SELECTIVE GRAMMATICAL IMPAIRMENTS ACROSS SPOKEN AND WRITTEN MODALITIES IN THREE PERSONS WITH APHASIA

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To my parents, who enabled me to have the best education and offered unceasing encouragement and prayers throughout the experience

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Grammatical deficits occur in persons with aphasia when the ability to produce one grammatical category, typically nouns or verbs, is more impaired than another category. These deficits are most often examined in oral tasks, such as naming and producing sentences. In the current study, two verbal (i.e., oral naming and oral reading) and two written (i.e., written naming and writing to dictation) tasks were examined to determine if any relationship across or between modalities existed in three persons with nonfluent aphasia. Specifically, the following questions were asked: (a) Are there significant differences across nouns and verbs in oral naming, oral reading, written naming, and writing to dictation? (b) Does a double-dissociation exist across any of these modalities (i.e., nouns are more impaired in one modality and verbs are more impaired in the other modality)? (c) Based on an error analysis of incorrect responses, are the levels of impairment different for nouns and verbs across modalities? No significant statistical difference across nouns and verbs in any modality was noted. Similarly, no double dissociation across modalities was found in any of the three participants. Trends regarding accuracy data, however, were noted in all three participants. In addition, error analyses served as

an appropriate medium to identify linguistic deficits present for nouns and verbs across modalities in each participant.

CHAPTER 1
INTRODUCTION

Brief Overview of Aphasia

Aphasia is an acquired neurogenic language impairment that results from damage to the brain most often caused by cerebrovascular accidents (CVAs). There are seven aphasia syndromes that can be subdivided into fluent and nonfluent aphasias. Nonfluent aphasias include Broca's, transcoritcal motor, and global aphasia. Fluent aphasias include Wernicke's, conduction, transcortical sensory, and anomic aphasia.

The patterns of language impairments can vary across and within individuals with aphasia. Deficit patterns in spoken language production and comprehension, as well as, reading and writing can be differentially impaired within the aphasia types (Chapey, 1994). Impaired naming abilities tend to be the residual deficit following recovery for any type of aphasia (Hillis, 2007). Thus, the remaining impairment would then imply that naming deficits can result from damage to various areas of the brain. All aphasia types are characterized by word retrieval difficulties, but differences in production, comprehension, and repetition differentiate the subtypes further.

Broca's aphasia, the most common type of nonfluent aphasia, results from frontal cortical lesions and is characterized by effortful speech with impaired grammar (e.g., reduction in use of function words and morphology, prosody), reduced rate of speech and repetition abilities as well as poor spelling and reading; comprehension is relatively intact. Wernicke's Aphasia, the most common type of fluent aphasia, occurs from posterior cortical lesions which result in relatively preserved fluency, poor comprehension, and poor repetition, spelling, and writing abilities. Conduction Aphasia is characterized by anterior-parietal cortical lesions resulting in fair-to-good fluency, intact comprehension for words and simple sentences, and poor repetition, spelling, and reading ability. Anomic aphasia is primarily characterized by impaired naming with preserved

fluency, comprehension, repetition ability, and variably impaired spelling and reading. The primary deficit, however, is impaired naming. The location of the lesion in this aphasia type is variable across individuals (Chapey, 1994; Hillis, 2007).

Modality Specific Deficits

Individuals with aphasia can exhibit patterns of deficits across modalities (Arevalo, Moineau, Saygin, Ludy, & Bates, 2005; Berndt, Mitchum, Haendiges, and Sandson, 1997a, 1997b; Druks, 2002). Traditionally, individuals with Anomic Aphasia are noted to have fluent speech, but with reduced oral naming abilities. Similarly, individuals with Wernicke's Aphasia are noted to have relatively fluent speech, but with noted reduced abilities with oral naming and comprehension. In Broca's aphasia, individuals are noted to have nonfluent speech with reduced oral naming abilities and preserved comprehension (Chapey, 1994; Druks; Hillis, 2007; Zingeser & Berndt, 1990). Some researchers have found oral naming abilities to be reduced in individuals with fluent aphasias when compared to spoken or written word/picture verification (Hillis & Caramazza, 1991). Arevalo et al. (2005) found that picture-naming was the most difficult tasks for individuals with fluent and nonfluent aphasia when compared to word reading and repetition. In a later study with a group of diversely diagnosed persons with aphasia (i.e., Broca's, Anomic, and Wernicke's Aphasia), Arevalo et al. (2007) again found the participants to be significantly less accurate with picture naming.

Noun and Verb Deficits

Aware of modality impairments associated within the aphasias, researchers have more closely examined grammatical deficits made by individuals with aphasia. Traditionally, individuals with Broca's Aphasia were thought to demonstrate more verb deficits, while individuals with Wernicke's and Anomic Aphasia tended to demonstrate more noun deficits. Evidence for this assertion, however, has not been consistent across studies; thus revealing that

specific noun and verb deficits are not solely confined to a particular aphasia (Arevalo et al., 2007; Arevalo et al., 2005; Berndt et al., 1997a, 1997b; Druks, 2002; Hillis & Caramazza, 1995; Hillis, Tuffiash, & Caramazza, 2002).

Arevalo et al. (2005) found that when considering the three word-processing tasks of picture-naming, word reading, and repetition, 21 individuals with aphasia (i.e., Anomic, Broca's, and Wernicke's) demonstrated a noun advantage in picture-naming alone. In an individual with primary progressive aphasia, a clearly reduced ability to orally naming verbs was documented, while written naming of verbs and comprehension of verbs remained relatively intact (Hillis et al., 2002). In a single case study, an individual with aphasia demonstrated a greater difficulty with verbs in reading tasks than with nouns (Hillis and Caramazza, 1995). Arevalo et al. (2007) found that in a group of 21 individuals with either Anomic, Broca's, or Wernicke's Aphasia, all were significantly less accurate with verbs in picture naming when compared to single word reading and word repetition. Conversely, Berndt et al. (1997a) found that in a group of 11 persons with aphasia (i.e., Anomic, Broca's, Wernicke's, and transcortical sensory aphasia), five individuals had more trouble with nouns, two had more trouble with verbs, and four had no significant difference between nouns and verbs in picture naming ability. The dynamic noun and verb grammatical deficits within modalities noted between the documented individuals with aphasia has prompted researchers to more closely examine relationships regarding theoretical models of language processing, cortical representation, and noun and verb retrieval.

Double Dissociations across Modality and Grammatical Class

Double dissociations across modalities and grammatical deficit can also occur, so that a grammatical class deficit (e.g., noun deficit) can exist within one modality (e.g., oral naming), while a different grammatical class deficit (e.g., verbs deficit) can occur in a different modality

(e.g., written naming) (Hillis & Caramazza, 1995; Hillis et al., 2002; Rapp & Caramazza, 2002; Shapiro & Caramazza, 2002).

After examining the evidence regarding selective impairments, many researchers have begun to view double-dissociations in individuals with aphasia as a series of interconnected processing subsystems that have been damaged, instead of a single underlying impairment (Berndt et al., 1997a, 1997b; Caramazza & Miceli, 1991; Caramazza & Rapp, 2002; Kay, Lesser, & Coltheart, 1996). Hillis and Caramazza (1995) worked with an individual with severe anomic aphasia who exhibited increased difficulties producing nouns in oral tasks, and showed greater impairment in verbs when recognizing written forms. Rapp and Caramazza (2002) reported findings from an individual with aphasia who demonstrated increased difficulties with producing nouns in spoken activities and increased difficulties with verbs in written activities (originally reported between May 1994- April 1995). The authors posited that the individual's deficits arose from problems retrieving/maintaining stable word-forms (i.e., noun word-forms in spoken tasks and verb word-forms in written tasks). The study examined the possible effects of abstractness of verbs and selective morphological difficulties within various individuals with aphasia and determined that the deficits were not due to object or action distinction, but to grammatical properties associated with the stimuli. The authors concluded that these findings, along with data collected from the studied individual with aphasia, support the existence of grammatical category distinctions at post-semantic levels among various pathways of each feature set. For further information, see the section titled "Rapp and Caramazza model."

Language Models

Despite a number of cases reporting double-dissociations across modality and grammatical class (Hillis & Caramazza, 1995; Hillis et al.,, 2002; Rapp & Caramazza, 2002; Shapiro & Caramazza, 2002), theories regarding the loci of impairment within the language system remain

controversial. Nonetheless, evidence regarding double dissociations has been used to further establish the existence of multi-system language models that allow explanation for the occurrence of selective impairments (Berndt et al., 1997a, 1997b; Caramazza & Miceli, 1991; Rapp & Caramazza, 2002; Kay et al., 1996). This section examines some traditional models of lexical access and how they are able or unable to account for the double dissociation findings across modality and grammatical class.

Levelt Model

Dissociations are generally thought to occur within the syntactic or semantic areas of the language system. Levelt's Tier Speech Production Model (1989) is commonly used to explain the syntactic or semantic basis for the dissociation. The model consists of three levels: the conceptualizer (determines what sounds will be used), formulator (converts conceptual sound structure into a linguistic structure), and articulator (physical components used for sound production) (Levelt, 1989). In an updated model, lexical representation is comprised of two levels between the formulator and articulator. The first level, the lemma, is an abstract lexical representation that matches semantic information to the conceptualized information and also plays a role in defining sentence structure. The second level, the lexeme, stores word forms that are specified for oral (i.e., phonologic) and written (i.e., orthographic) output, which are activated and then theoretically inserted into the previously formulated sentence structure (Levelt, 1992).

Analyzing the collected data relating to language processing, researchers have made assertions regarding the origin of double dissociations within the Levelt model (1992). A number of researchers have concluded that items are not grouped according to grammatical class, but through semantic/physical features, leaving the dissociation to occur within that system (Berndt et al., 1997a, 1997b). For example, an individual with aphasia may see a picture of tiger,

which would in turn activate other related animals, such as a lion or cheetah. Berndt et al. (1997a, 1997b) argued that if errors occurred at the lemma level (i.e., semantic level), serious destructive effects would be seen in sentence production, which is formulated at that level. These researchers argue that if the level of impairment was at the lower lexical level, the lexeme level (i.e., phonological and/or orthographic output level), sentence production would subsequently be notably less affected. Conversely, Caramazza & Hillis (1991) argue that their data reveal impairment at the lower lexeme level. They assert that if an individual with aphasia has a noun or verb deficit in one output modality and not in another (e.g., noun impairment with oral naming and not written naming), then the impairment must exist at the lexeme level. Druks (2002) added that although the evidence for impairment at this level is not equally strong, the majority of investigators infer that the impairments do occur at the lexeme level.

Rapp and Caramazza Model (2002)

Rapp and Caramazza (2002) created a newer schematic depiction of language processing that would account for the interpretation of "modality specific grammatical dissociations as modality-specific dissociations between words referring to objects and actions" (p. 398). The model is based on the hypothesis that grammatical category deficits occur because defining features of nouns correspond to perceptual features, while defining features of verbs correspond to motor actions. It is assumed that these information categories are located in separate brain areas that communicate with the output lexicons using various pathways. The researchers state that modality and grammatical errors occur from selective damage to perceptual feature and motor feature pathways that correspond to grammatical categories, since action information plays a significant role in the definition of many verbs and perceptual features compose a great majority of concrete nouns. Separate pathways exist for each of these feature sets thereby

providing an explanation for noun and verb differences in terms of the semantic differences between perceptual objects and actions (Rapp & Caramazza) (Figure 1-1).

Ellis and Young Model (1988)

The model that will be used to guide the research questions and interpretation of results in this study is the Kay et al. (1996) adapted Ellis and Young model (1988). This model depicts language processing as a multi-modal input and output system and consists of three input modalities (i.e., speech, pictures & seen objects, and print) and two output modalities (i.e., speech and print) (Figure 1-2).

Auditory input is initially processed via auditory phonological analysis (i.e., speech) and orthographic information (i.e., print) is processed via the abstract letter identification modality. The stimuli are then processed to the phonological input lexicon and orthographic input lexicon, respectively, where a list of appropriately matched phonological and orthographic words is activated. For visual material, such as pictures and objects, the visual object recognition system is activated. Stimuli from all three input modalities are then processed through the semantic system where conceptual meaning is retrieved and assigned to the stimuli. Theoretically, this level is analogous to Levelt's lemma level (1992). Next, the identified stimuli are transferred to either the phonological output lexicon (i.e., speech output) or the orthographic output lexicon (i.e., writing/print) where the appropriate word-form is retrieved. This level corresponds to Levelt's lexeme level (1992). Finally, the newly assigned word is temporarily stored in a buffer until it is produced.

Using this model, an individual can repeat auditory stimuli (i.e., speech), copy orthographic stimuli (i.e., print), read aloud orthographic stimuli (e.g., oral reading), and write to auditory stimuli (e.g., writing to dictation) without utilization of the semantic system. For example, if an individual is to repeat auditory stimuli, the semantic system can be bypassed

completely using the route of auditory phonological analysis→ phonological input buffer→ phonological input lexicon→ phonological output lexicon→ phonological output buffer. Similarly, an individual can bypass the semantic system when copying orthographic stimuli using the route of abstract letter identification→ orthographic input lexicon→ phonological output lexicon→ orthographic output lexicon→ orthographic output buffer. An individual can bypass the semantic system as well when reading orthographic stimuli aloud. The route of abstract letter identification→ orthographic input lexicon→ phonological output lexicon→ phonological output buffer would be utilized in this situation. Finally, for writing to auditory stimuli, the route of auditory phonological analysis→ phonological input buffer→ phonological input lexicon→ phonological output lexicon→ orthographic output lexicon→ orthographic output buffer would be used. These routes would allow an individual with aphasia to process and produce words that are regular (e.g., dog) and irregular (e.g., leopard) without having to comprehend the meaning of the word (i.e., access the semantic system) (adapted Ellis & Young model, 1988; as cited in Kay et al., 1996).

The adapted Ellis and Young model (1998; as cited in Kay et al., 1996) also accounts for non-lexical retrieval via acoustic-to-phonological conversion (i.e., auditory stimuli converted into oral speech) and letter-to-sound rules (i.e., print/reading stimuli converted into oral speech) pathways. Nonsense words or non-words are processed through these two pathways; stimuli are not assigned semantic meaning or retrieved from the lexicon because they do not exist in the native language. For example, if an individual read the word "tanipe" aloud, it would theoretically be processed using the letter-to-sound rules pathway (i.e., "sounded out") because there is not a lexical item corresponding to this letter string in the orthographic input lexicon. Another non-lexical route that may be used is the sound-to-letter rules pathway. This route

enables individuals to transfer non-lexically retrieved words from the phonological output buffer (i.e., temporarily stored speech forms of words that have been presented auditorily) to the orthographic output buffer (i.e., temporarily stored print/written forms of words) to then produce the word orthographically. This route allows for people to write nonwords from dictation. The final non-lexical route is the acoustic-to-phonological conversion. With spoken input, the stimuli would travel around the semantic and phonological systems to the phonological output buffer. This route enables individuals to repeat nonwords. It is speculated that individuals with language processing impairment, such as individuals with aphasia, often use the non-lexical routes as well as the lexical routes that bypass the semantic system (Kay et al.).

