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A single-subject study examining the effects of a behavioral intervention for verbal recurrent perseveration

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A SINGLE-SUBJECT STUDY EXAMINING THE EFFECTS OF A BEHAVIORAL INTERVENTION FOR VERBAL RECURRENT PERSEVERATION

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ABSTRACT

BACKGROUND: Approximately 1 million people in the United States suffer from aphasia and > 50% of those people may demonstrate recurrent perseverations. No consensus has been forthcoming on whether (1) a therapy that directly confronts clients with imminent pre-articulatory automatisms (the perseverations) or (2) a more typical neuropsychological therapy that eschews any direct confrontation with automatic behaviors works best.

PURPOSE: The purpose of this study was to determine the treatment efficacy of a non-confrontational picture naming intervention on naming ability in individuals with aphasia and recurrent perseverations.

METHODS: This is a prospective single-subject ABAB multiple baseline design replicated across 3 right-handed individuals with moderate fluent aphasia subsequent to left hemisphere ischemic strokes to answer the study's experimental questions. Participants ranged from 61 to 77 years of age and ranged from 7.5 to 13.0 months post stroke. Further, the participants demonstrated total and/or blended perseverations errors on ≥10% of a confrontational picture naming task that consisted of 60 items derived from the categories of the Naming in Categories subtest of the *Boston Diagnostic Aphasia Examination Third Edition* (Goodglass, Kaplan, & Barresi, 2001).

Multiple measurements of accuracy and efficiency were taken during the naming intervention, after the intervention, and during other speech tasks including single word repetition, reading, and picture description. Consistent with single-subject design, we used visual inspection to determine whether or not improvement in picture naming associated with the non-confrontational intervention had occurred. We also opted to analyze the data using paired t-test, Ordinary Least Squares (OLS) and Generalized Least Squares (GLS) with type 1 error rate set at $\alpha = 0.05$.

RESULTS: All three subjects increased performance on picture naming accuracy and decreased their number of recurrent perseverative responses with intervention. Only one subject elicited anticipatory errors in this study, and he demonstrated an increase in anticipatory proportion when presented with facilitating cues compared to pre-intervention performance. Preliminary results suggested communication improvements after the intervention extended beyond the speech process undergoing treatment. Significant individual variation in improvement was seen in response to therapy.

CONCLUSION: The results of this study provided preliminary evidence regarding the efficacy of a non-confrontational picture naming intervention as a strategy to improve speech accuracy and efficiency. In addition, preliminary evidence suggests that the immediate improvements are feasible with relatively short duration and frequency of intervention.

CHAPTER 1
INTRODUCTION

Recurrent perseveration is defined as the inappropriate involuntary partial or complete repetition of a previously emitted response after several correct intervening utterances or responses, distinguishing it from other types of perseveration that appear to be an extension or continuation of the immediately preceding response (Sandson & Albert, 1984). Both forms of perseveration occur across stimulus presentations. Perseveration is also observed in spontaneous speech as well as in segmental and word-level perseverations within the response to a stimulus. Factors susceptible to recurrent perseveration include levels of communication processing (e.g., cognitive, linguistic, motor); response modality (spoken or written expression, drawing, oral reading); task (spontaneous speech, verbal repetition, confrontation naming), and combinations of these (Christman, Boutsen, & Buckingham, 2004). Individuals with and without aphasia demonstrate recurrent perseveration. However, researchers propose recurrent perseveration may occur hundreds of times greater in adults with aphasia than healthy adults in spontaneous speech (Buckingham, Avakian-Whitaker, & Whitaker, 1978; Schwartz, Saffran, Bloch, & Dell, 1994). Perseveration errors negatively impact an individual's communication competency and efficiency; hence, researchers have explored theories for pathophysiology and targets for intervention. Several therapeutic approaches to ameliorate the perseveratory responses have been proposed (Basso, 2004; Cohen & Dehaene, 1998; Helm-Estabrooks, Emery, & Albert, 1987; McNamara, & Albert, 2004; Santo-Pietro & Rigrodsky, 1986).

The investigation of treatment(s) for recurrent perseveration, however, is in its infancy. Exploratory research has utilized visual analysis and other hypotheses to predict that the utilization of specific behavioral intervention techniques will minimize perseverative responses (Basso, 2004; Helm-Estabrooks, Emery, & Albert, 1987). Early studies of treatment for

perseveration (e.g., Helm-Estabrooks et al., 1987) concluded that perseverative behaviors can be raised to a conscious level, thereby aiding the client to produce a nonperseverative response (Helm-Estabrooks & Albert, 2004; Helm-Estabrooks et al., 1987). These researchers distinguished the ability to detect a perseverate on the heels of its production, from therapy that might allow the client to "feel" that a perseveration was about to occur and therefore blocks its occurrence. That is an altogether different cognitive ability and has proved to be extremely difficult to remediate. Psycholinguistically, it is an attempt to instill a pre-editing ability of an automaton about ready to happen to the patient.

Conversely, a non-confrontational approach does not focus upon the perseverative response on line, forcing the client to confront what is automatic. In addition, those interventions restrict their therapy to disrupted language processing modalities that have been compromised by the brain damage, where subjects cannot retrieve target items or otherwise respond correctly to the input stimulus (Basso, 2004; Whitworth, Webster, & Howard, 2005). These researchers suggest that the frequency of perseverative responses will decrease as a function of language recovery without direct obliging the client to directly confront an extremely automatic behavioral production. (Basso, 2004; Cohen & Dehaene, 1998; Corbett, Jefferies, Lambon Ralph, 2008; Dell, Burger, & Svec, 1997; Moses, Sheard, & Nickels, 2007).

Studies that support the efficacy of confrontational and non-confrontational approaches for reducing perseverations are lacking. Few studies of treatment for recurrent perseveration have been published. Those published have disparity in theoretical foundations on which the studies were based and study designs (e.g., variables measured and the outcome measures chosen), limiting statistical comparison. It is imperative to transition single-subject research designs for recurrent perseveration treatment from subjective analysis to a quasi-experimental

model. Such a progression in statistical control will allow for the assessment of actual effects of an intervention. Consistent application of methods to obtain quantifiable results will allow for pooling of cases to increase statistical power.

1.1 Statement of the Problem

Researchers and clinicians assert that recurrent perseveration is a significant barrier to an individual's ability to communicate (Basso, 2004; Morganstein & Certner-Smith, 2001). Two disparate therapeutic approaches to decrease perseveration responses exist: first, a treatment focused directly on perseverative errors (confrontational) and second, a treatment focused directly on language recovery without focus on perseverative responses (non-confrontational approach). Currently, there is no consensus on whether a confrontational or non-confrontational approach is most effective for eradicating recurrent perseveration. It is logical for clinicians to gravitate towards the non-confrontational approach because it is consistent with a parsimonious treatment that not only minimizes perseveration errors, but also supports language recovery. Furthermore, the non-confrontational treatment avoids placing the client in the unpleasant cognitive state of having to do battle with automata.

To the author's knowledge, there is no study in the aphasia literature that has directly examined the effects of a non-confrontational picture naming intervention among persons with fluent aphasia on not only their naming accuracy and perseveration error frequency, but also on the performance of other speech tasks. Specific speech tasks include single-word oral reading, single-word repetition, and propositional speech. Despite the potential to uncover a measure of speech recovery and some of the recondite causes of perseverations, the systematic study of the relationship between the anticipatory proportion (anticipation errors/anticipation + perseverative errors) and the performance on expressive language tasks after intervention has also been

slighted. Therefore it is valid to collect data on a motivated hypothesis to examine the effects of a non-confrontational intervention on (a) picture naming ability, (b) perseveration and anticipation error frequency, and on (c) other dimensions of favorable outcome (e.g., improvement in other tasks such as propositional speech, oral reading, and repetition).

The goal of this investigation is to add evidence to the efficacy of a non-confrontational picture naming intervention for individuals with moderate fluent aphasia and verbal recurrent perseveration errors by accomplishing three specific aims.

1.2 Specific Aims

- Specific aim 1: Determine the difference in picture naming ability among participants with fluent aphasia and verbal recurrent perseveration before a non-confrontational picture naming intervention, while participating the intervention, during withdrawal, and during re-intervention.
- Specific aim 2: Determine the difference in picture naming ability among participants with fluent aphasia and verbal recurrent perseveration errors before a non-confrontational picture naming intervention, after participating in the intervention, during withdrawal, and after re-intervention.
- Specific aim 3: Determine the difference in three performance measures of repetition, oral reading and picture description among participants with fluent aphasia. We will also determine the number of verbal recurrent perseveration errors. These counts will be taken before the non-confrontational picture naming intervention, post-intervention, during withdrawal, and after re-intervention.

1.3 Research Hypotheses

Based on the three specific aims, five experimental hypotheses were generated.

- Hypothesis 1: Three participants with moderate fluent aphasia that receive a non-confrontational picture naming intervention will demonstrate significantly greater percentage of correctly named items, an increase in number of words per minute, a decrease in number of segmental and whole-word perseverations, and an increase in anticipatory errors during picture naming responses than before the intervention.
- Hypothesis 2: After participation in a non-confrontational picture naming intervention, the participants with moderate fluent aphasia will demonstrate significantly greater percentage of correctly named items, an increase in number of words per minute, a decrease in number of segmental and whole-word perseveration errors, and an increase in anticipatory errors during picture naming responses than before the intervention and during the withdrawal period.
- Hypothesis 3: The non-confrontational picture naming intervention will have a positive lasting effect on the percentage of correctly repeated items, number of words per minute, and AP during repetition responses among participants with moderate fluent aphasia. Performance will be compared to their repetition ability before the intervention and during withdrawal.
- Hypothesis 4: The non-confrontational picture naming intervention will have a positive lasting effect on the percentage of correctly orally-read items, number of words per minute, and AP during oral reading responses among participants with moderate fluent aphasia. Again, this will be compared to oral reading ability before the intervention and during withdrawal.
- Hypothesis 5: The non-confrontational picture naming intervention will have a positive lasting effect on the words per minute, and increase in the proportion of anticipation errors, a decrease in perseveration errors, and increase in percentage of correct information units

during picture description responses among participants with moderate fluent aphasia. This will be compared to performance before the intervention and during withdrawal.

CHAPTER 2
REVIEW OF THE LITERATURE

2.1 Speech Errors

Unintended deviations from the speech plan have taken on great significance in theories of language production for what they reveal about the mental processes involved in speech planning and production (Dell, 1986; Lashley, 1951; MacKay, 1987). Speech errors can be categorized in terms of the size of the linguistic units involved and the nature of the error itself (Dell, Burger, & Svec, 1997). Linguistic units of all sizes can slip, within the confines of articulatory gestures to domains of whole clauses (Mowrey & MacKay, 1990). The most commonly collected errors involve units that correspond to phonemes, words, or morphemes (Dell et al., 1997). The nature of the disturbances refers to whether errors involve the intrusion of linguistic material from outside the utterance, which are referred to as noncontextual errors from "plan external" sources. Contextual errors, derived from "plan internal sources" include anticipations, perseverations, and exchanges (Cutler, 1981; Dell et al., 1997; Fromkin, 1971; Garrett, 1980a; Stemberger, 1985). Speech generated by patients with aphasia is reported to contain a low incidence of exchange errors in comparison to perseverations and anticipations (Pate, Saffran, & Martin, 1987; Schwartz et al., 1994; Talo, 1980). Data further suggest that an error-prone language-production system is inherently perseveratory, while a relatively error-free system tends to err, when it does, by anticipating (Dell et al., 1997). Schwartz and colleagues (1994) distinguished between a "good" error pattern in which errors were less likely and mostly anticipatory, and a "bad" pattern characterized by more errors overall and by the existence of increased error rates of perseverations relative to anticipations. Although the focus of this review will be primarily on perseverative errors, we must also examine features and implications of anticipatory errors to fully describe the recovery of spoken language in persons with aphasia.

Therefore, general aspects, common features and implication(s) of both anticipation and perseveration errors are briefly reviewed.

2.2 Anticipations and Perseverations

Anticipations may involve replacement of a word or sound by one that was planned in the message but intended to occur later in the utterance [e.g., cup of coffee→ cuff of coffee; (Fromkin, 1971)]. For an anticipation to occur, vulnerability of the current target word must co-occur with primed activation of a planned future utterance. The anticipation error may involve an entire planned response, with single, or multiple phonemes, and a word that planned material. Perseverations, in contrast, consist of the inappropriate carryover of a preceding production when a planned production is expected. A typical for example would be, "beef noodle"→ "beef needle" where the /i/ is carried over from /b i f/ and substitutes for the /u/ of /n u d l/ (Cohen & Dehaene, 1998; Fromkin, 1971). Santo-Pietro and Rigrodsky (1982) labeled perseverative errors of an entire response as total perseverative errors. An example of total perseveration would be, during the following picture naming task a subject was presented pictures of "chisel, axe, writing, and juggling" → "chisel, axe, writing, chiseling" where the entire word "chisel" is carried over and substituted for the "juggle." Errors of single or multiple phonemes may be blended perseverative errors if they coalesce with another word to be produced as in the previous example of "beef noodle"→ "beef needle." These terms will be referred to as such throughout this dissertation.

Anticipation and perseveration errors and their targets at the phonological level usually involve similar sounds from similar word categories and syllable positions. The resulting errors are typically phonologically well formed. That is, 'all honor the specific segment-ordering

conventions of the language' [Garrett, 1984, p. 190]. According to Dell's (1986) model, contextual errors occur by virtue of the overlapping fashion in which phonemes are retrieved. After a given target word is selected, it is subsequently plausible that for any one of its phonemes, some other phoneme may be active, usually because of shared features or shared adjacent contexts [what Dell has called "the repeated phoneme" effect, (Dell, 1984)]. Contextual errors arise when a non-planned phoneme activated is erroneously selected.

2.3 Proximity and Continuity

Related to the repeated phoneme effect, a tendency for both anticipation and perseverative errors to obey a 'proximity assumption' has been observed (Garrett, 1980a; 1980b; Goldmann et al., 2001; Schwartz et al., 1994). The 'proximity assumption' argues:

> "For noncontextual errors, the nearest instance of the phoneme(s) comprising the error is not a source, but a random occurrence. The distance between the error and this matching segment should not be shorter than the average distance between successive appearances of the segment in the speech sample from which it is drawn. If the error is contextual (e.g., anticipation and perseveration), the nearest instance of the phoneme(s) comprising the error is a likely source and thus should occur closer to the error than expected by chance in that speech sample" (Goldmann et al., 2001 p.290).

In summary, according to the 'proximity assumption,' contextual errors are likely to have nearby sources for the error whereas noncontextual errors have more recondite sources.

The 'proximity assumption' is well supported by studies of "normal slips-of –the-tongue" (Garrett, 1980a; 1980b; Schwartz et al., 1994). For example, in the Schwartz and colleagues (1994) reanalysis of the London-Lund corpus, 63% of contextual sound errors had sources to the right in the adjacent open class word which suggested errors were anticipatory. The proximity

assumption was also supported in Goldmann and colleagues' (2001) study of contextual speech errors among subjects with aphasia. Analysis of phonological anticipatory and perseveratory errors elicited by a subject with Wernicke's aphasia who demonstrated anticipatory source-error distances were significantly shorter than chance baselines. However, generalization of the results from the studies is limited because specific distances from source-error (e.g., temporal or number of trials) vary across studies.

Data suggest that a compromised language-production system, for whatever reason, is inherently perseveratory. A less compromised system, when it errors, tends to "look ahead" for its error (Dell et al., 1997b). Accordingly, Dell and colleagues (1997b) propose that speech errors rest on a continuum. The '*continuity hypothesis*' proposed by Dell and colleagues (1997b) indicates that the non-transient aphasic malfunctions of speech production processes share certain key characteristics with transient malfunctions we call "slips-of-the-tongue" in non-pathologically involved speakers. Thus, the continuity hypothesis crucially proposes a connection between health and disease. It is therefore logical and imperative to examine the relationship between the two types of errors in order to quantify language recovery from disease (e.g., aphasia, or any other situation in which the human language system is compromised).

2.4 Anticipatory Proportion

An anticipatory proportion [AP] or anticipation ratio allows researchers and clinicians to compare the extent to which errors are anticipatory or perseverative (Dell et al., 1997; Garnham et al., 1981). The AP equals the number of anticipations divided by the sum of anticipation and perseverations, AP= A/A+ P (Dell et al., 1997). Dell and colleagues (1997) proposed that the observed high anticipatory ratio in spontaneous speech slips-of-the-tongue in normality suggests that they are indicative of the relatively intact language system in a healthy adult. And,

consequently, a lower AP suggests a developing language system of a young child (Stemberger, 1989) or one that is deprived by brain damage of its normal input (e.g., adult with aphasia). The disrupted modality has often been referred to as "*deafferented.*" Cohen and Dehaene (1998) argue that verbal perseverative behavior is the result of "a given processing level being deprived of its normal input [or *deafferented*]," that is, "persistent activity inherited from previous trials is no longer overcome by current input, and is revealed in the form of perseverations" (p. 1941).

2.5 Frequency of Recurrent Perseveration

Healthy participants make an average of 4% perseverative responses on the same neuropsychological measures (Ramage, Bayles, Helm-Estabrooks, & Cruz, 1999). In addition, recent studies have demonstrated a relatively high perseveration rate as well in healthy participants and in patients with aphasia who are experimentally presented with specific stimulus items that bias competition towards previous responses rather than towards new targets (Corbett, Jefferies, & Ralph, 2008). Depending upon the study, the percentage of patients with aphasia who have demonstrated recurrent perseverative behavior on neuropsychological measures such as the Wisconsin Card Sorting Test, have ranged between 50% (Basso, 2004) to 93% (Helm-Estabrooks, Emery, & Martin, 1987; Santo Pietro & Ridrodsky, 1986; Yamadori, 1981). Several stimulus manipulations (also referred to as "intrinsic stimulus factors") have been studied. These include stimulus modality (Helm-Estabrooks Ramage, Bayles, & Cruz, 1998; Moses, Nickels, & Sheard, 2004), speed of presentation (Dell et al., 1997; Martin & Dell, 2004; Vitkovitch & Humphreys, 1991), target frequency (Dell et al., 1997; Schwartz et al., 1994), semantic relatedness (Hirsh, 1998), and stimulus repetition (Gotts, Incisa della Rocchetta, & Cipolotti, 2002). What follows is a summary of investigations that have investigated the different types of

stimulus conditions that increase recurrent perseverative frequency in both healthy adults and those with aphasia.

According to Corbett and colleagues (2008) the likelihood of producing a perseverative error depends on how tightly the stimulus specifies the response. Picture naming is more vulnerable to error than repetition or reading (Moses et al., 2004); Santo Pietro & Ridrodsky, 1982). Data support the assumption that confrontation naming tasks elicit the greatest number of recurrent perseverations when compared to repetition and reading (Corbett et al., 2008; Helm-Estabrooks Ramage, Bayles, & Cruz, 1998; Moses et al., 2004), the caveat of cross-stimulus phenomena notwithstanding. Moses and colleagues (2004) proposed that a higher perseveration rate during picture naming could be explained by the dependence of picture naming on semantic memory, a source of response ambiguity. If the patient perseverates on trials in which the input only weakly stimulates the target response, (s) he should also show this limitation for propositional speech and naming over repetition and reading. For example, during picture naming phonological output is achieved via semantics resulting in the activation of a number of semantically related items that compete with the target. In contrast during repetition and reading tasks, the target phonology is more precisely specified by the spoken/written verbal input which in turn reduces perseverative error (Corbett et al., 2008; Moses et al., 2004).

Rate of speech affects the time between units in a speech sequence (e.g., words in a sentence), and therefore reduces the time between a current target word and a potential intruder from the past (Martin & Dell, 2004). Studies have indicated that errors increase as speech rate increases, with perseverations increasing relative to anticipations. Dell and colleagues (1997) asked unimpaired subjects to produce complex tongue twister phrases (e.g., Chef's sooty shoe soles) and varied the speech rate which the phrases were produced. Using the AP as a measure,

they found that anticipation errors were significantly greater at slow rates than at fast rates. Vitkovitch and Humphreys (1991) used a speeded picture-naming task to induce naming errors in normal speakers. They reported increasing the pace of this task increased rates of semantic errors. Analysis of the types of errors indicated many were perseverations from previous trials. Pacing speed interacted with frequency, with more perseverations on low-frequency targets.

According to connectionist models, connections that mediate activation and priming are learned (Dell et al., 1997). Therefore, lack of familiarity with a sequence of sounds or words (e.g., low frequency targets) would be associated with weaker connection strengths and would be labeled as "bad" patterns (Schwartz, Saffran, Bloch, & Dell, 1994). Moreover, learning a sequence involves the strengthening of connections between plans and their elements. Hence, practice would enhance the capacity to activate the present and the future. Errors in these conditions will be anticipatory, which are considered "good" errors or what Schwartz and colleagues (1994) refer to as errors with a "good" pattern. Strengthening connections with practice should result in a shift in error pattern (i.e., anticipatory proportion should increase with practice). On the other hand, practice does not have much effect on post-activation decay rates because the deactivation of the past and normal return rates to resting states in the model are not achieved through practice (Dell et al., 1997). Therefore, practice may temporarily enhance malfunction of the deafferented system and not the rates at which activated items return to their resting states (Dell et al., 1997).

Schwartz and colleagues (1994) and Dell and colleagues (1997) examined errors produced by normal speakers reciting tongue twisters before and after practice. Baseline data (e.g., before practice) indicated speaking tongue twisters at a normal rate resulted in numerous errors and a disproportionate rate of perseverations. After practice, the number of errors

decreased and the predominant type of error shifted from perseverative to anticipatory. This phenomenon was termed the "anticipatory practice" effect (Dell et al., 1997). Dell and colleagues (1997) demonstrated both rate and practice had powerful effects not only on the AP but also on the overall error rate.

Perseverations in healthy subjects and patients with aphasia are often semantically related to the target (Hirsh, 1998; Vitkovitch and Humphreys, 1991). Martin and colleagues (1998) argued that semantic representations of previously selected words decay slower than their phonological representations. Consequently, when a current target utterance shares semantic and phonological features with a prior utterance or simply its semantic features, the propensity of that feature overlap eliciting a substitution error will last longer than if the two shared only phonological features. The pattern of interaction observed between feature overlap of target and error and the temporal distance (e.g., lag) is a classic representation of the basic computations of the word processing system (Martin, Roach, Brecher, & Lowery, 1998). In production, the semantic features of a word to be produced are accessed first. They accumulate more activation than the phonological features, which are primed later. And, as just noted, they decay more slowly after post-selection inhibition. It follows then that semantic features assume a higher probability of intruding as a perseveration (Martin et al., 1998).

Gotts and colleagues (2002) reported perseverative rate increases when stimuli are repeated. When an item is presented several times, its residual activity increases. In turn, the target is not only easy to respond to but the item will override weakly activated targets, resulting in a perseverative response (Corbett et al., 2008; Gotts et al., 2002). This suggestion is supported by the observation of *repetition priming*, which is defined as a faster identification following one or more stimulus repetitions (Ostergaard, 1998).

In summary, with repetition priming aside, recurrent perseverations at the sound and word level are governed by the same constraints as substitution errors (Martin & Dell, 2004). Perseveration is highly likely when stimulus manipulations bias competition towards previous responses. On the other hand, it is natural that when stimulus manipulations bias competing plans towards new target words perseveration is not likely (Corbett et al., 2008). Finally, we note that, a high perseveration rate occurs not only with appropriate stimulus manipulations, but also with brain damage. In aphasia, the frequency of perseveration does not differ between fluent and nonfluent subjects (Basso, 2004; Helm-Estabrooks et al., 1987). Also, patients with global aphasia and stereotyped speech produce perseverations; however, these were less varied than seen in fluent aphasia (Basso, 2004). Moreover, patients with fluent aphasia from left temporoparietal damage typically demonstrate recurrent perseveration in the modality or modalities that are compromised (deafferented) by brain damage (Papagno & Basso, 1996; Basso, 2004; Sandson & Albert, 1987). The theoretical assumption that patients will only perseverate at input-output testing domains affected by lesions and will not perseverate at all in unaffected domains, makes it difficult to ever argue for some primary, overall perseveration deficit. Or, put another way, an overall disruption of inhibition is not something one would expect. See Schwartz and Dell (2011) for recent remarks on this generalization.

2.6 Theoretical Origins of Perseverative Errors

There are studies that strongly suggest that perseverative errors are due to a primary failure to inhibit activation. Post activation strengths were overly high and failed to be inhibited from re-occurring. By saying this, it is usually claimed that the post activated item is slowed up from its return to its resting state. In addition, the "failure to inhibit" was never crucially

restricted to language impairments in aphasia (Goldstein, 1948; Helm-Estabrooks et al., 1987; Santo-Pietro & Rigrodsky, 1986).

Other research, however, indicates that perseverative errors are the consequences of underlying break down of language processing, a "deafferentation" of certain input-output interfaces in different modalities (Basso, 2004; Cohen & Dehaene, 1998; Dell, 1986; Dell, Burger, & Svec, 1997; Martin & Dell, 2004; Martin, Roach, Brecher, & Lowery, 1998). This theory accords with earlier observations that perseveration was more of a warning sign that there was pathology somewhere. Perseveration was thought to be a harbinger indicating something was wrong. It was a manifestation of an underlying dysfunction. Many investigators have proposed that altered neuropharmacological homeostasis is brought about by neurological insult, and that therein lies the underlying cause of deafferentation (Fuld, Katzman, Davies, & Terry, 1982; Gotts & Plaut, 2002; McNamara, & Albert, 2004; Sandson & Albert, 1987). The first theory places the focus directly upon the perseveration s a failure to inhibit intrusion, while the second concentrates instead upon the areas of the input-output disruption.

The type of perseveration produced also reflected the level of language impairment. For example, total (whole word) perseverations occurred with impaired lexical retrieval and blended perseverations with phonological impairment (Cohen & Dehaene, 1998). Studies of error patterns in aphasia indicate a correspondence between locus of impairment and the type of error that dominates an error pattern (Martin & Dell, 2004). Papagno and Basso (1996) reported that perseveration was confined to the subject's impaired modality. Perseveration was only present in the disrupted modality, where a subject could not elicit correct responses. For example, according to the language-processing model for single words (Patterson & Shewell, 1987), there are four main stages involved in retrieving words from the semantic system (as in picture naming) including the semantic system, the phonological output lexicon, phonological assembly,

and articulatory programming. Any one or a combination of these modalities can become disrupted with brain damage, and hence, influence the rate of verbal recurrent perseveration. According to cognitive neuropsychological literature, failure to inhibit is less likely to account for the types of perseveratory errors detected in aphasics than the deaffrentation theory.

Foygel and Dell (2000) proposed a computational model explaining the second account of perseveration. In that study, the authors fit the computational model to naming error patterns by reducing connection weights 1) between semantic features and lexical nodes or 2) between lexical nodes and phonological nodes, or 3) both. With weakened connections between the semantic level and the lexical level, the model predicted more whole-word substitutions (e.g., apple→ orange; apple→ ankle) than phonological segment errors (apple→/æpɛt/). When connection weight values between the lexical level and the phonological level are reduced, the model predicts a higher rate of phonological error and fewer whole-word substitutions. These predictions about phonemic and lexical substitutions can be extended to patterns of sound versus whole-word perseverations (Martin & Dell, 2004). If impairment from aphasia affects connections (e.g., deafferentation) from semantic to lexical representations, word level perseverations should dominate. If the deafferentation affects connections between lexical and phonological representations, phonological perseverations should dominate (Martin & Dell, 2004). It remains to be seen if within stimulus ranges or cross stimulus transitions produce more full word perseverations or phonemic perseverations. The architectures of connectionist models will also have to consider any possible biasing of the context of responding. Scene descriptions and other kinds of spontaneous language production will also have to be evaluated for any sample biasing effect for segmental or full word perseverative responses.

Studies generally support the connectionist hypothesis that posits deafferentation as the primary source of recurrent perseverations. They have not supported abnormal decay nor inhibition breakdowns. The predominant influence is the deafferented system or systems (Gotts & Plaut, 2004; Plaut & Shallice, 1993). Furthermore, an increase in decay resistance of a previous response occurs particularly when a new stimulus is coincidentally related to the post-activated competition semantically, visually, or both. Here, the very nature of the stimulus reactivates the previous target production, which simply does not "turn off," when that new current stimulus is presented (Plaut & Shallice, 1993; Dell, 1986). According to Gotts and Plaut (2004), another reason speakers may produce perseverations on the immediately proceeding response, is that they are unable to exit from a previously resulting attractor state due to the weakness of the new input. In connectionist terminology, each new stimulus must have enough power (the requisite weight value) to drive out or otherwise eliminate the previous state and to create a new one. However, if a particular perseveration was linked to each response, then it would not meet the definition of 'recurrent' perseveration, since most definitions of "recurrent" allow, and in fact require, some intervening responses that are correct.

Cohen and Dehaene (1998) demonstrated that if some feature of a stimulus has not made its way into the patient's response, it does not contribute to subsequent or recurrent perseverations. Furthermore and very importantly, the probability that an error would be a perseveration from a previous trial is an exponentially decreasing function of the number of trials after the trial in which the perseverate actually occurred. Their study utilized a maximum lag of 15 intervening trials. After that point, if a form produced happened to look just like the earlier perseverate, the probability that it was actually the same perseverate linked to the earlier productions cannot be reliably estimated. Cohen and Dehaene argue accordingly that

perseverations obey a 'proximity assumption' over longer lags. Furthermore, it is simply not the nature of anticipation transpositions to occur out of a response to a future stimulus. This assumption is supported by Buckingham (1985) who proposed perseverations may operate over a longer window than anticipations. In agreement with Dell and colleagues' model (1997), Cohen and Dehaene (1998) propose that an exponentially decaying internal variable is responsible for the recurrence of perseveration in the deafferented modality.

In summary, current research suggests that perseverative errors are dependent on specific language-processing breakdown and not to some primary and overall disruption in inhibition. In this sense, the perseveration is indicating a breakdown somewhere in the system. That is, it adumbrates some pathologically caused deafferentation (Basso, 2004; Cohen & Dehaene, 1998; Moses et al., 2007). Specifically, Moses and colleagues (2007) suggested

> "…different types of perseverative errors are influenced by the processing demands of language tasks, relative to an individual's language-processing breakdown. Hence, all total and blended perseverative errors must be included in any comprehensive analysis of perseverative errors"(p. 996).

