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The Effects of Verb Network Strengthening Treatment on

Sentence Production in Individuals with Aphasia

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The Effects of Verb Network Strengthening Treatment on Sentence Production in Individuals with Aphasia

by

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Dedication

This work is dedicated to Laura, whose continual support made this journey possible, and to my mother, who always encouraged me to think big.

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The Effects of Verb Network Strengthening Treatment on

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Some persons with aphasia exhibit a selective verb deficit, which results in a reduced ability to produce verbs in most contexts. A functional level (Bock & Levelt, 1994) impairment may result in impaired sentence production because the verb serves as the semantic-syntactic interface of a sentence. This interface is related to a verb's relationship with its arguments/thematics. Arguments fill the syntactic slots of subject and object, and those same words serve as thematic roles by referring to who does what to whom. The current study investigates the effect of Verb Network Strengthening Treatment (VNeST) on sentence production using a single subject experimental design

across subjects in 4 participants, 2 with nonfluent aphasia and 2 with fluent aphasia. Participants received semantic treatment aimed at re-strengthening the connections between a verb (e.g., *measure*) and related thematic pairs that refer to the doer and receiver of the action (e.g., *carpenter/lumber*, *chef/sugar*). The ability to produce thematic role pairs for trained verbs was tested during treatment while generalization to the ability to produce sentences containing a subject, verb, and object in a picture description task with trained verbs (e.g., *The carpenter is measuring the stairs.*) and semantically related untrained verbs (e.g., *The nurse is weighing the baby.*) was monitored. In addition, pre- and post-treatment single word retrieval of verbs (*The Northwestern Verb Production Battery* (*NVPB*) (Thompson, 2002)) and nouns (*The Boston Naming Test* (Goodglass & Kaplan, 1983)) was examined as well as sentence production abilities in unrelated picture description (*NVPB*) and constrained connected speech tasks. All participants met treatment criteria and exhibited generalization to sentence production with sentences containing trained and semantically related untrained verbs. Participants 1, 2, and 3 exhibited improvements on all pre- and post-treatment measures, including connected speech. Participant 4 exhibited gains on multiple measures but did not show improvement in connected speech. These findings indicate that treatment aimed at strengthening the verb network results in improved word retrieval in naming and sentence production across multiple tasks. Theoretical and clinical implications regarding the impact of using VNeST on rehabilitation of sentence production deficits in aphasia are discussed.

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CHAPTER 1

BRIEF INTRODUCTION TO APHASIA CLASSIFICATIONS

Acquired aphasia refers to a loss of language ability following brain damage to the language centers of the brain, generally in the perisylvian region of the left hemisphere (in right handed individuals). There are a number of clinical classifications of aphasia based on behavioral deficits. Clinical classifications in aphasia are often, but not always, associated with damage to specific brain areas.

Nonfluent aphasias are characterized by halting verbal output with decreased phrase length and a reduced use of function words (e.g., articles, conjunctions, prepositions) with relatively spared comprehension. The most common type of nonfluent aphasia is Broca's aphasia, which is associated with agrammatism. Agrammatism is characterized by comprehension deficits related to the inability to understand sentences for which comprehension of the syntax is crucial to understanding the sentence's meaning. (For example, in reversible sentences where the doer and receiver of the action are both animate (e.g., *The boy is chasing the girl.* vs. *The girl is chasing the boy.*). The most notable deficit in the speech of aphasics with agrammatism is the extensive omission of function words and inflectional morphemes with a relatively more intact usage of content words, particularly nouns (Caplan, 1999). Repetition is also impaired. Broca's aphasia is associated with lesions in the cortex of the posterior part of the inferior frontal gyrus and can extend to underlying white matter and involve the insula and the basal ganglia (Damasio, 1998). Transcortical Motor Aphasia (TMA) is less common than Broca's aphasia. It is characterized by nonfluent speech, syntactic errors, and

perseveration with relatively intact repetition (Damasio, 1998). Lesion sites for TMA can vary, but they are typically located in the left frontal lobe involving the prefrontal and premotor cortices. (Damasio, 2001).