The adapted Ellis and Young model (1988; as cited in Kay et al., 1996) can be used as a guide to explain single modality deficits in individuals with aphasia. To that end, Kay et al. have created a psycholinguistic test battery, The *Psycholinguistic Assessment of Language Processing in Aphasia* (PALPA) to assist clinicians and researchers in localizing deficits in persons with aphasia (1992).

Noun and Verb Cortical Locations

One theory argues that noun and verb dissociation arises along lexical lines, which are processed in separate cortical areas (Caramazza & Hillis, 1991). Hillis & Caramazza (1995) concluded that an implication for this difference involved lexical phonological knowledge for nouns and verbs being independently represented in the brain. The researchers furthered the theory of separate noun and verb locations in various modalities after analyzing an individual with aphasia who was severely impaired in recognizing and comprehending written verbs, even though her performance on recognizing and comprehending spoken verbs and spoken/written nouns was considered within normal limits. The participant's performance on concrete and abstract nouns was identical; therefore, this situation would further imply that lexical

phonological knowledge and lexical orthographic knowledge for nouns and verbs are independently represented in the brain (Hillis & Caramazza, 1995).

Recent studies have begun to use imaging techniques (e.g., fMRI and PET) to determine distinct brain regions designated for speech across modality tasks, as well as, noun and verb processing (Paulesu et al., 1997; Perani et al., 1999). No study, however, has offered sufficient evidence to allow researchers to confidently conclude that nouns and verbs activate separate and discrete cortical areas. Instead, the majority of these studies have shown areas that were activated more by one category than by another or that no areas were activated more by nouns than verbs (Arevalo et al., 2005; Paulesu et al., 1997; Perani et al., 1999).

Other recent studies have asserted that noun and verb retrieval differences are not due to separate anatomical locations, but to factors underlying each concept (Arevalo et al., 2005). In a review of the literature, Druks (2002) compiled a list of factors that objects and actions should possess in order to evaluate word retrieval effectively. These factors included a high degree of name agreement and matching of frequency, age-of-acquisition, and familiarity (Druks). Arevalo et al. (2007) investigated the effect of manipulability on activating and processing nouns and verbs (i.e., objects that can and cannot be manipulated and actions that do and do not involve fine hand movements). The researchers found an overall lower verb accuracy across individuals with aphasia and with control participants; however, individuals with aphasia (i.e., Broca's and Wernicke's Aphasia) were significantly more accurate with processing non-manipulable items, while control participants were significantly more accurate with processing manipulable items. Further, when analyzed as a group (i.e., Broca's, Wernicke's, and Anomic Aphasia), individuals with aphasia showed a significant affect of manipulability with verbs (actions) rather than nouns (objects). This effect of manipulability was seen across all three aphasia types. The researchers

hypothesized this result was due to motor cortex damage in the area were hand movement is processed/analyzed (Arevalo et al., 2007).

Berndt et al. (1997b) concluded that either grammatical class, or imageability, or both features play a role in performance, but the effects of the factor or class are independent from one another. Results in this area of research have provided further insight regarding the foundation of nouns and verbs; however, further research is required before a conclusion regarding the origin can be established. Jonkers and Bastiaanse (1998) furthered this point by asserting that if these extraneous factors are appropriately controlled for, a dissociation between nouns and verbs could prove to be just one-directional (i.e., all persons with aphasia would show greater difficultly with verb retrieval compared to noun retrieval or vice versa).

Evidence for Double Dissociations

Certain researchers have documented the existence of double dissociations between modalities and grammatical classes in persons with aphasia (Hillis & Caramazza, 1991; Hillis & Caramazza, 1995; Rapp & Caramazza, 2002). Hillis and Caramazza (1991) asserted that the presence of a double-dissociation between two individuals using the same stimuli implies that noun and verb differences can be attributed to degree of difficulty between the two word classes. This was evident when looking at two individuals with aphasia with flawless auditory comprehension of both nouns and verbs. One presented difficulties with oral production of nouns, while the other demonstrated difficulties with oral production of verbs (Hillis & Caramazza, 1991). In a review of the literature, it was asserted that these noun/verb differences occur at the lexical level. The argument was based on the fact that the affected participants had intact comprehension for the impaired category, which would further support the existence of the double dissociation (e.g., impaired speaking or writing with intact comprehension) (Druks, 2002). Berndt et al. (1997a), however, made the relevant point that researchers should be aware

that certain comprehension test are not sensitive enough to pick up mild semantic deficits, which could affect whether a double-dissociation truly existed.

Questioning the Existence of Double Dissociations

Although several studies have documented double-dissociations, its existence remains questionable due to the inability to reliably duplicate the findings (Arevalo et al., 2005; Odell, Hashi, Miller, & McNeil, 1995). Arevalo et al. (2005) mentioned that double dissociation studies often suffer from a small sample size (i.e., single case studies) and are not sufficiently representative of the population. In addition to the limited sample, many of the studies have been designed in such a way that correct/good and incorrect/poor performance was not clearly and statistically defined. These factors contribute to the ability to properly duplicate and/or document double-dissociations in various individuals, and thus weaken the validity of the findings (Arevalo et al., 2005).

Similarly, Odell et al. (1995) found methodological weaknesses in certain studies which asserted the presence of a selective impairment in persons with aphasia. Specifically, test-retest reliability, task difficulty, and task sensitivity were found to be deficient in certain studies. The researchers stated that due to these inequities, the studies failed to support the existence of a true selective impairment in the individuals. Odell et al. concluded that to meaningfully interpret double-dissociations within an individual, researchers should first fulfill the six criterion established by their study. Additional information regarding the criteria can be found in Odell et al. (2005).

Research Questions

In this study, the verbal and written outputs of three persons with aphasia were examined to determine if a relationship, particularly a double dissociation between nouns and verbs, existed across modalities. Specifically, the questions asked are as follows:

1. Are there significant differences across nouns and verbs in oral naming, oral reading, written naming, and writing to dictation?

2. Does a double-dissociation exist across any of these modalities (i.e., nouns are more impaired in one modality and verbs are more impaired in the other modality)?

3. Based on an error analysis of incorrect responses, are the levels of impairment different for nouns and verbs across modalities?

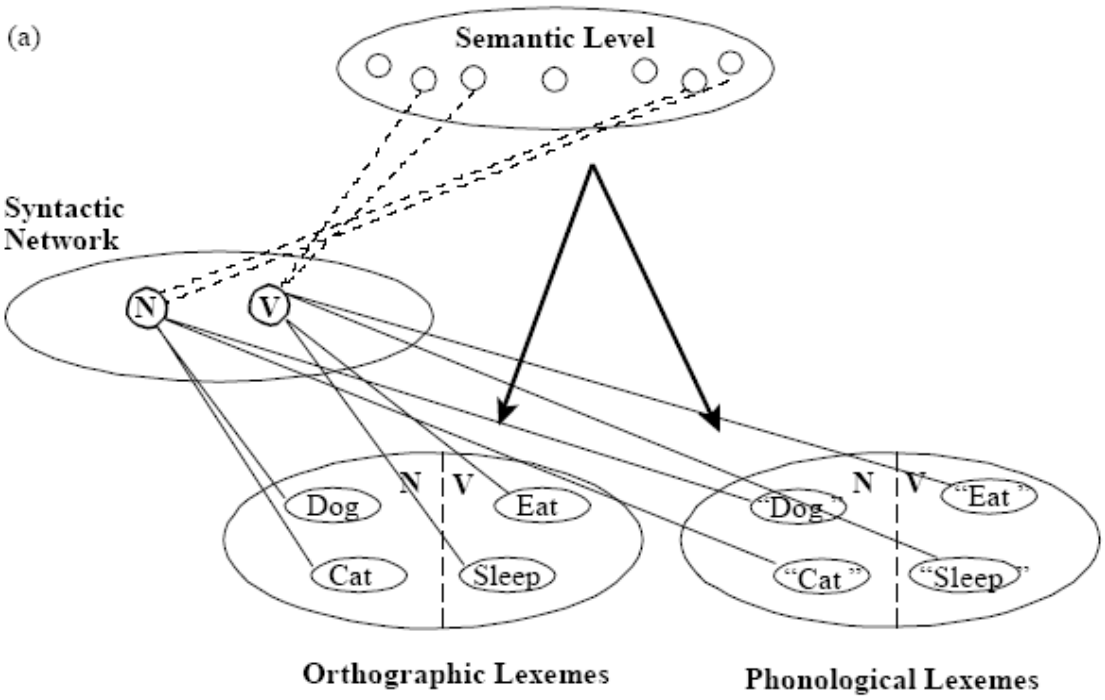


Figure 1-1. Rapp and Caramazza model (2002). [Reprinted with permission from Elsevier Limited. Rapp, B., & Caramazza, A. (2002). Selective difficulties with spoken nouns and written verbs: A single case study. (Page 397, Figure 4-a). *Journal of Neurolinguisitics, 15*, 373- 402.]

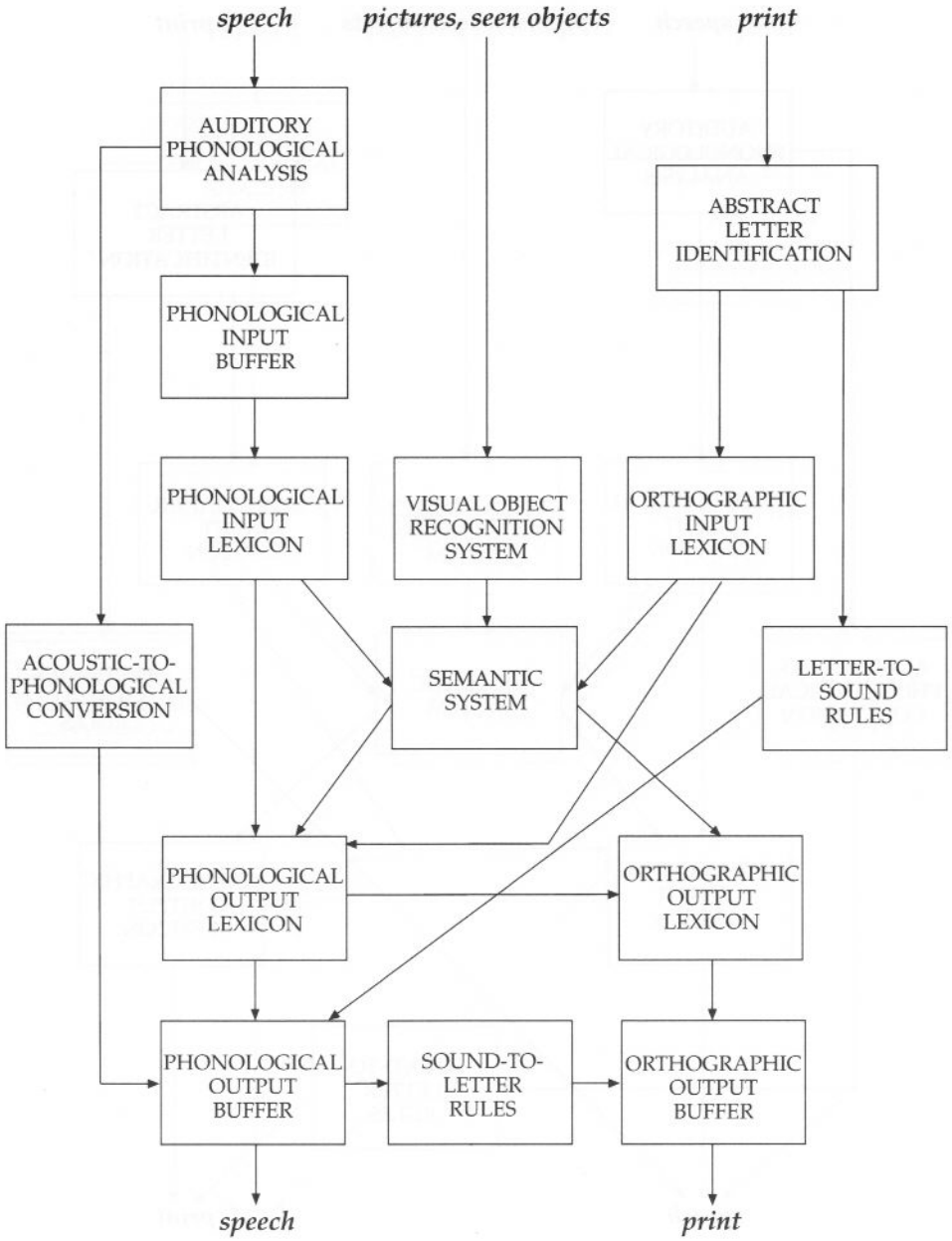


Figure 1-2. Ellis and Young model (1988; as cited in Kay, Lesser, & Coltheart, 1996). [Reprinted with permission from Psychology Press: Taylor and Francis Group. Kay, J., Lesser, R., & Coltheart, M. (1996). Psycholinguistic Assessments of Language Processing in Aphasia (PALPA): An introduction. (Page 15, Figure 9). *Aphasiology, 10*, 159-215.]

CHAPTER 2
METHODS

Participants

Three participants, two females and one male, were recruited from the University of Florida Speech & Hearing Clinic and hospitals in the Central Florida area to participate in this study. Participant 1 (P1) is a 41-year-old, right-handed female with 16 years of education. Participant 2 (P2) is a 49-year-old, right-handed female with 12 years of education, and Participant 3 (P3) is a 57-year-old, right-handed male with 12 years of education. P1 was diagnosed with Broca's Aphasia based on the *Western Aphasia Battery (WAB;* Kertesz, 1982) criteria. P2 was diagnosed with Conduction Aphasia based on WAB criteria; however, through clinical judgment and consideration that the participant demonstrated extremely limited verbal output with relatively intact comprehension, the diagnosis was determined to be more accurately described as Broca's Aphasia. P3 also was diagnosed with Conduction Aphasia based on WAB criteria; however, through clinical judgment, the diagnosis was determined to be more accurately described as Broca's Aphasia secondary to the occasional strings of fluent and grammatical speech with limited verbal output and relatively intact comprehension demonstrated by the participant (Table 2-1 and Table 2-2).