Total and blended perseverative errors were defined by Santo-Pietro and Ridrodsky (1982) as the reproduction of an entire response or a single or multiple phonemes from an earlier response, respectively. Connectionist and cognitive neuropsychological theoretical models may provide useful insight not only to the assessment of patients with aphasia and recurrent perseverations, but also to intervention planning.

2.7 Intervention for Recurrent Perseveration

As a result of the theoretical divide of the origin of perseveration, two disparate behavioral treatment methods exist. One method is a direct confrontation of perseveration error when it occurs, the Treatment of Aphasia Perseveration (TAP). The other utilizes typical cognitive neuropsychological protocols directed at identifying and treating specific language processing domains disrupted from the damage (e.g., stroke), without regard to the patient's perseveration (Basso, 2003). Exploratory research has demonstrated that both behavioral treatments engendered a decrease of the frequency of recurrent perseverative responses (Helm-Estabrooks et al., 1987; Basso, 1993; 2003; 2004). Currently, no series comparing the efficacy of a confrontational or a non-confrontational treatment approach has been established.

The treatment goal of the TAP (Treating Aphasic Perseveration) program (Helm-Estabrooks et al., 1987) is to increase naming scores and decrease perseveration scores on the treatment items as well as to generalize to items of the BDAE Confrontation Naming subtest. The TAP treatment approach involves manipulation of extrinsic environmental constraints (e.g., various cueing strategies) and teaching the patient strategies to actively and purposely inhibit perseverative responses before they happen to the subject. Implementing cues such as phonemic, whole-word, and sentence contexts to improve spoken word production among patients with specific underlying language processing deficits is certainly not a new concept in aphasia research (Hills, 1989; Hills & Caramazza, 1994; Miceli et al., 1996; Nettleton & Lesser, 1991; Spencer et al., 2000). However, including strategies in therapy to volitionally confront perseverative responses set forth is a novel concept by Helm-Estabrooks and colleagues (1987). Utilizing a single-case study and a multiple baseline design with three patients with aphasia, Helm-Estabrooks and colleagues (1987) demonstrated TAP to be more effective than other

treatments for repetition of single words, semantic associations, and picture descriptions. And, in so doing, the authors reduced the percentage of perseverations on the BDAE Confrontation Naming subtest. Results indicated that subsequent to TAP sessions, participants significantly improved their scores on the BDAE Visual Confrontation Naming subtest in comparison to the other treatments. There was one exception. A participant with conduction aphasia was presented with an alternative therapy (in addition to TAP) that consisted of work with single words, semantic associations, and picture descriptions. Improvement in the Confrontation Naming was nearly comparable for confrontation and non-confrontation treatments.

However, one should exercise caution when interpreting the reported TAP improvements since the authors relied on visual analysis rather than statistical analysis to examine naming accuracy and perseveration rate. In addition, testing the TAP's effectiveness would be difficult, since the specific cueing strategies that improved picture naming varied across treatment sessions and participants, and they were not specified in the study. Thus, the limited details of the intervention present a hindrance to replication of the study. Moreover, with an alternating treatment design, such as the one utilized by Helm-Estabrooks and colleagues (1987), it is difficult to rule out carry-over effects from one treatment to another (Thompson, 2006). It would be unreasonable to expect the effect of aphasia treatment to wash out between experimental periods and undesirable if it occurred. Robey, Schultz, Crawford, and Sinner (1999) suggested:

> "……. two treatments applied to one person cannot be compared on the basis of a common baseline of performance unaltered by treatment. Moreover, it is unreasonable to expect the effects of treatments to be linearly additive, that is, one cannot expect that if treatment_1 brings about *a* units of change, and treatment_2 brings about *b* units of change, administering treatment_1 and then treatment_2 would yield a total magnitude of *a* plus *b*

units of change. As a result, direct comparisons of two treatments administered to the same subject or subjects often yield ambiguous findings. The most direct solution is to test one treatment per subject" (p.449).

Contrary to the TAP philosophy, data has suggested that patients demonstrate a post-articulatory monitoring or awareness of the perseveration after it happens to them. They react negatively and become frustrated, realizing it is wrong. On the contrary, pre-articulatory editing capability seems extremely difficult to train. There was no evidence that any conscious inhibition was able to block recurrent perseveration before it happened (Papagno & Basso; 1996; Buckingham, 2007; also see Levelt (1989) for some discussion of pre-and post-articulatory editing in ongoing speech, p. 466-70). Dell and colleagues (1997) defended the automaticity assumption in their serial-order computational model. According to the model (Dell et al., 1997), learning a sequence of units (e.g., sounds or words) entails the strengthening of connections from a plan to its elements. A plan for sequencing the sounds of a word, for example, would be the word form and the sounds would be the elements. Connections between a plan and its elements are excitatory. A second feature of their model is its ability to activate not only the present but also the future connections needed for upcoming elements (priming function). A third component needed for successful serial ordering of elements is the "turning off" of the immediately past activated elements. This has also been referred to as a decay function. The "turn off" function is presumed to be inherent in the system and is not learned in the way activation of present and future connections are learned (Dell et al., 1997; Martin & Dell, 2004). In accordance with the serial-order model, the balance between an automatic deactivation of past and learned activation of present and future should predict accurate or anticipatory responses. Therefore, if we are to support the connectionist and cognitive

neuropsychological account for perseveration, it is unlikely that we will have much success in training pre-articulatory control of ensuing perseverative infiltrations in on-line speech production, as suggested in the TAP.

A further study has demonstrated that perseverations emerged only where patients were unable to give a correct response due to specific functional damage in relation to a model of normal procession (Basso, 2004; Papagno & Basso, 1996). This suggests that perseverations do not unfold in the same neuropsychological settings for all patients with aphasia (Papagno & Basso, 1996). The perseverations should vary relative to a patient's language-processing breakdown. Basso's (2004) proposed treatment of perseveration is crafted around the specific deficits of the underlying functional damage, be it picture naming, repeating heard items, writing to oral dictation and so on. If effective, it would ipso facto abolish perseveration without treating it directly. Basso's (2004) non-confrontational treatment approach is supported by the connectionist modeling of perseveration (Gotts and Plaut, 2004). Where the simulation of deafferentation brought forth recurrent perseveration, and when connection weights were numerically increased in the affected input-output domain, the perseveration was accordingly abolished.

Case studies presented by Basso (1993; 2004) supported the more conventional non-confrontational intervention approach. Patients dedicated approximately one hour daily to therapy tasks, either with a speech pathologist or a trained family member, for various durations (e.g., 5 months and up to two years). Results indicated a decline in the severity of aphasia and an almost complete eradication of perseverative errors, with no management at all of the perseverations in terms of pre-articulatory training to catch and either to correct or to avoid the articulation of a perseverate all together. Daily living improvement, as defined by ability to

sustain a conversation, was also reported (Basso, 1993). However, the author reported the results of the case studies in the absence of statistical control over the measurement process. Therefore, the efficacy of Basso's proposed non-confrontational intervention remains statistically unsubstantiated.

In summary, these two intervention approaches are disparate, yet each achieved similar results in small series of patients without sophisticated statistical analyses. Specifically, each decreased the frequency of perseverative errors. Research addressing the issue of how to decide which therapeutic approach to adopt with a client that demonstrates fluent aphasia and recurrent perseveration errors is needed in the aphasia rehabilitation literature (Basso, 2004). According to *a priori* assertions, a non-confrontational intervention for eradication of recurrent perseveration is more parsimonious than a confrontational intervention.

CHAPTER 3
DESIGN AND METHODS

3.1 Design

This is a prospective single-subject ABAB multiple baseline design replicated across 3 right-handed individuals with moderate fluent aphasia subsequent to left hemisphere ischemic strokes to answer the study's 2 experimental questions : 1) Is there a significant difference in picture naming ability among participants with fluent aphasia and verbal recurrent perseveration before a non-confrontational picture naming intervention, while participating in the intervention, after participating, during withdrawal, and during re-intervention? 2) Is there a significant difference in of repetition, oral reading, and picture description ability among the participants before the picture naming intervention, during the intervention, during the withdrawal, and during re-intervention? Dependent measures included percentage of correctly named words, repeated words, and orally read items, number of words per minute, number of segmental and whole-word perseverations, number of anticipatory errors, anticipatory proportion, and percentage of correct information units for the picture description task.

The picture naming, word repetition, oral reading, and the Cookie Theft Picture description probes were administered for 8 baseline sessions for all 3 participants. The non-confrontational intervention for improving naming ability included 10 treatment pictures and phonemic and/or semantic cueing. The participants received the same 3 cueing strategies in random order. Stimulus items were selected from incorrect responses elicited during the 60-item naming task presented during the study eligibility screening. The frequency and duration of the non-confrontational picture naming intervention consisted of two 45-minute sessions per week for four weeks, for a total of eight sessions. Treatment was administered by an SLP, who was also the investigator, in each participant's home. Four sessions were completed during B1 and 4

sessions were completed during B2. A withdrawal phase consisting of 4 sessions (45 min twice a week for two weeks) intercepted the intervention phases. The probes were administered at least 5 min after the picture naming intervention during each intervention session with 5 minute resting intervals between each probe. Order of treatment stimuli and probe presentation was also randomized.

3.2 Participants

- Participant Recruitment Procedures

We used 3 participants in this study recruited from past and current caseloads of neurology and speech-language pathology clinics in the New Orleans metropolitan area. The investigator distributed printed information approved in IRB (#3101 and #10-174165) to physicians and speech-language pathologists of various clinics within New Orleans. Laminated index cards (4'' X 6'') publicized a brief description of the purpose of the study, participant inclusion and exclusion criteria, and a prepared script to refer to when approaching potential participants for the study was provided. 4 X 6 sized index cards were selected to publicize information. They are portable, easily stowed in lab coat pockets and durable. See Appendix A for the printed script. The physician or speech-language pathologist approached potential participants initially. Subsequently, potential participants were asked to agree to release their names and contact information to the Co-Principal Investigator (Co-PI). Appropriate referrals were made to the Co-PI for this study, after which the Co-PI then contacted the participants directly, scheduled an appointment to obtain informed consent, performed the screening, and if appropriate, performed the study.

Three individuals with a lesion to the left hemisphere were recruited between July 2010 and August 2011 for a single-subject multiple baseline design allowing the researcher to isolate

and analyze mechanisms of change resulting from a specific therapy for the three individuals. The research protocol for this study was approved by the Louisiana State University's (#3101) and the Tulane Medical Center Institutional Review Board (#10-174165) to ensure protection of study participants. All potential participants participated in the informed consent process prior to data collection. The participants were community-dwelling volunteer at least six months post-onset of stroke and were recruited from East Jefferson General Hospital. See Table 3.1 for the participants' demographics.

Participants were excluded if they reported a history of neurologic, psychiatric, or language deficit other than those associated with the left hemispheric stroke. They were excluded if they were less than 18 or more than 89 years old, left-handed, non-community-dwelling, non- American English speaking, illiterate, unable to follow directions due to hearing loss, or severe uncorrected vision deficits. In addition, participants were excluded if they were less than six months post-onset or had less than nine years of education. Participants eligible for the study had a neurologist's diagnosis of stroke with the insult involving the left hemisphere. The diagnosis will be categorized by the pathology and etiology determined by computed tomography (CT) scan or Magnetic Resonance Imaging (MRI). Each participant had a National Institute of Health Stroke Scale (Brott et al., 1989) total score of 3-15 (see Table 3.2 for all items on the scale and specific ceiling scores for each category). Participants elicited full word and/or phonemic perseverations on $\geq$ 10% of the confrontation naming items as identified by a speech-language pathologist. Table 3.3 gives the complete listing of inclusion and exclusion criteria.

- Informed Consent

  The Co-PI obtained informed consent for all 3 participants using the procedures established in IRB# (3101 and 10-174165).

Table 3.1 Participant demographics

Participant number (n=3)	Gender	Age, years	Race	Handedness	Education (years)	Site of Lesion	Onset date of acquired neurological damage	Duration of aphasia (months)	NIHSS total score	WAB AQ	Type of Aphasia	Perseveration Frequency
1	M	69	C	R	12	L PCA	01/12/10	13	8	75.8	Fluent TCS	38
2	F	61	C	R	18	L MCA	07/25/10	9.5	3	69.0	Fluent CND	20
3	M	77	C	R	13	L MCA	09/23/10	7.5	3	62.0	Fluent CND	10

M=Male; F=Female; C=Caucasian, R=Right handed; L PCA= left posterior cerebral artery; L MCA=left middle cerebral artery; NIHSS Score = National Institute of Health Stroke Scale Total Score WAB AQ = Western Aphasia Battery Aphasia Quotient; TCS= transcortical sensory aphasia; CND= conduction aphasia

Table 3.2. National Institute of Health Stroke Scale Items and Inclusion Scores

Stroke Scale Item	Stroke Scale Category	Eligibility Cutoff Ranges
1a	Level of Consciousness	0
1b	Level of Consciousness Questions	0-2
1c	Level of Consciousness Commands	0-2
2	Best Gaze	0-1
3	Visual	0-1
4	Facial Palsy (Right side)	0-1
5a	Motor Arm Left Arm	0
5b	Motor Right Arm	0-2
6a	Motor Left Leg	0
6b	Motor Right Leg	0-1
7	Limb Ataxia	0
8	Sensory	0-1
9	Best Language	1-2
10	Dysarthria	0-1
11	Extinction and Inattention	0-1

From "Measurements of acute cerebral infarction: A clinical examination scale" by T. Brott , H. P. Adams, C. P. Olinger, J. R. Marler, W.G. Barsan, J. Biller, et al. 1989, *Stroke, 20*(7) p. 865. Copyright 1989 by American Heart Association.

The Co-PI received all of the required training in the proper procedures for obtaining informed consent and protecting the individual's health care information for both Health

Insurance Portability and Accountability Act (HIPPA) and National Institute of Health (NIH) compliance. The informed consent process included a thorough oral briefing of each potential subject, including all the elements of informed consent, especially a discussion of the potential loss of privacy. Each participant demonstrated full understanding of what he/she agreed to and had all questions answered. Signatures for consent forms and a HIPPA Authorization agreement were obtained. A copy of the signed consent form and HIPPA Authorization agreement was provided to each potential participant. Screening Measures

The Co-PI screened all participants. The screening battery included a review of medical records and rehabilitation reports to establish that visual acuity and perception were sufficient to allow for discrimination of pictures and line drawings. Self-reported hearing screening, a determination of handedness with a six-item survey, the *Western Aphasia Battery-Revised* (Bedside Form) [*WAB-R*] (Kertesz, 2006), and a confrontational naming task were administered. Handedness was determined by questioning the patient or relative about hand preference for six various tasks, with four out of the six items deciding handedness (Kertesz, 1979, p.56). See Appendix B for the list of questions. The *WAB-R* (Bedside Form) is a short form test derived from the *Western Aphasia Battery* (*WAB*). There are many benefits to short forms for neuropsychological tests. First, the healthcare climate often requires clinicians to streamline their batteries. Second, for patients who are severely impaired, full-length versions of tests may elicit excessive frustration and emotional distress (Fastenau, Denburg, & Mauer, 1998). Shewan and Kertesz (1980) described the reliability and validity characteristics of the *WAB*. In summary, the *WAB* demonstrated high internal consistency measures and high test-retest reliability which support the stability and the temporal reliability of the test. Inter- and intra-judge reliability was

very high, suggesting consistent scoring within and between scorers. The *WAB* satisfied face- and content-validity criteria.

Table 3.3. Inclusion/exclusion criteria for study participants

Inclusion Criteria	Exclusion Criteria
A neurologists' diagnosis of stroke with the insult involving the left hemisphere greater than 6 months ago.	A history of other neurological, psychiatric, or language impairments other than those associated with left hemisphere stroke
A National Institute of Health Stroke Scale [NIHSS] Total Score of 3-15[a]	A NIHSS Total Score greater than 15[a]
>8 years of education	Receiving speech-language therapy
Right-handed	<8 years of education
Displaying full word or phonemic perseverative speech errors during 10% or > of a picture naming sample as identified by a speech-language pathologist.	Left-handed or familial history (parents/siblings) of left handedness
A Western Aphasia Battery-Revised Bedside Form Aphasia Quotient < 93.8 [b]	Western Aphasia Battery-Revised Bedside Form Aphasia Quotient > 93.8[b]
Functional word reading skills	Unable to read functional words
Living in the community	Living in a long-term care facility.
Native English speaker	Non- American English speaking
Hearing acuity sufficient to follow directions	Severe uncorrected hearing loss
Visual acuity sufficient to read large print	Severe uncorrected vision deficits
18 to 89 years old	Less than 18 or more than 89 years old

[a] (Brott et al., 1989) [b](Kertesz, 2006)

Results from the *WAB* and the *Neurosensory Center Comprehensive Examination for Aphasia* (Spreen, & Benton, 1977) were highly correlated, indicating good construct validity.

WAB Aphasia Quotient [*WAB* AQ] scores and Raven's *Coloured Progressive Matrices* scores (Raven, 1965) significantly correlated, suggesting that the language portions of the *WAB* are not totally independent from nonverbal functioning. *WAB* AQ scores reliably differentiate between aphasic and control groups, with only a small overlap for high functioning anomic aphasic subjects. Participants demonstrated fluent aphasia classification (< 93.8) and a Moderate Severity Aphasia Rating Score (range of subjects' scores was 62-75.8) denoted by specific scoring criteria of the *WAB-R* (Kertesz, 2006).

During the picture naming task, the participants were presented 60 pictures with one picture stimuli at a time displayed as a Microsoft Office PowerPoint 2007 utilizing a Dell XPS M140 personal computer. Categories for the picture naming task were taken from the Naming in Categories subtest of the *Boston Diagnostic Aphasia Examination Third Edition* (Goodglass, Kaplan, & Barresi, 2001). The categories included colors, letters, actions, numbers, animals, and tools. The picture stimuli were black and white except the "color" items selected from a "clip-art" computer program. Participants were instructed to "Name the following pictures." The presentation pace was monitored with an imposed 5 sec time interval between presentation of stimulus and patient's verbal response. Although no strict time constraints were imposed to respond, if a response is not given after 20 seconds, an error was recorded and the subsequent stimulus was presented. The examiner provided no feedback regarding the accuracy or appropriateness of participants' responses, but did provide occasional conversation markers such as "uh-huh" and head nods allowing the speaker to continue. Eligible participants demonstrated whole word or phonemic perseveration errors on at least 10% or greater than 10% of the 60 items presented. Studies suggest that perseveration errors that are elicited greater than 7% of an individual's verbal responses indicated probable "disturbed brain function" (Allison, 1966, p.

1029). The Generative Naming and Verbal Definitions tasks of a study conducted by Ramage, Bayles, Helm-Estabrooks, and Cruz (1999) with normal subjects elicited relatively low rates of perseveration (approximately 1%); only recurrent perseveration was observed. Albert and Sanson (1986) and Bayles, Trosset, Tomoeda, Montgomery and Wilson (1993) reported comparable rates (2.1% and 1.8% respectively) of perseveration in normal controls on Generative Naming tasks. Therefore, subjects with a perseveration ratio of 10% or greater during confrontation naming task could be considered as demonstrating an "abnormal" or high rate of perseveration errors and may benefit from a behavioral intervention. Participants demonstrated whole word or phonemic perseveration errors on at least 10% of the 60 items presented during a picture naming task. Twenty items, including all items named incorrectly during the screening task, were extrapolated for use during the experimental phases for each participant.

If a participant failed any portion of the screening battery, participation in the study was discontinued. A list of all potential participants contacted as well as those who actually participated including those screened out was compiled. The list was kept by the researcher, coded to protect participant confidentiality, and stored in a secured site at Tulane Medical Center. A total of three subjects were enrolled and zero participants dropped out.

3.3 Materials

- Setting and Apparatus

All testing and intervention phases took place in a quiet room of the participants' choice either at the participant's home or at Tulane Medical Center. All three participants chose their home as the place for testing and intervention. The participant and Co-Principal Investigator (Co-PI) sat facing each other across a table that held a digital audio recorder and a Dell XPS

M140 personal computer. All participants' spoken responses to the stimuli were captured with a Dynex DX-28 headset noise-resistant microphone positioned 2 cm from the speaker's mouth and digitally recorded with a Sony ICD-UX71 recorder for subsequent transcription and analysis. Any phonemic and/or semantic cues delivered by the examiner were digitally recorded with a Sony ICD-UX71 recorder. Background noise was < 30dB- as measured by an American Recorder SPL-8810 sound pressure level meter throughout recording. The sound level meter was calibrated prior to each recording.

- Stimulus Materials

The 60 picture stimuli presented during the screening procedures were black and white except the "color" items selected from a "clip-art" computer program. The stimuli were presented as a Microsoft Office PowerPoint 2007 presentation utilizing a Dell XPS M140 personal computer. Letters and numbers were 72 point, bold Times New Roman print. The 20 pictures that were used during the experiment were extrapolated from the incorrectly named items during the confrontational naming task of 60 items. The incorrectly named items were chosen to evaluate if there would be a positive effect of the non-confrontational intervention on improving naming accuracy. The repetition stimuli were the names of the 20 pictures presented during the naming task. The 20 items were read to the participant by the Co-PI. The same 20 words were used in the reading aloud task with bold 72 point Times New Roman print. Reading aloud stimuli were presented as a Microsoft Office PowerPoint 2007 presentation utilizing a Dell XPS M140 personal computer.

Traditional aphasia assessment procedures typically use a single scene or action picture stimulus to elicit spontaneous speech samples from adults with aphasia (Goodglass & Kaplan, 1983; Kertesz, 1979). The Cookie Theft Picture is a black-and-white line drawing that has

previously been shown to elicit a descriptive monologue with relatively predictable content that requires little time to transcribe (Hux, Wallace, & Snell, 2008; Yorkston & Beukelman, 1980). Although describing a scene that communication partners are simultaneously viewing is not representative of most daily communicative interactions (Snow & Douglas, 2000), the limitations associated with picture descriptions must be outweighed by the benefits of relatively short transcription time; ease of elicitation, analysis, interpretation; and translation to treatment planning (Hux et al., 2008). Researchers have established a priori methods to analyze the accuracy and efficiency of discourse produced during the Cookie Theft picture descriptions (Hux et al., 2008; Nicholas, Olbler, Albert, & Helm-Estabrooks, 1985; Nicholas & Brookshire, 1993; 1995; Yorkston & Beukelman, 1980). In the present study, a standardized rule-based scoring system, the Correct Information Unit (CIU) analysis was used to evaluate the informativeness and efficiency of the connected speech of the participants in response to the Cookie Theft picture (Nicholas & Brookshire, 1993). See Appendix E for a fuller description of the CIU analysis.

3.4 Procedures

- Research Assistant Training

Connected speech data transcription and scoring of 50% of participants' responses were completed by a research assistant (RA) at Tulane Medical Center, who is a licensed speech-language pathologist blinded to the hypotheses. The RA received all of the required training in the proper procedures for protecting the individual's health care information for both HIPPA and NIH compliance. Prior to the initiation of data collection, the Co-PI presented an in-service training and written directions for the rigid transcription and scoring protocol to the RA at Tulane Medical Center. After participation in this in-service training and at any time during the study, the RA was allowed to ask the investigator questions.

- Identification of Stimuli

After successfully completing the screening process, the Co-PI selected twenty items that were named incorrectly during the 60 item picture naming examination. If the participant elicited less than twenty errors, all items named incorrectly and random items named correctly were included to sum to twenty. Ten of the twenty items were selected for picture naming intervention and the other ten were control items.

- Data Collection During Baseline, After Treatment, and During Treatment Withdrawal

Prior to the initiation of the experimental phases, a random order of the type of expressive task (i.e., picture naming, oral reading, word repetition, and picture description tasks) was established for each participant for each of the 20 sessions. Unique sets of random orders for presentation were obtained to control for task familiarity. The present investigator used the Research Randomizer (Urbaniak & Plous, 2011), a web-based random number generator. A random order for each of the items within each expressive task was obtained to control for listener familiarity using Research Randomizer (Urbaniak & Plous, 2011).

The investigator presented the four expressive tasks including picture naming, single-word oral reading, single-word repetition tasks, and the Cookie Theft picture description task from the *Boston Diagnostic Aphasia Examination* (Goodglass & Kaplan, 1983). These were presented during the baseline and withdrawal phases and after each intervention phase for a total of 20 sessions. A 5 min resting interval was imposed by the trained speech-language pathologist between tasks in order to minimize priming effects and the chance of perseverating from items in different tasks (Cohen &Dehaene, 1998; Moses, Sheard, & Nickels, 2007). Since we were investigating recurrent perseveration, we wanted to avoid as much as possible what is referred to as "stuck in set" perseveration, where items are perseverated across task types. Each participant

responded to all speech tasks in each of the 20 sessions. Responses were orthographically transcribed during each task and digitally recorded with a Sony ICD-UX71 Recorder for later orthographic transcription and analysis. For any segmental errors, we were careful to note the phonology of the derailments.

For the picture naming task the participants were presented with one picture stimuli at a time displayed as a Microsoft Office PowerPoint 2007 utilizing a Dell XPS M140 personal computer and instructed to "Name the following pictures." The presentation pace was always monitored with a 5 sec time interval between presentation of stimulus and patient's verbal response. Although no strict time constraints was imposed to respond to the tasks, if a response was not given after 20 seconds, an error was recorded as a "no response" and the subsequent stimulus was presented. The examiner provided no feedback regarding the accuracy or appropriateness of participants' responses, but did provide occasional conversational turns indicating that the speaker could and should continue "holding the floor" such as "uh-huh" and head nods. Often there is a paucity of data collected if the subject cannot "hold the floor" so to speak. We simply point out here that there are numerous pragmatic conversation rules that are inherent in clinical discourse with patients.

For the reading task, participants were presented with single words displayed as a Microsoft Office PowerPoint 2007 utilizing a Dell XPS M140 personal computer and instructed to "Read the following words." The examiner advanced the pictures during the PowerPoint presentation. Although no strict time constraints were imposed to respond to the tasks, if a response was not given after 20 seconds, an error was recorded and the subsequent stimulus was presented for both naming and reading aloud. Again, we point out that anticipatory errors can only logically accrue within the response to some one item. It makes no sense to expect an

anticipatory error, anticipating what one might respond with to an upcoming stimulus. The bias for perseveration in cross stimulus responses task is almost too obvious to mention.

For the repetition task, 20 items from the same subtest were presented auditorially by the examiner. Participants were instructed to "Repeat each word." The examiner's mouth was obscured to prevent lip reading. A single repetition by the examiner was given if requested. The examiner provided no feedback regarding the accuracy or appropriateness of participants' responses. Again, turn taking markers were provided such that the subject would continue holding the floor.

For the picture description task, the participants were presented with The Cookie Theft picture displayed as a Microsoft Office PowerPoint 2007 utilizing a Dell XPS M140 personal computer and instructed to "Tell me everything that is happening in this picture." The examiner responded only with encouragement to continue (e.g., "Anything else?") and natural conversational acknowledgments. A three minute time limit was imposed for this task. The examiner provided no feedback regarding the accuracy or appropriateness of participants' responses, but she did provide occasional verbal or facial approval for the subject to continue responding.

- Data Collection During Treatment

Each participant received two intervention phases (B1 and B2) with each phase consisting of 4 sessions over 2 weeks (total of 8 intervention sessions). The treatment schedule for all participants followed a standard-limited schedule equal to 2 treatment sessions per week for 4 weeks (2 hr per week for 1 month). There are three general classifications for defining treatment schedules for clients with chronic aphasia. These include: (1) standard-limited schedule equal to 2 hr per week for 6 months or less; (2) low-frequency-unlimited schedule of 1-

2 hours of group or individual treatment over a period of months, years, or many years with occasional breaks for various reasons; and (3) intensive schedule of 8.8 hr per week for 11 weeks (Bhogal, Teasell, & Speechley, 2003; Marshall, Block, & Pierson, 2009). The standard-limited schedule was chosen for this study because Raymer, Kohen, and Saffell (2006) reported that more frequent training (4-5 times per week) lead to greater improvements in picture naming performance during acquisition than a less frequent training schedule (1-2 times per week). However, that advantage diminished at one month post treatment. The researchers suggested that a less frequent training schedule may be just as useful as more frequent training for promoting long-term effects of lexical training. In addition, Marshall and colleagues (2009) reported the standard-limited treatment schedule turns out to be equivalent to the amount of treatment that is funded by most health insurance companies.

Treatment phases were conducted twice per week for two consecutive weeks. Each participant received two intervention phases (B1 and B2) each including 4 sessions over 2 weeks (total of 8 intervention sessions). Each of the eight intervention sessions began with an alternating treatment for naming pictures. The order of 16 unique sets of numbers for the treatment and control items was randomized in the same manner as with previous tasks. Half of the intervention sessions involved the treatment with the 10 treatment words and the other half of the session involved naming 10 control words. Again, the order of presentation was randomized Eight unique sets of numbers were obtained.

Prior to presenting each set of stimuli (treatment and control items), the experimenter alerted the participant to the condition with the phrase, "For the next 20 minutes I will be giving you feedback about your errors," and "For the next 20 minutes I will not be giving you feedback about your errors." The non-confrontational intervention for improving naming ability included

10 treatment pictures and phonemic and/or semantic cueing. During the non-confrontational intervention, the speech pathologist administered the 10 stimuli identified during the screening period. The participant was presented with one picture stimuli at a time displayed as a Microsoft Office PowerPoint 2007 utilizing a Dell XPS M140 personal computer. Additional sets extrapolated from the screening naming task were only administered if the participant correctly names 90% of the items from the initial set. The speech-language pathologist clearly established the task set before offering a new stimulus with the phrase, "Ready, I'm going to show you a new item." The presentation pace was always monitored with an imposed 5 sec time interval between presentation of stimulus and patient's verbal response. If a patient's response to a particular stimulus was immediately correct, a new item was presented after a 5 sec delay.