By contrast, fluent aphasias are characterized by fluent speech with relatively impaired comprehension. Patients with Wernicke's aphasia (the most common fluent aphasia) exhibit extensive use of stereotypic phrases as well as semantic paraphasias (*spoon* for *fork*) and phonemic paraphasias (*slair* for *stair*). In more severe cases, neologisms (nonwords not resembling the target semantically or phonetically (e.g., *brodle* for *cookie*) can result in jargon-like speech. Paragrammatism, characterized by grammatical errors such as incorrect tense markers for verbs and misuse of pronouns (*he* for *she*), is also observed. Auditory comprehension can be severely impaired. Lesions associated with Wernicke's aphasia center over the posterior two-thirds of the left superior gyrus, although in some cases they extend into other parts of the temporal lobe and into the inferior parietal lobe (Bhatnagar & Andy, 1995; Helm-Estabrooks & Albert, 1991). Patients with conduction aphasia (CA) have less abundant speech than those with Wernicke's aphasia. The hallmark of CA is impaired repetition of words and sentences relative to fluency in spontaneous speech. Auditory comprehension is relatively impaired. Lesion sites in CA can vary, but they are typically in the supramarginal gyrus and extend to underlying white matter comprising the arcuate fasciculus, the pathway that connects the posterior and anterior language areas (Damasio, 2001).

CHAPTER 2

BRIEF INTRODUCTION TO VERB ARGUMENTS AND THEMATIC ROLES

The present study involves the remediation of verbs and their arguments/thematic structure. In order to assist the reader in understanding the theoretical underpinnings and rationale of the study, this chapter provides relevant linguistic background.

A verb is central to the syntax and semantics of a sentence. Every verb has two types of syntactic information that ensures a well-formed sentence: *strict subcategorization* and *argument structure*. Subcategorization refers to the type of phrasal category that follows the verb. For example, the verb *spill* requires a direct object noun phrase (NP) as in *The boy spilled milk* whereas a verb such as *give* requires a NP and a prepositional phrase (PP) as in *The boy gave the present to the girl* (Shapiro, 2000).

Verb argument structure differs from subcategorization in that it is not concerned with the syntactic form of the phrasal categories allowed by the verb. Instead it is concerned with the *number* of participants described by the verb. Therefore, in the previous examples it can be seen that *spill* requires two participants (boy/milk) and *give* (boy/present/girl) requires three. The number of arguments that a verb takes is referred to as the verb's "place." For example, *spill* is referred to as a 2-place obligatory verb because it requires two participants (Shapiro, 2000). Argument structure constructions assign a basic pattern of experience. For example, the possessive construction (e.g., *Evelyn landed a job.*) means X acquires/possesses Y and contains the form S-V-O. A transitive construction such as *Sharon shredded the cabbage* means X acts on Y, and its form is also S-V-O. These simple sentence types typically relate to basic human

experiences, a concept captured in the scene-encoding hypothesis which states: Constructions that correspond to basic simple sentence types encode as their central senses, event types that are basic to human experience (p. 205, Goldberg, 1998).

Evidence from language acquisition reveals that central aspects of argument structure constructions encode scenes that are semantically related to basic human experience. For example, "light," or general verbs such as *do, go, make, get, put* are among the first acquired. Each of these verbs is associated with common meanings. For example, *make* has semantics related to the resultative construction meaning that X causes Y to become Z. The verb *go* is associated with the intransitive motion such that X moves to Y. (Clark, 1978 as described in Goldberg, 1998). In time, specific or "heavy" verbs with form and meaning related to these general verbs will be added as vocabulary and experiences increase. For example, the verb *make* may be used for many specific activities such as *bake* or *build* early in acquisition, but with time and experience the more specific verbs will be acquired.

Thematic roles and verb arguments are represented by the same lexical items in a sentence. However, their functions differ. As discussed, arguments are syntactical elements and refer to the number of participants described by a verb. Thematic roles provide information related to who does what to whom in the sentence. The doer of the action ("who") is referred to as the *agent*, and the receiver of the action is the *patient* (e.g., *The boy* (agent) *hit the ball* (patient)). (Many thematic role possibilities exist, but this discussion will only refer to those relevant to the present study.). Verbs have a *thematic grid* which consists of the sets of thematic roles assigned to their arguments.

Different verbs have different numbers of arguments and different types of potential thematic roles, and so it is the verb that assigns appropriate arguments and thematic roles. The thematic grid of a two-place verb such as *weigh* is "projected" to the syntax which refers to the number and arrangement of the arguments. Because a verb's meaning is related to who can perform the action and to what, a verb's argument structure is determined, to a large degree, by its meaning, as explained by the lexical-conceptual structure theory (Jackendoff, 1972) that claims that thematic roles like agent, patient, etc. are simply terms that describe another level of representation. The thematic-semantic properties of a verb are what the current study aims to target in order to improve sentence production in people with aphasia who exhibit verb deficits.