Inclusion criteria included a) right handedness; b) a diagnosis of aphasia with significant lexical retrieval impairments and relatively intact comprehension; c) no more than moderate cognitive impairments; d) a negative history of neurological impairments (other than stroke), alcoholism, learning disorder, etc. All participants met these criteria; however, after completion of testing, a more detailed case history with P3 revealed a possible learning disorder, which had not previously been diagnosed. He reported having trouble learning and reading as a child as well as being held back one year in elementary school despite active parent involvement and

assistance. Two additional people with aphasia were tested and not included in the study due to one subject's over-qualified ability to complete the tasks and another subject's inability to produce words in the oral or written modalities. Participants who met the above listed criteria completed standardized and non-standardized assessments to determine the associated level of language impairments as well as the existence of a selective noun and/or verb deficits. The comprehensive evaluation included (a) *Western Aphasia Battery (WAB;* Kertesz, 1982), to determine the type and severity of the aphasia; (b) *Boston Naming Test* (*BNT*, Goodglass, Kaplan, & Weintraub, 1983), to determine oral naming abilities of nouns across a range of frequencies; (c) word fluency tasks, to look at generative naming abilities; (d) *Pyramids and Palm Trees* (Howard & Patterson,1992)*;* (e) *Kissing and Dancing Test* (Bak & Hodges, 2003), to determine the presence of semantic deficits; (f) *An Object and Action Naming Test* (across multiple modalities) (Druks & Masterson, 2000), to determine deficits in various modalities as well as the possibility of noun or verb deficits.

Materials

Lexical retrieval abilities as measured by stimuli from *An Object & Action Naming Test* (Druks & Masterson, 2000) were the primary dependent variable for this study. *An Object & Action Naming Test* consists of two forms (Form A and Form B), which are matched for printed word frequency, rated familiarity of the verbal labels, and rated age-of-acquisition (Druks & Masterson). Form A and Form B each consist of 81 object line-drawings and 50 action line-drawings. The pictures were used for oral naming and written naming. For the oral reading task, the words corresponding to each picture were typed and glued onto three-by-five note cards, in 16-point, Times New Roman font. Action words were typed in the present form rather than the present progressive (i.e., "-ing") form provided through *An Object & Action Naming Test* (Druks & Masterson). An example of this change would include the word "Kicking" typed as "Kick" so

that oral reading of verbs was not complicated by additionally requiring the processing and reading of morphology.

Each participant was assessed using the 131 words/pictures provided through *An Object & Action Naming Test* (Druks & Masterson, 2000). Although the test was divided into object and action sections, it was evident that certain items could be considered both an action and object (i.e., ambiguous) by the participant. For example, the object word "tie" could be considered as a noun (i.e., a garment worn by a male around the neck) or a verb (i.e., to join or connect two items). Nouns and verbs considered to be "ambiguous" were removed and analyzed separately. Ambiguous nouns and verbs were classified by determining those with a word frequency greater than 25% of the cumulative word frequency. Word frequency was determined using the *Computational Analysis of Present-Day American English* (Kucera & Fancis, 1964). Statistics regarding word frequency, rated familiarity of the verbal labels, and rated age-of-acquisition were completed to ensure validity of the non-ambiguous word lists created for the study. Removing the ambiguous items did not result in a significant difference ($p > .05$) across any of the above listed characteristics, as determined through the use of a Mann-Whitney Test.

Procedures

An Object & Action Naming Test (Druks & Masterson, 2000) provides noun and verb stimuli in two forms (Form A and B). P1 and P2 received Form A, and P3 received Form B. The battery was administered over several sessions, for approximately 2 hours each session. All sessions were video- and/or audio- recorded to ensure the accuracy of scoring and uniform testing.

Participants were tested across six modalities; however, this study was completed to examine the relationship between four modalities: oral naming and written naming as well as oral reading and writing-to-dictation. For oral naming, each participant was provided with the

object and action line drawings to name orally. All answers were manually recorded by the examiner. At a later date, the participants were provided with the object and action line drawings in a different order and were asked to write the name of the object/action using a pen and paper provided. Oral reading was completed using the three-by-five note cards described above. The participant read aloud the object and actions printed on the cards, while the examiner manually recorded his/her reply. Finally, the participants were asked to write object and actions words dictated in a different order by the examiner. This modality was completed with the participant recording his/her answers with a pen and paper provided. Data collected in oral modalities was video- and audio-recorded, while written modalities were video-recorded only.

Oral reading and writing-to-dictation action words were auditorily and visually presented to participants in present form rather than the present progressive form (e.g., "crawl" instead of "crawling"). This change was implemented to ensure that participants were solely tested on verb knowledge and not scored or penalized according to morphological changes of a word.

Accuracy Scoring

Responses were audio recorded or produced orthographically by the participant. All collected data was audio- and/or video- recorded to ensure accuracy. Recorded responses were considered accurate if no phonologic (i.e., no sound omission, addition, or substitution), orthographic (i.e., no letter omission, additional, or substitution), or semantic errors were present. During written naming, however, verbs written in present progressive (i.e., using a gerund "-ing") form or present form by the participant were considered correct. Accuracy results for all participants are present in Table 2-2 and lexical accuracy results are present in Table 2-3.

Error Analysis

An error analysis was completed to determine if any trends emerged through the types of errors made by each participant. Errors were labeled and divided into the following eleven

categories: Semantic Error in the Same Grammatical Class, Semantic Error in a Different Grammatical Class, Greater than or Equal to 50% of Phonemes/ Graphemes (i.e., sounds/ letters) Produced Correctly, Less than 50% of Phonemes/ Graphemes Produced Correctly, Mixed Error (i.e., both a phonologic and semantic error), Unrelated Word within the Same Grammatical Class, Unrelated Word in a Different Grammatical Class, Perseveration (i.e., repetition of a previously stated/written word), Jargon (i.e., a nonsense word fabricated by the participant), "I Don't Know" (IDK) or No Response (NR) given by the participant, and/or an Unintelligible/Indiscernible answer provided by the participant. Using the targeted word, *candle,* an example of each error type is provided in Table 2-4.

Reliability

Inter-rater reliability was done by a trained communication sciences and disorders graduate student familiar with aphasic speech on 37% of the naming responses. Two different modalities within different grammatical classes were evaluated for each participant. For example, with Pt 1, reliability was completed for written naming of verbs and oral reading of nouns. A point-to-point evaluation was conducted on each response, resulting in 93% agreeability.

Table 2-1. Descriptive Information Regarding Participants

Pt.	Sex	Education (years)	Age	Site of Lesion	Type of Aphasia	Months Post Onset	WAB-Aphasia Quotient	CLQT
1	F	16	41	Left MCA	Broca's	48	55.5	2.0 (moderate)
2	F	12	49	Left MCA	Broca's	9	36.8	1.8 (moderate)
3	M	12	57	Left Posterior Watershed Region	Broca's	24	55.8	2.8 (mild)

Note: Pt: Participant; M: Male; F: Female; WAB: Western Aphasia Battery; CLQT: Cognitive Quick Linguistic Test.

Table 2-2. Accuracy Scores for all Participants

	Total Possible	P1	P2	P3
WAB				
Spontaneous Speech				
Information Content	10	8	4	7
Fluency	10	5	2	4
Total	20	13	6	11
Comprehension				
Yes/No Questions	60	51	58	54
Auditory Word Recognition	60	49	54	54
Sequential Commands	80	51	60	46
Total	200	151	172	154
Repetition				
Total	100	25	23	46
Naming				
Object Naming	60	29	11	29
Word Fluency	20	7	3	3
Sentence Completion	10	6	1	6
Responsive Speech	10	5	0	8
Total	100	47	15	46
Aphasia Quotient				
Total	100	55.5	36.8	55.8
Praxis	60	57	54	60
Reading and Writing				
Reading	100	54	65	80
Writing	100	46.5	60.5	57.5
Total	200	100.5	125.5	137.5
CLQT				
Attention Score	215	114(mod)	156(mild)	133(mild)
Memory Score	185	83(severe)	70(severe)	134(mod)
Executive Function Score	40	23(mod)	15(severe)	25(WNL)
Language Score	37	12(severe)	6.5(severe)	19(severe)
Visuospatial Skills Score	105	75(mild)	68(mild)	84(WNL)
Clock Drawing Score	13	13(WNL)	11(mild)	9(mod)
Composite Severity Score	4	2(mod)	1.8(mod)	2.8(mild)

Note: WAB: Western Aphasia Battery; CLQT: Cognitive Linguistic Quick Test

Table 2-3. Lexical Test Scores for all Participants

Test	Total Possible	P1	P2	P3
BNT Raw Score	60	19	1	7
% Correct		31.67	1.67	11.67
Pyramids and Palm Trees Raw Score	52	49	49	52
% Correct		94.23	94.23	100
Kissing and Dancing Raw Score	52	51	47	49
% Correct		98.07	90.38	94.23
Verbal Fluency/ Generative Naming	Seconds	CLQT	CLQT	CLQT
Animals	0-15	6	1	1
	16-30	2	0	2
	31-45	1	0	1
	46-60	1	0	0
Total animals		10	1	4
M words	0-15	1	1	0
	16-30	0	1	1
	31-45	0	0	0
	46-60	0	0	0
Total M words		1	2	1
Verbs/actions	0-15	1	1	3
	16-30	0	0	1
	31-45	0	0	0
	46-60	0	0	0
Total verbs/ actions words		1	1	4

Note: BNT: Boston Naming Test; CLQT: Cognitive Linguistic Quick Test.

Table 2-4. Error Analysis Categories (Targeted Word: Candle)

Error Type	Example
Descriptive Characteristic	Waxy
Semantic Error in Same Grammatical Class	Match
Semantic Error in Different Grammatical Class	Burn
≥ 50% of Phonemes/ Graphemes Correct	"Canl"/ Candl
< 50% of Phonemes/ Graphemes Correct	"Ca"/Canl
Mixed Phoneme/ Grapheme Error	"Satch"/ Satch
Unrelated word within the Same Grammatical Class	Table
Unrelated word within a Different Grammatical Class	See
Perseveration	Foot*
Jargon	Cadoo
IDK/ NR	"I don't Know"
Unintelligible/ Indiscernible	C…..?

Note: *A word previously answered during the assessment.

CHAPTER 3
RESULTS

The accuracy data for each participant will be discussed in turn (Table 3-1 through Table 3-3). Following the accuracy data are the error analysis data (Figure 3-1 through Figure 3-3).

Accuracy

A Fisher's Exact Test was used to analyze oral naming, oral reading, written naming, and writing to dictation accuracy results to determine if there was a difference in naming accuracy between nouns and verbs within each modality (Berndt et al., 1997a). There was no significant difference across any modalities for participant 1, 2, or 3.

Participant 1 (P1) Accuracy

Overall, Participant 1 exhibited higher accuracy on tasks in the oral modality as compared to tasks in the written modality (Table 3-1 and Figure 3-1).

Oral naming

Although P1 exhibited a higher percent accuracy for noun naming (60.81%) as compared to verb naming (45.16%), this difference was not significant ($p = 0.1956$).

Oral reading

There was no statistical difference between noun oral naming (68.92%) and verb oral naming (67.74%) ($p = 1.000$).

Written naming

There was no statistical difference between noun written naming (9.46%) and verb written naming (3.23%) ($p= 0.4314$).

Writing to dictation

There was no statistical difference between noun writing to dictation (10.81%) and verb writing to dictation (6.45%) ($p= 0.7196$).

Participant 2 (P2) Accuracy

Participant 2 demonstrated higher percent accuracy on written tasks as compared to oral tasks (Table 3-2 and Figure 3-2).

Oral naming

There was no statistical difference between noun oral naming (4.05%) and verb oral naming (0%) (p= 1.437).

Oral reading

There was no statistical difference between noun oral reading (17.57%) and verb oral reading (16.13%) (p= 1.0000).

Written naming

There was no statistical difference between noun written naming (66.22%) and verb (51.61%) (p= 0.2789).

Writing to dictation

There was no statistical difference between noun writing to dictation (74.32%) and verb writing to dictation (83.87%) (p= 0.3225).

Participant 3 (P3) Accuracy

Participant 3 did not demonstrate greater percent accuracy for oral or written tasks; however, he did reveal a trend toward decreased naming abilities (Table 3-3 and Figure 3-3).

Oral naming

There was no statistical difference between noun oral naming (30.99%) and verb oral naming (31.03%) (p= 1.0000).

Oral reading

Although noun oral reading was lower (45.07%) than verb oral reading (65.52%), the difference was not statistically significant (p= 0.0793).

Written naming

There was no statistical difference between noun written naming (24.29%) and verb written naming (27.59%) (p= 0.8010).

Writing to dictation

There was no statistical difference between noun writing to dictation (76.06%) and verb writing to dictation (82.76%) (p= 0.1708).

Error Analysis

The results of the error analysis conducted on all incorrect responses on *An Object and Action Naming Test* (Druks & Masterson, 2000) across all modalities are presented on Figures 3-4 to 3-6.

Participant 1 Error Analysis

Oral naming

Nouns. Semantic errors were the most predominant error type for verb naming, with production of semantically related nouns (48.28%) more prevalent than production of semantically related verbs (3.45%) (as determined by same and different grammatical class errors, respectively). The next highest level of errors was phonemic errors (20.69%) with at least 50% of target phonemes produced correctly and more than 50% of the target verbs produced incorrectly 3.45% of the time. Unrelated words in the same grammatical class (i.e., nouns) were produced 10.34% of the time, followed by mixed (6.90%) and unrelated different grammatical class errors (6.90%).

Verbs. Semantic errors were the most predominant error type for oral naming with verbs, with production of semantically related nouns (i.e., semantic different grammatical class, 29.41%) produced more often than production of related verbs (i.e., semantic same grammatical class, 11.76%). The next highest level of errors was unrelated grammatical class errors (same

grammatical class 5.88%, different grammatical class 29.41%). Only two other error types were observed, mixed errors (17.6%) and jargon (5.88%).

Oral reading

Nouns. The primary error was phonemic (39.13%, ≥ 50% phonemes correct and 17.39%, < 50% correct), followed by semantic same grammatical class (21.74%), then NR/IDK and Mixed (both = 8.70%), and jargon (4.35%).

Verbs. The error types for verb reading were evenly distributed across semantic errors (30%), phonemic errors (≥ 50% phonemes correct) (30%), and unrelated word errors (30%). NR/IDK errors composed 10% of all errors.

Written naming

Nouns. The predominant error for written naming was NR/IDK responses (50.75%), followed by jargon (14.93%), ≥ 50% of graphemes correct (10.45%), semantic same grammatical class (7.46%), and unrelated same grammatical class (7.46%). The remaining 4 error categories were all less than 5% each.