If the response was incorrect or not given within 5 sec, up to 3 auditory cues were administered to elicit correct, non-perseverative responses from the participants. The participants received the same 3 cueing strategies in random order. The Research Randomizer was used to obtain the 10 unique sets of numbers for each intervention session (Urbaniak & Plous, 2011). The cueing strategies included providing 1) an open-ended constraining sentence to elicit the target word (e.g., "You tell time with your….."), 2) a phonemic cue of the initial phoneme of the target word (e.g., "This is a / wa:_- /_____." if the item in this cloze test began with the labio-velar glide /w/ followed by an / a /), and 3) an auditory cue that was the same as the target item (e.g., "Say this word -watch"). Correct responses to cues were always followed by the question, "So what is this?" It was the response to this question that was scored. During each treatment session, we scored the percentage of correctly named 10 treated items, the number of items named per minute, and the AP.

After completing the treatment, each participant responded to picture naming task of treatment and control items, oral reading, word repetition, and picture description tasks. Random order of the four tasks was established prior to the intervention phase for each participant. The participants were given 5 minute resting intervals between tasks, to minimize priming effects and the chance of "stuck-in-set" perseveration (Cohen & Dehaene, 1998; Moses, Sheard, & Nickels, 2007).

- Scoring and Timing Procedures

The speech samples were scored by the Co-PI and a research assistant. To ensure that the two scorers would be consistent in their interpretation of the scoring rules, they first independently scored transcripts for 1 subject who was responding to the 5 eliciting stimuli during one session. Then they compared their scoring, discussed disagreements, and clarified misunderstandings. Following this initial scoring, the Co-PI scored all of the transcripts, except for 15 of the Cookie Theft Picture description transcripts; they were scored by the research assistant.

Errors for picture naming, repetition, and oral reading were coded on three levels.

1. Their relationship to the target (see Table 3.5).
2. Whether they were perseverative, anticipatory, or paradigmatic substitutions (non-sequential errors).
3. In case they were perseverative or anticipatory, were they total or blended (see Table 3.6).
4. Perseverative errors were scored over a lag of 15 responses matching to a prior response in a perseverative set or chain consistent with the procedures of Cohen and Dehaene (1998). The criteria for classification are presented in Table 3.6. Both "don't know" and "description" responses were coded as non-perseverative.

Table 3.4. Non-confrontational therapy for picture naming

Task	Spoken naming of picture set **Participant asked to name the picture; provided with cues if unable to**
Materials	1. 20 black and white line drawings of letters, numbers, colors, actions, animals, tools/implements. 20 items which the participant could not name (10 treatment and 10 control items). Baseline and treatment withdrawal measures of all items will be obtained over 12 sessions. Repeated measures will be obtained over 8 intervention sessions (during and after intervention). Task carried out until the participant named 90% of the items correctly. 2. "Cookie theft picture." Repeated measures will be obtained over 20 sessions (8 baseline, 4 treatment withdrawal, and 8 after each picture naming intervention). 3. 20 printed words. 10 words trained during naming task and 10 used as controls. Repeated measures will be obtained over 20 sessions (8 baseline, 4 treatment withdrawal, and 8 after each picture naming intervention). 4. 20 words for repeating. 10 words trained during naming task and 10 used as controls. Repeated measures will be obtained over 20 sessions (8 baseline, 4 treatment withdrawal and 8 after each picture naming intervention).
Phonemic and Semantic Cueing	1. Picture stimulus + What's this called? 2. Verbal open-ended constraining sentence 3. Phonemic cue of the initial phoneme of the target word 4. Verbal cue that will be the same as the target item *None for picture naming, repetition, oral reading, and picture description task after intervention
Feedback on error	Proceed through cues until naming response is successful. *No feedback for picture naming, repetition, oral reading, and picture description task after intervention
Feedback if correct	When correct without cues allow 5 sec interval between the next stimuli. If correct after cue, participant encouraged to then say the word but no feedback provided on spoken production. *No feedback for picture naming, repetition, oral reading, and picture description task after intervention

Subsequently, correct words were identified in each transcript, and the speech samples were timed. Time occupied by the examiner prompts, the imposed 5 sec interval between stimulus items, and time of participant commentary that preceded or followed their responses to the eliciting stimulus were subtracted from the overall time for each sample. Correct, incorrect, anticipation error, perseveration error, and time counts were used to calculate three measures: (1) percentage of correct responses: (during intervention: [number of correct responses/10] X 100; baseline, treatment withdrawal, and post-intervention: [number of correct responses/20] X100); (2) number of correct words per minute; and (3) AP ratio of treated and control words for picture naming, repetition, and oral reading: [AP= anticipation errors/anticipation + perseveration errors].

- Connected speech measures

Using the same scoring protocol for scoring single-word speech tasks, the correct, incorrect, anticipation error, and perseveration error counts were used to calculate the AP. Published rules to score words and correct information units (CIUs) were used (Nicholas & Brookshire, 1993). Rules are provided in Appendix E. After words and CIUs were identified in each transcript, the connected speech samples were timed. Time occupied by examiner prompts and by patient commentary preceding or following their responses to the Cookie Theft stimuli were subtracted from the overall time for each sample. Time, word, and CIU counts were used to calculate two measures: (1) words per minute, and (2) percent of words that were correct information units.

Table 3.5. Target-error coding criteria

Error	Description
Lexical (real word) errors	
Semantic	Real word that is semantically related to target
Formal	Single syllable: real word shares the initial phoneme and 1 phoneme of the rhyme. Two or more syllables: real word shares two phonemes of the rhyme.
Mixed	Real word that is both semantically and phonologically related to target
Unrelated	Real word that was not related to the target in any obvious way.
Non-lexical (non-word) errors	
Phonological	Non-word that shared either the initial phoneme or at least 50% of phonemes with target
Neologistic	Non-word sharing less than 50% of phonemes with the target and with a different initial phoneme Nonsensical combination of real words or non-word and real word
Other errors	
Don't know	Indication that response was unknown or if item is not responded to at all
Description	Attempts to describe as opposed to name item

From "Insights into recurrent perseverative errors in aphasia: A case series approach," by M. Moses, C. Sheard, L. Nickels, 2007, *Aphasiology*, *21*(10/11) p.981. Copyright 2007 by the Psychology Press. Adapted with permission of the publisher.

- Inter-rater reliability

To assess inter-rater reliability, the Co-PI and RA both independently scored a representative sample of the transcripts consisting of responses to each of the 4 speech tasks, picture naming, repetition, oral reading, and picture description from one session from one participant. Point-to-point inter-rater percent agreement for percentage of correct responses, perseveration errors, anticipation errors, and percentage of CIUs were calculated with the following formula: [total agreements/(total agreements + total disagreements)] x 100. Coding agreement was reviewed according to the coding criteria and independently recorded until a

minimum of 90% inter-rater agreement was reached. Table 3.7 provides a summary of the inter-rater percent agreement for measures obtained from the task responses.

Table 3.6. Perseverative and anticipatory error coding criteria

	Criteria
Anticipatory error	Replacement of a word or sound by one that was intended to occur later in the utterance [e.g., cup of coffee→ cuff of coffee; (Fromkin, 1971)]
Perseveration error	
Total	Exact repetition of a prior response up to a distance of 15 previous responses. Could be a total repetition of a previous word but may only form part of a new compound word response.
Blended	50% phonemes in common with a prior response up to a distance of 15 previous responses in approximately the same order (Hirsh, 1998) OR 1. Same initial consonant and one phoneme of the rhyme (monosyllabic); two phonemes shared in the rhyme (two or more syllable words).

From "Insights into recurrent perseverative errors in aphasia: A case series approach," by M. Moses, C. Sheard, L. Nickels, 2007, *Aphasiology*, *21*(10/11) p.982. Copyright 2007 by the Psychology Press. Adapted with permission of the publisher.

3.5 Data Analysis Plan

- Stata was used to produce descriptive statistics as were the following inferential statistical tests. A total display of the descriptive statistics for each dependent variable is provided in Appendix G.

- **Hypothesis 1** Three participants with moderate fluent aphasia that received a non-confrontational picture naming intervention were predicted to demonstrate significantly greater percentage of correctly named items, an increase in number of words per minute, a decrease in number of perseverations, and an increase in anticipatory proportion during a picture naming task during intervention compared to pre-intervention. This hypothesis was tested using a paired *t*-test with the Type 1 error rate set at α=0.05.

- **Hypothesis 2** After participation in a non-confrontational picture naming intervention, the participants with moderate fluent aphasia were again predicted to demonstrate significantly greater percentage of correctly named items, an increase in number of words per minute, a decrease in number of perseveration errors, and a higher anticipation proportion of errors during a picture naming task than before the intervention and during the withdrawal period. This hypothesis was tested using Ordinary Least Squares (OLS). Type 1 error rate set at $\alpha = 0.05$. The dependent measures were percentage of correctly named items, number of words per minute, and proportion of anticipation and perseveration errors. In addition, data were pooled by subjects and the hypothesis was tested using Generalized Least Squares (GLS).
- **Hypothesis 2 (continued)** "This model includes separate binary variables for each subject in order to capture the different intercepts for each of the separate subjects. Furthermore, this model is estimate using a GLS estimator. Pooled cross-sectional time-series models often involve violations of Ordinary Least Squares (OLS) assumptions of homoskedasticity and uncorrelated error terms. While OLS estimates are unbiased in the presence of autocorrelation, these estimates are not efficient, and the variability of OLS coefficients contaminates tests of statistical significance. To account for this, we estimate our pooled cross-sectional time-series models using feasible Generalized Least Squares (FGLS). The model assumes a heteroskedastic error structure across panels with no cross-sectional correlation and is estimated using panel-specific estimates of first-order autocorrelation" (Power & Garand, 2007, pp. 437-438).

The general regression equation for each individual subject is:

Depvar = $a + b_1$ (Intervention) + b_2 (Withdrawal) + b_3 (Re-Intervention) + e. The regression equation was used for Hypothesis 2, 3, 4, and 5.

Table 3.7. Coding agreement for measures during naming, repetition, oral reading, and picture description tasks

	Co-PI	RA	% agreement
Naming			
Percentage correct	85	85	100
Number of perseveration Errors	0	0	100
Number of anticipation errors	3	3	100
Repetition			
Percentage correct	90	90	100
Number of perseveration errors	0	0	100
Number of anticipation errors	1	1	100
Oral Reading			
Percentage correct	75	85	88
#perseveration errors	1	0	0
#anticipation errors	2	2	100
Picture Description			
Percentage CIU	33.31	37.46	89
#perseveration errors	26	23	88
#anticipation errors	0	0	100

The regression equation for pooled data involving all subjects simultaneously is: Depvar = a+ b_1 (Intervention) + b_2 (Withdrawal) + b_3 (Re-Intervention) + b_4 (Subject 2) + b_5 (Subject 3) + e. The regression equation was used for Hypothesis 2, 3, 4, and 5.

- **Hypothesis 3** The non-confrontational picture naming intervention was predicted to have a positive lasting effect on the percentage of correctly repeated items, number of words per minute, and AP during a repetition task among participants with moderate fluent aphasia. This was not predicted to occur on their repetition tested before the intervention. Nor was it predicted to occur during withdrawal. This hypothesis was tested using OLS. Type 1 error rate set at $\alpha = 0.05$. The dependent measures were percentage of correctly repeated items, number of words per minute, and proportion of anticipation and perseveration errors. In addition, data were pooled by subjects and the hypothesis was tested using GLS.
- **Hypothesis 4** The non-confrontational picture naming intervention was predicted to have a positive lasting effect on the percentage of correctly orally-read items, number of words per minute, and AP during an oral reading task among participants with moderate fluent aphasia. These scores were predicted to outstrip those on oral reading before the intervention and during withdrawal. This hypothesis was tested using OLS. Type 1 error rate set at $\alpha = 0.05$. The dependent measures were percentage of correctly read words, number of words per minute, and proportion of anticipation and perseveration errors. In addition, data were pooled by subjects and the hypothesis was tested using GLS.
- **Hypothesis 5** The non-confrontational picture naming intervention was predicted to have a positive lasting effect on the words per minute, proportion of anticipation and perseveration errors, and the percentage of correct information units during a picture description task among participants with moderate fluent aphasia. The performance before the intervention

and during withdrawal was not predicted to mirror the post-intervention scores. This hypothesis was tested using OLS. Type 1 error rate set at $\alpha = 0.05$. The dependent measures were number of words per minute, AP, and the percentage of correct information units. In addition, data were pooled by subjects and the hypothesis was tested using GLS.

CHAPTER 4
EMPIRICAL RESULTS FOR PICTURE NAMING

4.1 Hypothesis 1

Three participants with moderate fluent aphasia that receive a non-confrontational picture naming intervention will demonstrate significantly greater percentage of correctly named items, an increase in number of words per minute, a decrease in number of perseverations, and an increase in anticipatory proportion during a picture naming task during intervention compared to pre-intervention.

- Results of Hypothesis 1

This hypothesis was tested using a one-tailed dependent samples *t*-test with the Type 1 error rate set at $\alpha = 0.05$. A paired *t*-test was used to analyze the mean difference between the percentages of correctly named items, the number of words per minute, and the number of perseveration errors elicited with and without a non-confrontational intervention.

Subject 1 had significantly higher percentage of correctly named items ($M = 98.75$, $SD = 3.54$) [Figure 4.1], a significant increase in the number of words per minute ($M = 2.19$, $SD = 0.51$), and a significant decrease in the number of perseverations ($M = 0.00$, $SD = 0.00$) while receiving a non-confrontational picture naming intervention than without intervention ($M = 8.75$, $SD = 2.27$). There was a mean difference of 90 (95% CI 83.68-96.32) between groups of correctly named items, $t = 3.67$, $p < .001$; ($M = 0.61$, $SD = 0.32$) with a mean difference of 1.58 (95% CI 1.05-2.10) between groups for number of words per minute, $t(7) = 7.33$, $p < .001$; and ($M = 2.88$, $SD = 1.36$) with a mean difference of 2.88 (95% CI 1.74-4.01) between groups for number of perseverations, $t(8) = 6.00$, $p < .001$. There was no variance in the dependent

variable, anticipatory proportion (AP) for subject 1; therefore, an analysis here was not appropriate.

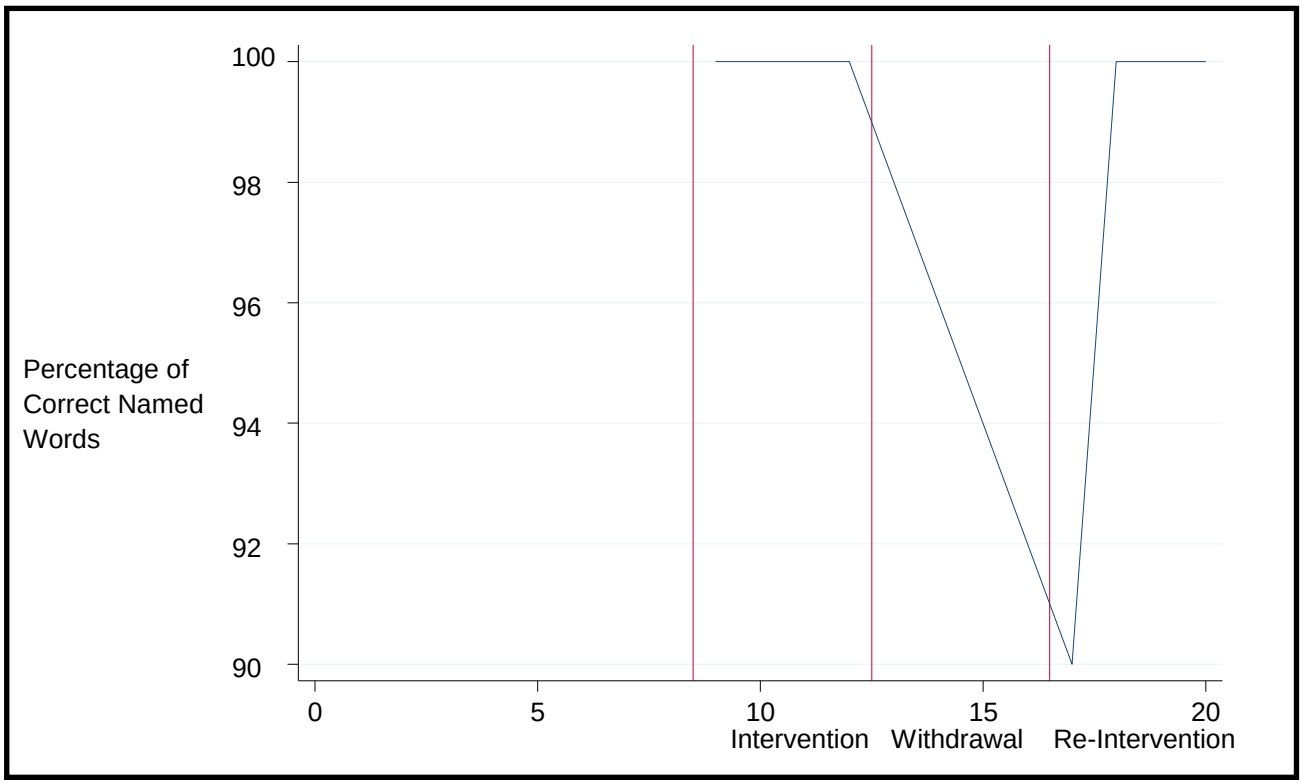

Figure 4.1 Percentage of correct named words with intervention, during withdrawal, and with re-intervention, Subject 1

Subject 2 had significantly higher percentage of correctly named items (M = 97.5, SD = 7.07) while receiving a non-confrontational picture naming intervention as opposed to without intervention (M = 76.25, SD = 24.46), with a mean difference of 21.25 (95% CI 3.69-38.81) between groups, $t(7) = 2.86$, $p < 0.05$. See Figure 4.2. On the other hand, contrary to what was predicted in the hypothesis, Subject 2 had a significant decrease in the number of words per minute (M = 7.22, SD = 4.48) while receiving a non-confrontational picture naming intervention, but not without intervention (M = 12.49, SD = 5.09) with a mean difference of -5.27 (95% CI -10.80-0.26) between groups, t (7) = -2.33, p = .06. There was no significant change in number of perseverations (M = 0.00, SD = 0.00) while receiving a non-confrontational picture naming

intervention than without intervention (*M* = 0.29, *SD* = 0.49) with a mean difference of 0.29 (95% CI -0.17-0.74) between groups, *t*(7) = 1.55, *p* = 0.09. There was no variance in my dependent variable, anticipatory proportion (AP), for subject 1; therefore, an analysis was not performed.

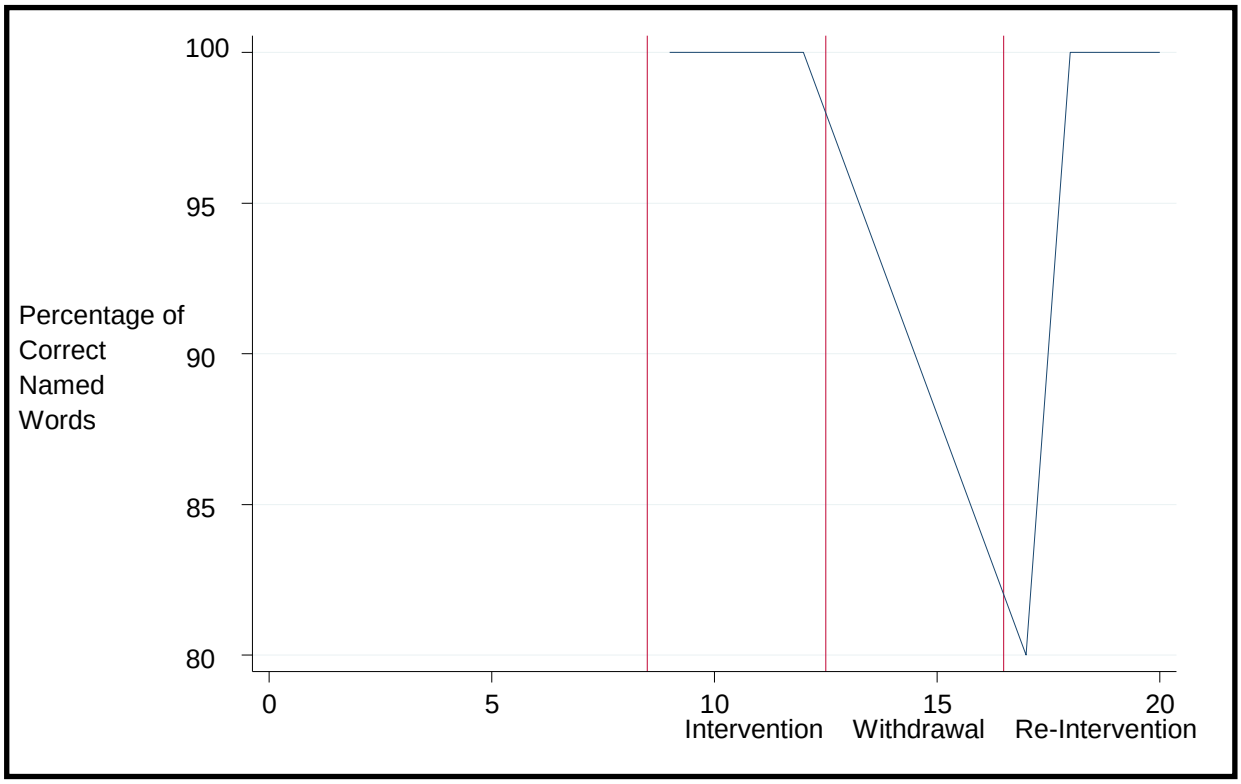

Figure 4.2 Percentage of correct named words with intervention, during withdrawal, and with re-intervention, Subject 2

Subject 3 had significantly higher percentage of correctly named items (*M* = 70.0, *SD* = 9.26) while receiving a non-confrontational picture naming intervention. This did not happen without intervention (*M* = 62.5, *SD* = 14.88). There was a mean difference of 7.5 (95% CI 0.09-14.91) between groups, *t*(7) = 2.39, *p* < .05. See Figure 4.3.

Contrary to the prediction of hypothesis 1, Subject 3 had a significant decrease in the number of words per minute (*M* = 2.96, *SD* = 1.16) while receiving a non-confrontational picture naming intervention and an increase in the number of words per minute without intervention (*M* = 9.88,

SD = 1.78). Results showed a mean difference of -6.92 (95% CI -8.82- -5.01) between groups, $t(7) = -8.57$, $p < .001$.

There was a significant decrease in number of perseverations (*M* = 0.00, *SD* = 0.00) while receiving a non-confrontational picture naming intervention which was not so without intervention (*M* = 0.50, *SD* = 0.53). There was a mean difference of 0.50 (95% CI 0.05-0.95) between groups, $t(7) = 2.65$, $p < 0.05$.

There was a significant increase in the anticipatory proportion (*M* = 0.58, *SD* = 0.40) while receiving the non-confrontational picture naming intervention, which did not appear without intervention (*M* = 0.06, *SD* = 0.18). There was a mean difference of 0.52 (95% CI 0.17-0.87) between groups, $t(7) = 3.50$, $p < 0.01$.

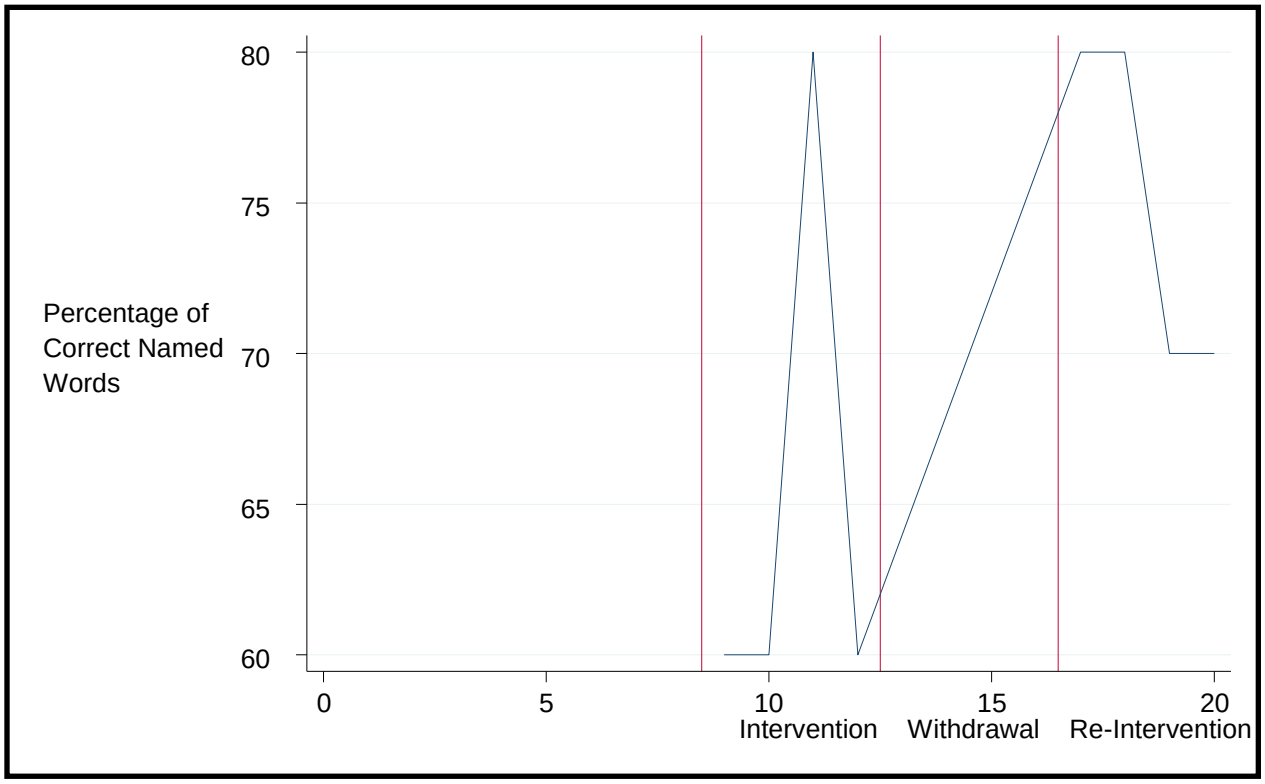

Figure 4.3 Percentage of correct named words with intervention, during withdrawal, and with re-intervention, Subject 3

- Summary of Results for Hypothesis 1, by Subject

In this study, all three subjects increased their performance on picture naming accuracy and decreased their number of recurrent perseverative responses with a non-confrontational picture naming intervention. Specifically, we utilized randomized cues including open-ended constraining sentence, a phonemic cue of the initial phoneme of the target word, and/or an auditory cue that was the same as the target item. All three subjects demonstrated perseveration errors when they could not elicit correct responses. If a perseveration error was not forthcoming, then the subjects would most often produce another kind of paraphasia. The perseveration errors were completely abolished when presented with randomized semantic and/or phonemic cues.

In addition, Subject 1 demonstrated an increase in number of words per minute with the intervention. Subject 3 was the only individual to elicit anticipatory errors in this study, thus the only participant to have anticipatory proportion (AP) analyzed. He demonstrated an increase in AP when presented with facilitating cues compared to pre-intervention performance. On the other hand, and contrary to the first hypothesis, Subjects 2 and 3 demonstrated a decrease in number of words per minute with intervention. Thus, we can reject the null hypothesis for Subject 1; however, we failed to find support for the working hypothesis for subjects 2 and 3. See Table 4.1 for the paired t-test results.

4.2 Hypothesis 2

After participation in a non-confrontational picture naming intervention, participants with moderate fluent aphasia will demonstrate significantly greater percentage of correctly named items, an increase in number of words per minute, a decrease in number of perseveration errors, and a higher anticipation proportion of errors during a picture naming task than before the intervention and during the withdrawal period.

Table 4.1. Paired t-test results for comparing percentage of correctly named items and pre-intervention and intervention, number of words per minute during pre-intervention and intervention, and number of perseverations, by subject

	Subject 1 *M*	Subject 2 *M*	Subject 3 *M*
Percentage of correctly named items			
Pre-intervention [-]	8.75	76.25	62.50
Intervention [+]	98.75	97.50	70.00
N	8	8	8
t	33.67***	2.86*	2.39*
Number of words per minute			
Pre-intervention [-]	0.61	12.49	9.88
Intervention [+]	2.19	7.22	2.96
N	8	8	8
t	7.33***	-2.33†	-8.57†††
Number of perseverations			
Pre-intervention [+]	2.88	0.29	0.50
Intervention [-]	0.00	0.00	0.00
N	8	7	8
t	6.00***	1.55	2.65*
AP			
Pre-intervention [-]	--	--	0.06
Intervention [+]	--	--	0.58
N	8	7	8
t	--	--	3.50**

(*= $p < .05$; **= $p < .01$; *** = $p < .001$, one tailed; †= $p < .05$; ††= $p < .01$; ††† = $p < .001$, two tailed)

("+" indicates the hypothesis predicted a positive effect of the intervention on the dependent variable and "-" indicates that the hypothesis predicted a negative effect of the intervention on the dependent variable)

- Results of Hypothesis 2

This hypothesis was tested using OLS and was performed on 20 observations of data to determine if there was a significant positive effect of post-participation in a non-confrontational intervention on the percentage of correctly named items, number of words per minute, and AP during two phases of intervention. We also sought to determine if there was a significant negative effect on the percentage of correctly named items, number of words per minute, number of perseveration errors, and AP before intervention was introduced and during the withdrawal phase. Subsequently, data were pooled by subjects and the hypothesis was tested using GLS. Type 1 error rate set at $\alpha = 0.05$. The dependent measures were percentage of correctly named items, number of words per minute, number of perseverations, and AP.

Subject 1 There was no significant effect of a non-confrontational picture naming intervention on percentage of correctly named items at the 0.05 critical alpha level during intervention phases, $t = -1.27$, $p = .22$ and $t = 0.44$, $p = .67$, respectively, nor was it significant before intervention and during the withdrawal phase, $t = 0.88$, $p = .39$.

There was no significant effect of a non-confrontational picture naming intervention on number of words per minute at the 0.05 critical alpha level during intervention, $t = -0.99$, $p = .34$ and $t = 1.09$, $p = 0.15$, respectively, nor was it significant during the withdrawal phase, $t = 0.63$, $p = 0.54$.