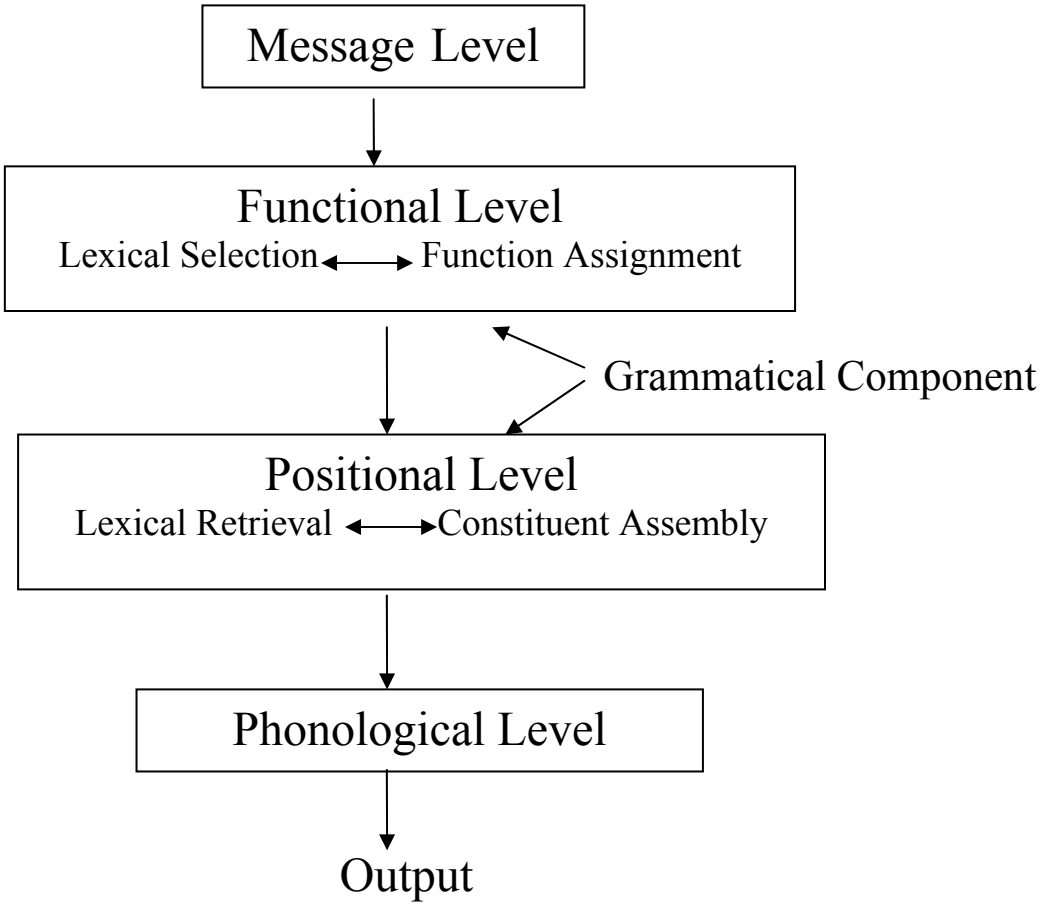
CHAPTER 3

MODELS OF SENTENCE PRODUCTION

Models of sentence production attempt to break down the complicated process of producing a sentence into component parts and describe the mechanisms underlying each component and their interactions. While models differ in a number of ways, the component parts of sentence production are typically presented as levels with a top-down organization representing 1) conceptualization of the message (Message level), 2) activation and assignment of grammatical information to content words (Functional level), 3) lexical retrieval, sentence frame construction, addition of morphology and inflection (Positional level), 4) phonological encoding (phonological encoding level), and 5) articulation (Articulatory level) (Bock and Levelt, 1994). See Figure 3.1 for a schematic of these levels.

Hierarchical models propose serial processing so that information only flows from the top down, and processing at one level must be complete before the information is sent to the next level (e.g., Bock, 1995; Bock & Levelt, 1994; Garrett, 1975, 1982, 1988). Interactive-activation (IA) models (e.g., Dell, 1986; Hinton & Anderson, 1989; McClelland & Rumelhart, 1981) are similar to serial models in that they both posit spreading activation of closely related items within both semantic and phonological domains. However, IA models differ in that they propose top-down processing and bottom-up feedback between these levels.