Verbs. The predominant error for written naming of verbs was NR/IDK responses (83.33%), with the remaining errors falling into mixed (6.67%), indiscernible (6.67%), and ≥ 50% correct graphemes (3.33%) categories.

Writing to dictation

Nouns. The primary error type was NR/IDK responses (68.18%), followed by indiscernible (12.12%) responses, ≥ 50% correct graphemes (7.58%), and jargon (4.55%). The remaining 3 categories were each composed of 3% or less of all errors.

Verbs. The primary error type was NR/IDK responses (75.86%), followed by indiscernible (10.34 %) responses, ≥ 50% correct graphemes (6.90%), semantic different grammatical class (3.45%), and unrelated same grammatical class (3.45%) errors.

Participant 2 Error Analysis

Oral naming

Nouns. Jargon (33.80%) was the main error for oral naming with nouns, followed by NR/IDK errors (23.94%), and phonemic errors (16.90%, ≥ 50% phonemes correct and 8.45%, < 50% correct). Unintelligible responses (14.08%), unrelated same grammatical class errors (1.41%), and unrelated different grammatical class errors (1.41%) comprised the remaining error types.

Verbs. NR/IDK errors (54.84%) were the main error for oral naming with verbs, followed by phonemic errors with ≥ 50% of phonemes correctly stated (16.13%), unintelligible responses (12.90%), and unrelated different grammatical class errors (6.45%). Semantic different grammatical class errors (3.23%), mixed errors (3.23%), and jargon (3.23%) comprised the remaining errors.

Oral reading

Nouns. Jargon (36.07%) was the primary error for oral reading with nouns, followed by phonemic errors (24.59%, ≥ 50% phonemes correct and 11.48%, < 50% correct), and unintelligible errors (18.03%). Unrelated grammatical class errors (same grammatical class 6.56%, different grammatical class 1.64%) and perseveration (1.64%) comprised the remaining errors.

Verbs. Phonemic errors (38.46 %, ≥ 50% phonemes correct and 3.85 %, < 50% correct) were the primary error type for oral reading with verbs, followed by unrelated different grammatical class errors (26.92%), and jargon (19.23%) errors. The remaining errors were comprised of unintelligible responses (7.69%) and perseveration (3.85%).

Written naming

Nouns. The predominant error for written naming with nouns were grapheme errors (40.00%, ≥ 50% graphemes correct and 8.00 %, < 50% correct), followed by semantic errors (semantic same grammatical class 16.00%, semantic different grammatical class 4.00%), and NR/IDK errors (12.00%). Unrelated grammatical class errors (unrelated same and different grammatical class errors both at 8.00%) and jargon (4.00%) comprised the remaining error types.

Verbs. Unrelated different grammatical class errors (33.33%) and semantic (same grammatical class 13.33%, different grammatical class 20.00%) were the predominant error with written naming with verbs, followed by <50% of graphemes correctly produced (13.33%) and mixed errors (13.33%), and jargon (6.67%) errors.

Writing to dictation

Nouns. The main error type for writing to dictation with nouns was grapheme errors (52.63%, ≥ 50% graphemes correct and 5.26 %, < 50% correct), followed by NR/IDK responses (26.32%), and unrelated same grammatical class errors (10.53%).

Verbs. The main error type for writing to dictation with verbs was grapheme errors (40.00%, ≥ 50% graphemes correct and 20.00%, < 50% correct), which was followed by NR/IDK responses (40.00%).

Participant 3 Error Analysis

Oral naming

Nouns. The predominant error for oral naming with nouns was NR/IDK responses (63.27%), followed by unrelated grammatical class errors (same grammatical class 10.20%, different grammatical class 2.04%), and semantic errors (same grammatical class 8.16%, different grammatical class 2.04%). Greater than and equal to 50% of phonemes correctly

produced (6.12%) and unintelligible responses (6.12%), as well as, jargon (2.04%) comprised the remaining error types.

Verbs. The predominant error for oral naming with verbs was NR/IDK responses (60.00%) as well, followed by semantic errors (same grammatical class 20.00%, different grammatical class 10.00%), and unrelated same grammatical class errors (10.00%).

Oral reading

Nouns. The primary error for oral reading with nouns was NR/IDK responses (64.10%), followed by ≥ 50% of phonemes correctly produced (17.95%), and unrelated grammatical class errors (same grammatical class errors 7.69%, different grammatical class errors 2.56%). The remaining errors were unintelligible responses (5.13%) and jargon (2.56%).

Verbs. The primary error for oral reading with verbs was unrelated grammatical class errors (same grammatical class errors 20.00%, different grammatical class errors 30.00%), followed by phonemic errors (≥50% phonemes correct produced, 20.00% and <50% of phonemes correctly produced, 10.00%), and semantic errors (same grammatical class errors 10.00%, different grammatical class errors 10.00%).

Written naming

Nouns. NR/IDK responses (66.04%) were the main error type for written naming of nouns, followed by grapheme errors (≥50% graphemes correct produced, 15.09% and <50% of graphemes correctly produced, 1.89 %), and jargon (5.66%) and indiscernible responses (5.66%). The remaining errors were comprised of semantic same grammatical class errors (3.77%), and mixed errors (1.89%).

Verbs. NR/IDK responses (61.90%) were also the main error type for written naming of verbs, followed by semantic errors (same grammatical class errors, 9.52% and different

grammatical class errors, 4.76%), ≥ 50% of graphemes correctly produced and unrelated same grammatical class errors (both at 9.52%), and jargon errors (4.76%).

Writing to dictation

Nouns. The predominant error for writing to dictation with nouns was ≥ 50% of graphemes correctly produced (58.82%), followed by jargon (23.53%), and indiscernible responses (17.65%).

Verbs. The predominant error for writing to dictation with verbs was ≥ 50% of graphemes correctly produced (80.00%), which was followed by jargon errors (20.00%).

Table 3-1. P1 Accuracy Data

Modality	Nouns % Accuracy	Verbs % Accuracy
Oral Naming	60.81	45.16
Oral Reading	68.92	67.74
Written Naming	9.46	3.23
Writing to Dictation	10.81	6.45

Table 3-2. P2 Accuracy Data

Modality	Nouns % Accuracy	Verbs % Accuracy
Oral Naming	4.05	0.00
Oral Reading	17.57	16.13
Written Naming	66.22	51.61
Writing to Dictation	74.32	83.87

Table 3-3. P3 Accuracy Data

Modality	Nouns % Accuracy	Verbs % Accuracy
Oral Naming	30.99	31.03
Oral Reading	45.07	65.52
Written Naming	24.29	27.59
Writing to Dictation	76.06	82.76

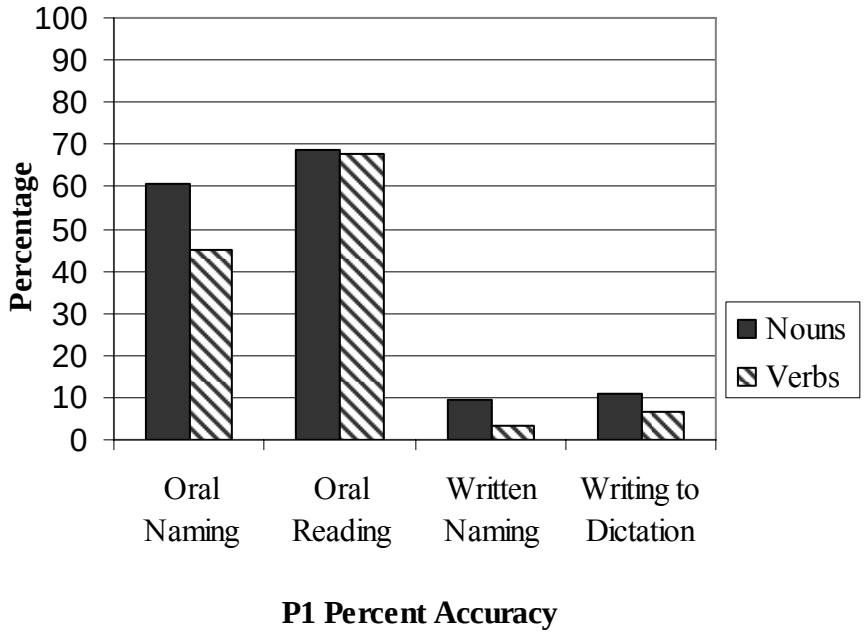


Figure 3-1. Visual Representation of P1's Accuracy Data.

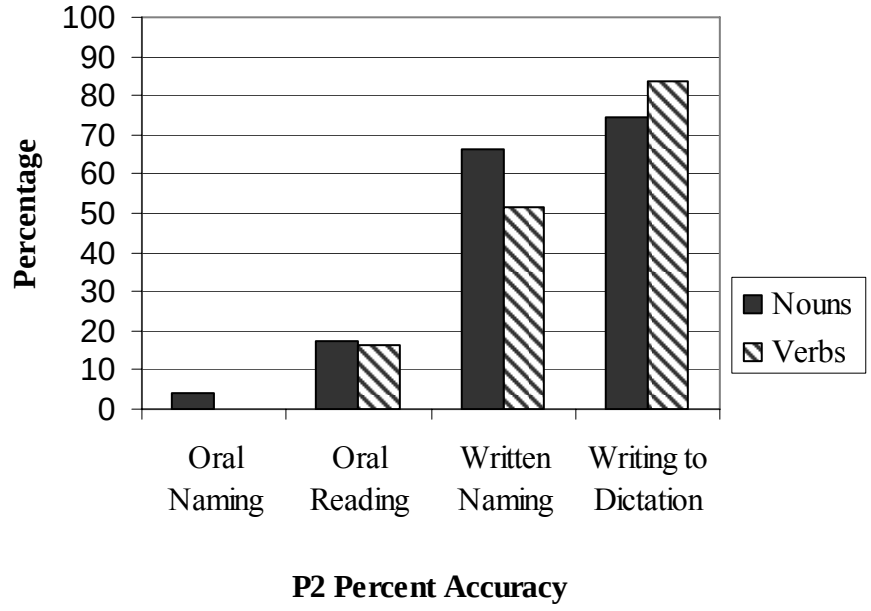


Figure 3-2. Visual Representation of P2's Accuracy Data.

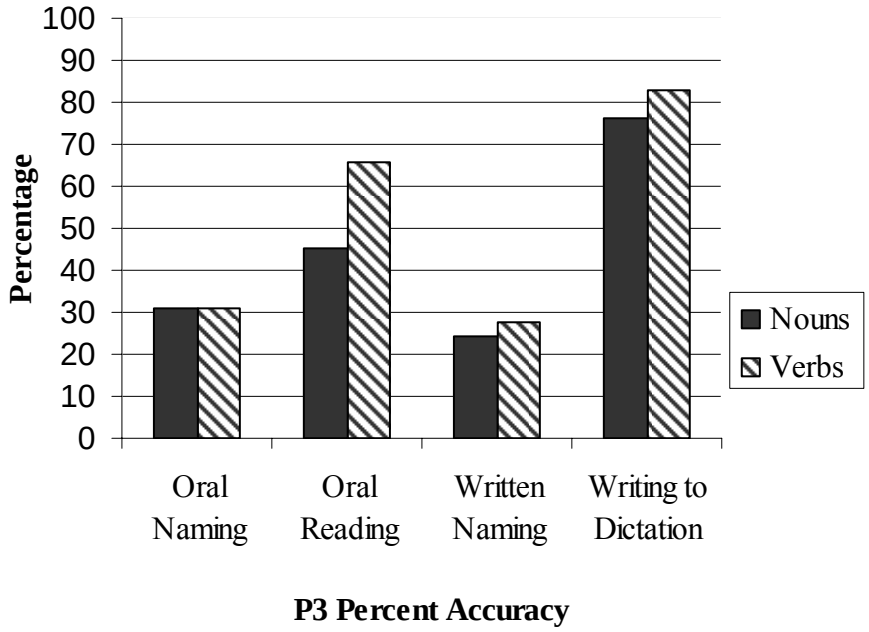
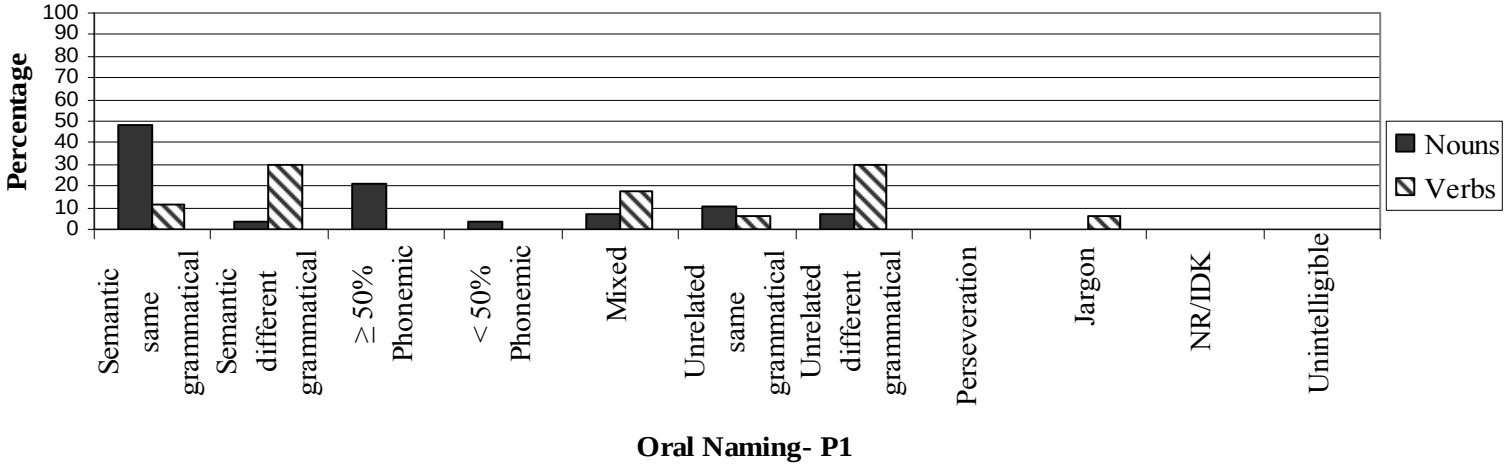


Figure 3-3. Visual Representation of P3's Accuracy Data.