There was no significant effect after a non-confrontational picture naming intervention on the number of perseveration errors elicited during a picture naming task at the 0.05 critical alpha level, during both intervention intervals, $t = -0.80$, $p = .22$ and $t = 0.92$, $p = .37$, respectively, nor was there significant effect during the withdrawal, $t = 0.15$ $p = .44$ (Figure 4.4). There is no

variation in our dependent variable, anticipatory proportion. Therefore an analysis is not appropriate.

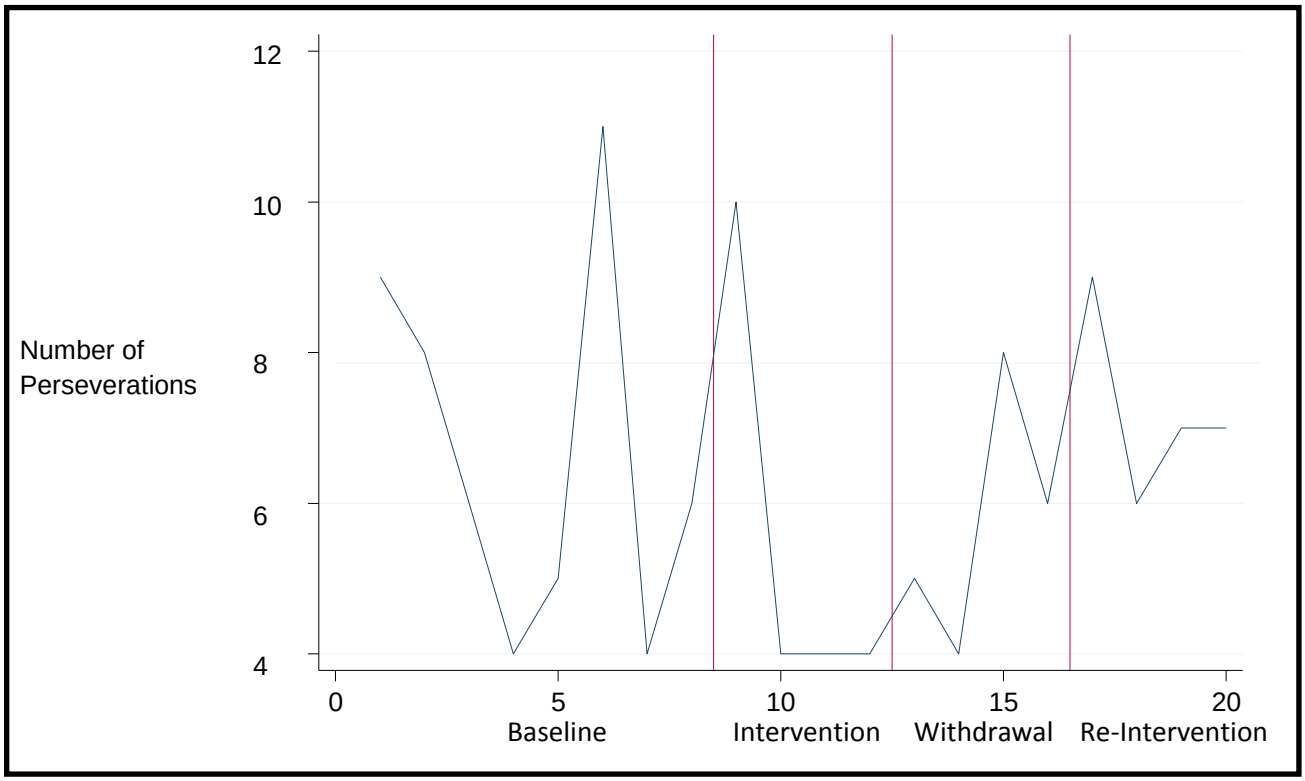

Figure 4.4 Number of perseverations during picture naming at baseline, after intervention, withdrawal, and after re-intervention, Subject 1

Subject 2 There was a significant negative effect of withdrawal from a non-confrontational picture naming intervention on percentage of correctly named items at the 0.05 critical alpha level, $t = -1.77$, $p < .05$. There was no significant effect of intervention on percentage of correctly named items during the intervention phases, $t = 0.90$, $p = .38$ and, $t = 1.28$, $p = .22$.

There was a significant positive effect of a non-confrontational picture naming intervention on number of words per minute at the 0.05 critical alpha level during the second phase of intervention, $t = 3.41$, $p < .01$. There was no significant effect of intervention number

of words per minute during the first intervention phase, t = 1.50, p = .08, nor was there a significant negative effect during the withdrawal phase, t = -1.70, p = .05.

There was no significant effect after a non-confrontational picture naming intervention on the number of perseveration errors elicited during a picture naming task at the 0.05 critical alpha level during both intervention intervals, t = -1.05, p = .15 and t = -1.01, p = .16, respectively (Figure 4.5). Neither was there a significant effect during the withdrawal, t = 1.01 p= .16, nor did we find any variation in our dependent variable (anticipatory proportion), therefore an analysis is not appropriate.

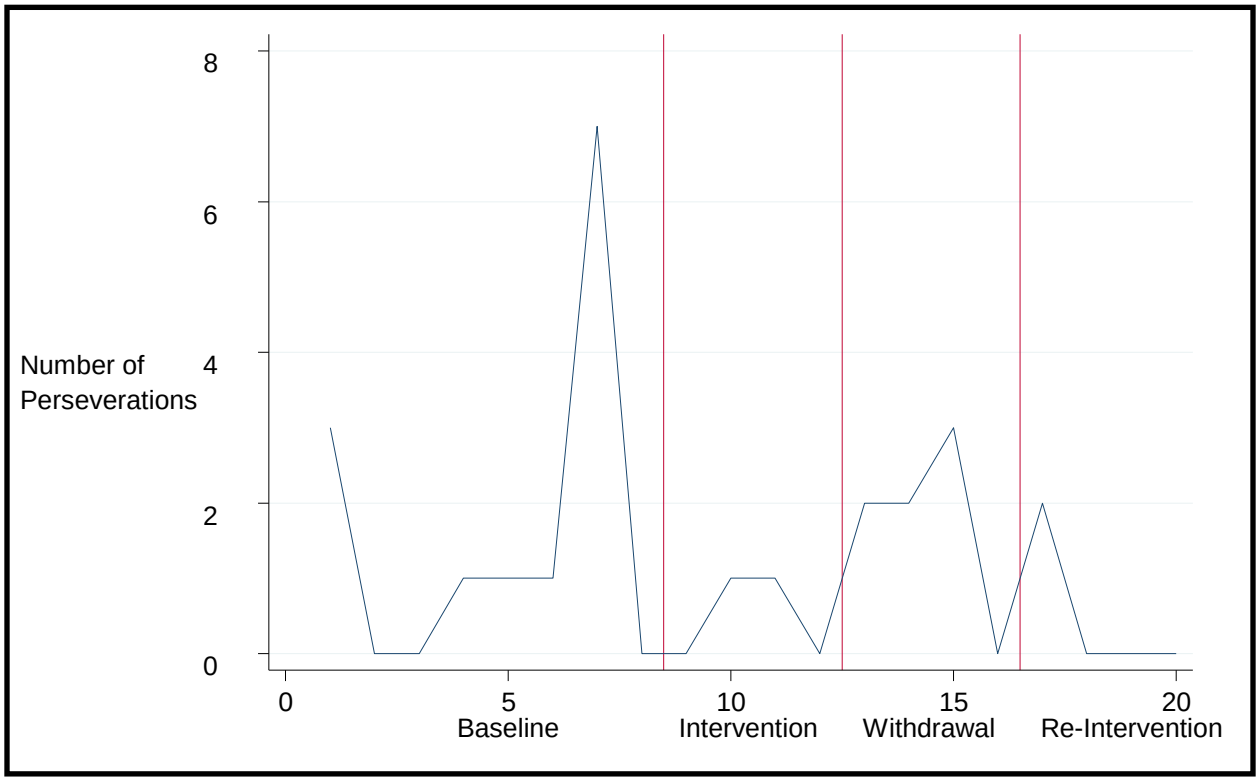

Figure 4.5 Number of perseverations during picture naming at baseline, after intervention, withdrawal, and after re-intervention, Subject 2

Subject 3 There was a significant positive effect of a non-confrontational picture naming intervention on number of words per minute at the 0.05 critical alpha level during the first phase

of intervention, $t = 2.55$, $p < .05$. There was no significant effect, however, of intervention on the number of words per minute during the second intervention phase, $t = 0.31$, $p = .76$, nor was there a significant negative effect during the withdrawal phase, $t = 0.42$, $p = .68$.

There was a significant negative effect of a non-confrontational picture naming intervention on number of perseveration errors elicited during a picture naming task at the 0.05 critical alpha level during the initial intervention $t = -3.06$, $p < .01$; however, there was no significant effect during the second phase of intervention, $t = 0.48$, $p = .32$, nor during the withdrawal, $t = 0.48$, $p = .64$, respectively (Figure 4.6).

There was a significant positive effect of intervention on AP at the 0.05 critical alpha level during the first phase of intervention $t = 2.93$, $p < .01$. On the contrary, there was no significant positive effect during the second phase of intervention $t = -0.46$, $p = .65$, nor was there a significant negative effect during the withdrawal phase, $t = -0.68$, $p = .25$.

In contradistinction to the directions of effect proposed in the hypothesis, there was a significant negative effect of a non-confrontational picture naming intervention on the percentage of correctly named items at the .05 critical alpha level during the first phase of intervention, $t = -2.32$, $p < .05$ and a positive effect during the withdrawal phase $t = 2.49$, $p < .05$. But, there was no significant effect during the second intervention phase $t = -0.19$, $p = .85$.

- Summary of Results for Hypothesis 2, by Subject

Subject 1 demonstrated no significant effect on the dependent variables (percentage correctly named items, number of words per minute, number of perseverations, and AP) during a naming task after participation in the intervention. Subject 2 demonstrated a significant negative withdrawal effect of intervention on percentage of correctly named items and a significant positive effect on number of words per minute during the second intervention interval. Subject 3

demonstrated a significant positive effect on percentage of correctly named items and number of words per minute during the first intervention, a significant negative effect on number of perseverations during the first intervention, and a significant positive effect on AP. On the other hand, and contrary to the hypothesis, Subject 3 demonstrated a significant positive effect on percentage of correctly named items during withdrawal.

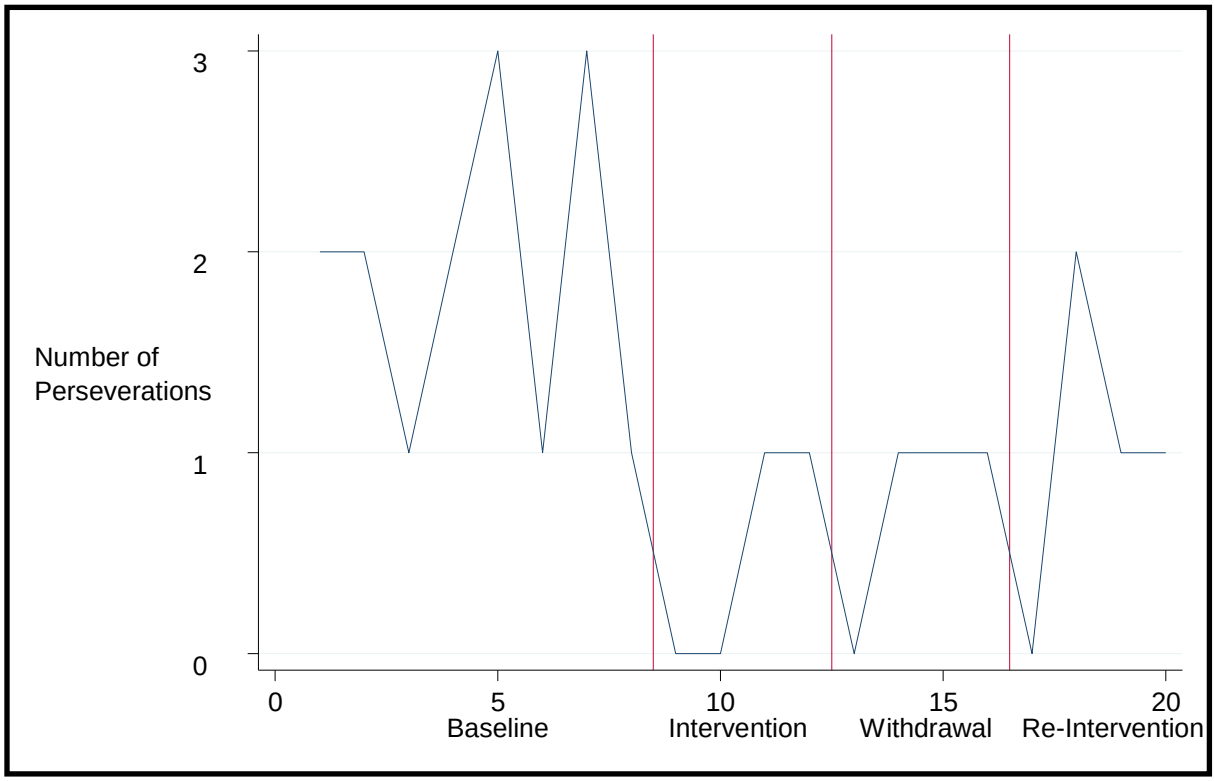

Figure 4.6 Number of perseverations during picture naming at baseline, after intervention, withdrawal, and after re-intervention, Subject 3

Thus, we fail to reject the null hypothesis for subject 1, and fail to find support for the working hypothesis for Subjects 2 and 3. See Table 4.2 for the Ordinary Least Squares regression (OLS) results for models of percentage of correctly named items, number of words per minute, and AP during a picture naming task for each subject.

Pooled by subjects When the data were pooled across subjects, there was a significant negative effect of intervention during the first intervention, $t = -1.98$, $p < .05$.

Table 4.2. Ordinary Least Squares (OLS) regression results for models of percentage of correctly named items, number of words per minute, number of perseverations, and AP during a picture naming task, by subject

	Subject 1		**Subject 2**		**Subject 3**	
	b	*t*	*b*	*t*	*b*	*t*
Percentage correctly named items						
Constant (baseline)	13.75	4.83	67.88	8.72	68.14	20.86
Intervention [+]	-6.25	-1.27	12.13	0.90	-13.13	-2.32†
Withdrawal [-]	5.00	0.88	-27.50	-1.77*	16.25	2.49*
Re-Intervention [+]	-2.5	-0.44	20.00	1.28	-1.25	-0.19
N	20		20		20	
R^2	0.10		0.17		0.34	
Number of words per minute						
Constant (baseline)	0.60	4.46	5.77	4.23	6.68	10.27
Intervention [+]	-0.25	-0.99	3.55	1.50	2.75	2.55*
Withdrawal [-]	0.18	0.63	-4.63	-1.70	0.51	0.42
Re-Intervention [+]	0.29	1.09	9.32	3.41**	0.38	0.31
N	20		20		20	
R^2	0.16		0.50		0.52	
Number of perseverations						
Constant (baseline)	6.63	8.16	1.63	2.64	1.88	7.22
Intervention [-]	-1.13	-0.80	-1.13	-1.05	-1.38	-3.06**
Withdrawal [+]	0.25	0.15	1.25	1.01	0.25	0.48
Re-Intervention [-]	1.50	0.92	-1.25	-1.01	0.25	0.48

N	20	20	20
R^2	0.09	0.12	0.43

(Table 4.2. continued)

	Subject 1		Subject 2		Subject 3	
	b	*t*	*b*	*t*	*b*	*t*
AP						
Constant (baseline)	--	--	--	--	0.33	3.55
Intervention [+]	--	--	--	--	0.47	2.93**
Withdrawal [-]	--	--	--	--	-0.13	-0.68
Re-Intervention [+]	--	--	--	--	-0.09	-0.46
N	20		20		20	
R^2	--		--		0.39	

(* $p < .05$; ** $p < .01$; *** $p < .001$, one tailed)

("+" indicates the hypothesis predicted a positive effect of the intervention on the dependent variable and "-" indicates that the hypothesis predicted a negative effect of the intervention on the dependent variable)

However, there was no significant positive effect during the second phase of intervention $t = -0.08$, $p = .47$, nor was there a significant negative effect during the withdrawal phase, $t = 1.51$, $p = .07$.

There was a significant negative effect of the non-confrontational picture naming intervention on the number of perseveration errors elicited during a picture naming task at the 0.05 critical alpha level during the initial intervention $t = -4.65$, $p < .001$. On the other hand, there was no significant effect during the second phase of intervention, $t = 0.44$, $p = .66$, nor during the withdrawal, $t = 1.33$, $p = .09$, respectively.

There was no significant effect of the intervention on the number of words per minute, t = 0.89, p = .19, and t = 0.79, p = .21, respectively, and there was no significant negative effect during the withdrawal phase t = 0.01, p = .99.

There was no significant effect of intervention on the AP during both intervention phases t = 0.28, p = .39 and t = 0.03, p = .49, respectively, nor during the withdrawal phase t = -0.05, p = .48.

- Summary of Results for Hypothesis 2, Pooled by all Subjects

When the data were pooled by all subjects, there was a significant decrease in number of perseveration errors during the first phase of intervention and a significant increase in number of words per minute during the naming task after the intervention during both intervention phases. On the other hand, contrary to the proposed direction of the effects for percentage of correctly named items, there was a significant negative effect of the intervention on percentage of correctly named items. In addition, there was no significant effect of the intervention on AP. Thus, we fail to find support for the working hypothesis when the data are pooled by all subjects. See Table 4.3 for the Generalized Least Squares regression results for models of percentage of correctly named items pooled by all subjects.

4.3 Discussion of Results for Hypotheses 1 and 2

Picture naming is a reliable and sensitive measure of word finding ability (Nickels, 2002) and data support the assumption that confrontation naming tasks elicit the greatest number of recurrent perseverations when compared to repetition and reading (Corbett et al., 2008; Helm-Estabrooks Ramage, Bayles, & Cruz, 1998; Moses et al., 2004). This study utilized a picture naming intervention with randomized phonological and/or semantic cues that were related to the target to facilitate a correct response. All subjects demonstrated an increase in percentage of

correctly named pictures and a decrease in the number of perseveration errors during a picture naming task with the intervention. The increase in picture naming ability and decrease in number of perseveration errors during a non-confrontational intervention suggests that performance on a picture naming task was augmented with facilitating cues, with no specific attention to perseveration errors, allowing all three adults to overcome their tendency to produce incorrect responses (including recurrent verbal perseverations). These findings could be explained by the view that picture naming difficulties for persons with aphasia resulted from the inability to appropriately regulate activation within the semantic and/or phonemic systems (Cohen & Dehaene, 1998). When the clinician provided semantic and/or phonemic cues related to the target, the subjects were able to overcome this deficit possibly by (1) changing or strengthening the links between the semantic and phonological representations (Cohen & Dehaene, 1998; Howard, 2000; Papagno & Basso, 1996, Schwartz, Dell, Martin, Gahl, & Sobel, 2006); (2) changing the process or strategy the subjects utilized for accessing the word (Best et al, 2006); and/or (3) repairing damage to lexical representations (Basso, 2004).

In addition, all subjects possibly demonstrated lasting improvements of the first intervention (10-30 min after the intervention was presented) suggested by the results that showed all three subjects had lower number of perseverations errors compared to their baseline status. Furthermore, the relative positive change observed with Subject 3's AP during and after the picture naming intervention further supports not only that the intervention probably facilitated correct responses, but also that those gains were maintained. Dell and colleagues (1997) proposed that a high anticipatory ratio suggests a relatively intact language system and a lower ratio suggests one that is deprived of its normal input (e.g., adult with aphasia). Therefore,

the increase in Subject 3's AP after the intervention may also suggest probable language process or system recovery with the intervention.

Table 4.3. Generalized Least Squares (GLS) regression results for models of percentage of correctly named items, number of words per minute, number of perseverations, and AP during a picture naming task, pooled by all subjects

	b	*t*
Percentage correctly named items		
Constant (baseline)	13.34	5.63
Intervention [+]	-7.17	-1.98†
Withdrawal [-]	6.32	1.51
Re-Intervention [+]	-0.34	-0.08
Subject 2	56.65	11.18***
Subject 3	55.00	19.29***
N	60	
Pseudo R^2	0.76	
Number of words per minute		
Constant (baseline)	0.05	0.09
Intervention [+]	0.65	0.89
Withdrawal [-]	0.01	0.01
Re-Intervention [+]	0.61	0.79
Subject 2	7.34	4.92***
Subject 3	8.15	10.63***
N	58	
Pseudo R^2	0.63	

Number of perseverations

Constant (baseline)	6.94	17.19***
Intervention [-]	-1.40	-4.65***

(Table 4.3 continued)

	b	*t*
Withdrawal [+]	0.47	1.33
Re-Intervention [-]	0.15	0.44
Subject 2	-5.12	-10.65***
Subject 3	-5.12	-12.81***
N	60	
Pseudo R^2	0.71	

AP

Constant (baseline)	-0.00	-.017
Intervention [+]	0.00	0.28
Withdrawal [-]	-0.00	-0.05
Re-Intervention [+]	0.00	0.03
Subject 2	-0.00	-0.00
Subject 3	0.53	4.04***
N	60	
Pseudo R^2	0.69	

(*= $p < .05$; **= $p < .01$; *** = $p < .001$, one tailed; †= $p < .05$; ††= $p < .01$; ††† = $p < .001$, two tailed)

("+" indicates the hypothesis predicted a positive effect of the intervention on the dependent variable and "-" indicates that the hypothesis predicted a negative effect of the intervention on the dependent variable)

Since one cannot attribute to the non-confrontational picture naming intervention all of the increase in naming and decrease in perseverations over time, what other variables can account for these changes in speech production? Although the list is by no means exhaustive, there are categories of variables that either would be expected to have an impact on picture naming and/or have been shown in previous research to influence naming accuracy and perseveration errors. First, all subjects had repeated exposure and opportunities to say the names of the pictures. To minimize practice effects, the order of speech tasks and the stimulus items in each task were randomized, and all subjects were presented with an alternating treatment design (ABAB). However, due to the nature of the repeated measure design of this study and small number of participants caution in interpreting the significance of the intervention is warranted. Next, there was inherent activation of semantic and phonological processes during repetition, oral reading of the same words presented in the picture naming task.

Thirdly, Subjects 2 and 3 appeared to be motivated individuals during treatment. They reported independent practice of the treatment items between treatment sessions. Subject 2 reported she would memorize the picture items presented in therapy, search the internet for items to locate their names, and then rehearse their names. Subject 3 reported that his spouse transcribed all of the names of the picture items presented during therapy and he would read the names of the items daily approximately sixty minutes prior to each therapy session. In addition, subject 3 reported silently and orally reading portions of the daily newspaper. The accuracy of their practice sessions is unknown.

Lastly, in this study the nature of the word retrieval deficit (e.g., semantic vs. phonological vs. mixed) was not specified. Some researchers propose therapy should be motivated by an analysis of the client's impairment to distinguish phonological versus semantic

deficits (Nettleton & Lesser 1991). Evaluating the different types and frequency of perseveration and anticipation errors should provide the clinician with specific knowledge of an individual's language-processing impairments and measurement of language recovery, respectively. In turn this should allow the clinician to develop an intervention that builds upon and develops the individual's strengths, and that addresses the impaired processes. A closer examination of each subject's pre-therapy abilities and types of errors (phonological versus semantic) may inform the discussion as to why the subjects positively responded to a naming intervention that included both semantic and phonological cues.

CHAPTER 5
EMPIRICAL RESULTS FOR SPEECH TASKS

5.1 Hypothesis 3 (repeated here for convenience)

The non-confrontational picture naming intervention will have a positive effect on the percentage of correctly repeated items, number of words per minute, and AP during a repetition task among participants with moderate fluent aphasia compared to their repetition ability before the intervention and during withdrawal.

- Results of Hypothesis 3

This hypothesis was tested using Ordinary Least Squares regression (OLS) and was performed on 20 observations of data to determine if there was a significant effect of participation in a non-confrontational picture naming intervention on the percentage of correctly repeated words, number of words per minute, and AP during a repetition task over two phases of intervention and one withdrawal phase. In addition, data were pooled by subjects and the hypothesis was tested using GLS. Type 1 error rate set at $\alpha = 0.05$. The dependent measures were percentage of correctly repeated words, number of words per minute, and AP.

Subject 1 There was a positive significant effect of a non-confrontational picture naming intervention on percentage of correctly repeated words at the 0.05 critical alpha level during the intervention phases, $t = 1.79$, $p < .05$; but, there was no significant effect during the re-intervention $t = 0.0$, $p = .5$, nor during the withdrawal phase, $t = -0.0$, $p = 1.0$.

There was a significant positive effect of a non-confrontational picture naming intervention on number of words per minute at the 0.05 critical alpha level during the first intervention $t = 1.84$, $p < .05$ and withdrawal phase, $t = 2.38$, $p < .05$; but again, no significant effect during the second intervention phase $t = 0.62$, $p = .27$. Subject 1 elicited no perseveration errors during the repetition task. There is therefore no variation with the dependent variable,

number of perseveration errors. Therefore, an analysis was not appropriate. There is no variation in our dependent variable, anticipatory proportion; therefore an analysis was not appropriate.

Subject 2 There was a significant negative withdrawal effect of a non-confrontational picture naming intervention on number of words per minute at the 0.05 critical alpha level during the withdrawal phase, $t = -4.02$, $p < .01$; However, we did not see any significant effect during the two intervention phases $t = 1.10$, $p = .15$ and $t = 0.83$, $p = .21$, respectively.

There was no significant effect of our non-confrontational picture naming intervention on percentage of correctly repeated words at the 0.05 critical alpha level during the intervention phases, $t = 0.51$, $p = .31$ and $t = 0.44$, $p = .34$, respectively, nor during the withdrawal phase $t = 0.0$, $p = .5$. There was no significant effect of intervention on the number of perseveration errors elicited during a repetition task during both intervention phases, $t = -0.64$, $p = .27$ and $t = -1.11$, $p = .14$, respectively, nor during the withdrawal phase $t = 1.11$, $p = .14$ (Figure 5.1). There was no variation in the dependent variable, anticipatory proportion. Consequently, an analysis was not appropriate.

Subject 3 We found a significant positive effect of a non-confrontational picture naming intervention on percentage of correctly repeated words at the 0.05 critical alpha level during both intervention phases, $t = 3.09$, $p < .01$ and $t = 2.41$, $p < .05$, respectively. However, there was no significant effect during the withdrawal phase $t = -1.34$, $p = .10$.

There was a significant positive effect of our non-confrontational picture naming intervention on number of words per minute at the 0.05 critical alpha level during the first intervention phase, $t = 2.13$, $p < .05$, but no significant effect during the second intervention phase $t = 1.61$, $p = .06$, nor during the withdrawal phase $t = -0.84$, $p = .21$.

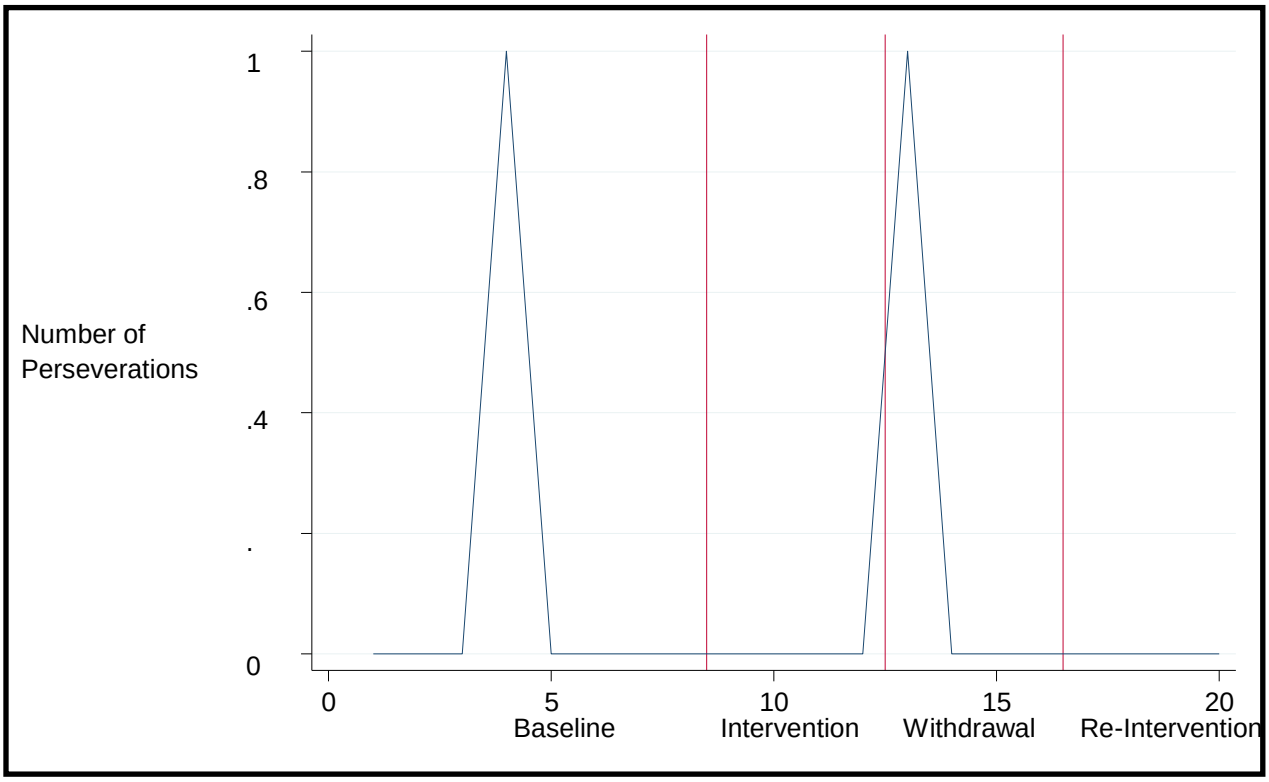

Figure 5.1 Number of perseverations during word repetition task at baseline, after intervention, withdrawal, and after re-intervention, Subject 2

There was no significant effect of intervention on the number of perseveration errors elicited during a repetition task during both intervention phases, t = -1.32, p = .10 and t = -0.98, p = .17, respectively, nor during the withdrawal phase t = 0.98, p = .17 (Figure 5.2). No significant effect was observed from intervention on AP at the 0.05 critical alpha level during both phases of intervention t = 0.91, p = .19 and t = 1.51, p = .08, respectively, nor during the withdrawal phase t = -1.51, p = .08.

