance phase. In contrast, semantic errors remained stable during training and maintenance phases. The percentage of utterances that began with a false start ranged from 15-25% across all phases of the study. Interestingly, after training, F.P. produced the target at some point in her utterance more often than before training. See figure 3.

Reaction Time Data
Reaction time data analysis is in progress.

Participant #2: L.G.

L.G. completed the baseline phase and is currently participating in the training phase of the protocol. Training is expected to be completed by the end of January, with anticipated completion of the maintenance phase by late February. Baseline data are currently being analyzed.

TABLES & FIGURES

Table 1. Summary of Stimulus Dosage in Anomia Treatment Studies

Reference	Number of Aphasic Subjects	Tx Description	Type and Number of Stimuli	Number of Repetitions	Duration of Each Session	Total Length of Treatment
(Fridriksson, Morrow-Odom, Moser, Fridriksson, & Baylis, 2006)	3	Spaced retrieval, massed practice, errorless learning	15 nouns selected by patient	3 items per day were trained (at least 27 repetitions per day) – no way of determining how many attempts were made (incorrect trials)	4 hr/day (2 hr, 30-min break, 2 hr)	2 weeks (with a weekend break b/t weeks)
(Breitenstein, Kamping, Jansen, Schomacher, & Knecht, 2004)	2	Implicit associative learning (correct and incorrect pairings)	50 drawings and 50 pseudo-words	Correct pairings: presented 20 times across the entire training session; incorrect: presented twice	5 training blocks of 200 trials each (no time specified)	1 day
(Martin, Fink, Laine, & Ayala, 2004)	11	Contextual priming: semantic, phonological, or unrelated primes	10 pictures (5 trained, 5 untrained)	Each item repeated 4 times consecutively and then named; this procedure was repeated 8 times (32	Not reported	3 days (one type of priming each session)

Reference	Number of Aphasic Subjects	Tx Description	Type and Number of Stimuli	Number of Repetitions	Duration of Each Session	Total Length of Treatment
				repetitions at least per session)		
(Meinzer, Elbert, Wienbruch, Djundja, Barthel, & Rockstroh, 2004)	28	CIAT or model-based (i.e., based on ling. Impairment)	Not reported	Not reported	3 hours/day	10 consecutive days (30 hours)
(Cornelissen, Laine, Tarkiainen, Jarvensivu, Martin, & Salmelin, 2003)	3	Contextual priming technique (Martin and colleagues)	50 trained black and white drawings (concrete objects)	5 repetitions of each picture	1 hr/session	3 times/week for approx. 3 weeks (until 70% correct)
(Pulvermuller, Neininger, Elbert et al., 2001)	17	CIAT vs. "conventional treatment"	16 pictures	Not reported	CIAT: 3-4 hours/day	Conventional: 3-5 weeks (20-54 hours) CIAT: 10 days (23-33 hours)
(Patterson, Purell, & Morton, 1983)	14	Repetition Priming	10 pictures that participants had difficulty naming (from a set of 265)	1 vs. 5 repetitions	Not reported	One day

Table 2. Participant Profiles

	F.P.	L.G.
Age	90	47
Gender	Female	Female
Time Post Onset (at time of enrollment)	6 months	3.5 years
Date of CVA	1/08/07	8/28/04
Education	High School	College Grad (BA)

Beck Depression Inventory (BDI-II) Beck (1978)	3/63	10/63
Informal Assessment of Agnosia* *Inclusion = > 8/10*	10/10	10/10
Boston Naming Test (BNT)(Kaplan, Goodglass, & Weintraub, 2001)	10/60	5/60
Western Aphasia Battery (WAB)* Kertesz (1982) *Inclusion = AQ > 25*	AQ=73..9	AQ=30.1
Raven's Coloured Progressive Matrices* Raven (1976) *Inclusion = >12*	18/36	36/36
Subtests 1-3 of the Reading Comprehension Battery for Aphasia (LaPoint & Horner, 1979)	29/30	30/30
The Pyramids and Palm Trees Test (Howard & Patterson, 1992)	38/52	48/52
Subtest 54 (naming by frequency) of the Psycholinguistic Assessment of Language Processes in Aphasia (PALPA) (Kay, Lesser, & Coltheart, 1992)	25/60	26/60
Trial Run of the Repetition Priming Protocol* *Inclusion = >5*	9/25	13/25