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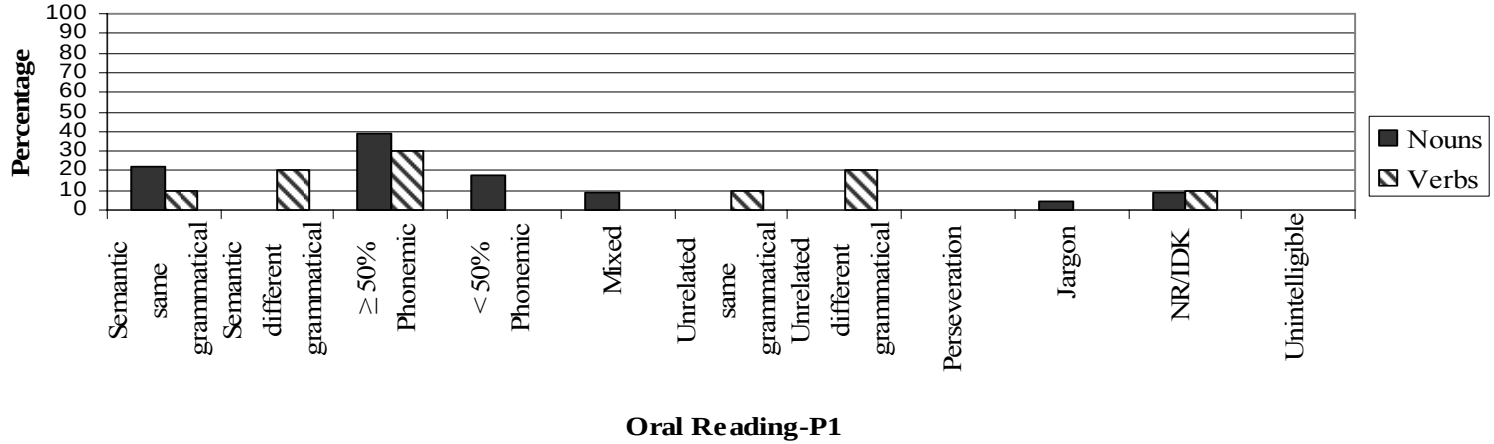
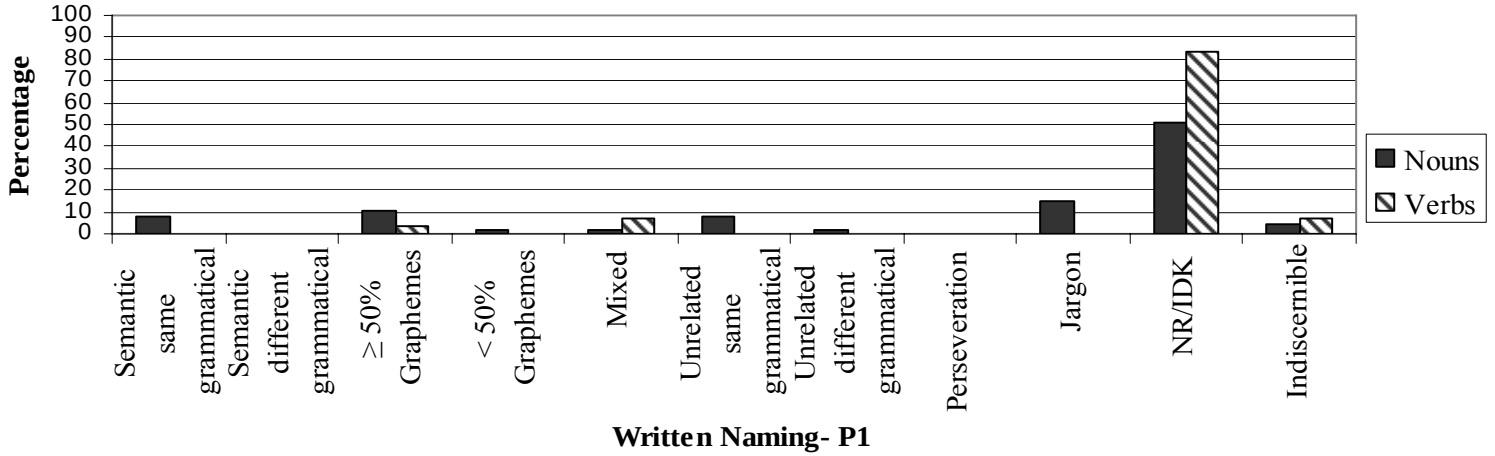


B

Figure 3-4. P1's Error Analyses Graphs. A) Error Analyses Graph of Oral Naming for P1. B) Error Analyses Graph of Oral Reading for P1. C) Error Analyses Graph of Written Naming for P1. D) Error Analyses Graph of Writing to Dictation for P1.



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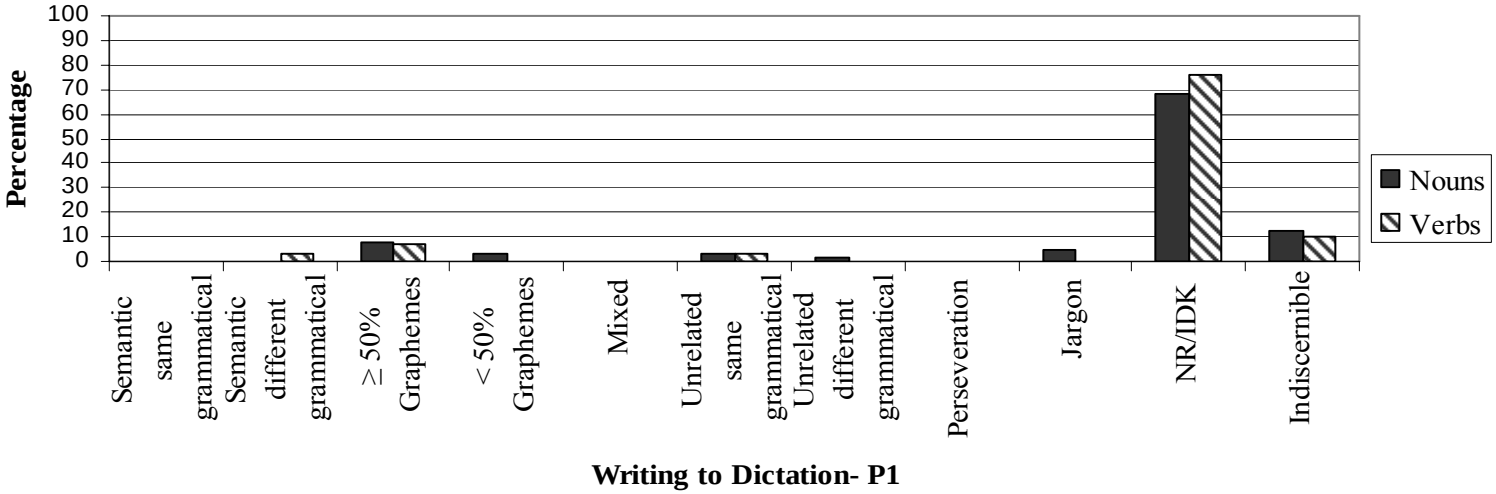
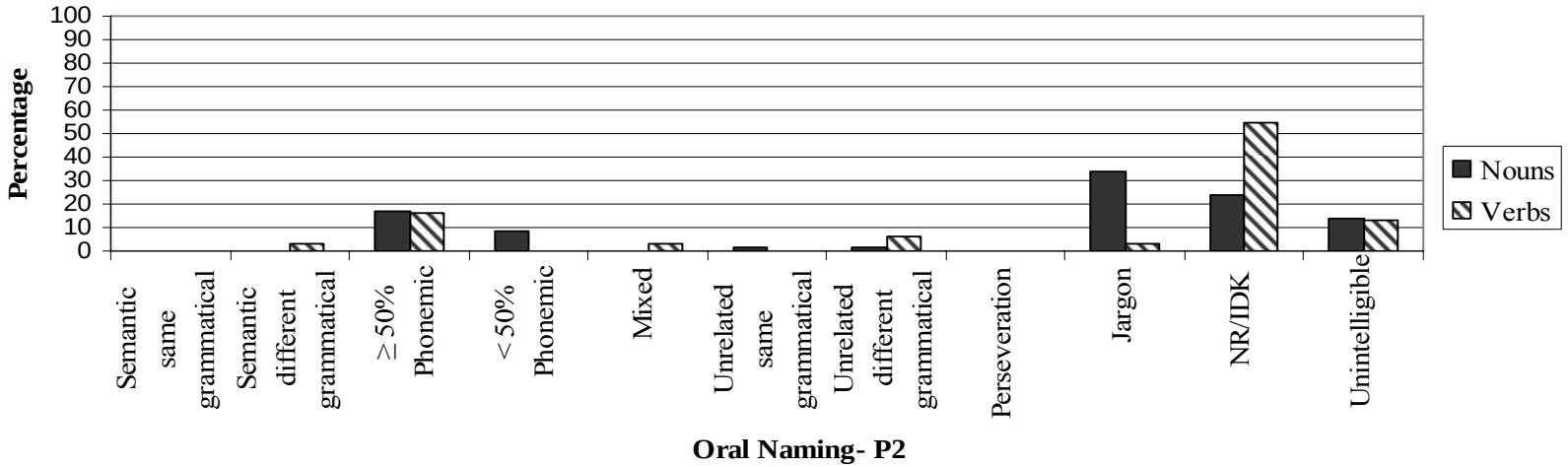


D

Figure 3-4. Continued



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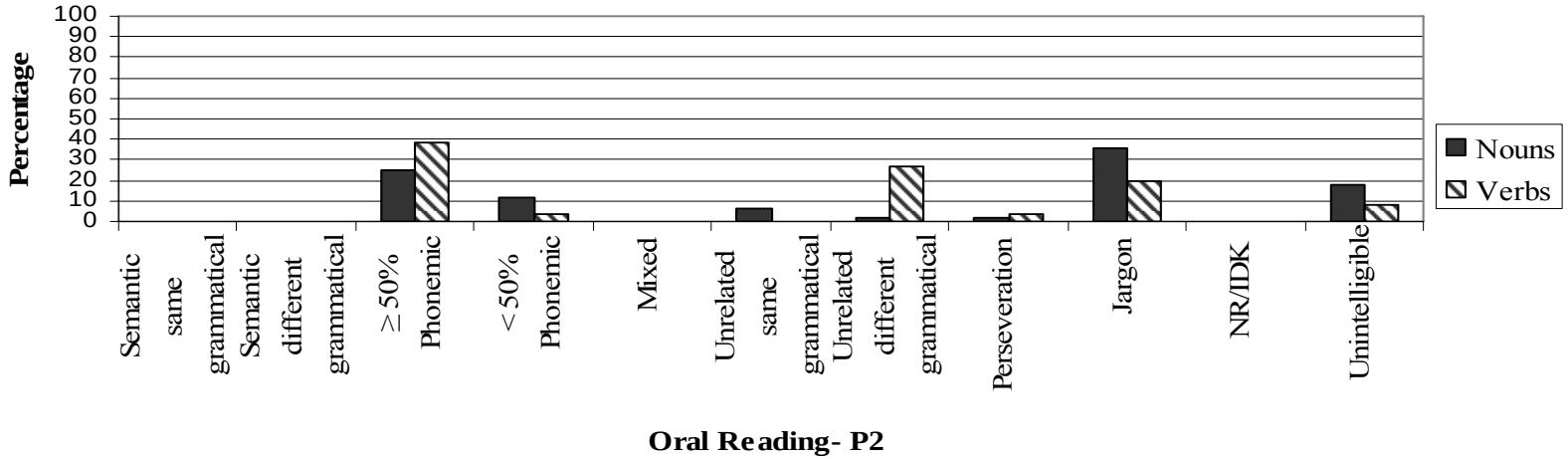
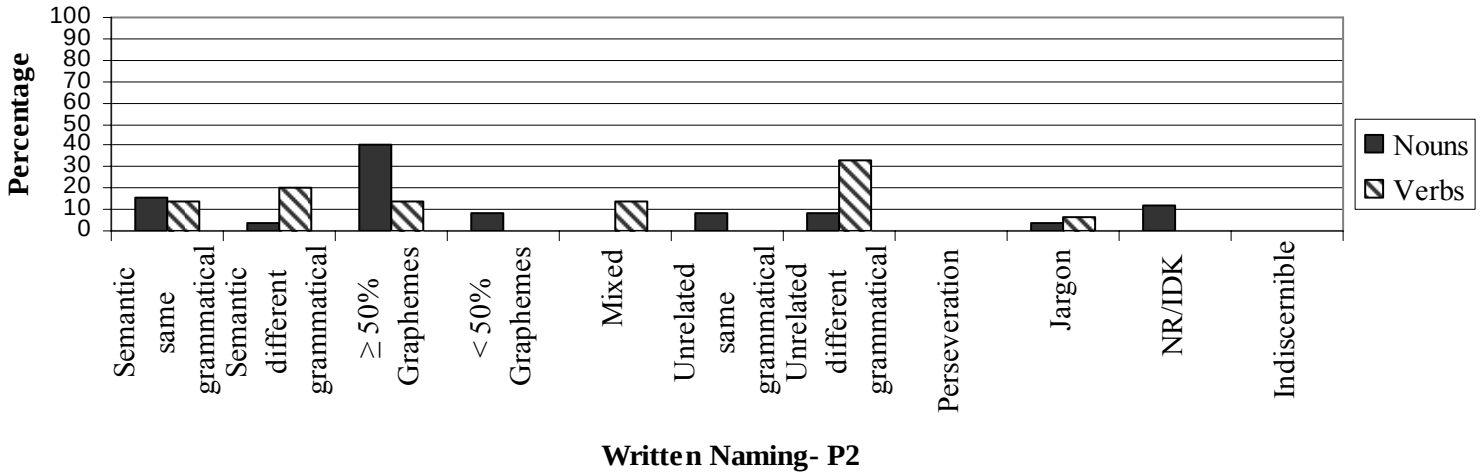


B

Figure 3-5. P2's Error Analyses Graphs. A) Error Analyses Graph of Oral Naming for P2. B) Error Analyses Graph of Oral Reading for P2. C) Error Analyses Graph of Written Naming for P2. D) Error Analyses Graph of Writing to Dictation for P2.