Figure 3.1. Schematic of Bock and Levelt's (1994) sentence production model



The treatment approach of the current study is to strengthen specific verb-thematic representations in the lexicon to increase their availability for activation in the early stages of sentence production, namely at the Functional level. The primary variable of interest is production of verbs and their thematics in sentences. Given the top-down approach of treatment, a hierarchical model, specifically Bock and Levelt's (1994) model, will be used as the theoretical foundation for the study. A brief description of the first three levels of Bock and Levelt's (1994) model (most relevant to the proposed study) and a discussion of lexical organization follows.

The Message Level of Representation involves the preverbal, conceptual, nonlinguistic level of information the speaker wants to convey (Garrett, 1982). Levelt (1989) and Bock & Levelt (1994) discuss the message level of representation in terms of the speaker's perception of an event, and argue that "event roles" govern the thematic relations among the constituents of the message by identifying who is doing what to whom.

The Functional level of representation essentially encodes the conceptual information of the message. The functional level involves lexical selection and function assignment (Bock and Levelt, 1994). Bock and Levelt's model separates *Lexical selection* into two-stages: 1) activation of the lemma and 2) spreading activation to the phonological form of the word (lexemes) (see Figure 3.2). At the lemma level the target word and words semantically related to the target are activated (e.g., the target is *orange*, but *apple*, *grapefruit*, *cantaloupe*, etc. are also activated). Additional related concepts are also activated. For example, the concept of fruit may be activated because it is the

superordinate category of orange and apple. Further, the concepts of tree and skin may be activated since apples and oranges grow on trees and have skin. Such connections comprise the lexicon, which is organized as a network, and the activation of one concept spreads to multiple related concepts. The word with the strongest activation (typically the target) is ultimately produced. However, a nontarget word can also be selected, resulting in a semantic paraphasia (e.g., *apple* instead of *orange*), an error often observed in individuals with aphasia (and normal individuals as well). Semantic errors likely occur due to deficits at the functional level. Blending errors, where two semantically similar words are co-activated and phonologically blended also occur in normal and aphasic speech (e.g., *A my* offered him some celery indicates a blending of *man* and *guy* (Bock, 1995). Together these errors provide evidence that the mental lexicon is semantically organized and that lexical selection at the lemma level involves activation of the target item in addition to semantically related items (Thompson & Faroqi-Shah, 2002). The principles of lexicon as network and spreading activation from activated lemmas to related concepts are important assumptions in the current study and will be discussed relevant to the predictions of this study in Chapter 7.

Selection of a word at the functional level of representation occurs by way of access to abstract lexical meanings ("lemmas") that contain information about word meaning and word class. Upon selection of a lemma, its syntax becomes available for further grammatical encoding which creates the appropriate syntactic environment for the word. For example, retrieving the word *escort* makes available the information that the word is a transitive verb that takes two arguments which in turn correspond to their own

semantic information. Information about thematic roles and the subcategorization frame are also activated (Levelt, 1989). Further, verb lemmas also encode the verb number (singular, plural), person (1^{st} (I/we), 2^{nd}(you), 3^{rd} (he/she,they)), tense (e.g., present, past), and mood (e.g., progressive). These features result, to some extent, from the conceptual representation of the intended message.

The second stage within Functional processing, *function assignment,* involves assigning grammatical roles to the selected lemmas (based on the intended message) including the thematics of a verb (e.g., agent, patient, etc.). The ordering of words (e.g., in English, which has a strong word order component) also occurs at the functional level, so in an active sentence such as *The woman chases the boy,* the content words would be selected and put in the correct order (*woman, chase,* and *boy*). Individuals with aphasia make typical errors that indicate a function assignment deficit. Namely, they reverse the roles of the agent and patient (e.g., *The dog chases the woman*), most often observed when both the agent and patient are animate (e.g., *dog* and *woman* vs. *dog* and *car*).

The verb is integral to function assignment because it is central to the selection of the participants in the sentence that are related to it. Specifically, the number of arguments a verb takes is part of its representation. For example, the transitive verb *cut* takes two arguments as in the sentence *Arthur cuts the tomato*. A dative verb requires three participants as in *Arthur gave the tomato* to *Anna.*

Verbs are also concerned with the assignment of thematic roles (e.g., *Arthur* and *tomato* in the above example), which express who does what to whom or who experiences the action. Different types of verbs have different types of thematic roles.