Table 3. Error Coding Taxonomy

Error Description	Error Code	Example	False Start	Eventually Accurate
			FS = false start *NFS = no false start*	*EA = eventually accurate* *NA = not accurate*
I. Accurate				
	A. Target only			
	B. Filler + target	um, uh, a, the		
	C. Multiple correct productions	"mattress mattresses"		
	D. Multiple productions the first correct	"bra bravere"		
II. Errored				
	A. No response or "I don't know" "I'm sorry"			
	B. Mixed			

	i. Phonological + semantic	/dan/ for /kæt/		
	ii. Phonological + unrelated word	/flon/ for /kæt/		
	C. Semantic			
	i. Unrelated	"shoe" for "cat"		
	ii. Supraordinate	"mammal" for "cat"		
	iii. Coordinate	"dog" for "cat"		
	iv. Subordinate	"Siamese" for "cat"		
	v. Related adjective	"white" for "milk"		
	vi. Related verb	"drink" for "milk"		
	D. Perseveration	Produces any previously produced item		
	E. Phonological			
	i. Omission	/æt/ for /kæt/		
	ii. Substitution	/kɪt/ for /kæt/		
	iii. Addition	/kræt/ for /kæt/		
	iv. Nonword			
	F. Picture description	"a woman washing dishes"		

Figure 1. F.P. Trained vs. Untrained Accuracy Data

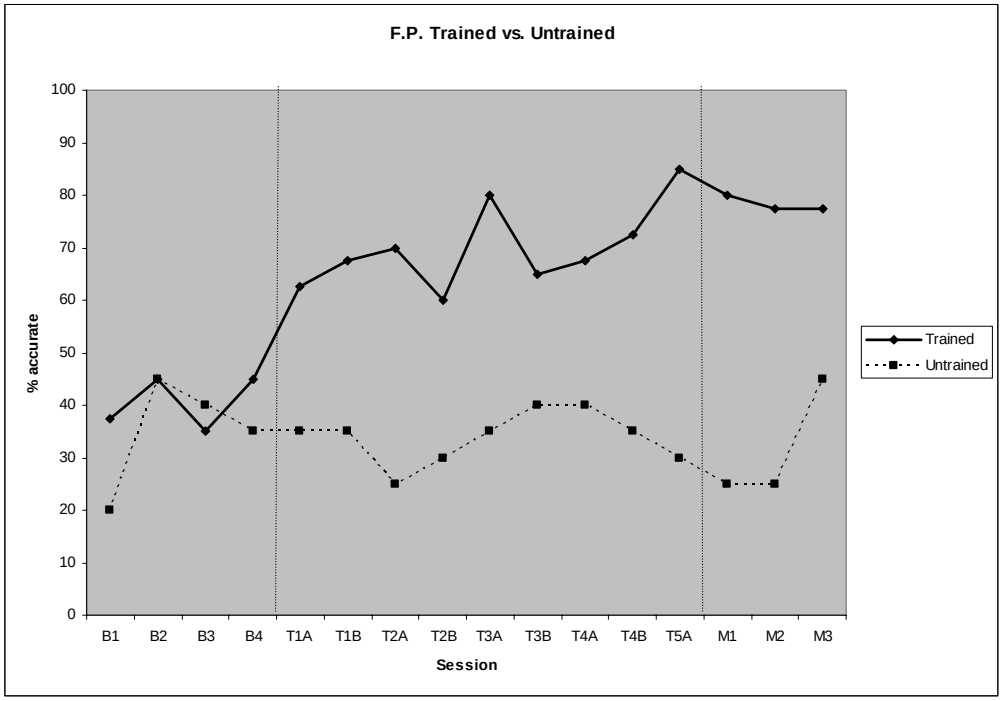


Figure 2. F.P. Accuracy Data – 1 vs. 4 Presentations (Trained Items)