- Summary of Results for Hypothesis 3, by Subject

Subjects 1 and 3 probably had significant lasting effects of the intervention during B1 on the percentage of correctly repeated words and on the number of words per minute during a repetition task because they demonstrated better performance and efficiency during B1 compared to pre-intervention, when the intervention was withdrawn, and B2. There were no significant

effects on AP for Subject 3. Subject 2 demonstrated significant negative intervention withdrawal effects on number of repeated words per minute. There were no significant lasting effects of the intervention on percentage of correctly repeated items, nor on the number of repeated items per minute. Thus, we fail to uncover any support for the working hypothesis for Subjects and 1 and 3, and we fail to reject the null hypothesis for Subject 2.

See Table 5.1 for OLS regression results for models of percentage of correctly repeated words, number of words per minute, and AP during a repetition task for each subject.

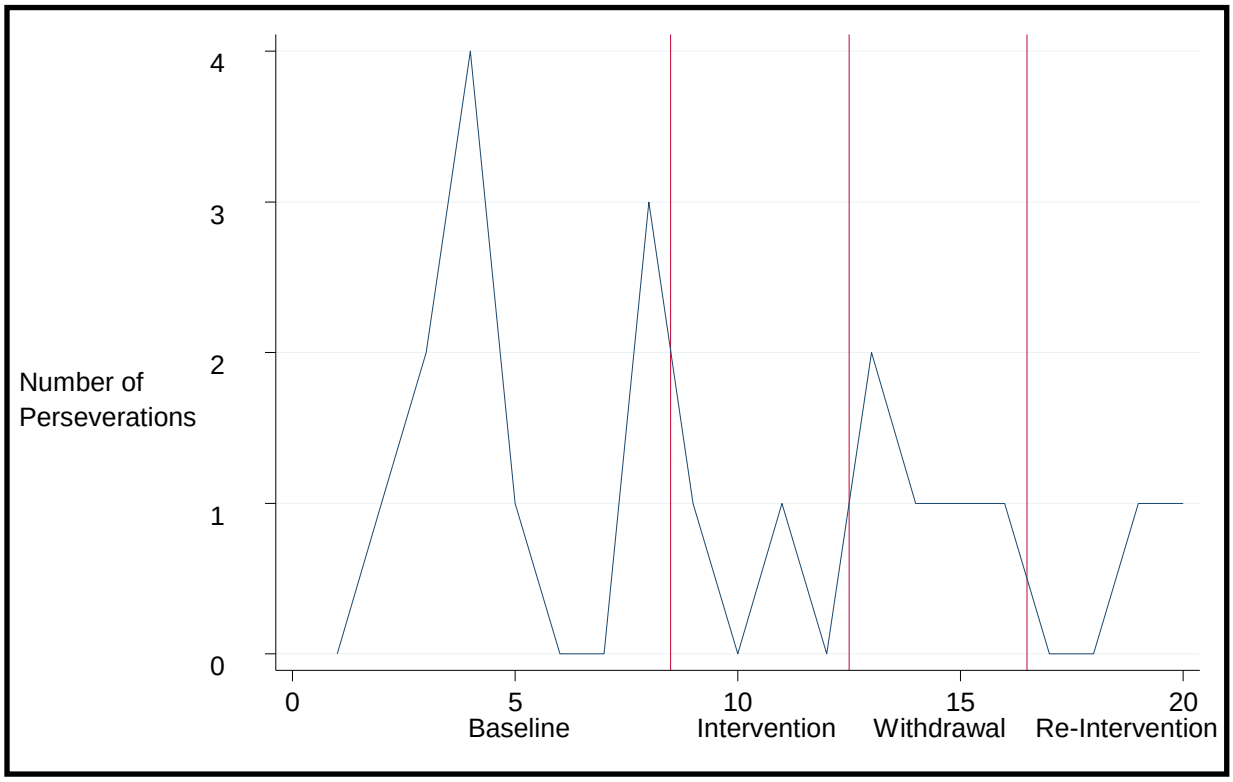

Figure 5.2 Number of perseverations during word repetition task at baseline, after intervention, withdrawal, and after re-intervention, Subject 3

Table 5.1. Ordinary Least Squares (OLS) regression results for models of percentage of correctly repeated words, number of words per minute, and AP during a repetition task, by subject

	Subject 1		**Subject 2**		**Subject 3**	
	b	*t*	*b*	*t*	*b*	*t*
Percentage of correctly repeated words						
Constant (baseline)	98.13	162.15	96.25	68.03	71.25	30.47
Intervention [+]	1.88	1.79*	1.25	0.51	12.50	3.09**
Withdrawal [-]	0.00	0.00	0.00	0.00	-6.25	-1.34
Re-Intervention [+]	-0.00	-0.00	1.25	0.44	11.25	2.41*
N	20		20		20	
R^2	0.26		0.06		0.58	
Number of words per minute						
Constant (baseline)	23.69	11.17	20.91	16.98	9.41	10.26
Intervention [+]	6.78	1.84*	2.34	1.10	3.39	2.13*
Withdrawal [-]	10.08	2.38*	-9.90	-4.02***	-1.55	-0.84
Re-Intervention[+]	2.62	0.62	2.03	0.83	2.96	1.61
N	20		20		20	
R^2	0.16		0.59		0.40	
Number of perseveration while repeating						
Constant (baseline)	--	--	0.13	1.11	1.38	3.60**
Intervention [-]	--	--	-0.13	-0.64	-0.88	-1.32
Withdrawal [+]	--	--	0.25	1.11	0.75	0.98
Re-Intervention [-]	--	--	-0.25	-1.11	-0.75	-0.98
N	20		20		20	
R^2	--		0.10		0.15	

(Table 5.1 continued)

	Subject 1		Subject 2		Subject 3	
	b	*t*	*b*	*t*	*b*	*t*
AP						
Constant (baseline)	--	--	--	--	0.64	6.59
Intervention [+]	--	--	--	--	0.15	0.91
Withdrawal [-]	--	--	--	--	-0.29	-1.51
Re-Intervention [+]	--	--	--	--	0.29	1.51
N	20		20			20
R^2	--		--			0.17

(* $p < .05$; ** $p < .01$; *** $p < .001$, one tailed)

Pooled by subjects When the data were pooled across subjects, there was a significant positive effect of intervention on the percentage of correctly repeated items during the first intervention phase $t = 1.81$, $p < .05$. However, there was no significant effect during the second intervention phase $t = 0.83$, $p = .20$ nor during the withdrawal phase $t = -0.38$, $p = .35$.

There was no significant effect of intervention on the number of words per minute during both phases of intervention $t = 1.48$, $p = .07$ and $t = 1.34$, $p = .09$, respectively, nor during the withdrawal phase $t = -0.73$, $p = .24$.

There was no significant effect of intervention on the AP during both intervention phases $t = 0.11$, $p = .46$ and $t = 0.16$, $p = .44$, respectively, nor during the withdrawal phase $t = -0.19$, $p = .43$.

- Summary of Results for Hypothesis 3, Pooled by Subjects

When the data were pooled across all subjects, there was a positive effect on the subjects' performance on repeating words accurately after the picture naming intervention during B1.

There was no significant effect of intervention on the number of perseveration errors elicited during a repetition task during both intervention phases, t = -0.54, p = .29 and t = -0.63, p = .26, respectively, nor during the withdrawal phase t = 0.81, p = .21. There were no significant lasting effects of the intervention on the number of words repeated, or on the AP. Thus, we fail to find support for the working hypothesis. See Table 5.2 for the Generalized Least Squares regression results for models of percentage of correctly repeated words, number of words per minute, and AP during a repetition task, pooled by all subjects

Table 5.2. Generalized Least Squares (GLS) regression results for models of percentage of correctly repeated words, number of words per minute, and AP during a repetition task, pooled by subjects

	b	*t*
Percentage of Correctly repeated words		
Constant (baseline)	97.63	102.84***
Intervention [+]	2.60	1.81*
Withdrawal [-]	-0.62	-0.38
Re-Intervention [+]	1.35	0.83
Subject 2	-1.96	-1.49
Subject 3	-20.57	-10.19***
N	60	
Pseudo R^2	0.77	
Number of Words per minute		
Constant (baseline)	30.51	11.94***
Intervention [+]	2.54	1.48
Withdrawal [-]	-1.37	-0.73
Re-Intervention [+]	2.54	1.34

(Table 5.2 continued)

	b	*t*
Number of Words per minute		
Subject 2	-13.44	-4.45***
Subject 3	-20.53	-8.00
N	60	
Pseudo R^2	0.68	
Number of perseverations while repeating		
Constant (baseline)	0.11	0.17
Intervention [-]	-0.06	-0.54
Withdrawal [+]	0.10	0.81
Re-Intervention [-]	-0.07	-0.63
Subject 2	0.10	0.95
Subject 3	0.98	3.36**
N	60	
Pseudo R^2	0.35	
AP		
Constant (baseline)	-0.00	-0.02
Intervention [+]	0.00	0.11
Withdrawal [-]	-0.00	-0.19
Re-Intervention [+]	0.00	0.16
Subject 2	0.00	0.00
Subject 3	0.68	6.87***
N	60	

(Table 5.2 continued)

	b	*t*
AP		
Pseudo R^2	0.81	

(*p < .05; **p < .01; *** p < .001, one tailed)
("+" indicates the hypothesis predicted a positive effect of the intervention on the dependent variable and "-" indicates that the hypothesis predicted a negative effect of the intervention on the dependent variable)

5.2 Hypothesis 4 (repeated here for convenience)

The non-confrontational picture naming intervention will have a positive lasting effect on the percentage of correctly orally-read items, number of words per minute, and AP during an oral reading task among participants with moderate fluent aphasia compared to their oral reading ability before the intervention and during withdrawal.

- Results of Hypothesis 4

This hypothesis was tested using OLS and was performed on 20 observations of data to determine if there was a significant effect of participation in a non-confrontational picture naming intervention on the percentage of correctly read words, number of words per minute, and AP during an oral reading task over two phases of intervention and a withdrawal phase. In addition, data were pooled by subjects and the hypothesis was tested using GLS. Type 1 error rate set at $\alpha = 0.05$. The dependent measures were percentage of correctly read words, number of words per minute, and AP.

Subject 1 There was a significant negative effect of withdrawal from the intervention on percentage of correctly read words at the 0.05 critical alpha level during the withdrawal phase,

t = -1.85, p < .05. There was no significant lasting effect of a non-confrontational picture naming intervention on percentage of correctly read words during both intervention phases, t = 1.43, p =.09 and t = 1.23, p= .12, respectively.

There was a significant negative effect of withdrawal from the intervention on number of words read per minute at the 0.05 critical alpha level during the withdrawal phase, t = -1.94, p < .05. But, again there was no significant effect of a non-confrontational picture naming intervention on percentage of correctly read words during both intervention phases, t = 1.47, p =.08 and t = 1.16, p= .13, respectively.

There was no significant effect of intervention on the number of perseveration errors elicited during an oral reading task during both intervention phases, t = -0.0, p = .50 and t = 0.80, p = .44, respectively, nor during the withdrawal phase t = 1.0, p = .17 (Figure 5.3). There was no variation in the dependent variable of anticipatory proportion, and therefore, an analysis is not appropriate.

Subject 2 There was a significant positive effect of a non-confrontational picture naming intervention on number of words read per minute at the 0.05 critical alpha level during both intervention phases, t = 2.44, p < .05 and t = 2.83, p < .01, respectively, and there was a significant negative effect during the withdrawal phase, t = -2.61, p < .01.

There was no significant effect of a non-confrontational picture naming intervention on percentage of correctly read words at the 0.05 critical alpha level during both intervention phases, t = 0.81, p =.22 and t = 1.68, p= .06, respectively. It was not significant during the withdrawal phase, either t = -1.40, p = .09. There was no significant effect of intervention on the number of perseveration errors elicited during an oral reading task during both intervention phases, t = -1.17, p = .13 and t = -0.51, p = .31, respectively, nor during the withdrawal phase t =

1.02, p = .16 (Figure 5.4). Again, there was no variation in the AP, dependent variable, and therefore a further analysis was not carried out.

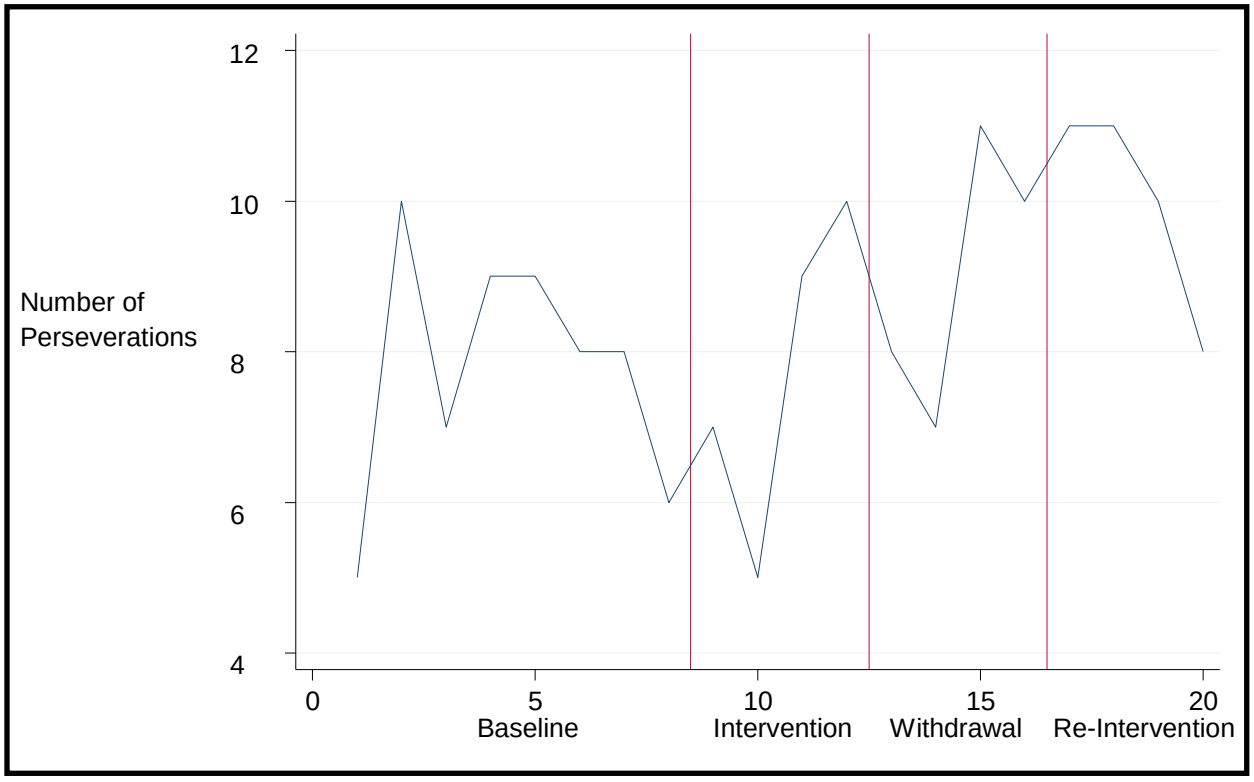

Figure 5.3 Number of perseverations during single word oral reading task at baseline, after intervention, withdrawal, and after re-intervention, Subject 1

Subject 3 There was no significant effect of a non-confrontational picture naming intervention on percentage of correctly read words at the 0.05 critical alpha level during both intervention phases, t = 0.50, p =.62 and t = -0.0, p= 1.0, respectively, nor was it significant before intervention and during the withdrawal phase, t = 1.16, p = .26.

There was no significant effect of a non-confrontational picture naming intervention on number of words per minute at the 0.05 critical alpha level during intervention, t = -0.41, p =.69 and t = 0.96, p= .18, respectively. Neither was it significant during the withdrawal phase, t = -0.56, p =.29.

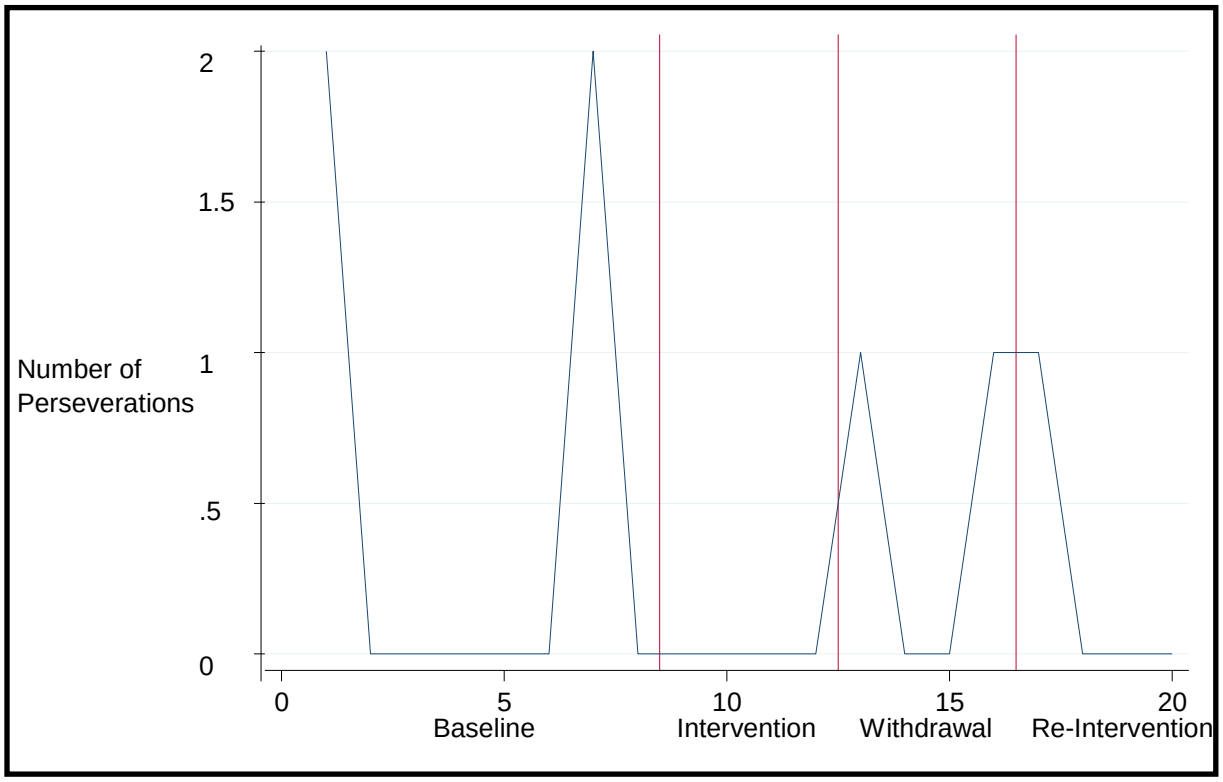

Figure 5.4 Number of perseverations during single word oral reading task at baseline, after intervention, withdrawal, and after re-intervention, Subject 2

There was no significant effect of intervention on the number of perseveration errors elicited during an oral reading task during both intervention phases, t = -1.15, p = .13 and t = -0.50, p = .31, respectively, nor during the withdrawal phase t = 0.50, p = .31 (Figure 5.5). There was no significant effect of intervention on AP at the 0.05 critical alpha level during intervention t = 0.54, p = .30 and t = 0.81, p = .22, respectively, nor was there a significant effect during the withdrawal phase, t = -0.36, p = .36.

- Summary of Results for Hypothesis 4, by Subject

Subject 1 demonstrated a significant intervention withdrawal negative effect on the percentage of correctly read words and the number of words read per minute. There were no significant lasting effects of the intervention on any of the other dependent variables. Subject 2 demonstrated probable significant lasting effects of the intervention on the number of words read

per minute during B1 and B2 demonstrated by a higher efficiency during B1 and B2 compared to A1 and A2. In addition, Subject 2 demonstrated significant negative withdrawal effects from the intervention on the number of words per minute elicited. However, there were no significant effects on percentage of correctly read words. There were no significant positive lasting effects on any of the dependent variables for Subject 3. Thus, we fail to reject the null hypothesis for Subjects 1 and 3, and we fail to offer any support for this working hypothesis for Subject 2. See Table 5.3 for the Ordinary Least Squares regression results for models of percentage of correctly read words, number of words per minute, and AP during a reading task, by Subject.

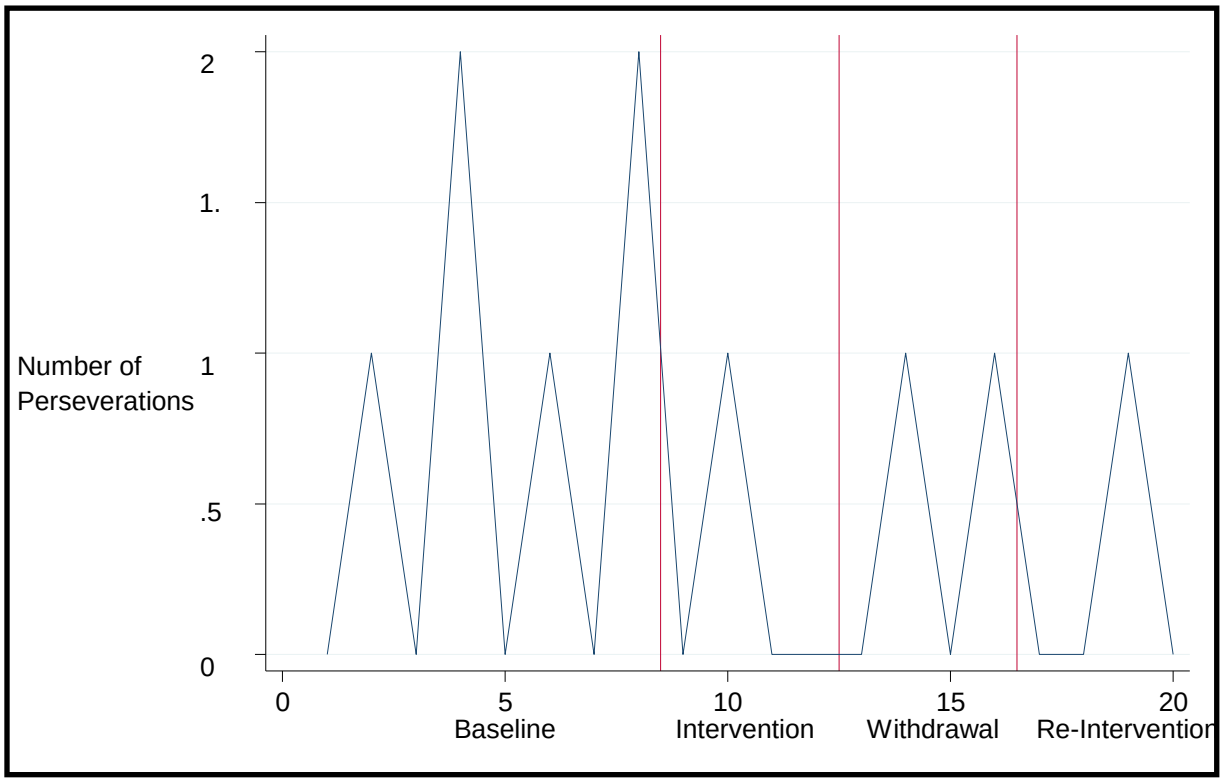

Figure 5.5 Number of perseverations during single word oral reading task at baseline, after intervention, withdrawal, and after re-intervention, Subject 3

Table 5.3. Ordinary Least Squares (OLS) regression results for models of percentage of correctly read words, number of words per minute, and AP during a reading task, by subject

	Subject 1		**Subject 2**		**Subject 3**	
	b	*t*	*b*	*t*	*b*	*t*
Percentage of correctly read words						
Constant (baseline)	3.75	3.70**	91.88	41.27***	75.63	35.02***
Intervention [+]	2.5	1.43	3.13	0.81	1.88	0.50
Withdrawal [-]	-3.75	-1.85*	-6.25	-1.40	5.00	1.16
Re-Intervention [+]	2.5	1.23	7.5	1.68	-0.00	1.00
N	20		20		20	
R^2	0.20		0.18		0.25	
Number of words per minute						
Constant (baseline)	0.14	3.69**	14.11	10.35***	14.551	4.52***
Intervention [+]	0.11	1.47	5.75	2.44*	-0.67	-0.41
Withdrawal [-]	-0.16	-1.94*	-7.11	-2.61**	-1.05	-0.56
Re-Intervention [+]	0.09	1.16	7.73	2.83**	1.80	0.96
N	20		20		20	
R^2	0.21		0.47		0.08	
Number of perseverations while reading						
Constant (baseline)	7.75	12.37***	0.50	2.03	0.75	3.00**
Intervention [-]	-0.00	-0.00	-0.50	-1.17	-0.5	-1.15
Withdrawal [+]	1.25	1.00	0.50	1.02	0.25	0.50
Re-Intervention [-]	1.00	0.80	-0.25	-0.51	-0.25	-0.50
N	20		20		20	
R^2	0.25		0.09		0.11	

(Table 5.3 continued)

	Subject 1		Subject 2		Subject 3	
	b	*t*	*b*	*t*	*b*	*t*
AP						
Constant (baseline)	--	--	--	--	0.73	7.05***
Intervention [+]	--	--	--	--	0.10	0.54
Withdrawal [-]	--	--	--	--	-0.08	-0.36
Re-Intervention [+]	--	--	--	--	0.17	0.81
N	20		20			20
R^2	--		--			0.07

(* $p < .05$; ** $p < .01$; *** $p < .001$, one tailed)

Pooled by subjects When the data were pooled across subjects, there was a significant positive effect of intervention on the percentage of correctly read items during both intervention phases $t = 1.78$, $p < .05$ and $t = 1.79$, $p < .05$, respectively, and a significant negative effect during the withdrawal phase $t = -1.72$, $p < .05$.

There was no significant effect of intervention on the number of words per minute during both intervention phases $t = 0.48$, $p = .32$ and $t = 1.04$, $p = .15$, respectively, nor during the withdrawal phase $t = -0.94$, $p = .17$.

When the data were pooled across subjects, there was no significant effect of intervention on the number of perseveration errors elicited during an oral reading task during both intervention phases, $t = -1.63$, $p = .05$ and $t = -0.44$, $p = .33$, respectively, nor during the withdrawal phase $t = 1.38$, $p = .08$.

There was no significant effect of intervention on the AP during both intervention phases $t = 0.05$, $p = .48$ and $t = 0.05$, $p = .48$, respectively, nor during the withdrawal phase $t = -0.03$, $p = .49$. Thus, our findings fail to support the working hypothesis. See Table 5.4 for the Generalized Least Squares regression results for models of percentage of correctly read words, number of words per minute, and AP during the reading task, pooled by all subjects.

5.3 Hypothesis 5 (repeated here for convenience)

The non-confrontational picture naming intervention will have a positive effect on the words per minute, proportion of anticipation and perseveration errors, and the percentage of correct information units during a picture description task among participants with moderate fluent aphasia, and this will be compared to their performance before the intervention and during withdrawal.

- Results of Hypothesis 5

This hypothesis was tested using OLS and was performed on 20 observations of data to determine if there was a significant effect of participation in a non-confrontational picture naming intervention on number of words per minute, AP, and the percentage of correct information units during a picture description task over two phases of intervention and a withdrawal phase. In addition, data were pooled by subjects and the hypothesis was tested using GLS. Type 1 error rate set at $\alpha = 0.05$. The dependent measures were number of words per minute, AP, and the percentage of correct information units.

Subject 1 Contrary to hypothesis 5, there was a significant positive effect of withdrawal from a non-confrontational intervention on the number of words per minute elicited during a picture description task at the 0.05 critical alpha level, $t = 2.73$, $p < .05$. However, there was no significant effect of intervention, $t = 0.16$, $p = .43$ and $t = -0.16$, $p = .87$, respectively.

Table 5.4. Generalized Least Squares (GLS) regression results for models of percentage of correctly read words, number of words per minute, and AP during a reading task, pooled by all subjects

	b	*t*
Percentage of correctly read words		
Constant (baseline)	3.16	3.07**
Intervention [+]	2.82	1.78*
Withdrawal [-]	-3.11	-1.72*
Re-Intervention [+]	3.23	1.79*
Subject 2	88.49	55.13***
Subject 3	74.47	45.01***
N	60	
Pseudo R^2	0.98	
Number of words per minute		
Constant (baseline)	0.89	0.17
Intervention [+]	0.38	0.48
Withdrawal [-]	-0.81	-0.94
Re-Intervention [+]	0.88	1.04
Subject 2	16.04	11.25***
Subject 3	13.77	15.56***
N	58	
Pseudo R^2	0.85	
Number of perseverations while reading		
Constant (baseline)	8.59	22.64***
Intervention [-]	-0.45	-1.63

(Table 5.4 continued)

	b	*t*
Number of perseverations while reading		
Withdrawal [+]	0.44	1.38
Re-Intervention [-]	-0.17	-0.44
Subject 2	-8.12	-21.04***
Subject 3	-7.96	-20.44***
N	60	
Pseudo R^2	0.91	
AP		
Constant (baseline)	-0.00	-0.03
Intervention [+]	0.00	0.05
Withdrawal [-]	-0.00	-0.03
Re-Intervention [+]	0.00	0.05
Subject 2	0.00	0.00
Subject 3	0.80	7.47***
N	60	
Pseudo R^2	0.85	

(* $p < .05$; ** $p < .01$; *** $p < .001$, one tailed)

("+" indicates the hypothesis predicted a positive effect of the intervention on the dependent variable and "-" indicates that the hypothesis predicted a negative effect of the intervention on the dependent variable)

There was no significant effect of intervention on the number of perseveration errors elicited during a picture description task during both intervention phases, $t = 0.06$, $p = .96$ and $t = 1.22$, $p = .24$, respectively, nor during the withdrawal phase $t = -0.19$, $p = .85$ (Figure 5.6). There is no variation in the dependent variable, anticipatory proportion, and, therefore, an analysis is not appropriate.

There was no significant effect of a non-confrontational picture naming intervention on percentage of correct information units (CIU) at the 0.05 critical alpha level during intervention, $t = 1.34$, $p = .10$ and $t = -1.75$, $p = .10$, respectively, nor was it significant during the withdrawal phase, $t = 0.09$, $p = .93$.