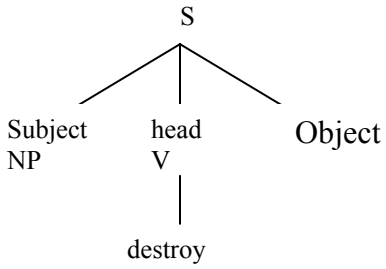
Transitive verbs such as *cut* contain an agent (who performs the action, e.g., *Arthur* in the above sentence) and a patient (the receiver of the action, e.g., *tomato*). In contrast, a psychological verb has an experiencer who experiences a mental state and a *theme* which is the content or object of the mental state (e.g., *The children* $_{\text{EXPERIENCER}}$ *admired the teacher* $_{\text{THEME}}$.) (Thompson & Faroqi-Shah, 2002). In summary, at the Functional level of representation a set of lemmas is activated along with their corresponding syntactic functions (which are linked together by argument structures of the verb lemmas).

The *Positional level of representation* is highly integrated with the activities of the Functional level. Positional processing computes the order in which the selected lemmas will appear in the sentence (constituent assembly) along with the grammatical morphemes (morpheme retrieval) (Bock & Levelt, 1994). It is at the positional level that the lemmas that were previously coded with their grammatical structure are organized into hierarchical phrasal constituents (e.g., noun phrases, verb phrases). Constituent assembly constitutes the generation of surface structure where the major lexical items are sequenced with the specification of phrase structures for lexical items.

Lexical items are then inserted into the tree along with required elements for each phrasal node. The configuration of a fragment or sentence depends on the form class of the selected lemma. With respect to verbs, a selected verb generates a fragment containing a slot for the verb and slots for all the verb's arguments (typically NP's). For example, a transitive verb such as *destroy* would contain two NP slots, one for the agent and one for the patient. Fragments for NP's contain slots for the head of the NP (the

noun) and a determiner phrase (e.g., *the*). See Figure 3.2 for a syntactic tree representing basic syntactic frame for *destroy*.

Figure 3.2. Syntactic tree of the verb *destroy*



Bock and Levelt (1994) argue that the selection of a structural frame is dependent on the availability of individual lexical items from the lexicon at the Functional level. Empirical evidence has indicated that as lexical items become available, they are incrementally inserted into the sentence frame (Bock & Levelt, 1994), suggesting that selection of a planning frame (e.g., a transitive frame (NP-V-NP)) cannot occur before the lexical items supporting the planning from are selected (Thompson & Faroqi-Shah, 2002). A verb lemma, including connections to its thematics, must be intact and available for sufficient activation so that the information can be conveyed to the processing level for constituent and morphological assembly. The functional level lexicon is the component of sentence production that the current study aims to target because it is central to activation, grammatical class and lexical role assignment, and word ordering of the content words of a sentence. As will be discussed in the next chapter, verb deficits at the functional level often occur in individuals with aphasia.

CHAPTER 4

VERB RETRIEVAL AND THEMATIC IMPAIRMENTS IN APHASIA

Agrammatic aphasia

A verb deficit is defined as greater difficulty retrieving verbs than nouns. Double dissociation of retrieval abilities across grammatical forms is well-documented in agrammatic aphasia (Berndt, Mitchum, Haendiges & Sandson, 1997a; Kim & Thompson, 2000; Marshall, Pring, & Chiat, 1998; McCarthy & Warrington, 1985; Miceli, Silveri, Villa, & Caramazza, 1984; Zingeser & Berndt, 1990), while individuals with anomic aphasia show the opposite pattern, naming verbs more easily than nouns (Berndt et al., 1997a; Luzzatti, Raggi, Zonca, Pistarini, Contardi, & Pinna, 2002; Miceli, et al., 1984; Zingeser & Berndt, 1990). A number of theories to explain selective verb deficits have been put forth over the years. Some researchers have argued that there are separate lexicons for verbs and nouns and that poor action naming is related to a deficit in accessing the verb lexicon (Miceli et al., 1984, Williams & Canter, 1987). Others have argued that verb deficits are related to the semantic complexity (Breedin, Saffran, & Schwartz, 1998) or the syntactic properties of verbs that may be retrieved, even in naming tasks (Zingeser & Berndt, 1990). Behavioral data has demonstrated that the problem is not necessarily a syntactic or semantic deficit but rather a relationship between the semantic-syntactic elements of a verb.