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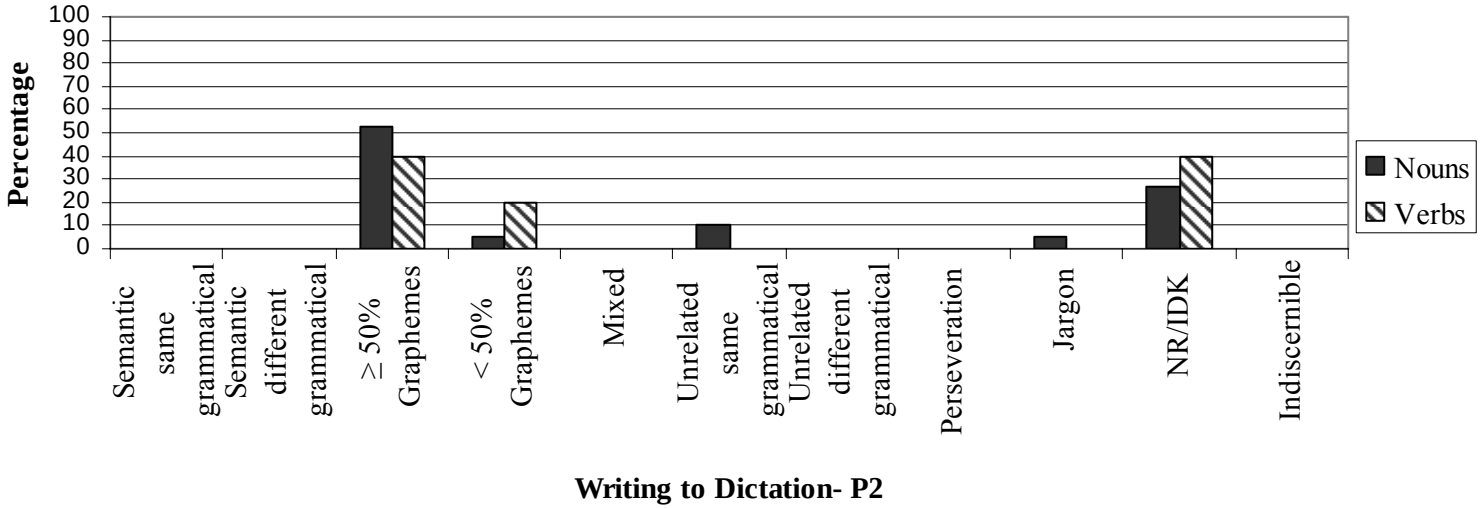

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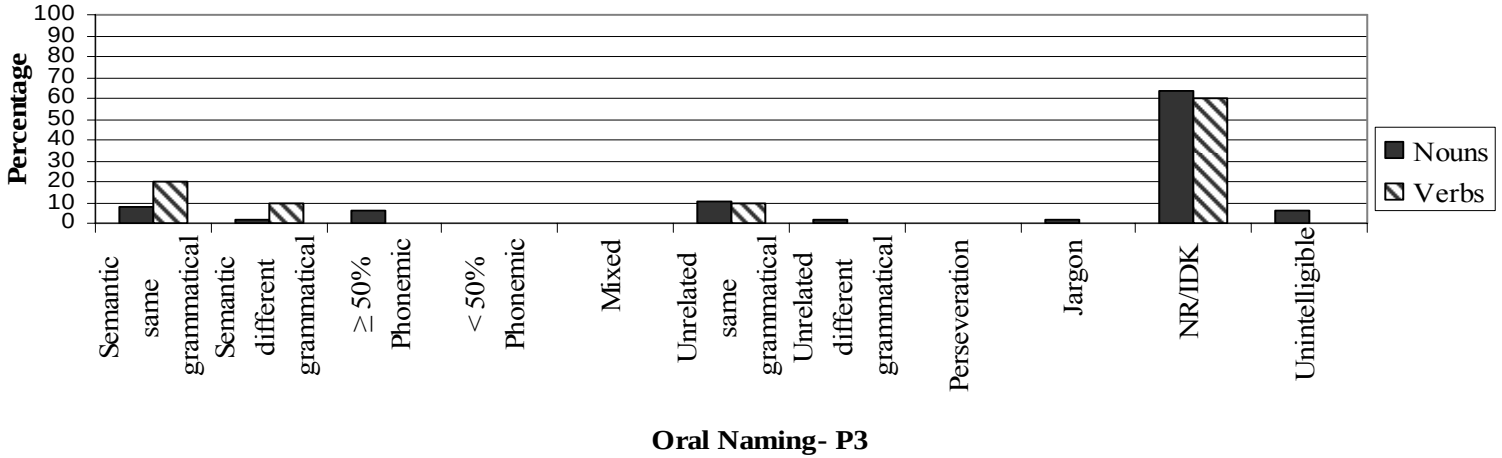
Figure 3-5. Continued



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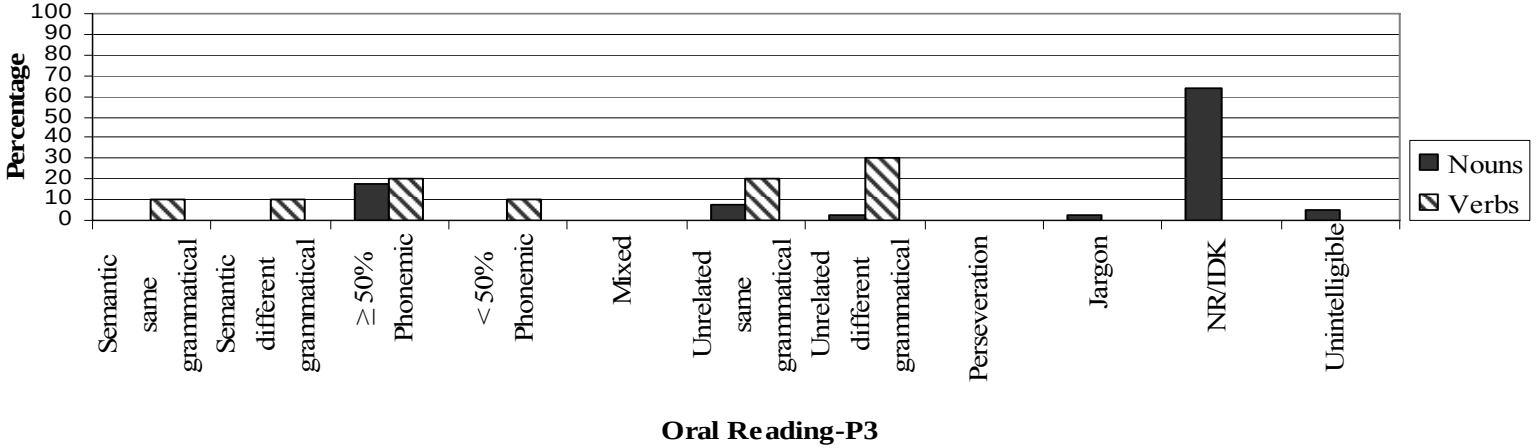
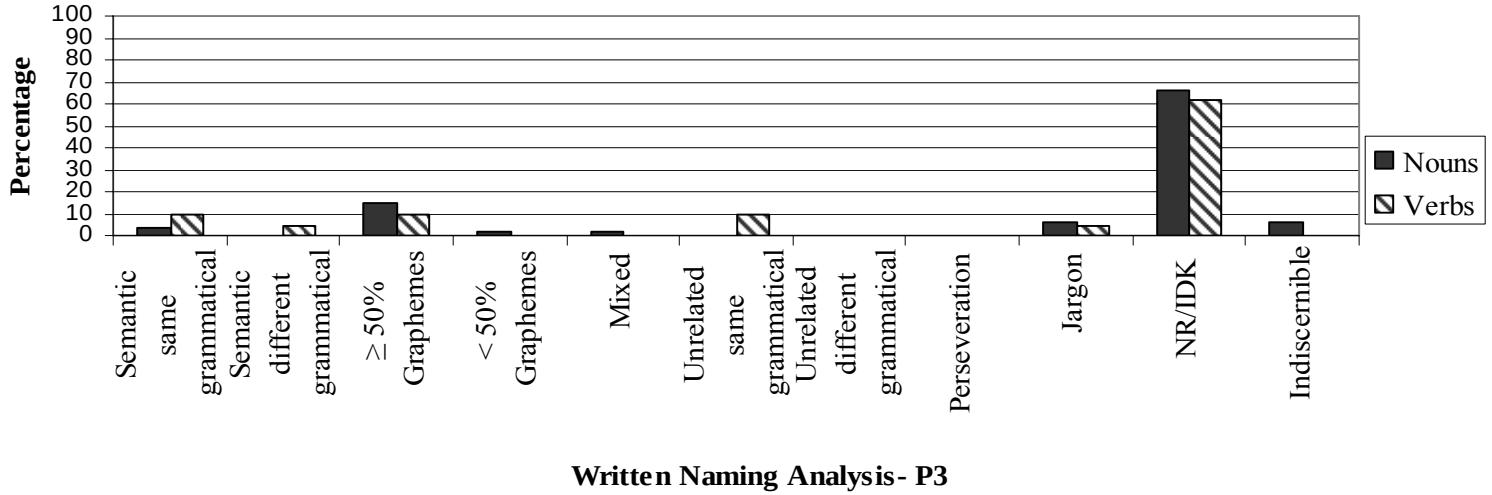


B

Figure 3-6. P3's Error Analyses Graphs. A) Error Analyses Graph of Oral Naming for P3. B) Error Analyses Graph of Oral Reading for P3. C) Error Analyses Graph of Written Naming for P3. D) Error Analyses Graph of Writing to Dictation for P3.



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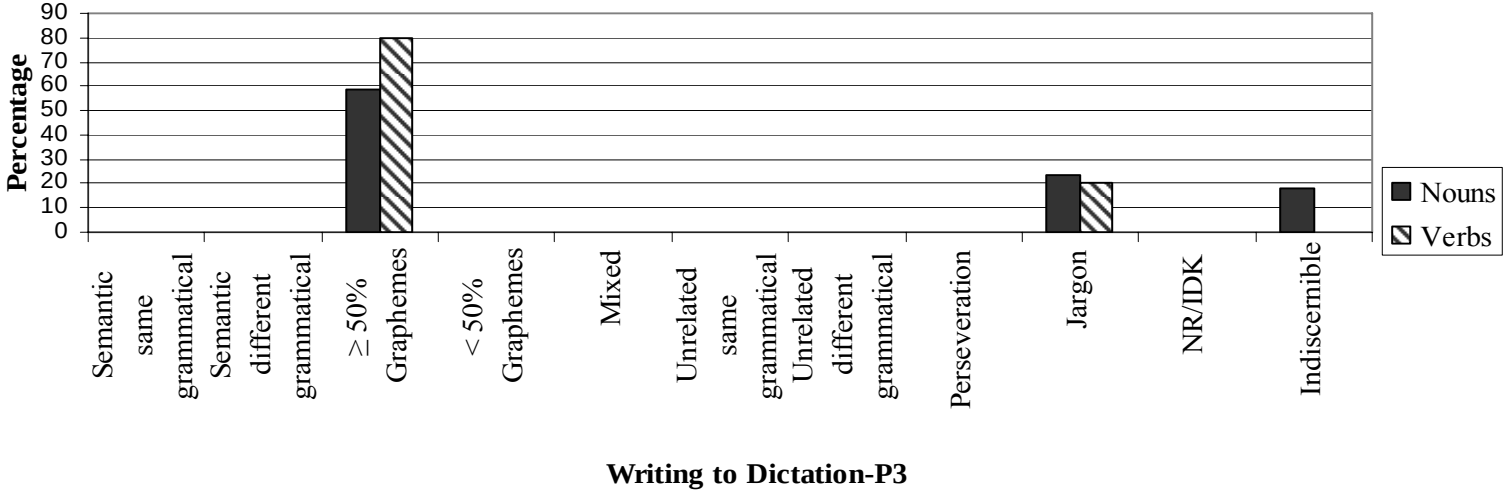

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Figure 3-6. Continued

CHAPTER 4
DISCUSSION

The purpose of this study was to examine the existence of a significant difference between nouns or verbs as well as the presence of a double dissociation, in oral naming, oral reading, written naming, and writing to dictation were examined for three participants with nonfluent aphasia. Then, using the adapted Ellis and Young model (1988; as cited in Kay, Lesser, & Coltheart, 1996), the modality and/or pathway deficit associated with each tested modality was targeted following error analyses in order to evaluate whether this close analysis would reveal differences in noun and verb processing potentially not seen in accuracy performance.

There were no significant differences between nouns and verbs in oral naming, oral reading, written naming, and writing to dictation regarding accuracies in any of the three participants. Additionally, a double dissociation across any of the modalities was not identified in the participants. These results are not uncommon and appear consistent with findings from other related studies (e.g., Miceli, Silveri, Nocentini, & Caramazza, 1988; Berndt, Mitchum, Haendiges, & Sandson, 1997a). In Miceli et al., only seven out of 25 participants with aphasia were found to demonstrate grammatical category differences. The Berndt et al. (1997a) study had similar findings as well. Seven out of the 11 tested individuals with aphasia demonstrated an advantage in either nouns or verbs, while four individuals showed no grammatical class advantage (Berndt et al., 1997a). Furthermore, selective grammatical impairments and double dissociations in the literature generally pertain to a limited number of documented individuals (e.g., Hillis & Caramazza, 1991; Hillis & Caramazza, 1995; Rapp & Caramazza, 2002).

Overall, no significant difference in noun or verb retrieval within any modality was noted; thus, no double dissociation within a grammatical deficit across the modalities was present for any participant (i.e., research questions 1 and 2). Therefore, the focus of the discussion will

regard the results of the error analysis and address whether there is a difference in impairment level for nouns or verbs in any modality across each participant (i.e., research question 3). Since there was no evidence of a double dissociation, the Rapp and Caramazza model (2002) will not be used to examine hypothesized error levels. Rather, the adapted Ellis and Young model (1988; as cited in Kay et al., 1996) will be used because it is well-accepted and appropriate to explain the proposed level of deficit associated with each tested modality. Through the completion of an error analysis for each modality, locations of possible deficits for nouns and verbs within the linguistic model were identified for the participants. Although no statistical difference between noun and verb accuracies existed, modality impairments and/or noun or verb impairments were noted the participants. These trends provide valuable insight regarding interpretation of the error analyses and possible deficit locations.

Participant 1

P1 demonstrated a trend toward greater accuracy with oral tasks (i.e., oral naming and oral reading). P1 also showed a trend toward increased accuracy with nouns across all modalities (e.g., oral naming nouns, 60.81%; oral naming verbs, 45.16%; written naming nouns, 9.46%; written naming verbs, 6.45%). This trend can also be seen in results from additional lexical testing. P1's increased ability to name more nouns (i.e., animals) than verbs (i.e., actions) in generative naming tasks further reveals a greater deficit with verbs (Table 2-3).