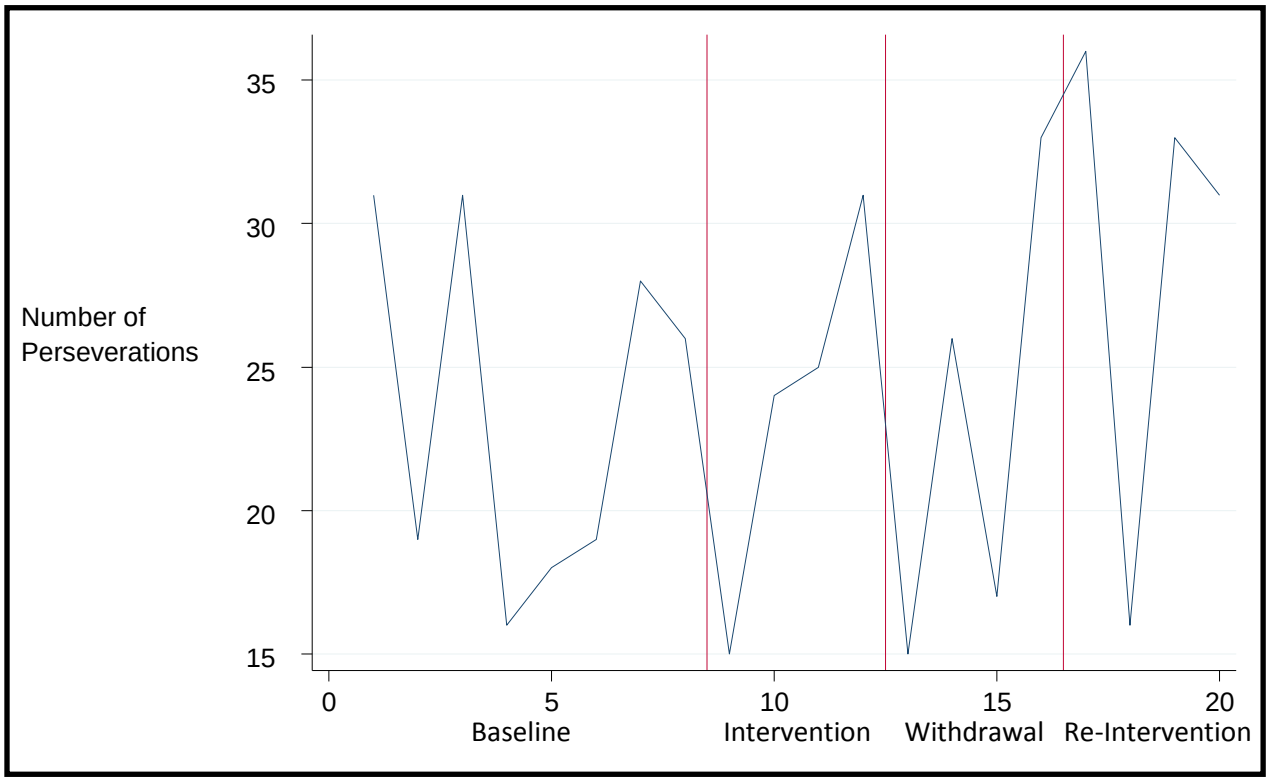

Figure 5.6 Number of perseverations during picture description task at baseline, after intervention, withdrawal, and after re-intervention, Subject 1

Subject 2: There was no significant effect of a non-confrontational picture naming intervention on number of words per minute during a picture description task at the 0.05 critical alpha level during intervention, t = -0.49, p =.63 and t = 0.42, p= .34, respectively, nor was it significant during the withdrawal phase, t = -0.64, p =.27.

There was no significant effect of the non-confrontational picture naming intervention on percentage of correct information units (CIU) during a picture description task at the 0.05 critical alpha level during intervention, t = 0.85, p =.20 and t = -0.42, p= .68, respectively. Neither was it significant during the withdrawal phase, t = 0.16, p =.88. There was no significant effect of intervention on the number of perseveration errors elicited during a picture description task during both intervention phases, t = -1.22, p = .12 and t = -0.83, p = .21, respectively. Nor did this hold during the withdrawal phase t = 1.28, p = .11 (Figure 5.7). There is no variation in the dependent variable, anticipatory proportion. Again, therefore, an analysis was not appropriate.

Subject 3 With this subject there was a significant positive effect of a non-confrontational picture naming intervention on AP during a picture description task at the 0.05 critical alpha level during the first intervention phase, t = 2.11, p < .05. But, there was no significant effect during the second intervention, t = -1.49, p= .16, nor during the withdrawal phase, t = -0.81, p =.22. There was no significant effect of intervention on the number of perseveration errors elicited during a picture description task during both intervention phases, t = -1.49, p = .08 and t = 0.50, p = .62, respectively, nor during the withdrawal phase t = 0.33, p = .37 (Figure 5.8).

There was a significant positive effect as well of the non-confrontational picture naming intervention on percentage of CIU during a picture description task at the 0.05 critical alpha level during the first intervention phase, t = 2.24, p < .05. However, there was no significant effect of

intervention during the second phase of intervention t = 1.18, p= .13, nor during the withdrawal phase, t = -0.38, p =.36. There was no significant effect of a non-confrontational picture naming intervention on number of words per minute during a picture description task at the 0.05 critical alpha level during intervention, t = 0.61, p =.27 and t = 0.46, p= .32, respectively, nor was it significant during the withdrawal phase, t = -0.19, p =.43

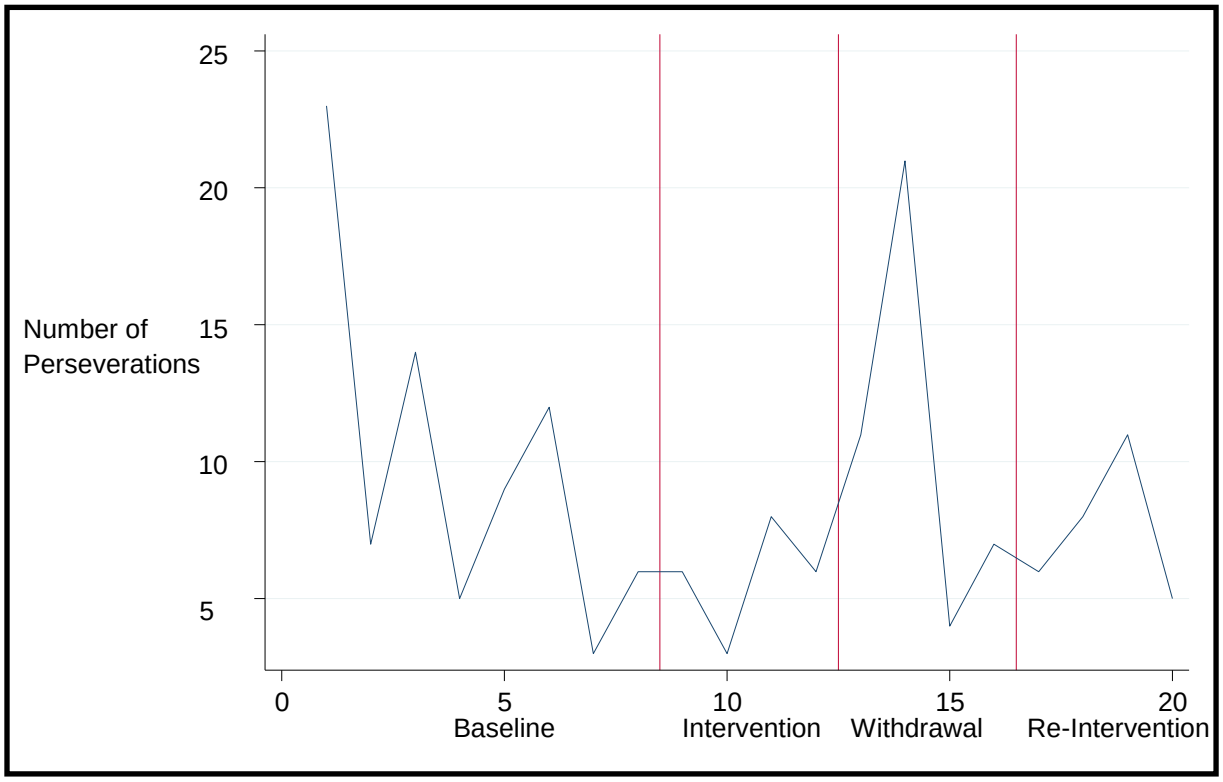

Figure 5.7 Number of perseverations during picture description task at baseline, after intervention, withdrawal, and after re-intervention, Subject 2

- Summary of Results for Hypothesis 5, by Subject

Subject 1 possibly demonstrated a significant positive effect from withdrawal of intervention or from delayed effect of the intervention during B1 on number of words per minute during a picture description task. Subject 3 demonstrated possible significant lasting positive effects from the intervention on AP and percentage of CIU during B1 demonstrated by better performance in comparison to his performance during A1, A2, and B2. Subject 2 demonstrated

no significant effects on any of the dependent variables. There was no significant effect of a picture naming intervention on the number of perseverations during an oral reading, repetition, and picture description task for all three subjects. Thus, we fail to reject the null hypothesis for subjects 1 and 2, and thereby fail to find support for the working hypothesis for subject3. See Table 5.5 for the Ordinary Least Squares regression results for models of number of words per minute, AP, and percentage of correct information units (CIU) during a picture description task for each subject.

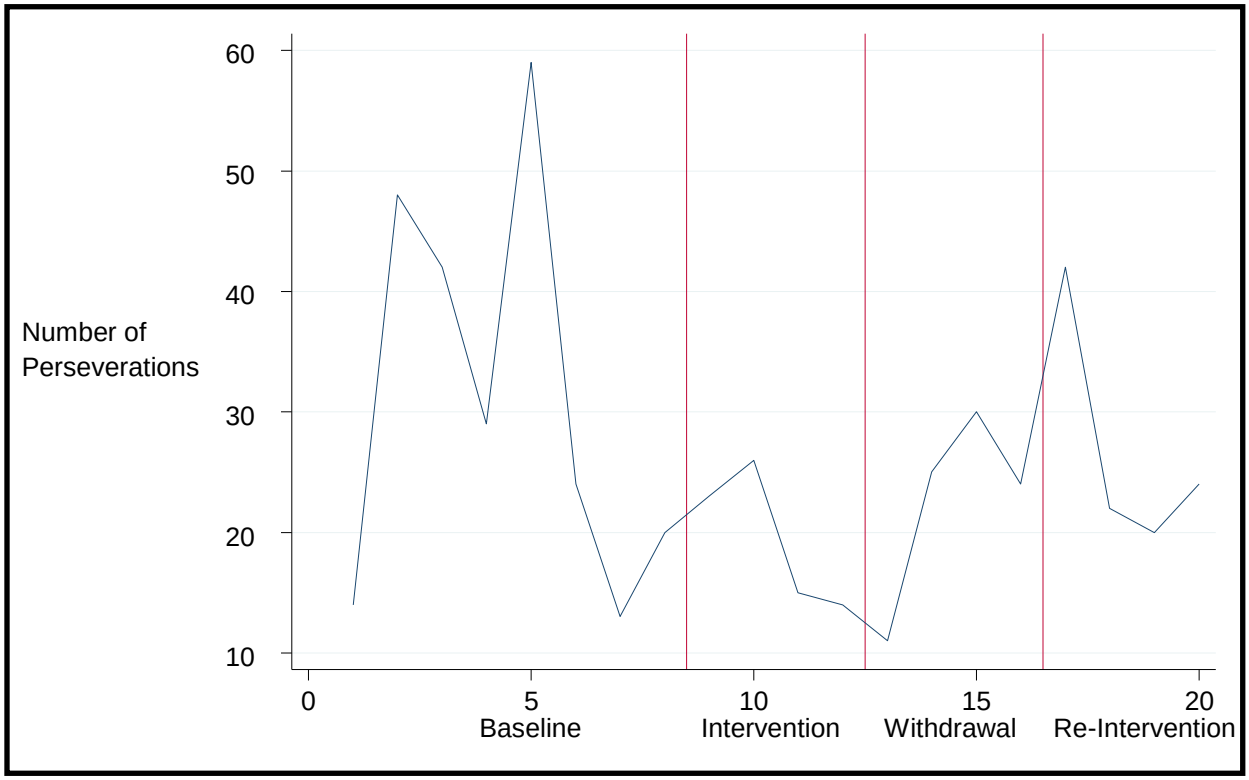

Figure 5.8 Number of perseverations during picture description task at baseline, after intervention, withdrawal, and after re-intervention, Subject 3

Pooled by subjects When the data were pooled across subjects there was a significant positive effect of a non-confrontational picture naming intervention on percentage of CIU during a picture description task at the 0.05 critical alpha level during the first intervention phase, t =

2.85, $p < .01$. However, there was no significant effect of intervention during the second phase of intervention $t = -0.77$, $p = .44$, nor during the withdrawal phase, $t = -0.14$, $p = .45$.

There was no significant effect of intervention on the number of words per minute elicited during a picture description task during both intervention phases $t = 0.16$, $p = .44$ and $t = 0.70$, $p = .24$, respectively, nor during the withdrawal phase $t = 0.47$, $p = .64$.

There was no significant effect of intervention on the number of perseveration errors elicited during a picture description task during both intervention phases, $t = -1.55$, $p = .06$ and $t = 0.21$, $p = .83$, respectively, nor during the withdrawal phase $t = 1.13$, $p = .13$. There was no significant effect of intervention on the AP during both intervention phases, $t = 0.03$, $p = .49$ and $t = -0.14$, $p = .89$, respectively, nor during the withdrawal phase $t = -0.0$, $p = 1.0$. Thus, we fail to find support for the working hypothesis. See Table 5.6 for the Generalized Least Squares (GLS) regression results for models of number of words per minute, AP, and Percentage CIU during a picture description task, pooled by all subjects.

5.4 Discussion of Results for Hypotheses 3, 4, and 5 (repeated here for convenience)

The non-confrontational picture naming intervention will have a positive lasting effect on the percentage of correctly repeated items, number of words per minute, and AP during a repetition, reading, and picture description tasks among participants with moderate fluent aphasia compared to their repetition, oral reading, and picture description ability before the intervention and during withdrawal.

Although picture naming is a reliable and sensitive measure of word finding ability (Nettleton & Lesser, 1991), it is open to criticism on the grounds of limited generalization and functionality (Howard, 2000). In this study, the results suggested that the effect from a relatively small amount of word retrieval intervention was not always restricted to the speech process undergoing

treatment (i.e., picture naming). When the data were pooled for all three subjects, the preliminary results indicated possible lasting positive effects of a picture naming intervention on repeating words accurately and on the percentage of correct information units elicited during a picture description task during B1 as demonstrated by better performance compared to A1, A2, and B2. In addition, the intervention possibly had lasting effects on oral reading performance during B2 because the performance scores significantly decreased when the intervention was withdrawn and then increased when the intervention was re-introduced. These findings could be explained by the view that when the clinician provided semantic and/or phonemic cues during the picture naming intervention, the subjects possibly (1) changed or strengthened the links between the semantic and phonological representations (Cohen & Dehaene, 1998; Howard, 2000; Papagno & Basso, 1996, Schwartz, Dell, Martin, Gahl, & Sobel, 2006); (2) changed the process or strategy the subjects utilized for accessing the word (Best et al, 2006); and/or (3) repaired damage to lexical representations (Basso, 2004). However, caution should be used interpreting these results because the repetition, oral reading and picture description tasks were subjected to the same confounding variables that existed during the picture naming intervention (i.e., repeated exposure to the tasks, inherent activation of semantic and phonological processes during repetition, oral reading of the same words presented in the picture naming task, independent practice between treatment sessions, and probable subject variance of pre-therapy semantic and/or phonological deficits). Hence, it is difficult to ascertain from this study which variables contributed to shaping the accurate and efficient responses on untreated language processes.

Further, intervention effects were expected to have lasting negative effects on the number of perseveration errors elicited during repetition, reading, and picture description tasks by all

subjects. The results of this study were not highly consistent with this prediction. The coefficient for perseveration during B1 and B2 is negative for Subjects 2 and 3; however, none were statistically significant. Among Subjects 2 and 3, it appears that after they participated in a picture naming therapy they had a decrease in the number of recurrent verbal perseverations during repetition, reading, and picture description. However, at best this is a "trend," where the correlation is not particularly strong. It would still boost the AP however, but that boost would certainly not reach statistical significance.

Table 5.5. Ordinary Least Squares (OLS) regression results for models of number of words per minute, AP, and percentage of correct information units (CIU) during a picture description task, by Subject

	Subject 1		**Subject 2**		**Subject 3**	
	b	*t*	*b*	*t*	*b*	*t*
Number of words per minute						
Constant (baseline)	115.02	23.48***	92.85	26.94***	99.93	31.10***
Intervention [+]	1.37	0.16	-2.90	-0.49	3.41	0.61
Withdrawal [-]	26.75	2.73†	-4.41	-0.64	-1.20	-0.86
Re-Intervention [+]	-1.58	-0.16	2.87	0.42	2.99	0.46
N	20		20		20	
R^2	0.53		0.09		0.06	
Number of perseverations while describing a picture						
Constant (baseline)	23.5	9.15***	9.88	5.06***	31.13	6.92***
Intervention [-]	0.25	0.06	-4.13	-1.22	-11.63	-1.49
Withdrawal [+]	-1.0	-0.19	5.00	1.28	3.00	0.33
Re-Intervention [-]	6.25	1.22	-3.25	-0.83	4.50	0.50
N	20		20		20	

(Table 5.5 continued)

	Subject 1		Subject 2		Subject 3	
	b	*t*	*b*	*t*	*b*	*t*
Number of perseverations while describing a picture						
R^2	0.11		0.12		0.14	
AP						
Constant (baseline)	--	--	--	--	0.05	2.30
Intervention [+]	--	--	--	--	0.07	2.11*
Withdrawal [-]	--	--	--	--	-0.03	-0.81
Re-Intervention [+]	--	--	--	--	-0.06	-1.49
N	20		20		20	
R^2	--		--		0.30	
Percentage of CIU						
Constant (baseline)	23.51	10.94***	64.84	16.95***	33.17	12.98***
Intervention [+]	4.97	1.34	5.66	0.85	9.92	2.24*
Withdrawal [-]	0.40	0.09	1.23	0.16	-1.92	-0.38
Re-Intervention [+]	-7.51	-1.75	-3.23	-0.42	6.00	1.18
N	20		20		20	
R^2	0.23		0.08		0.43	

(*= $p < .05$; **= $p < .01$; *** = $p < .001$, one tailed; †= $p < .05$; ††= $p < .01$; ††† = $p < .001$, two tailed)

Table 5.6. Generalized Least Squares (GLS) regression results for models of number of words per minute, AP, and Percentage CIU during a picture description task, pooled by all subjects

	b	*t*
Number of words per minute		
Constant (baseline)	124.0	27.97***
Intervention [+]	0.66	0.16
Withdrawal [-]	2.23	0.47
Re-Intervention [+]	3.33	0.70
Subject 2	-36.20	-7.37***
Subject 3	-24.04	-5.25***
N	60	
Pseudo R^2	0.62	
Number of perseverations while describing a picture		
Constant (baseline)	25.29	14.18***
Intervention [-]	-3.57	-1.55
Withdrawal [+]	3.03	1.13
Re-Intervention [-]	0.56	0.21
Subject 2	-15.74	-8.60***
Subject 3	1.83	0.64
N	60	
Pseudo R^2	0.48	
AP		
Constant (baseline)	0.00	0.02
Intervention [+]	0.00	0.03
Withdrawal [-]	0.00	0.00

(Table 5.6 continued)

	b	*t*
AP		
Re-Intervention [+]	-0.00	-0.14
Subject 2	0.00	0.00
Subject 3	0.06	1.92
N	60	
Pseudo R^2	0.44	
Percentage of CIU		
Constant (baseline)	21.59	13.04***
Intervention [+]	6.94	2.85**
Withdrawal [-]	-0.39	-0.14
Re-Intervention[+]	-2.19	-0.77
Subject 2	43.01	18.06***
Subject 3	14.38	7.28***
N	60	
Pseudo R^2	0.84	

(* $p < .05$; ** $p < .01$; *** $p < .001$, one tailed)

("+" indicates the hypothesis predicted a positive effect of the intervention on the dependent variable and "-" indicates that the hypothesis predicted a negative effect of the intervention on the dependent variable)

5.5 Summary

This study aimed to evaluate the usefulness of a therapeutic approach among subjects with chronic aphasia and word retrieval difficulties that were discharged from outpatient speech-language pathology treatments, were between seven and a half to thirteen months post onset of

their stroke, and were not receiving intervention from other programs. Beginning steps towards showing that a non-confrontational intervention approach for this population can have positive effects in a relatively short period of intervention without exposing individuals to repeated requests to volitionally control their unintended perseverative responses were demonstrated. Some researchers propose therapy should be motivated by an analysis of the client's impairment(s) to distinguish phonological versus semantic deficits (Nettleton & Lesser , 1991). However, rarely in clinic do we see clients that present with isolated impairments. The nature of the deficit is not specified in this study. Rather, to accommodate all subjects that may present with phonological and/or semantic impairments, all subjects were presented with randomized phonological and semantic facilitation cues including (1) open-ended constraining sentence, (2) a phonemic cue of the initial phoneme of the target word, (3) and/or an auditory cue that was the same as the target item.

The study also demonstrated, although inconsistently across subjects, that the non-confrontational picture naming intervention made a difference not only on word retrieval ability during picture naming but also on performance of other untreated speech tasks immediately following the picture naming intervention. These findings provide preliminary evidence of intervention generalization to untreated language processes. Caution is necessary in comparing the subjects in this study with other subjects. All of the subjects had a stroke involving the left cerebral hemisphere and a Western Aphasia Battery-Revised Aphasia Quotient (Kertesz, 2006) that was in the moderate fluent aphasia range. Similar changes may not be expected for adults with strokes involving bilateral hemispheres, greater aphasia severity, or with non-fluent aphasia. Nonetheless, the results of this study highlight the potentially considerable theoretical relevance of non-confrontational naming intervention effects in informing larger debates about the

essential nature of a parsimonious intervention that is effective in decreasing perseveration responses and promoting language recovery.

CHAPTER 6
CONCLUSION

It is estimated that approximately one million people in the United States suffer from aphasia (National Institute of Neurological Disorders and Stroke [NINDS], 2010) and that between 50%-93% of those people may demonstrate recurrent perseverative behavior (Basso, 2004; Helm-Estabrooks, Emery, & Martin, 1987; Santo Pietro & Ridrodsky, 1986; Yamadori, 1981). Yet, no consensus has been forthcoming on whether (1) a therapy that directly confronts the client with imminent pre-articulatory automatisms (the perseverations) (e.g., TAP) or (2) a more typical neuropsychological therapy that eschews any direct confrontation with automatic behaviors is most efficacious for eradicating recurrent perseveration elicited during speech tasks by people with fluent aphasia. The current study was motivated to provide experimental evidence regarding the effects of a non-confrontational picture naming intervention on naming ability. In the spirit of the continuity hypothesis (Dell et al., 1997b), we investigated the impact of the intervention on perseveration and anticipation errors elicited during naming. Finally, analysis of generalization effects to other speech responses was conducted to examine the efficacy of the intervention.

The spirit of this reasoning is that since slips-of-the-tongue in normalcy are marked by a significantly larger number of anticipatory errors than of perseverative errors. An increase in the AP ratio throughout recovery from aphasia indicates that the patients are approaching normalcy, which of course is the goal of intervention in the clinic. The continuity hypothesis places paraphasias and slips-of-the-tongue on a quantitative scale, an idea that goes back to Herbert Spencer, Hughlings-Jackson, Sigmund Freud and William James (Menand, 1998).

According to the results of this study, we can infer that all subjects demonstrated an immediate increase in naming ability and a decrease in perseveration errors with the non-

confrontational intervention. Interestingly, significant differences were seen among subjects and how they responded to therapy; this warrants further discussion. In chapters four and five we discussed at length the level of statistical significance associated with the various coefficients in our models. We identified and sorted through the substantive effect that the intervention has on each dependent variable and on each subject on the assumption that this would also be clinically relevant. One way we examine the effect of a behavioral intervention was to quantify its *relative* effect on the dependent variables. Measures of relative effects express the effect of each independent variable relative to the total range on the dependent variable. The relative effect of the intervention on the dependent variables in our study is calculated by using the following equation:

-Relative effect = b/range.

Where b is the unstandardized regression coefficient for the variable associated with the initial intervention variable and the range is the difference between the maximum and minimum values on the dependent variable. The use of this measure is designed to capture the share of the total range in the dependent variable that is "explained" by the effects of the first intervention on the dependent variable. For instance, if the range on the dependent variable is 10 and the coefficient for the intervention variable is 2.00, the effect of the intervention variable on the dependent variable represents 20% (i.e., 0.20) of the range in that dependent variable.

The first intervention phase should arguably contain the "purest" effect of the intervention due to the fact that the subjects had only been exposed to baseline testing prior to the intervention. Subsequently, there is limited contamination of the subjects' responses from practice or carry-over effects. Consequently, it is appropriate to examine the phase with the least contamination to obtain the relative effects of the intervention. We will conclude with each

subject's top six largest relative effects of the intervention on various speech tasks. The reader should refer to Appendix H for the details of the relative effects of the intervention on each dependent variable after the first intervention phase for each subject and for the results when all three subjects were pooled.

Subject 1 demonstrated a (1) negative effect on number of words per minute while naming; (2) negative effect on percentage of correctly named items; (3) positive effect on percentage of correct information units while describing a picture; (4) positive effect on the number of words per minute while repeating; (5) positive effect on percentage of correctly read words; and (6) positive effect on the number of words per minute elicited while reading.

Subject 2 demonstrated a (1) positive effect on percentage of correct information units while describing a picture; (2) negative effect on the number of perseverations elicited while naming; (3) negative effect on the number of perseverations elicited while describing a picture; (4) positive effect on the number of words per minute while naming; (5) positive effect on the number of words per minute while reading; and (6) positive effect on the number of words per minute while repeating.

Subject 3 demonstrated a (1) negative effect on the number of perseverations while naming; (2) positive effect on the percentage of correctly repeated words; (3) negative effect on the number of perseverations elicited while describing a picture; (4) positive effect on the anticipatory proportion while naming; (5) negative effect on the number of perseverations while repeating; and (6) positive effect on the number of words per minute while naming.

When the data were **pooled**, there was a (1) negative effect on the number of perseverations during naming; a (2) positive effect on percentage of correct information units

while describing a picture; a (3) negative effect on the percentage of correctly named items; (4) positive effect on the percentage of correctly repeated words; a (5) negative effect on the number of perseverations elicited while describing a picture; and a (6) positive effect on the number of words per minute elicited while repeating.

6.1 Limitations of the Study

Although the present study provided evidence regarding the efficacy of a non-confrontational picture naming intervention as a strategy to improve speech accuracy and efficiency, it has limitations that should be acknowledged. Four important limitations include (1) use of a small sample size that shared a similar profile, (2) lack of an analysis of conversational speech (3) lack of a comparison of the effects of using clinician selected therapy items versus subject selected therapy items, and (4)we did not compare intensive versus non-intensive therapy dosage.

The most obvious limitation was the small number of subjects. In considering the effectiveness of aphasia therapy, there has been much debate over which one is appropriate (Howard, 1986; Robey, 1998; Robey, Schulz, Crawford, & Skinner, 1999). Once again, Schwartz and Dell (2010) have advocated the use of case-series design to complement single-subject techniques. Case-series allow for analysis of changes that occur with intervention related to individual deficits and strengths, and they test for trends and the efficacy of intervention among a number of different individuals (Schwartz & Dell, 2010). Only three subjects were used in this study and only one participant produced anticipation errors during the experiment, allowing AP to be calculated. The other two patients produced perseverations exclusively, but alas, zeros do not compute well in equations, as we all know. Therefore, the results cannot be generalized to a larger population. To make matters worse, all three participants shared the same

profile. That is (1) they all had a stroke that only involved the left hemisphere, (2) they all had a Western Aphasia Battery-Revised Aphasia Quotient (Kertesz, 2006) that was in the moderate fluent aphasia range, (3) they suffered a stroke within seven to thirteen months from the initiation of therapy, and (4) they had relatively low NIH Stroke Scale Scores.

Picture naming is a reliable and sensitive measure of word finding ability (Nettleton & Lesser, 1991); however, it is open to criticism on the grounds of limited functionality (Howard, 2000). In this study, it appeared that the effect the intervention had was not always restricted to what was targeted in the treatment. It is not unreasonable to suspect that some of these recondite effects may have had a positive effect on picture description responses. Many have claimed on the other hand that picture description is not representative of most daily communicative interactions (Snow & Douglas, 2000). According to principles of adult learning theory, adults are internally motivated to learn those things that will help them cope effectively with real-life situation (Knowles, Holton, & Swanson, 1998; Merriam & Cafarella, 1999). Self-narrative (storying of self) or conversational speech with analysis of anticipation and perseveration errors, type of errors related to the stimulus, and percentage of content information units would be important to test generalization to life participation (Shadden & Hagstrom, 2007).

Another principle of adult learning suggests that adults learn best when they, themselves, take responsibility for defining what they want to learn (Knowles, Holton, & Swain, 1998; Merriam & Cafarella, 1999). Although the results of the present study suggest that a non-confrontational picture naming intervention with clinician selected therapy items improved picture naming performance, further research using a control group (e.g., subject selection of therapy items) to more powerfully determine the efficacy of appropriate therapy materials is warranted.

In our study, all three subjects received approximately 8 hours of direct intervention during 2 months and demonstrated an improvement in their picture naming accuracy and a significant decrease in perseverative errors. According to the National Outcomes Measurement System Report (2011), intensive intervention (measured by hours of treatment) brings about better functional outcomes for patients with stroke and aphasia. For example, bringing a patient to a Level 7 (the rating associated with the highest level of independence participating in a full range of activities), requires an average of 13.4 hours of treatment per month. However, until this study is replicated with a control group (e.g., typical intervention intensity vs. intensive intervention), any conclusions about intensive word retrieval intervention as superior, worse than, or the same as non-intensive treatment are premature.