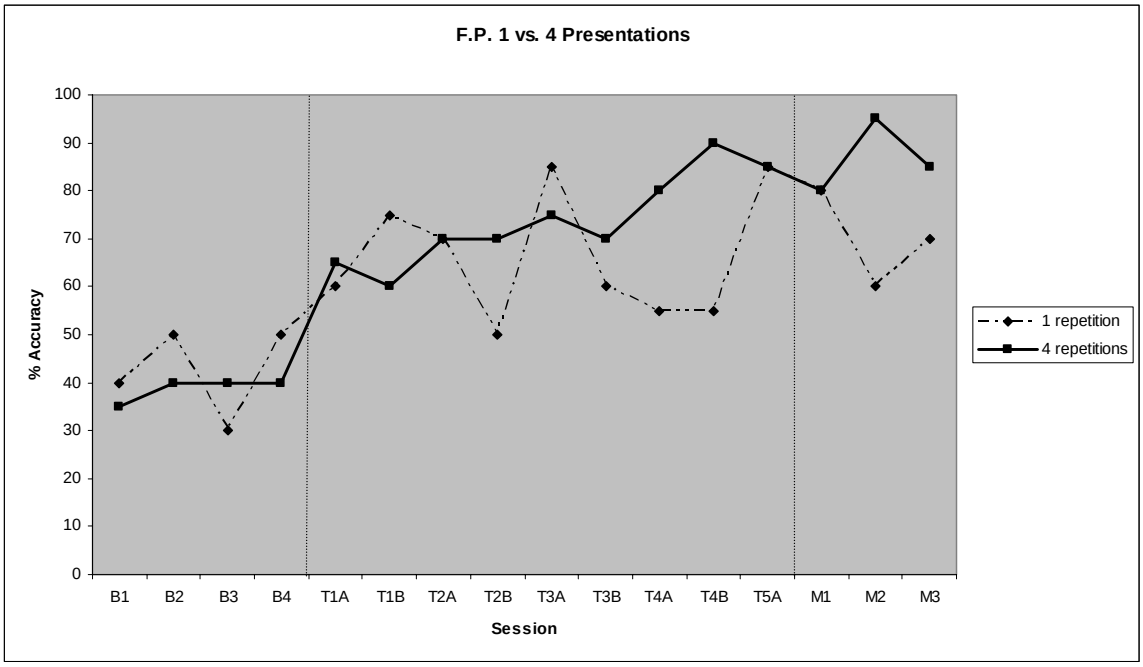
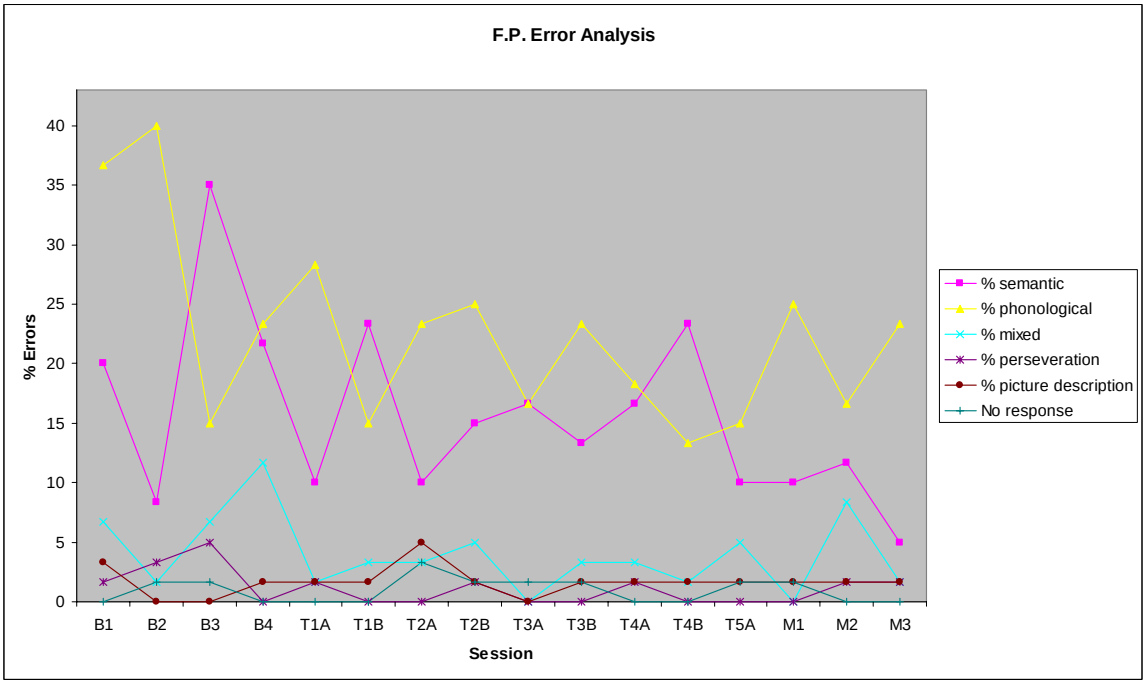


Figure 3. F.P. Error Analysis



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