Based on Participant 1's error analysis, the following deficits were recognized (Table 4-1). For oral naming, P1's greatest percentage of errors for nouns was semantic, followed by phonemic, and then unrelated same grammatical class errors. Due to the high percentage of semantic errors, it is likely that the semantic system is impaired; however, considering P1's over all naming accuracy, her *Pyramids and Palm Trees* (Howard & Patterson,1992) results, and generative naming scores, it is probable that semantic system remains intact to an extent (Table

2-2 and 2-3). A deficit in the visual object recognition system is unlikely for nouns or verbs, considering P1's high scores on the *Pyramids and Palm Trees* (Howard & Patterson, 1992) and *Kissing and Dancing Test* (Bak & Hodges, 2003) (94.23% and 98.07 %, respectively), which utilize the visual object recognition naming route. The lack of a deficit in the visual object recognition naming route would be seen in written naming as well. Due to the phonemic errors and mixed errors, impairment in the phonological output lexicon and partial impairment in the pathway between the semantic system and phonological output lexicon is likely present. It is uncertain, however whether the number of phonemic errors ≥ 50% of the targeted phonemes was do to previous semantic system/pathway errors or to impairment of the phonological output system itself. Unrelated same and different grammatical class errors made by P1 were often due to naming other objects present in the picture/stimuli or to the participant describing the object (e.g., for a picture of a cherry, the participant said "yucky"), which could also imply that the participant was unable to correctly activate the targeted word semantically and therefore described the object or named another item in the picture that was more easily activated.

The majority of errors for oral naming with verbs for P1 was semantic, followed by unrelated different grammatical classes, and then mixed errors. This would also imply that an impairment in the semantic system because verbs were not always activated or retrieved appropriately (i.e., words from another grammatical class, such as nouns, were activated instead). Impairment in the pathway leading from the semantic system to the phonological output lexicon is likely present as well, when considering the number of mixed errors. The number of unrelated grammatical errors was primarily due to P1 naming nouns rather than verbs, providing more evidence that verbs are more impaired in this participant. This type of error would occur in the semantic system as well.

P1 showed the greatest percentage of errors for oral reading with nouns in phonemic errors (≥ 50% and < 50% phonemes correctly produced), followed by semantic, and then mixed and NR/IDK response errors. This would then imply a primary impairment in the phonological output lexicon. When considering the percentage of semantic same grammatical class and mixed errors, an impairment in the semantic system and a partial impairment in the pathway between the semantic system and the phonological output lexicon is likely present as well. Since P1 was overall more accurate with nouns across modalities, the greater percentage of ≥ 50% phonemes correctly produced and the presence of < 50% phonemes correctly produced errors with nouns (as compared to verbs) likely demonstrates a greater attempt of using the semantic system when reading nouns.

The greatest percentage of errors pertaining to oral reading of verbs came from ≥ 50% of phonemes correctly produced, which was followed by semantic and unrelated different grammatical class errors (i.e., words from other grammatical classes were produced, which could suggest semantic system impairment). These errors would imply a deficit within the semantic system and the phonological output lexicon as well.

It is possible, however, that an alternative route may have been utilized by P1 for oral reading with nouns and verbs. Through previous testing of P1's ability to copy printed words with the same word list (not reported in the results section), P1 was able to copy nouns and verbs with 98.77% and 100% accuracy, respectively. Therefore, it is possible that she used the route of abstract letter identification→ orthographic input lexicon→ phonological output lexicon→ phonological output buffer to read the printed words aloud. Considering P1's primary error type with oral naming of nouns and verbs was semantic (i.e., the semantic system was impaired), it is probable that the participant utilized the above route to avoid use of the impaired semantic

system. Partial use of this route to avoid semantic system use would explain the overall increased accuracy within the modality. Thus, the primary impairment for nouns and verbs in this modality is primarily within the semantic system with additional involvement in the phonological output lexicon. Impairment in the orthographic input lexicon is unlikely, considering P1's accuracy with copying words.

Use of the non-lexical route: abstract letter identification→ letter-to-sound rules→ phonological output buffer for oral reading is unlikely considering P1's copying ability and possible use of the above listed route that bypasses the semantic system. In addition, irregular words, such as "weigh", were read aloud correctly by the participant, which would not be possible when using the non-lexical route.

In the written modality, greater than 50% of the errors for nouns and verbs in both tasks were NR/IDK responses for P1. In written naming with nouns P1 displayed the greatest number of errors with NR/IDK responses, followed by jargon, ≥ 50% and < 50% graphemes correct, and semantic same grammatical class. This would imply a primary deficit at the orthographic output lexicon rather than the semantic level, since oral naming accuracy was much higher. However, as indicated with the oral modality results, the semantic system is likely degraded to some extent, considering the percentage of semantic and unrelated same grammatical class errors. P1 had overall greater accuracy with nouns across all modalities; therefore, the presence of semantic errors in written naming of nouns is likely due to P1's increased attempts to provide answers. With verbs, however, activation of the semantic system may not have been as strong, considering the greater percentage IDK/NR responses with verbs as compared to nouns.

For written naming with verbs the greatest number of errors after NR/IDK responses was mixed errors, followed by indiscernible errors, and errors where ≥ 50% graphemes were

correctly written. These errors would imply a deficit in the pathway between the semantic system and orthographic output lexicon. Partial/possible impairment of the semantic system is likely considering the pathway involvement and the results from written naming with nouns.

For writing to dictation with nouns, P1 had the primary number of errors with NR/IDK responses. Indiscernible responses were next, followed by ≥ 50% correct graphemes, and then jargon. These errors would imply a deficit at the orthographic output lexicon for nouns with writing to dictation.

For writing to dictation with verbs, the primary number of errors, after NR/IDK responses, was indiscernible responses, followed by ≥ 50% correct graphemes, then semantic different grammatical class and unrelated same grammatical class errors. A deficit in the orthographic output lexicon and a partial/possible deficit in the semantic system would be consistent with these error types. Impairment in the phonological input lexicon, which is utilized in writing to dictation, is unlikely considering P1's high accuracy with repetition (not reported in results) of nouns (81.48%) and verbs (88.00%) when using the same word lists.

During writing to dictation, it is important to consider that the participant may have utilized the route of auditory phonological analysis→ phonological input buffer→ phonological input lexicon→ phonological output lexicon→ orthographic output lexicon→ orthographic output buffer to avoid use of an impaired semantic system. Utilization of this route is possible; however, its use would not increase accuracy due to the impaired orthographic output lexicon. Considering that P1's overall accuracy for writing to dictation was low, it is likely that the orthographic output lexicon is the primary site of impairment. Possible/partial impairment in the semantic system is likely for nouns and verbs as well, considering the semantic errors made with verbs in writing to dictation and the semantic impairment already documented in previous

modalities. Partial/possible impairment of the phonological output lexicon (when using the alternative route) is also likely considering the previous deficits present in oral naming and oral reading.

Use of the non-lexical route: acoustic-to-phonological conversion → phonological output buffer→ sound-to-letter rules→ orthographic buffer is unlikely when considering P1's adequate repetition ability and the possible use of the above listed route that bypasses the semantic system. In addition, the semantic system is at least partially intact in P1 and irregular words, such as "knock," were written correctly by the participant, which would further prove that the non-lexical route was not utilized.

Overall for P1, it is apparent through error analysis that the semantic system is primarily impaired for oral tasks, while the orthographic output lexicon, with partial involvement of the semantic system, is primarily impaired for written tasks. The semantic system is impaired for nouns and verbs in the oral modalities, with probable phonological output lexicon involvement in oral reading of nouns and verbs and oral naming of nouns. Conversely, there is an orthographic output lexicon impairment for nouns and verbs in the written modalities, with partial semantic system involvement. A pattern regarding noun and verb deficits within specific modalities (i.e., double dissociations) was not apparent for P1 after completing the error analysis.

Participant 2

P2 displayed a trend toward increased accuracy in written modalities (i.e., written naming and writing to dictation). No trend of noun or verb impairment was present across oral or written modalities. This lack of a trend is further supported by P2's results in lexical testing of noun and verb generative naming, where she obtained the same score in both tasks (Table 2-3).

For oral naming of nouns, P2's greatest percentage of errors was jargon and NR/IDK responses, which were followed by phonemic errors (≥ 50% and < 50% phonemes correctly

produced). Considering these errors, it is likely that there is a significant deficit in the phonological output lexicon, which would inhibit P2 from naming several of the pictures (i.e., NR/IDK responses) and/or cause the retrieval of incorrect phonemes (i.e., jargon/phonemic errors) (Table 4-2).

Similarly, considering that the majority of errors were with NR/IDK responses and ≥ 50% of phonemes correctly produced for oral naming of verbs, it is likely that the phonological output lexicon is impaired for verbs as well. This explains P2's inability to correctly retrieved phonemes or name over half of the missed pictures.

Less than 10% of the errors for nouns and verbs in oral naming were either semantic or unrelated grammatical class errors, which imply partial impairment of the semantic system. However, it is clear that the primary deficit location in this modality is in the phonological output lexicon. P2's high scores on the lexical tests, *Pyramids and Palm Trees* (Howard & Patterson, 1992) and *Kissing and Dancing Test* (Bak & Hodges, 2003) (94.23% and 90.38%, respectively) provide further evidence that the semantic system remains primarily intact as well as that the visual object recognition systems is functional for this modality and written naming (Table 2-2).

Further evidence of phonological output lexicon impairment is seen through P2's repetition accuracy (not present in results section). For repetition with nouns and verbs, P2 achieved 20.99% and 20.00% accuracy, respectively. Since repetition uses a route that bypasses the semantic system, it is clear that the phonological output lexicon is impaired and it is possible that the phonological input lexicon is impaired as well.

The greatest percentage of errors for nouns in oral reading was jargon and phonemic errors (≥ 50% and < 50% phonemes correctly produced). This would again imply that the phonological output lexicon is greatly impaired, which inhibits P2 from naming several of the pictures and/or

causes the retrieval of incorrect phonemes. Partial impairment of the semantic system is possible considering the small percentage of unrelated same grammatical class errors.

The greatest percentage of errors for verbs with oral reading was phonemic errors (≥ 50% and < 50% phonemes correctly produced), followed by unrelated different grammatical class errors, and jargon. These error types would also imply an impairment with the phonological output lexicon. Partial impairment of the semantic system may also be involved when considering the percentage of errors made with unrelated different grammatical class (e.g., verbs were produced as related nouns).

Similar to P1, it is possible that an alternative route may have been utilized by P2 for oral reading with nouns and verbs. Through previous testing of P2's ability to copy printed words using the same word list (not previously reported in the results), P2 was able to copy nouns and verbs with 100% accuracy. Therefore, it is possible that she also used the route of abstract letter identification→ orthographic input lexicon→ phonological output lexicon→ phonological output buffer to read the printed words aloud. Considering the perfect accuracy P2 showed with copying, it is clear that the orthographic input lexicon is functional. Although partial impairment of the semantic system is evident through the oral naming and oral reading analyses, primary use of this route to bypass the semantic system is unlikely given the similarities in accuracy scores in both modalities (i.e., both with low accuracy). Thus it further supports the conclusion that an impairment in the phonological output lexicon exists.

Use of the non-lexical route: abstract letter identification→ letter-to-sound rules→ phonological output buffer is also unlikely considering P2's ability to accurately copy. Also, irregular words (e.g., "weight") were read aloud correctly by the participant, which would not be possible if using the non-lexical route.

Initially P2 appeared to have greater accuracy with nouns in written naming and greater accuracy with verbs in writing to dictation. This prompted further analysis in the written modalities. The main error type for verbs in written naming was unrelated different grammatical class errors and semantic different grammatical class errors (i.e., semantic system impairment). Considering the unrelated and semantic errors were in different grammatical classes (e.g., verbs→ nouns), P2's increased accuracy with nouns in this modality is easily understood. Graphemic and mixed errors (both at 13.33%) followed the unrelated grammatical errors/ semantic errors in written naming with verbs, showing partial impairment at the orthographic output lexicon and the pathway between it and the semantic system as well. Graphemic errors were the primary error made for nouns in written naming, followed by semantic and unrelated grammatical class errors. This would imply a deficit at the orthographic output lexicon with partial impairment at the semantic system for nouns.

Considering the error results above, a difference in the level of processing for noun and verbs was established in written naming. Overall, a higher level of processing for nouns was apparent through the higher accuracy (66.22%), as well as, the fact that responses were closer to the targeted word (i.e., ≥ 50% graphemes correctly produced). Increased impairment with verbs in written naming was evident through the slightly decrease accuracy (51.61%), as well as, the fact that the primary error types of unrelated grammatical class and semantic class errors involved changing of verbs to another grammatical class (i.e., nouns). This difference in noun and verb processing is not accounted for in the adapted Ellis and Young model (1988); however, it is consistent with the Caramazza model (2002) where nouns and verbs are processed separately at each lexical level. Further investigation of the model regarding the modality errors would be needed before drawing a conclusion.

Conversely, the error analyses of writing to dictation initially showed increased accuracy with verbs. For writing to dictation with nouns, graphemic errors and NR/IDK responses were the primary error, followed by unrelated same grammatical class errors. A deficit at the orthographic output lexicon is likely due to the high number of grapheme errors and inability to retrieve any correct graphemes (i.e. NR/IDK responses). Partial/ possible involvement with the semantic system due to the presence of unrelated grammatical class errors is probable as well.

For verbs, the predominant error with writing to dictation was graphemic as well, which was followed by NR/IDK responses. A deficit at the orthographic output lexicon is likely when considering the participant's inability to correctly retrieve any or all of the accurate graphemes.

During writing to dictation, it is important to consider that the participant may have utilized the route of auditory phonological analysis→ phonological input buffer→ phonological input lexicon→ phonological output lexicon→ orthographic output lexicon→ orthographic output buffer to avoid use of the semantic system if it is impaired. Considering P2's poor repetition abilities and phonological deficits, it is likely that the phonological input lexicon and/or the phonological output lexicon are impaired and that she did not utilized this route for nouns or verbs when writing to dictation.

Use of the non-lexical route: acoustic-to-phonological conversion → phonological output buffer→ sound-to-letter rules→ orthographic buffer is possible, considering P2's poor repetition abilities. P2 may have utilized the non-lexical route on occasion; however, it is evident that the semantic system was also activated at times due to the presences of semantic errors with nouns and certain irregular words (e.g., "kneel") were written correctly by the participant, which also suggest the use of a lexical route.

Considering the error types and possible routes for writing to dictation, the possibility of increased accuracy with verbs over nouns within the modality is not as evident. For instance, verbs had a higher percentage of IDK/NR responses (i.e., the participant did not attempt to write those words). Also, the increased accuracy with verbs may have been contributed to the use of the non-lexical route. Utilization of this route is less likely for nouns considering the presence of semantic errors. Combining the results from the error analyses of the two written modalities, it is possible that a different level of processing for nouns and verbs was present in written naming; however, a different level of processing in writing to dictation is less likely.