6.2 Future Studies

In the present work, we interpret these results as supporting a non-confrontational picture naming intervention to promote errorless speech and eradicate perseveration errors when clients with moderate fluent aphasia name pictures. Each subject responded differently to the picture naming intervention, as demonstrated by inconsistent generalization effects to other speech tasks. These differences were possibly due to significantly dissimilar pre-intervention semantic and phonological abilities and/or diverse specific deficits of the underlying functional damage. A rarely noted logistical aspect of testing for perseveration versus anticipation is that only within the response to some one stimulus item or during spontaneous speech, scene description and the like can both perseveration and anticipation errors occur. An obvious bias is found in studies of perseveration across different stimulus presentations. No client could possibly anticipate an element that he or she might produce to some subsequent stimulus. This is to say, only perseverations can be observed on both sides of some stimulus. Lexical anticipation may be seen

within the confines of the planned units for producing a sentence or phrase as a response to some stimulus. Anticipation to stimulus 1 cannot logically be brought over from a lexical item that may be produced in response to stimulus 2. One may carry over phonemes from responses to item 1 in the response to item 2, but one cannot logically anticipate any phonemes when responding to item 1, which might be produced in response to item 2.

Further data analysis should be conducted with the data from subject 3 of this study to corroborate the AP by sorting through the perseveration errors to determine the frequency of cross stimulus versus within stimulus errors. Subsequently, researchers should analyze the within stimulus effects of the intervention on the AP (anticipation errors/anticipation + within stimulus perseveration errors) for subject 3. In addition, sorting through and analyzing the types of errors (semantic versus phonemic) elicited by all of the subjects may shed further light on why each subject had varied responses to the intervention. Doing this would be expected to craft more precise interventions to each individual's underlying language impairment.

Future research replicating this study using a larger population of adults with aphasia with different profiles that demonstrate both anticipation and perseveration errors during picture naming and conversational speech (such as storying of self or conversational speech) is needed to test generalization and efficacy of the intervention. In addition, a future study could add a control group (e.g., where subjects select therapy items, themselves) which may help to determine the efficacy of appropriate therapy materials is warranted.

When replicating the study, researchers may also consider using equally spaced time intervals (e.g., 12 observations for each phase), expanding the intervals to encompass at least 12 observations versus 4 observations, and omitting A2 and B2 phases. Expanding the time interval would not only increase the statistical power of the study but it would also address the questions

of whether an individual benefits from protracted therapy (e.g., >13 hours per month as proposed by ASHA NOMS). The rationale for omitting A2 and B2 phases stems from the burden of the withdrawal phase reported by all three subjects. Each subject completed a brief informal interview with the Co-PI that addressed their perception of the study design. All three subjects reported a preference to continue with the intervention rather than "withdrawing" and waiting for the re-intervention.

Moreover, the AP may have additional applications in pathologies that go beyond those we have discussed in this dissertation - aphasia and its amelioration. In our literature chapter we cited the one study that has been done that traced severe perseveration and its resolution as the effects of the sodium amytal drained from the system. The AP was a powerful correlate with improvement here. We have initiated pilot investigations of the frequency of recurrent verbal perseverations (blended and total) within verbal fluency tasks (semantic and phonemic) after 4 collegiate athletes suffered concussions during February 2011-September 2011. Preliminary results suggested that the collegiate athletes demonstrated a high frequency of whole word and blended perseverations while completing verbal fluency tasks (also called "generative naming") during the initial phases of recovery. Subsequent testing suggested that each athlete demonstrated various recovery rates, defined as eradication or decrease of perseverative errors. Possible factors contributing to recovery rates include but are not limited to intervention, age, sex, education, and history of concussions. Further studies should identify anticipatory errors within verbal fluency tasks to investigate the applicability of the AP in measuring neurocognitive recovery this kind of after acute brain trauma, specifically among athletes who endure one and/or repeated concussions. Further research should also evaluate collegiate athletes' AP during verbal fluency tasks pre-participation to establish normative data.

In addition, further research should examine the athlete's pre-concussion abilities and history to contribute to the discussion as to why each demonstrated various recovery rates. Perhaps, the AP may ultimately become a valuable asset in the clinician's toolkit that will contribute evidence pertaining to the athlete's neurocognitive status to team physicians in a relatively efficient manner. In the future, the AP may contribute to and supplement the clinical decisions regarding the safe return of athletes to his or her sport.

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APPENDIX A
RECRUITMENT INVITATION

Official Title: A single-subject study examining the effects of a behavioral intervention for verbal recurrent perseveration.

Study Purpose: "In this study researchers are examining the effectiveness of a speech-language therapy for verbal perseveration experienced by individuals with stroke-induced aphasia. We hypothesize that the treatment will lead to improvements in speech production."

"Is this something you may be interested in?"

A) If participant responds "Yes" **VERIFY INCLUSION/EXCLUSION CRITERIA.**
B) If the participant responds "No" "Thank you for your time. In case you may change your mind or have further questions, please feel free to contact Jenifer Juengling-Sudkamp at telephone # 504 491 4794 or email: jjueng1@lsu.edu)."

Inclusion Criteria: If NO is circled below, PATIENT INELIGIBLE	Exclusion Criteria: If YES is circled below, PATIENT INELIGIBLE
A neurologists' diagnosis of stroke with the insult involving the left hemisphere greater than 6 months ago. Y N	A history of other neurological, psychiatric, or language impairments other than those associated with left hemisphere stroke Y N
A National Institute of Health Stroke Scale [NIHSS] Total Score of 3-15[a] Y N	Receiving speech-language therapy Y N
9 years or greater of education Y N	Left-handed or familial history (parents/siblings) of left handedness Y N
Right-handed Y N	
Displaying full word or phonemic Perseverative speech errors during SPEECH Y N	
Living in the community Y N	
Native English speaker Y N	
Hearing acuity sufficient to follow directions Y N	
Visual acuity sufficient to read large print Y N	
18 to 89 years old Y N	

If participant meets inclusion/exclusion criteria, obtain Consent of participant or responsible party to release contact information to the Co-PI (Jenifer Juengling-Sudkamp):

"May I give Jenifer Juengling-Sudkamp your contact information so she may contact you by telephone to discuss the details of the study with you?" **Obtain contact information and distribute to Jenifer Juengling-Sudkamp (504-491-4794 or email: jjueng1@lsu.edu).**

"In case you would like to contact her with any questions, her contact information is (phone: 504 491 4794 or email: jjueng1@lsu.edu)."

OR

If he/she responds "No": "Thank you for your time. In case you may change your mind or have further questions, please feel free to contact Jenifer Juengling-Sudkamp at telephone # 504 491 4794 or email: jjueng1@lsu.edu)."

If the participant does not meet inclusion/exclusion criteria, "Unfortunately you are not eligible for the study based on its inclusion and exclusion criteria. If you are not receiving speech therapy services and would like to please let me know so I may write a prescription and/or referral for the service. You may contact any service provider you wish or one that is covered by your medical care plan/insurance to receive services.

NIH Stroke Scale Cut-Off Ranges

Stroke Scale Item	Stroke Scale Category	Eligibility Cutoff Ranges
1a	Level of Consciousness	0
1b	Level of Consciousness Questions	0-2
1c	Level of Consciousness Commands	0-2
2	Best Gaze	0-1
3	Visual	0-1
4	Facial Palsy (Right side)	0-1
5a	Motor Arm Left Arm	0
5b	Motor Right Arm	0-2
6a	Motor Left Leg	0
6b	Motor Right Leg	0-1
7	Limb Ataxia	0
8	Sensory	0-1
9	Best Language	1-2
10	Dysarthria	0-1
11	Extinction and Inattention	0-1

From "Measurements of acute cerebral infarction: A clinical examination scale" by T. Brott , H. P. Adams, C. P. Olinger, J. R. Marler, W.G. Barsan, J. Biller, et al. 1989, *Stroke, 20*(7) p. 865.

Telephone Script for Scheduling Initial Visit

Hi Mr./Mrs._____ thank you for your interest in participating in our study. My name is Jenifer Juengling-Sudkamp and I will be coordinating your initial visit. We will ask that you participate in a consent process prior to proceeding with your participation in the study. If you agree to participate in the study, we will discuss a date and time that is convenient for you to complete an aphasia test and picture naming task during your initial visit to determine if you are eligible to participate.

Is there a particular day or time that is convenient for you to participate in the consent process?

NO: Proceed with scheduling.

YES: Okay, I will make every attempt to accommodate your schedule. Proceed with scheduling appointment.

Circle Appointment Location:

Participant's Home Address _____

or

Tulane Medical Center

Date:_____ Time:_____

Instructions for initial visit: If you use reading glasses and/or hearing aids please bring them with you. If patient receiving services at Tulane Medical Center: Remember to bring your parking pass so we can validate it.

Do you have any questions at this moment?

Thank you for your time today as well as your willingness to be a part of our study. Please to not hesitate to contact me if you have any further questions or concerns. Again, my name is Jenifer Juengling-Sudkamp and I can be reached at 504-491-4794. I will follow up with you the day before your appointment to confirm that you are still able to make it. Thank you for your time and I look forward to meeting you.

APPENDIX B
STIMULI TO DETERMINE HANDEDNESS

	Which hand do you prefer for:		
1	Writing	Left	Right
2	Throwing	Left	Right
3	Cutting	Left	Right
4	Drawing	Left	Right
5	Brushing	Left	Right
6	Using a Spoon	Left	Right

From "Aphasia and associated disorders: Taxonomy, localization, and recovery," by A. Kertesz, 1979, p. 56. Copyright 1979 by Grune & Stratton.

APPENDIX C
THE COOKIE THEFT PICTURE DESCRIPTION SCORE SHEET

# of Perseverations (TP + BP)	# of Total Perseverations (TP)	# of Blended Perseverations (BP)	# of Anticipation	# of words	# CIU

APPENDIX D
NAMING, ORAL READING, AND REPETITION SCORE SHEET

Target	Response	Ant	TP/ BP	Lexical errors: (target relation) Sem, For, Mix, or UR	Non-lexical errors (target relation): PH or Neo	Other errors: DNK or DC

Per=Perseveration, Ant=Anticipation, NS=Non-sequential shift; T=Total, B=blended; Sem=Semantic, For=Formal, Mix=Mixed, UR=Unrelated; PH=phonological, Neo=Neologistic; DK=Don't Know, DC=Description

APPENDIX E
STIMULI

Stimuli used for picture naming, oral reading, and repetition tasks.
(* trained items during picture naming intervention)

Subject 1	Subject 2	Subject 3
*****green	butterfly	*****orange
orange	*beetle	*white
digging	*penguin	drinking
drinking	kangaroo	writing
sleeping	deer	juggling
*tiger	*leopard	laughing
snail	raccoon	talking
*elephant	screw	whistling
*mouse	knife	painting
frog	*needle	*rhinoceros
skunk	iron	*grasshopper
*cow	*kettle	frog
] *screwdriver	*ruler	*caterpillar
*umbrella	anchor	wrench
*spoon	*pitcher	axe
*axe	ladder	*umbrella
*envelope	*chain	*chisel
48	*hanger	*screwdriver
H	*pliers	*500
W	boom	*48

APPENDIX F
RULES FOR SCORING AND COUNTING WORDS AND CORRECT INFORMATION UNITS (CIUs)

From Nicholas, L.E. & Brookshire, R.H. (1993). A system for quantifying the informativeness and efficiency of the connected speech of adults with aphasia. *Journal of Speech and Hearing Research, 36* (pp 348-350).

Prior to determining which words should be included in counts of words and correct information units, delete statements that are made before or after the speaker performs the task or suggest that the speaker is ready to begin or has finished the task and do not provide information about the picture(s) or topic itself. Such statements generally are not produced consistently by speakers from one session to another and are deleted to help stabilized counts across sessions.

· I hope I can remember how I did this before.
*** I'll start by saying this.**
· I'm supposed to tell you about washing dishes.
· I'm ready to start.
*** That's about It.**
· I can't say any more.
· The end.
*** That's about what our Sundays are like.**

These statements should be grammatically separate from discussion of the picture(s) or topic. The following first statements by a speaker would be included in the word count.

* In the first picture, the man is angry.
* Well first of all, there's a couple fighting.
* Okay, there's a man and a woman.
* Well now, here's a picture of a party.

This does not include commentary on the task or on the speaker's performance that occurs while the speaker is discussing the picture(s) or topic. (See 1.22 for rules about commentary.)
Instructions: Draw a horizontal line through the middle of words that are to be deleted prior to making decisions about the word count.

1.0. COUNTING WORDS

Definition: To be included in the word count, words must be intelligible in context to someone who knows the picture(s) or topic being discussed. Context refers to what the scorer knows about the picture(s) or topic and what the scorer knows from the speaker's prior words. Words do not have to be accurate, relevant, or informative relative to the picture(s) or topic being discussed to be included in the word count.
Instructions: Cross out with red Xs words that are not to be included in the word count.

RULES FOR COUNTING WORDS

1.1. DO NOT COUNT THE FOLLOWING

1.11. Words or partial words that are not intelligible in context to someone who knows the picture(s) or topic being discussed.

· He went to the **frampi.**
· That appears to be a **norble.**

·He had a **st** ... **sn** ... steak.
1.12. Nonword filler (um, er, uh). (See 1.23 and 1.24 for a rule dealing with filler words and phrases, interjections, and informal terms.)
1.2. COUNT THE FOLLOWING
1.21. All words that are intelligible in context. Count words that contain sound substitutions, omissions, distortions, or additions if the word is intelligible in context **(hiscup** for hiccup). If the incorrect production results is another real word that does not appear to be the target word, it is still included in the word count (paper for pepper).
1.22. Commentary on the task, on the speaker's performance, or on the speaker's experiences.
*** This is pretty hard.**
· I can't think of that word.
· No, that's not right.
*** My wife and I used to fight like that.**
1.23. Filler words and phrases **(you know, I mean, okay).** Do not count nonword filler. (See 1.12.)
1.24. Interjections **(oh, oh boy, wow, golly, gosh, gee, aha, hmm)** and informal terms **(uh-huh [affirmative], un-uh [negative], nope, yep, yeah).**
1.25. Common contractions or simplifications of words (gonna for **going to, sorta** for **sort of, em for them). C**ontractions (both **standard [don't, he's]** and colloquial **[gonna, sorta])** are counted as two words.
1.26. Each word in hyphenated words **Jack-in-the-box** = 4 words).
1.27. Each word in numbers **(twenty-two** = 2 words, **one hundred thirty-four** = 4 words, **nineteen fifty-five** = 3 words).
1.28. Compound words as one word **(pancake, cowboy).**
1.29. Each word in proper names **(Mary Smith, St. Paul, Mason City** = 2 words each).
1.30. Count acronyms as one word (VA, VFW, TWA = 1 word each).
2.0. COUNTING CORRECT INFORMATION UNITS (CIUs)
Definition: Correct information units are words that are **intelligible** in context, **accurate** in relation to the picture(s) or topic, and **relevant** to and **informative** about the content of the picture(s) or the topic. Words do not have to be used in a grammatically correct manner to be included in the correct information count. Each correct information unit consists of a single word and only words that have been included in the word count can be considered for inclusion in the correct information unit count.
Instructions: Put a diagonal pencilled slash through words that are not to be included in the correct information count (man).
RULES FOR COUNTING CIUs
2.1. DO NOT COUNT THE FOLLOWING
(In this section, words in **bold print** would not be counted as correct information units.)
2.11. Words that do not accurately portray what is in the picture(s) or that do not seem accurate in relation to the topic being discussed, such as incorrect names, pronouns, numbers, actions, etc. If a word reflects regional usage (such as calling the midday meal "dinner" in some areas), it is counted as a correct information unit. If grammatical
incorrectness would lead to misunderstanding or uncertainty about the meaning of words, the grammatically incorrect words would not be counted as correct information units. (See 3.12 for examples of grammatically incorrect words that would be counted as correct information units.)

*The girl s riding her bike. (The picture shows a girl with a bike nearby which she may have been riding, but which she is not currently riding.)
* The **girl** is on a **ladder. She fell.** (The picture shows a boy on a stool who is tipping but has not fallen yet.)
* The **boys** and **girls** are arriving. (The picture shows only one boy and one girl arriving.)
If several people are involved in an action and only one of them is mentioned, the mentioned one is still counted as a correct information unit. This constitutes an incomplete description but not an inaccurate one.
The boy is arriving. (The picture shows a boy and a girl arriving.)
The man drove away. (The picture shows a couple driving away.)
2.12. Attempts to correct sound errors in words except for the final attempt.
* He put **paper popper** pepper on his food.
· She saw her with her mass... **mack.** .. mask.
2.13. Dead ends, false starts, or revisions in which the speaker begins an utterance but either revises it or leaves it uncompleted and uninformative with regard to the picture(s) or topic.
·**My si . .. no no not my sister ... my fa** ... with my wife.
· He goes over to her and puts **his** wants to give her a hug.
· He looks out and sees that **she had** the car ran into the tree.
*** The** ... **the ... that one oh forget It.**
· In the hose In the mouse in the house
·We go to a **party** no I mean a movie
If an utterance is incomplete, but some information about the picture(s) or topic has been given, count that information.
* The kitchen window was ...
In this example, the words the kitchen window was would be counted as correct information units (if they meet the other criteria). Even though the entire statement was not completed, the words are informative. Words that express some legitimate uncertainty or change in perception about characters, events, or settings in a picture are counted
as correct information units (if they meet the other criteria). See 2.18 for further examples.
* Her dad or maybe a neighbor was in the tree.
* From the looks of the candles, he must be four. No there is another candle on the table so he must be five years old.
2.14. Repetition of words or ideas that do not add new information to the utterance, are not necessary for cohesion or grammatical correctness, and are not purposely used to intensify meaning.
* The **blue** truck was blue.
* The restaurant was a new one. It was a **new restaurant.**
* She was cleaning washing the dishes.
Such repetition of words or ideas can be separated by other counted words.
*The mother was very angry. The daughter was crying. The **mother was very mad.**
Exceptions:
(a) If the repeated words or ideas are necessary for cohesion, they are counted. She went to the store. The store was closed.
(b) If words are repeated to achieve effect or to intensify a statement they are counted.
* The girl was very, very sad.
* They were fighting, really fighting.

(c) If repeated words are used to expand on previous information, they are counted.
* He put on a shoe ... a left shoe.
* There were some people ... a man and a woman.
2.15. The first use of a pronoun for which an unambiguous referent has not been provided. Subsequent uses of the pronoun for the same unspecified or ambiguous referent are counted as correct information units (if they meet the other criteria).
*She (no referent) was doing the dishes. I think she was daydreaming.
If an inaccurate referent is provided but it is clear that a pronoun refers back to it, the pronoun would be counted as a correct information unit.
*The fox (inaccurate referent) ate some of the cake and it was hiding.
2.16. Vague or nonspecific words or phrases that are not necessary for the grammatical completeness of a statement and for which the subject has not provided a clear referent and for which the subject could have provided a more specific word or phrase.
* The mother is drying one of those **things.**
* She gave him some stuff.
* He put **something** up to the tree but that one knocked it down.
* We had pancakes or scrambled eggs **or something** like that.
I wash the glasses and plates **and so on.**
The words "here" and "there" frequently fall into this category.
***** Here we have a boy.
·This here boy is crying.
* That mother there is doing dishes.
* There is a cat here and a dog there.
* The mother is there.
* She put them over here.
· She has a bike there.
* The cookies were up **there.**
The following are examples of uses of "here" and "there" that are necessary for the grammatical completeness of the statement and cannot be replaced by a more specific word. These uses of "here" and "there" would be counted as correct information units.
* There is a boy.
*Here comes the same couple.
The following is an example of a nonspecific word that is preceded by a clear referent and would be counted as a correct information unit.
* The boy opened the cupboard. The cookies were up there.
2.17. Conjunctive terms (particularly **so** and **then)** if they are used indiscriminately as filler or continuants rather than as cohesive ties to connect ideas.
* There is a man. Then there is a woman and **then** a cat.
When used cohesively, "then" indicates the temporal order or sequential organization of things or events.
· She had lunch and then she went to the store.
* When you go into my house you see the living room first, then the dining room, then the kitchen.
When used cohesively, "so" indicates a casual consequence.
· He was thirsty so he drank some juice.
* The mother was after the dog so the boy was crying.

2.18. Qualifiers and modifiers if they are used indiscriminately as filler or are used unnecessarily in descriptions of events, settings, or characters that are unambiguously pictured. The following examples concern unambiguously pictured information.

· **Apparently** this is a kitchen.

* **Evidently** the boy is on a stool.

· I **think that** the cat is in the tree.

*** It looks like** the man is up in the tree too.

· The boy is **sort of** crying and the dog is **kind of** hiding.

· **Of course,** the woman left in a huff.

When used informatively, qualifiers and modifiers suggest legitimate uncertainty on the part of the speaker about events, settings, or characters portrayed in the picture(s) or modify associated words in a meaningful way. The following examples concern ambiguously pictured information.

· Apparently this is a mother and her two children.

· I think she is his sister.

· It looks like he gave them the wrong directions.

· She must be daydreaming.

· He might be the girl's dad or maybe he's a neighbor.

· He is the father or a neighbor. I don't know which.

· He looks sort of sad.

* Evidently they went around in a circle.

2.19. Filler words and phrases **(you know, like, well,** I **mean, okay, oh well, anyway, yeah),** interjections when they do not convey information about the content of the picture(s) or topic (oh, **oh boy, wow, gosh, gee, golly, aha, mm),** and tag questions (It is really smashed up, Isn't It).

2.20. The conjunction "and." "And" is never counted as a correct information unit because it is often used as filler and we have found that its use as filler cannot be discriminated reliably from its uses as a conjunction.

2.21. Commentary on the task and lead-in phrases that do not give information about the picture(s) or topic and are not necessary for the grammatical completeness of the statement.

*** These pictures are poorly drawn.**

This is kind of hard.

*** In the first picture ...**

*** As I said the last time,** she was upset.

2.22. Commentary on the subject's performance or personal experiences.

· I can't **think of the name of that.**

· I **can't say** It.

· No, that's not right.

·**My kids were always getting Into trouble too.**

·**My wife and I used to fight like that.**

· They are fighting **but I don't know why.**

Some statements that contain personal information may be appropriate in procedural and personal information descriptions and, in such cases, they would be counted as correct information units (if they meet the other criteria).

See 3.16 for embellishments that are counted as correct information units. See previous page for statements that are deleted before beginning the word and correct information unit counts.

3.1. COUNT THE FOLLOWING (if they meet all other criteria) (In this section, words in bold print would be counted as correct information units.)
3.11. All words (nouns, adjectives, pronouns, verbs, adverbs, articles, prepositions, and conjunctions) that are intelligible in context, accurate in relation to the picture(s) or topic, and relevant to and informative about the content of the picture(s) or topic.
3.12. Words do not have to be used in a grammatically correct manner to be counted. Words that violate standard English grammar rules concerning appropriate verb tense and form, agreement in number between subject and predicate, agreement between articles and nouns, incorrect use of articles, and appropriate singular and plural forms are counted as correct information units unless these violations would lead to misunderstanding or uncertainty about the meaning of the words. See 2.11 for examples of words that would not be counted as correct information units.
* The firemans are coming.
* The firemen ain't rescued them yet.
· Put some stamp on it.
· The friends **Is** here.
* He don't look very happy.
3.13. Production of a word that results in another English word, if the production would be intelligible as the target word in context.
* He is standing on a school and it is tipping over.
3.14. The final attempt in a series of attempts to correct sound errors.
* He went to the musket ... minuet ... market.
3.15. Informal terms (nope, **yep, uh-huh, un-uh)** when they convey information about the content of the picture(s) or topic.
* She said "Uh-huh, I'll do it."
3.16. Words in embellishments that add to the events portrayed in the picture(s) or express a moral, if they are consistent with the situation or events portrayed. Words that express some legitimate uncertainty about characters, settings, or events in the pictures.
· **He's going to get hurt and his mom Is going to be angry.**
· **Some days everything seems to go wrong.**
· **That looks like a nice way to spend a summer day.**
· **Sooner or later cats usually get stuck up a tree.**
· **Mothers sometimes get distracted and don't notice things.**
· **This is the one about the accident-prone family.**
However, see 2.22 for examples of extraneous commentary that may resemble embellishments, but are not counted.
3.17. Verbs and auxiliary verbs **(is, are, was, were, to, has, have, will, would, has been,** etc.) as two separate correct information units-one for the auxiliary verb and one for the main verb.
* His mom **Is going to be** angry. (Each word in bold print is a correct information unit.)
3.18. Contractions [both standard (won't) and colloquial (gonna)j as two correct information units.
3.19. Each word in hyphenated words (father-in-law, **good-bye).**

APPENDIX G
CONSENT FORM

Principal Investigator: Sheryl Martin-Schild
Sheryl is available for questions about this study,
M-F, 9:00 a.m.-4:00 p.m. at (504) 988-1831 smartin2@tulane.edu
Co-Principal Investigator: Jenifer Juengling-Sudkamp
Jenifer is available for questions about this study,
M-F, 8:00 a.m. - 4:00p.m at (504) 491-4794 or jjueng1@tigers.lsu.edu
Research Assistant (RA): Jamie LeBoutillier
Study Title: A Single-Subject Study Examining the Effects of a Behavioral Intervention for Verbal Recurrent Perseveration
Performance Sites: In the participants' home or Tulane University Medical Center

Disclosure of Potential Conflict of Interest

The investigators in this study are also healthcare providers. They are interested in the knowledge to be gained from this study and in your well-being. Investigators may obtain salary or other financial support for conducting the research. You are under no obligation to participate in any research study offered to you.

Why is this study being done?

The purpose of this research study is to examine the effects of a behavior treatment on speech production among people with speech and language impairments, or aphasia, due to stroke.

What are the study procedures? What will I be asked to do?

The study will take place in a quiet setting of your choice either in your home or in a private treatment room in the Speech-Language Pathology Department at Tulane Medical Center. All data collection and treatment sessions will be conducted by a speech-language pathologist.

Number of Subjects: 6 participants from the New Orleans region.

All potential subjects will be asked to complete a **SCREENING PROCEDURE** administered by the Co-Principal Investigator (Co-PI) that will take approximately 45 minutes. If you fail any portion of the screening battery, your participation in the study will be discontinued. **The screening procedures will include 3 tasks**:

1. Confirmation of your eligibility to participate in the study by the Co-PI according to the following criteria. You may participate in the study if you have/are

(**Inclusion Criteria):**

(Inclusion Criteria continued)

- A neurologists' diagnosis of stroke with the insult involving the left hemisphere greater than 6 months ago.
- A National Institute of Health Stroke Scale [NIHSS] Total Score of 3-15 (determined by your neurologist)
- Right-handed
- Displaying full word or phonemic perseverative speech errors during 10% or more than 10% of a naming task as identified by a speech-language pathologist or neurologist.
- A Western Aphasia Battery-Revised Bedside Aphasia Quotient less than 93.8 identified by a speech-language pathologist
- Greater than 8 years of education
- Functional word reading skills
- Living in the community
- Native English speaker
- Hearing acuity sufficient to follow directions
- Visual acuity sufficient to read large print
- 18 to 89 years old

You may NOT participate in the study if you have/are (**Exclusion Criteria)**:

- A history of other neurological, psychiatric, or language impairments other than those associated with stroke
- A history of a right hemisphere stroke
- A NIHSS Total Score greater than 15
- Receiving speech-language therapy
- Left-handed or familial history (parents/siblings) of left handedness
- Western Aphasia Battery-Revised Bedside Aphasia Quotient greater than 93.8
- Less than 8 years of education
- Unable to read functional words
- Living in a long-term care facility.
- Non- American English speaking
- Severe uncorrected hearing loss
- Severe uncorrected vision deficits
- Less than 18 or more than 89 years old

2. Subjects will complete a six-item survey administered by the Co-PI consisting of yes/no questions to determine handedness
3. Subjects will complete a formal aphasia evaluation presented by the Co-PI using the *Western Aphasia Battery-Revised* (Bedside form) and a picture naming task.

After the completing the screening tasks you will be asked to participate in the following **EXPERIMENTAL PROCEDURES:**

The study will be conducted in four phases. In the first phase subjects will spend approximately 60 minutes describing a picture, naming pictures, repeating words, and reading aloud words for 8 sessions. In the second phase, subjects will spend approximately 20 minutes naming pictures with and without spoken cues from the Co-PI over 4 sessions (2 sessions per week). Following the naming task, subjects will spend approximately 40 minutes describing a picture, repeating words, and reading aloud words. In the third phase, subjects will spend approximately 60 minutes describing a picture, naming pictures, repeating words, and reading aloud words for 4 sessions (2 sessions per week. In the final phase, subjects will spend approximately 20 minutes naming pictures with and without spoken cues from the Co-PI. Following the naming task, subjects will spend approximately 40 minutes describing a picture, repeating words, and reading aloud words. All of the subjects' responses will be digitally recorded with a Sony ICD-UX71 Recorder for the investigators to review. Subjects may be contacted via telephone and/or mail by the Co-PI for a follow-up appointment after the conclusion of his/her participation in this study.

What are the risks or inconveniences of the study?

We believe there are no known risks associated with this research study. The possible associated inconveniences with this research study may include the time required to sit for each session, the time it takes to complete the study, or a breach of confidentiality.

What are the benefits of the study?

We hope that your participation in the study may improve your speech and language function. We also hope that your participation may advance the knowledge of aphasia rehabilitation and language recovery.

Will I receive payment for participation?

You will not be paid to be in this study.

Are there costs to participate?

There are no costs to you to participate in this study.

You may incur costs associated with transportation if you choose to participate at Tulane Medical Center. Your parking expenses at Tulane Medical Center will be validated after each session.

How will my personal information be protected?

Subjects' identity will remain confidential unless disclosure is required by law. The following procedures will be used to protect the confidentiality of your data:

- Research records will be labeled with a unique code. A master key that links names and codes will be maintained in a separate and secure location. All electronic files (e.g., database, spreadsheet, audio recordings) containing identifiable information will be password protected. Any computer hosting such files will also have password protection to prevent access by unauthorized users. Only the members of the research staff will have access to the passwords.
- Data that will be shared with others will be coded as described above to help protect your identity. The researchers will keep all study records (including any codes to your data) locked in a secure location indefinitely.
- At the conclusion of this study the researcher may publish her findings. Information will be presented in summary format and you will not be identified in any publications or presentations. Any master key, audio recordings, electronic files, and other data described in this paragraph will be maintained in accordance with the security provisions of this paragraph until destroyed by the researchers.

You should also know that the Tulane University Human Research Protection Office and the Biomedical Institutional Review Board (IRB) may inspect study records as part of its auditing program, but these reviews will only focus on the researchers and not on your responses or involvement. The IRB is a group of people who review research studies to protect the rights and welfare of research participants.

Can I stop being in the study and what are my rights?

You do not have to be in this study if you do not want to. If you agree to be in the study, but later change your mind, you may drop out at any time. There are no penalties or consequences of any kind if you decide that you do not want to participate.

You may be withdrawn from the study at any time. Conditions that may require such a withdrawal include missed appointments, non-adherence to procedures, and disruptive behavior during study procedures.

Who do I contact if I have questions about the study?

Take as much time as you like before you make a decision to participate in this study. We will be happy to answer any question you have about this study. If you have further questions about this study, want to voice concerns or complaints about the research or if you have a research-related problem, you may contact the principal investigator, (Sheryl Martin-Schild, 504-988-1831) or the co-principal investigator (Jenifer J. Sudkamp, 504-491-4794). If you would like to discuss your rights as a research participant, discuss problems, concerns, and questions; obtain information; or offer input with an informed individual who is unaffiliated with the specific research, you may contact the Tulane University Human Research Protection Office at 504-988-2665 or email at irbmain@tulane.edu.]

Documentation of Consent:

I have read this form and decided that I will participate in the research project described above. Its general purposes, the particulars of involvement and possible risks and inconveniences have been explained to my satisfaction. I understand that I can withdraw at any time. My signature also indicates that I have received a copy of this consent form.

_____ _____
Subject Date

_____ _____
Parent/Legally Authorized Representative (if applicable) Date

_____ _____
Person Obtaining Consent Date

I am unable to read but this consent document has been read and explained to me by _____ (name of reader). I volunteer to participate in this research.

_____ _____
Subject Date

_____ _____
Witness Date

_____ _____
Person Obtaining Consent Date

[Optional]

_____ _____
Principal Investigator Signature Date

Documentation of Consent:

I have read this form and decided that I will participate in the research project described above. Its general purposes, the particulars of involvement and possible risks and inconveniences have been explained to my satisfaction. I understand that I can withdraw at any time. My signature also indicates that I have received a copy of this consent form.

_____ _____
Subject Date

Parent/Legally Authorized Representative (if applicable)	Date
Person Obtaining Consent	Date

I am unable to read but this consent document has been read and explained to me by

_____ _____. I volunteer to participate in this research.

_____ _____

Subject Date

_____ _____

Witness Date

_____ _____

Person Obtaining Consent Date

APPENDIX H
DESCRIPTIVE STATISTICS

Descriptive statistics for Subject 1

	N	*M*	*SD*	Min	Max
Percentage of correctly named items					
Pre-intervention (phase 1 and 2)	8	8.75	6.41	0	20
Intervention (phase 1 & 2)	8	98.75	3.53	90.00	100
Intervention (phase 1)	4	100	0.00	100	100
Re-intervention	4	97.5	5.00	90.00	100
Number of words per minute					
Pre-intervention	--	--	--	--	--
Intervention	8	2.20	0.47	1.71	3.06
Number of perseverations					
Pre-intervention (phase 1 and 2)	8	2.88	1.36	1	5
Intervention (phase 1 and 2)	8	0.00	0.00	0.00	0.00
AP during treatment for naming					
Pre-intervention (phase 1 and 2)	--	--	--	--	--
Intervention (phase 1 and 2)	--	--	--	--	--
Percentage correctly named items (after treatment)					
Baseline	8	13.75	9.91	0.00	30.00
Intervention	4	7.5	5.00	0.00	10.00
Withdrawal	4	12.5	5.00	10.00	20.00
Re-Intervention	4	10	8.16	0.00	20.00
Sum of all phases	20	11.5	7.80	0.00	30.00
Number of words per minute during naming					
Baseline	8	0.60	0.51	0.00	1.64
Intervention	3	0.34	0.08	0.25	0.40
Withdrawal	4	0.53	0.17	0.39	0.76
Re-Intervention	4	0.82	0.27	0.50	1.15
Sum of all experimental phases	19	0.59	0.38	0.00	1.64
Number of perseverations during naming					
Baseline	8	6.63	2.50	4.00	11.00
Intervention	4	5.50	3.00	4.00	10.00
Withdrawal	4	5.75	1.71	4.00	8.00

Descriptive statistics for Subject 1 (continued)

	N	*M*	*SD*	Min	Max
Re-Intervention	4	7.25	1.26	6.00	9.00
Sum of all experimental phases	20	6.35	2.21	4.00	11.00
AP during naming					
Baseline	8	0.00	0.00	0.00	0.00
Intervention	4	0.00	0.00	0.00	0.00
Withdrawal	4	0.00	0.00	0.00	0.00
Re-Intervention	4	0.00	0.00	0.00	0.00
Sum of all experimental phases	20	0.00	0.00	0.00	0.00
Percentage of correctly repeated words					
Baseline	8	98.13	2.59	95	100
Intervention	4	100	0.00	100	100
Withdrawal	4	100	0.00	100	100
Re-Intervention	4	100	0.00	90	100
Sum of all experimental phases	20	99.25	1.83	95	100
Number of words per minute during repetition					
Baseline	8	23.69	7.16	15.45	36.36
Intervention	4	30.47	6.36	23.00	36.37
Withdrawal	4	40.55	2.81	37.74	44.44
Re-Intervention	4	43.17	4.88	38.46	50.00
Sum of all experimental phases	20	32.31	10.07	15.45	50.00
Number of perseverations during repetition					
Baseline	8	0.00	0.00	0.00	0.00
Intervention	4	0.00	0.00	0.00	0.00
Withdrawal	4	0.00	0.00	0.00	0.00
Re-Intervention	4	0.00	0.00	0.00	0.00
Sum of all experimental phases	20	0.00	0.00	0.00	0.00
AP during repetition					
Baseline	8	0.00	0.00	0.00	0.00
Intervention	4	0.00	0.00	0.00	0.00
Withdrawal	4	0.00	0.00	0.00	0.00
Re-Intervention	4	0.00	0.00	0.00	0.00
Sum of all experimental phases	20	0.00	0.00	0.00	0.00

Descriptive statistics for Subject 1 (continued)

	N	*M*	*SD*	Min	Max
Percentage of correctly read words					
Baseline	8	3.75	21	0.00	5.00
Intervention	4	6.25	2.50	5.00	10.00
Withdrawal	4	2.50	5.00	0.00	10.00
Re-Intervention	4	5.00	0.00	5.00	5.00
Sum of all experimental phases	20	4.25	2.94	0.00	10.00
Number of words per minute during reading					
Baseline	8	0.14	0.09	0.00	0.23
Intervention	3	0.25	0.11	0.16	0.38
Withdrawal	4	0.09	0.18	0.00	0.36
Re-Intervention	4	0.18	0.01	0.17	0.19
Sum of all experimental phases	19	0.16	0.11	0.00	0.38
Number of perseverations during reading					
Baseline	8	7.75	1.67	5.00	10.00
Intervention	4	7.75	2.22	5.00	10.00
Withdrawal	4	9.00	1.83	7.00	11.00
Re-Intervention	4	10.00	1.41	8.00	11.00
Sum of all experimental phases	20	8.75	1.88	5.00	11.00
AP during reading					
Baseline	8	0.00	0.00	0.00	0.00
Intervention	4	0.00	0.00	0.00	0.00
Withdrawal	4	0.00	0.00	0.00	0.00
Re-Intervention	4	0.00	0.00	0.00	0.00
Sum of all experimental phases	20	0.00	0.00	0.00	0.00
Number of words per minute during picture description					
Baseline	8	115.02	15.56	98.17	143.24
Intervention	4	116.39	7.80	111.58	127.97
Withdrawal	4	143.14	16.87	129.48	165.71
Re-Intervention	4	141.55	10.66	126.78	150.86
Sum of all experimental phases	20	126.22	18.56	98.17	165.71

Descriptive statistics for Subject 1 (continued)

	N	*M*	*SD*	Min	Max
Number of perseverations during picture description					
Baseline	8	23.50	6.16	16.00	31.00
Intervention	4	23.75	6.61	15.00	31.00
Withdrawal	4	22.75	8.34	15.00	33.00
Re-Intervention	4	29.00	8.91	16.00	36.00
Sum of all experimental phases	20	24.50	7.06	15.00	36.00
AP during picture description					
Baseline	8	0.00	0.00	0.00	0.00
Intervention	4	0.00	0.00	0.00	0.00
Withdrawal	4	0.00	0.00	0.00	0.00
Re-Intervention	4	0.00	0.00	0.00	0.00
Sum of all experimental phases	20	0.00	0.00	0.00	0.00
Percentage of CIU					
Baseline	8	23.51	6.63	15.31	33.73
Intervention	4	28.49	3.85	25.13	33.11
Withdrawal	4	28.89	7.10	20.83	37.95
Re-Intervention	4	21.38	5.42	13.64	26.02
Sum of all experimental phases	20	25.16	6.37	13.64	37.95

Descriptive statistics for Subject 2

	N	*M*	*SD*	Min	Max
Percentage of correctly named items					
Pre-intervention (phase 1 and 2)	8	76.25	24.46	40	100
Intervention (phase 1 and 2)	8	97.5	7.07	80.00	100
Intervention (phase 1)	4	100	0.00	100	100
Re-intervention	4	95	10.00	80.00	100
Number of words per minute					
Pre-intervention (phase 1 and 2)	--	--	--	--	--
Intervention (phase 1 and 2)	7	7.22	4.48	2.99	16.67
Number of perseverations					
Pre-intervention (phase 1 and 2)	8	0.25	0.46	0	1
Intervention (phase 1 and 2)	7	0.00	0.00	0	0
AP during treatment for naming					
Pre-intervention (phase 1 and 2)	--	--	--	--	--
Intervention (phase 1 and 2)	--	--	--	--	--
Percentage correctly named items (after treatment)					
Baseline	8	67.5	16.27	40	90
Intervention	4	80	18.26	60	100
Withdrawal	4	52.5	24.66	25	80
Re-Intervention	4	72.5	32.01	40	100
Sum of all experimental phases	20	68.15	22.21	25	100
Number of words per minute during naming					
Baseline	8	5.77	2.71	1.68	10.71
Intervention	4	9.33	2.32	5.93	11.11
Withdrawal	4	4.70	3.54	1.43	8.74
Re-Intervention	4	14.01	6.66	5.31	21.51
Sum of all experimental phases	20	7.91	5.00	1.43	21.51
Number of perseverations during naming					
Baseline	8	1.63	2.40	0.00	7.00
Intervention	4	0.50	0.58	0.00	1.00
Withdrawal	4	1.75	1.26	0.00	3.00
Re-Intervention	4	0.50	1.00	0.00	2.00
Sum of all experimental phases	20	1.20	1.70	0.00	7.00

Descriptive statistics for Subject 2 (continued)

	N	*M*	*SD*	Min	Max
AP during naming					
Baseline	8	0.00	0.00	0.00	0.00
Intervention	4	0.00	0.00	0.00	0.00
Withdrawal	4	0.00	0.00	0.00	0.00
Re-Intervention	4	0.00	0.00	0.00	0.00
Sum of all experimental phases	20	0.00	0.00	0.00	0.00
Percentage of correctly repeated words					
Baseline	8	96.25	4.43	90.00	100
Intervention	4	97.50	5.00	90.00	100
Withdrawal	4	97.50	2.89	95.00	100
Re-Intervention	4	98.75	2.50	95.00	100
Sum of all experimental phases	20	97.25	3.80	90.00	100
Number of words per minute during repetition					
Baseline	8	20.91	4.62	14.06	28.57
Intervention	4	23.25	2.84	20.41	26.67
Withdrawal	4	13.35	1.65	11.18	15.20
Re-Intervention	4	15.38	2.05	14.29	18.45
Sum of all experimental phases	20	18.76	5.00	11.18	28.57
Number of perseverations during repetition					
Baseline	8	0.13	0.35	0.00	1.00
Intervention	4	0.00	0.00	0.00	0.00
Withdrawal	4	0.25	0.50	0.00	1.00
Re-Intervention	4	0.00	0.00	0.00	0.00
Sum of all experimental phases	20	0.10	0.31	0.00	1.00
AP during repetition					
Baseline	8	0.00	0.00	0.00	0.00
Intervention	4	0.00	0.00	0.00	0.00
Withdrawal	4	0.00	0.00	0.00	0.00
Re-Intervention	4	0.00	0.00	0.00	0.00
Sum of all experimental phases	20	0.00	0.00	0.00	0.00

Descriptive statistics for Subject 2 (continued)

	N	*M*	*SD*	Min	Max
Percentage of correctly read words					
Baseline	8	91.88	7.53	80.00	100
Intervention	4	95.00	4.08	90.00	100
Withdrawal	4	88.75	6.29	80.00	100
Re-Intervention	4	96.25	4.79	90.00	100
Sum of all experimental phases	20	92.75	6.38	80.00	100
Number of words per minute during reading					
Baseline	8	14.11	4.38	7.05	18.56
Intervention	4	19.86	5.31	14.40	26.67
Withdrawal	4	12.75	1.76	11.61	15.38
Re-Intervention	4	20.48	1.81	18.37	22.22
Sum of all experimental phases	20	16.26	4.85	7.05	26.67
Number of perseverations during reading					
Baseline	8	0.50	0.93	0.00	2.00
Intervention	4	0.00	0.00	0.00	0.00
Withdrawal	4	0.50	0.58	0.00	1.00
Re-Intervention	4	0.25	0.50	0.00	1.00
Sum of all experimental phases	20	0.35	0.67	0.00	2.00
AP during reading					
Baseline	8	0.00	0.00	0.00	0.00
Intervention	4	0.00	0.00	0.00	0.00
Withdrawal	4	0.00	0.00	0.00	0.00
Re-Intervention	4	0.00	0.00	0.00	0.00
Sum of all experimental phases	20	0.00	0.00	0.00	0.00
Number of words per minute during picture description					
Baseline	8	92.85	7.25	82.58	103.70
Intervention	4	89.95	7.07	83.81	99.13
Withdrawal	4	85.54	14.84	68.75	100.88
Re-Intervention	4	88.41	10.68	80.00	104.00
Sum of all experimental phases	20	89.92	9.39	68.75	104.00

Descriptive statistics for Subject 2 (continued)

	N	*M*	*SD*	Min	Max
Number of perseverations during picture description					
Baseline	8	9.88	6.42	3.00	23.00
Intervention	4	5.75	2.06	3.00	8.00
Withdrawal	4	10.75	7.41	4.00	21.00
Re-Intervention	4	7.50	2.65	5.00	11.00
Sum of all experimental phases	20	8.75	5.41	3.00	23.00
AP during picture description					
Baseline	8	0.00	0.00	0.00	0.00
Intervention	4	0.00	0.00	0.00	0.00
Withdrawal	4	0.00	0.00	0.00	0.00
Re-Intervention	4	0.00	0.00	0.00	0.00
Sum of all experimental phases	20	0.00	0.00	0.00	0.00
AP during picture description					
Baseline	8	0.00	0.00	0.00	0.00
Intervention	4	0.00	0.00	0.00	0.00
Withdrawal	4	0.00	0.00	0.00	0.00
Re-Intervention	4	0.00	0.00	0.00	0.00
Sum of all experimental phases	20	0.00	0.00	0.00	0.00
Percentage of CIU					
Baseline	8	64.84	12.75	42.19	85.60
Intervention	4	70.50	2.30	68.55	73.21
Withdrawal	4	71.72	12.11	60.90	88.79
Re-Intervention	4	68.50	9.64	57.86	80.87
Sum of all experimental phases	20	68.08	10.35	42.19	88.79

Descriptive statistics for Subject 3

	N	*M*	*SD*	Min	Max
Percentage of correctly named items					
Pre-intervention (sum phase 1 and 2)	8	62.50	14.88	40	80
Intervention (sum phase 1 and 2)	8	70.00	9.26	60.00	80.00
Intervention (phase 1)	4	65.00	10.00	60.00	80.00
Re-intervention	4	75.00	5.77	70.00	80.00
Number of words per minute					
Pre-intervention	--	--	--	--	--
Intervention	8	2.96	1.16	1.72	5.41
Number of perseverations					
Pre-intervention (sum phase 1 and 2)	8	0.50	0.53	0	1
Intervention (phase 1 and 2)	8	0.00	0.00	0	0
AP during treatment for naming					
Pre-intervention (phase 1 and 2)	8	0.06	0.18	0	0.50
Intervention (phase 1 and 2)	8	0.58	0.40	0	1.00
Percentage correctly named items (after treatment)					
Baseline	8	68.13	5.94	60.00	75.00
Intervention	4	55.00	17.32	40.00	80.00
Withdrawal	4	71.25	2.50	70.00	75.00
Re-Intervention	4	70.00	8.16	60.00	80.00
Sum of all experimental phases	20	66.5	10.40	40.00	80.00
Number of words per minute during naming					
Baseline	7	6.68	1.57	4.80	9.26
Intervention	4	9.44	1.99	6.56	11.11
Withdrawal	4	9.94	1.73	8.48	12.39
Re-Intervention	4	10.32	1.71	8.47	12.60
Sum of all experimental phases	19	8.71	2.26	4.8	12.6
Number of perseverations during naming					
Baseline	8	0.50	0.53	0.00	1.00
Intervention	4	0.25	0.50	0.00	1.00
Withdrawal	4	0.50	0.58	0.00	1.00
Re-Intervention	4	0.50	1.00	0.00	2.00
Sum of all experimental phases	20	1.20	0.90	0.00	3.00

Descriptive statistics for Subject 3 (continued)

	N	*M*	*SD*	Min	Max
AP during naming					
Baseline	8	0.33	0.26	0.00	0.80
Intervention	4	0.79	0.25	0.50	1.00
Withdrawal	4	0.67	0.24	0.50	1.00
Re-Intervention	4	0.58	0.29	0.33	1.00
Sum of all experimental phases	20	0.54	0.31	0 .00	1.00
Percentage of correctly repeated words					
Baseline	8	71.25	7.44	65.00	80.00
Intervention	4	83.75	7.79	80.00	90.00
Withdrawal	4	77.50	8.66	65.00	85.00
Re-Intervention	4	88.75	2.50	85.00	90.00
Sum of all experimental units	20	78.50	9.33	65.00	90.00
Number of words per minute during repetition					
Baseline	8	9.41	2.91	5.78	14.95
Intervention	4	12.80	3.25	8.37	15.93
Withdrawal	4	11.25	1.75	9.60	13.56
Re-Intervention	4	14.21	1.59	12.00	15.65
Sum of all experimental units	20	11.42	3.07	5.78	15.93
Number of perseverations during repetition					
Baseline	8	1.38	1.51	0.00	4.00
Intervention	4	0.50	0.58	0.00	1.00
Withdrawal	4	1.25	0.50	1.00	2.00
Re-Intervention	4	0.50	0.58	0.00	1.00
Sum of all experimental phases	20	1.00	1.08	0.00	4.00
AP during repetition					
Baseline	8	0.64	0.34	0.20	1.00
Intervention	4	0.79	0.25	0.50	1.00
Withdrawal	4	0.50	0.00	0.50	0.50
Re-Intervention	4	0.79	0.25	0.50	1.00
Sum of all experimental units	20	0.67	0.28	0.20	1.00

Descriptive statistics for Subject 3 (continued)

	N	*M*	*SD*	Min	Max
Percentage of correctly read words					
Baseline	8	75.63	4.96	70.00	85.00
Intervention	4	77.50	6.45	70.00	85.00
Withdrawal	4	82.50	5.00	75.00	85.00
Re-Intervention	4	82.50	8.66	70.00	90.00
Sum of all experimental units	20	78.75	6.46	70.00	90.00
Number of words per minute during reading					
Baseline	7	14.55	3.27	10.00	18.28
Intervention	4	13.87	2.31	11.02	16.67
Withdrawal	4	12.83	2.55	10.14	16.19
Re-Intervention	4	14.63	1.38	13.33	16.50
Sum of all experimental units	19	14.06	2.52	10.00	18.28
Number of perseverations during reading					
Baseline	8	0.75	0.89	0.00	2.00
Intervention	4	0.25	0.50	0.00	1.00
Withdrawal	4	0.50	0.58	0.00	1.00
Re-Intervention	4	0.25	0.50	0.00	1.00
Sum of all experimental phases	20	0.50	0.69	0.00	2.00
AP during reading					
Baseline	8	0.73	0.31	0.33	1.00
Intervention	4	0.83	0.35	0.30	1.00
Withdrawal	4	0.75	0.29	0.50	1.00
Re-Intervention	4	0.92	0.17	0.67	1.00
Sum of all experimental units	20	0.79	0.28	0.30	1.00
Number of words per minute during picture description					
Baseline	8	99.93	12.00	83.93	114.12
Intervention	4	103.34	3.15	99.34	106.79
Withdrawal	4	102.15	9.50	94.60	116.03
Re-Intervention	4	105.13	2.23	103.70	108.46
Sum of all experimental units	20	102.10	8.59	83.93	116.0

Descriptive statistics for Subject 3 (continued)

	N	*M*	*SD*	Min	Max
Number of perseverations during picture description					
Baseline	8	31.13	16.82	13.00	59.00
Intervention	4	19.50	5.92	14.00	26.00
Withdrawal	4	22.50	8.10	11.00	30.00
Re-Intervention	4	27.00	10.13	20.00	42.00
Sum of all experimental phases	20	26.25	12.61	11.00	59.00
AP during picture description					
Baseline	8	0.05	0.05	0.00	0.13
Intervention	4	0.12	0.08	0.00	0.18
Withdrawal	4	0.09	0.07	0.00	0.15
Re-Intervention	4	0.03	0.02	0.00	0.05
Sum of all experimental units	20	0.07	0.06	0.00	0.18
Percentage of CIU					
Baseline	8	33.17	5.40	23.83	40.80
Intervention	4	40.09	10.10	33.21	56.14
Withdrawal	4	41.17	7.39	33.74	48.02
Re-Intervention	4	47.18	7.36	40.90	57.80
Sum of all experimental units	20	39.55	8.75	23.83	57.80

Descriptive statistics for all subjects

	N	*M*	*SD*	Min	Max
Percentage of correctly named items					
Pre-intervention	24	49.17	33.87	0.00	100
Intervention	24	88.75	15.13	60.00	100.00
Number of words per minute					
Pre-intervention	--	--	--	--	--
Intervention	23	3.99	3.29	1.71	16.67
Number of perseverations					
Pre-intervention (phase 1 and 2)	24	1.21	1.47	0	5
Intervention (phase 1 and 2)	24	0.00	0.00	0	0
Percentage correctly named items (after treatment)					
Sum of all experimental phases	60	48.72	30.30	0.00	100
Number of words per minute during naming					
Sum of all experimental phases	58	5.78	4.84	0.00	21.51
Number of perseverations during naming					
Sum of all experimental phases	60	2.92	2.96	0.00	11.00
AP during naming					
Sum of all experimental phases	60	0.18	0.31	0.00	1.00
Percentage of correctly repeated words					
Sum of all experimental phases	60	91.67	1.07	65.00	100
Number of words per minute during repetition					
Sum of all experimental phases	60	20.83	10.95	5.78	50.00
Number of perseverations during repetition					
Sum of all experimental phases	60	0.37	0.78	0.00	4.00
AP during repetition					
Sum of all experimental phases	60	0.22	0.36	0.00	1.00

Descriptive statistics for all subjects (continued)

	N	*M*	*SD*	Min	Max
Percentage of correctly read words					
Sum of all experimental phases	60	58.58	39.54	0.00	100
Number of words per minute during reading					
Sum of all experimental phases	58	10.27	7.83	0.00	26.67
Number of perseverations during reading					
Sum of all experimental phases	60	3.1	4.00	0.00	11.00
AP during reading					
Sum of all experimental phases	60	0.26	0.41	0.00	1.00
Number of words per minute during picture description					
Sum of all experimental phases	60	106.08	19.86	68.75	165.71
Number of perseverations during picture description					
Sum of all experimental phases	60	19.83	11.82	3.00	59.00
AP during picture description					
Sum of all experimental phases	60	0.02	0.05	0.00	0.18
Percentage of CIU					
Sum of all experimental phases	60	44.26	19.89	13.64	88.79

APPENDIX I
RELATIVE EFFECTS OF THE INTERVENTION

The relative effects of the intervention (B1) on picture naming, repetition, oral reading, and picture description in descending order, subject 1

	b	Range (max-min)	Relative effect (b/range)
Number of words per minute during naming			
Intervention	-0.25	0.15	1.67
Percentage correctly named items (after treatment)			
Intervention	-6.25	10.00	0.63
Percentage of CIU			
Intervention	4.97	7.98	0.62
Number of words per minute during repetition			
Intervention	6.78	13.37	0.51
Percentage of correctly read words			
Intervention	2.50	5.00	0.50
Number of words per minute during reading			
Intervention	0.11	0.22	0.50
Number of perseverations during naming			
Intervention	-1.13	6.00	0.19
Number of words per minute during picture description			
Intervention	1.37	16.39	0.08
Number of perseverations during picture description			
Intervention	0.25	16.00	0.02
Number of perseverations during reading			

The relative effects of a non-confrontational picture naming intervention (B1) on picture naming, repetition, oral reading, and picture description in descending order for subject 1 (continued)

	b	Range (max-min)	Relative effect (b/range)
Intervention	-0.00	5.00	0.00
Percentage of correctly repeated words			
Intervention	1.88	0	0.00
Number of perseverations during repetition			
Intervention	--	0.00	0.00
AP during repetition			
Intervention	--	0.00	0.00
AP during reading			
Intervention	--	0.00	0.00
AP during picture description			
Intervention	--	0.00	0.00
AP during naming			
Intervention	--	--	--

The relative effects of the intervention (B1) on picture naming, repetition, oral reading, and picture description in descending order, subject 2

	b	Range (max-min)	Relative effect (b/range)
Percentage of CIU			
Intervention	5.66	4.66	1.21
Number of perseverations during naming			
Intervention	-1.13	1.00	1.13
Number of perseverations during picture description			
Intervention	-4.13	5.00	0.83
Number of words per minute during naming			
Intervention	3.55	5.18	0.69
Number of words per minute during reading			
Intervention	5.75	12.27	0.47
Number of words per minute during repetition			
Intervention	2.34	6.26	0.37
Percentage of correctly read words			
Intervention	3.13	10.00	0.31
Percentage correctly named items (after treatment)			
Intervention	12.13	40.00	0.30
Number of words per minute during picture description			
Intervention	-2.90	15.55	0.19
Percentage of correctly repeated words			
Intervention	1.25	10.00	0.13
Number of perseverations during reading			
Intervention	-0.50	0.00	0.00

The relative effects of a non-confrontational picture naming intervention (B1) on picture naming, repetition, oral reading, and picture description in descending order for subject 2 (continued)

	b	Range (max-min)	Relative effect (b/range)
AP during naming			
Intervention	--	0.00	0.00
AP during repetition			
Intervention	--	0.00	0.00
AP during reading			
Intervention	--	0.00	0.00
AP during picture description			
Intervention	--	0.00	0.00
Number of perseverations during repetition			
Intervention	--	0.00	0.00

The relative effects of the intervention (B1) on picture naming, repetition, oral reading, and picture description in descending order, subject 3

	b	Range (max-min)	Relative effect (b/range)
Number of perseverations during naming (after treatment)			
Intervention	-1.38	1.00	1.38
Percentage of correctly repeated words			
Intervention	12.50	10.00	1.25
Number of perseverations during picture description			
Intervention	-11.63	12.00	0.97
AP during naming			
Intervention	0.47	0.50	0.94
Number of perseverations during repetition			
Intervention	-0.88	1.00	0.88
Number of words per minute during naming (after treatment)			
Intervention	2.75	4.55	0.60
Number of perseverations during reading			
Intervention	-0.50	1.00	0.50
Number of words per minute during picture description			
Intervention	3.41	7.45	0.46
Number of words per minute during repetition			
Intervention	3.39	7.56	0.45
Percentage of CIU			
Intervention	9.92	22.93	0.43
AP during picture description			
Intervention	0.07	0.18	0.39

The relative effects of a non-confrontational picture naming intervention (B1) on picture naming, repetition, oral reading, and picture description in descending order for subject 3 (continued)

	b	Range (max-min)	Relative effect (b/range)
Percentage correctly named items (after treatment)			
Intervention	-13.13	40.00	0.33
AP during repetition			
Intervention	0.15	0.50	0.30
AP during reading			
Intervention	0.10	0.70	0.14
Percentage of correctly read words			
Intervention	1.88	15.00	0.13
Number of words per minute during reading			
Intervention	-0.67	5.65	0.12

The relative effects of the intervention (B1) on picture naming, repetition, oral reading, and picture description, all subjects

	b	Range (max-min)	Relative effect (b/range)
Number of perseverations during naming			
Intervention	-1.40	11	0.13
Percentage of CIU			
Intervention	6.94	75.15	0.09
Percentage correctly named items (after treatment)	-7.17	100	0.07
Intervention			
Percentage of correctly repeated words			
Intervention	2.60	35	0.07
Number of perseverations during picture description			
Intervention	-3.57	56	0.06
Number of words per minute during repetition			
Intervention	2.54	44.22	0.06
Number of perseverations during reading			
Intervention	-0.45	11	0.04
Number of words per minute during naming			
Intervention	0.65	21.51	0.03
Percentage of correctly read words			
Intervention	2.82	100	0.03
Number of perseverations during repetition			
Intervention	-0.06	4	0.02
Number of words per minute during reading			
Intervention	0.38	26.67	0.01

The relative effects of a non-confrontational picture naming intervention (B1) on picture naming, repetition, oral reading, and picture description for all subjects (continued)

	b	Range (max-min)	Relative effect (b/range)
Number of words per minute during picture description			
Intervention	0.66	96.96	0.01
AP during naming			
Intervention	0.00	1	0.00
AP during repetition			
Intervention	0.00	1	0.00
AP during reading			
Intervention	0.00	1	0.00
AP during picture description			
Intervention	0.00	0.18	0.00
0.00			

VITA

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