Overall for P2, it is apparent through error analysis that the primary deficits in the lingual system is at the lexeme (i.e., output lexicon) level. The phonological output lexicon is impaired for nouns and verbs in the oral modalities, with partial semantic system deficits. The orthographic output lexicon is impaired for nouns and verbs in the written modalities, with partial semantic impairment in written naming. A higher level of processing for nouns was present in written naming; however, a pattern regarding noun and verb deficits within specific modalities (i.e., double dissociations) was not found for P2 after completing an error analysis.

Participant 3

P3 revealed a trend toward decreased naming abilities (i.e., decreased accuracy with oral and written naming). A trend toward increased accuracy with verbs across all modalities was also noted except for oral naming. These trends are further reinforced through P3's results from additional lexical testing, where he obtained the same score for noun and verb oral/generative naming tasks (Table 2-3).

The predominant error for P3 in oral naming with nouns was NR/IDK responses, followed by unrelated grammatical class errors, semantic errors, and ≥ 50% of phonemes correctly produced. It is likely that a deficit within the semantic system exists for oral naming of nouns.

This type of impairment would account for the unrelated grammatical class words that were activated and the semantic errors. The NR/IDK responses would likely be due the inability of the semantic system to activate/retrieve appropriate words well. The small percentage of phonemic errors (6.12%) suggests partial/possible impairment in the phonological output lexicon as well (Table 4-3). A deficit in the visual object recognition system is unlikely for nouns or verbs in oral/written naming, considering the majority of the errors were either semantic or phonemic and P3's high scores on the *Pyramids and Palm Trees* (Howard & Patterson, 1992) and *Kissing and Dancing Test* (Bak & Hodges, 2003) (100% and 94.23%, respectively), which utilize the visual object recognition naming route.

The predominant error for oral naming with verbs was NR/IDK responses, followed by semantic errors, then unrelated same grammatical class errors. Similar to nouns in this modality, these errors would likely be due to a deficit in the semantic system. P3's high accuracy with repetition of nouns (97.53%) and verbs (92.00%) (not reported in the results), which utilizes the route of auditory phonological analysis→ phonological input buffer→ phonological input lexicon→ phonological output lexicon→ phonological output buffer that bypasses the semantic system, further supports the conclusion that the impairment is primarily in the semantic system.

During oral reading, the primary error for nouns was NR/IDK responses, followed by ≥ 50% of phonemes correctly produced, and unrelated grammatical class errors. Without thorough investigation, these errors would initially imply an impairment at the phonological output lexicon to account for the phonemic errors and the participant's inability to correctly retrieve any phonemes (i.e., NR/IDK responses). A partial/possible impairment at the semantic system would also be probable, considering the number of unrelated grammatical class errors.

The primary error for oral reading with verbs was unrelated grammatical class errors, followed by phonemic errors, and semantic errors. These errors would imply a larger impairment at the semantic level for verbs in this modality, secondary to the increased percentage of unrelated grammatical errors and the presence of semantic errors. A notable impairment at the phonological output lexicon is likely as well, when considering the percentage of phonemic errors.

It is possible, however, that an alternative route may have been utilized by P3 for oral reading with nouns and verbs. Through previous testing of P3's ability to copy printed words using the same word list (not previously reported in the results), P3 was able to copy nouns and verbs with 92.59 % and 95.92% accuracy, respectively. Therefore, it is possible that he used the route of abstract letter identification→ orthographic input lexicon→ phonological output lexicon→ phonological output buffer to read the printed words aloud. Considering P3's primary error type with oral naming of nouns and verbs was semantic (i.e., the semantic system was impaired), it is probable that the participant utilized the above route to avoid use of the impaired semantic system. Since the majority of errors with nouns were phonemic rather than semantic, it is likely that the participant utilized this route for nouns more than verbs (i.e., the semantic system was bypassed more when processing nouns). Use of this route to bypass the semantic system would explain the overall increased accuracy within the modality as well.

It is also important to note that a higher level of processing exists for verbs in oral reading. This can be seen through the high percentage of IDK/NR responses and reduced accuracy with nouns. This difference in processing between the two grammatical classes can be further explained using the Caramazza model (2002), which has separate locations for noun and verb

processing at the semantic and phonological levels. Further investigation of the model is required, however, before drawing a conclusion.

Considering the above, the primary impairment for nouns and verbs in this modality is within the semantic system with additional involvement in the phonological output lexicon. Impairment in the orthographic input lexicon is unlikely, considering P3's accuracy with copying words.

Use of the non-lexical route: abstract letter identification→ letter-to-sound rules→ phonological output buffer is also unlikely considering P3's adequate copying ability and possible use of the above listed route that bypasses the semantic system. In addition, irregular words (e.g., "cheese") were read aloud correctly by the participant, which would not be possible through the use of the non-lexical route.

For written naming of nouns, NR/IDK responses were the main error type, which was followed by grapheme errors, and jargon/indiscernible responses. A small percentage of semantic and mixed errors were noted as well. Considering the high percentage of NR/IDK responses and grapheme errors, it is likely that the orthographic output lexicon is impaired. It is also possible that partial/possible impairment in the semantic system and the pathway between it and the orthographic output lexicon is present, considering the semantic and mixed errors.

For written naming with verbs, NR/IDK responses were also the main error type, which was followed by semantic errors, and then ≥ 50% graphemes correctly produced and unrelated same grammatical class errors (both at 9.52%). Considering the high percentage of NR/IDK responses as well as the semantic/ unrelated same grammatical class errors, it is likely that the semantic system is impaired for verbs in this modality. Orthographic output lexicon impairment would explain the percentage of ≥ 50% of graphemes correctly produced errors.

The predominant error for writing to dictation with nouns was ≥ 50% of graphemes correctly produced, followed by jargon, and indiscernible responses. Similarly, the predominant error for writing to dictation with verbs was ≥ 50% of graphemes correctly produced, which was followed by jargon. Phonological input and output lexicon impairment is unlikely considering P3's high accuracy with repetition (not reported in results) of nouns (97.53%) and verbs (92.00%) when using the same word lists.

Without thorough investigation, these errors would initially suggest sole impairment at the orthographic output lexicon to explain the grapheme errors. It is important to consider, however, that the participant likely utilized the route of auditory phonological analysis→ phonological input buffer→ phonological input lexicon→ phonological output lexicon→ orthographic output lexicon→ orthographic output buffer to avoid use of the impaired semantic system.

Use of the non-lexical route: acoustic-to-phonological conversion → phonological output buffer→ sound-to-letter rules→ orthographic output buffer is unlikely when considering P3's repetition ability and possible use of the above listed route that bypasses the semantic system. In addition, irregular words, such as "knit," were written correctly by the participant, which would further prove that the non-lexical route was not utilized.

P3's overall high accuracy with writing to dictation, the substantial percentage of graphemic errors as well as the absence of semantic errors when the semantic systems has already been established to be impaired, is further evidence that P3 bypassed the semantic system when writing to dictation. In view of the above, the primary impairment for nouns and verbs would be in the semantic system, followed by partial impairment in the orthographic output lexicon for nouns and verbs writing to dictation.

Overall for P3, it is apparent through error analysis that for both oral and written tasks the semantic system is primarily impaired. The primary semantic system impairment for nouns and verbs in the oral modalities has additional partial phonological output lexicon involvement in oral reading and in oral naming with nouns. The semantic system is primarily impaired for nouns and verbs in the written modalities, with additional impairment of the orthographic output lexicon for written naming and partial impairment of the orthographic output lexicon for writing to dictation. A higher level of processing for verbs was present in oral reading; however, a pattern regarding noun and verb deficits within specific modalities (i.e., double dissociations) was not found for P3 after completing the error analyses.

Table 4-1. Lexical Deficits Present in Participant 1 Based on Error Analysis

Modality/Impairment Location		Visual Object Recognition System	Semantic System	PIL	POL	Pathway Between Semantic and POL	OIL	OOL	Pathway between Semantic and OOL
Oral Naming	N	-	+		+	+/-			
	V	-	+		-	+			
Oral Reading	N		+		+	+/-	-		
	V		+		+	-	-		
Written Naming	N	-	+					+	-
	V	-	+/-					+	+
Writing to Dictation	N		+/-	-	+/-			+	-
	V		+/-	-	+/-			+	-

Note: POL: Phonological Output Lexicon; OOL: Orthographic Output Lexicon; (+): Primary impairment present at that level; (-): No impairment present at that level; (+/-): Partial/Possible impairment at that level.

Table 4-2. Lexical Deficits Present in Participant 2 Based on Error Analysis

Modality/Impairment Location		Visual Object Recognition System	Semantic System	PIL	POL	Pathway Between Semantic and POL	OIL	OOL	Pathway between Semantic and OOL
Oral Naming	N	-	+/-		+	-			
	V	-	+/-		+	-			
Oral Reading	N		+/-		+	-	-		
	V		+/-		+	-	-		
Written Naming	N	-	+/-					+	-
	V	-	+					+/-	+/-
Writing to Dictation	N		+/-	+	+			+	-
	V		-	+	+			+	-

Note: POL: Phonological Output Lexicon; OOL: Orthographic Output Lexicon; (+): Primary impairment present at that level; (-): No impairment present at that level; (+/-): Partial/Possible impairment at that level.

Table 4-3. Lexical Deficits Present in Participant 3 Based on Error Analysis

Modality/Impairment Location		Visual Object Recognition System	Semantic System	PIL	POL	Pathway Between Semantic and POL	OIL	OOL	Pathway between Semantic and OOL
Oral Naming	N	-	+		+/-	-			
	V	-	+		-	-			
Oral Reading	N		+		+/-	-	-		
	V		+		+/-	-	-		
Written Naming	N	-	+/-					+	+/-
	V	-	+					+	-
Writing to Dictation	N		+	-	-			+/-	-
	V		+	-	-			+/-	-

Note: POL: Phonological Output Lexicon; OOL: Orthographic Output Lexicon; (+): Primary impairment present at that level; (-): No impairment present at that level; (+/-): Partial/Possible impairment at that level.

CHAPTER 5
CONCLUSION

No significant statistical difference across nouns and verbs in oral naming, oral reading, written naming, and writing to dictation was noted for participant 1, 2, or 3. Similarly, no double dissociation across the above listed modalities was found in any of the three participants. Trends regarding accuracy data, however, were noted for all three participants. P1 demonstrated greater accuracy within oral tasks as well as increased accuracy with nouns across all modalities. P2 displayed increased accuracy in written tasks. She also initially presented with a possible trend of noun advantage in written naming and verb advantage in writing to dictation; however, this apparent trend was proven false after completing error analyses. P3 showed decreased accuracy with oral and written naming tasks, with a trend toward increased accuracy with verbs in all modalities except for oral naming (i.e., noun and verb deficits were similar in oral naming).

Based on error analyses, hypothesized levels of impairment within the linguistic system were identified. Participant 1 appeared to have impairment of the semantic system for oral tasks and primary impairment of the orthographic output lexicon with partial semantic system involvement for written tasks. The semantic system showed impairment for nouns and verbs in the oral modalities, with probable phonological output lexicon involvement in oral reading of nouns and verbs and oral naming of nouns. Conversely, an orthographic output lexicon impairment, with partial semantic system involvement, was present for nouns and verbs in the written modalities.

P2 displayed a primary deficit at the lexeme (i.e., output lexicons) level for both oral and written modalities. The phonological output lexicon was mainly impaired for oral tasks, while the orthographic output lexicon was mainly impaired for written tasks. The phonological output lexicon appeared impaired for nouns and verbs in the oral modalities, with partial semantic

system deficits. Conversely, the orthographic output lexicon appeared impaired for nouns and verbs in the written modalities, with partial semantic impairment in written naming. A higher level of processing was considered for both written modalities in P2. Nouns were noted to be processed at a higher level than verbs in written naming. In writing to dictation, however, it was determined that the greater percentage of accuracy with verbs was due to increased IDK/NR responses and use of an alternative non-lexical route. Therefore, a different level of processing in writing to dictation is less likely.

P3 demonstrated overall impairment of the semantic system for oral and written tasks. The primary semantic system impairment for nouns and verbs in the oral modalities showed additional partial phonological output lexicon involvement in oral reading and in oral naming with nouns. The primary semantic system impairment for nouns and verbs in the written modalities showed additional impairment in the orthographic output lexicon for written naming and partial impairment in the orthographic output lexicon for writing to dictation. A higher level of processing for verbs was established in oral reading as well.

Participant 3's, as well as P2's, apparent higher level of processing for verbs or nouns could not be explained by the adapted Ellis and Young model (1988; as cited in Kay, Lesser, & Coltheart, 1996). The Rapp and Caramazza model (2002), however, offers further explanation for the results. More testing is needed to conclusively determine a higher level of processing and appropriate application of the Rapp and Caramazza model.

Although not significant, the impairments inferred from the error analysis provide essential information about each participant. The importance of thorough testing regarding oral and written modalities is crucial because it offers valuable information of an individual's strengths. For example, P2 demonstrated high accuracy with written naming tasks even though her aphasia

quotient on the *Western Aphasia Battery (WAB;* Kertesz, 1982) was low (AQ = 36.8). Important conclusions regarding noun/verb deficits, as well as, the presence/absence of a double dissociation can be made using error analyses as well.

Although the stimuli from *An Object and Action Naming Test* (Druks & Masterson, 2000) is controlled for frequency, age of acquisition, and familiarity and it was further controlled for ambiguity in this study, other factors which affect lexical retrieval (e.g., manipulability, imageability, and word length) were not controlled for or examined. Therefore, those features cannot be ruled out as factors affecting the observed trends. Nonetheless, the current findings provide a thorough examination of the participants' lexical retrieval of nouns and verbs across a variety of tasks, as well as, highlight the importance of error analyses in understanding lexical retrieval deficits and interpreting them within current theoretical models of language processing.

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BIOGRAPHICAL SKETCH

Megan Elizabeth Ferguson is a native Floridian, who was born and raised in Winter Park, Florida. She earned a Bachelor of Arts degree in communication sciences and disorders from the University of Florida in December 2005. After graduation she worked as a mentored speech-language therapist in a Central Florida middle school. She preformed individualized treatment and collaborative therapy with teachers for students with speech, language, and cognitive deficits. Megan later returned to the University of Florida and received a Master of Arts degree in communication sciences and disorders in May of 2008. Following her marriage to Richard Ashford Denman III in August of 2008, she will begin her career in the field of speech-language pathology. She will utilize her advanced education as a speech-language therapist in a medical setting.