Individuals with agrammatic aphasia use proportionally fewer verbs (Bastiaanse et al., 1995; Kim & Thompson, 2000; Saffran, Berndt, & Schwartz, 1989, but see Bastiaanse and Jonkers (1998) and Berndt, Mitchum, Haendiges, & Sandson (1997b))

and have a less diverse repertoire of verbs (e.g., Bastiaanse & Jonkers, 1998; Berndt et al., 1997b) as compared to normal individuals. The reduced diversity of verbs may be related to an increased use of verbs with reduced semantic complexity. For example, participants with agrammatic aphasia use more semantically general "light" verbs (e.g., *go, take*) than semantically richer "heavy" verbs (e.g., *run, grab*) in sentence production in sentence generation tasks (Kohn, Lorch, and Pearson, 1989) and picture description tasks (Berndt et al., 1997b). Breedin, Saffran, & Schwartz (1998) found the opposite trend. However, their task was a story retelling with delayed repetition, so it is difficult to compare their findings with Kohn et al. (1989) and Berndt et al. (1997b), who used spontaneous speech tasks.

Regarding syntax, individuals with agrammatic aphasia prefer verbs requiring only one argument (e.g., *ski*) over two- or three-place verbs in naming tasks (Bastiaanse & Jonkers, 1998, Kiss, 2000, Thompson, Lange, Schneider & Shapiro, 1997). Additionally, transitive verbs that take two arguments (e.g., *destroy*) tend to be more difficult than intransitive verbs (e.g., *sleep*), which take only one argument. Therefore in single verb retrieval, one-place verbs are easier to retrieve than two-place verbs, which are easier to name than three-place verbs.

The pattern of increased difficulty with increasing number of arguments is also evident in sentence production (e.g., Kiss, 2000; McCann & Edwards, 2001), which affects the overall quality of a sentence. For example, Kiss (2000) performed a picture description task with two Hungarian individuals with Broca's aphasia and observed that when a one-place verb was retrieved, construct of the whole verb phrase was possible.

With two- and three-place verbs, retrieval of the verb's phonetic form did not necessarily result in syntactically complete sentences. Bastiaanse and Jonkers (1998) reported similar results when they examined the production of internal arguments (direct or indirect objects and prepositional phrases in sentences) and found that persons with agrammatic aphasia produced significantly more verbs without internal arguments than a matched normal group. As a result, they produced fewer constructions with one or two internal arguments. This trend has also been observed in spontaneous speech (Bastiaanse & Jonkers, 1998). The more "complex" a verb's argument/thematic structure, the less often it is retrieved in a number of production tasks, from naming to connected speech. When more complex verbs are retrieved, the sentence is compromised by decreased retrieval of verb arguments. Absent an appropriate verb and its arguments, a sentence clearly suffers in meaning and structure.

The inability of individuals with agrammatic aphasia to conceptualize arguments/thematic roles has also been captured in a verb categorization task. Thompson et al. (1997) asked individuals with agrammatic aphasia to categorize verbs into their respective argument structure categories (one-place, two-place, etc.), but they were unable. This appears to be a grammatical class specific deficit, as the same subjects were able to categorize nouns into superordinate categories (Thompson et al., 1997). The inability to categorize verbs did not impair the participants' ability to perform grammaticality judgment tasks.

A similar dichotomy between performance and competence was explored in a number of studies (Linebarger, Schwartz, & Saffran, 1983; Schwartz, Linebarger,

Saffran, & Pate, 1987; Schwartz, Saffran, & Marin, 1980) resulting in the Mapping Deficit theory. Mapping Deficit theory was based on the findings that persons with agrammatic aphasia exhibited intact grammaticality judgment while being unable to comprehend reversible sentences (where agent and patient are both animate). The theory has evolved over time, but it essentially argues that persons with agrammatic aphasia have an inability to "map" the proper thematic roles (who does what to whom) onto syntax. This is not a syntactic knowledge deficit, but a thematic mapping deficit. The authors also argue that persons with agrammatic aphasia also have processing deficits, and that when processing demands are reduced, performance improves. A number of treatment studies have used the basic hypothesis of the mapping deficit theory to guide treatment with equivocal results.

Fluent Aphasia

Verb deficits have been studied primarily in agrammatic aphasia. Considerably less research has been conducted on verb production in fluent aphasia, and the majority of the research has focused on sentence comprehension rather than production. With regard to production, individuals with fluent aphasia have traditionally been described as having more noun retrieval difficulties than verb retrieval difficulties, and output related to verbs has simply been described as fluent but paraphasic (Caramazza & Hillis, 1991; Kremin & Basso, 1993). However, recently some trends described in agrammatic aphasia have also been observed in Wernicke's aphasia.

The trend of increased difficulty in retrieving verbs in naming and in sentence production with increased number of arguments a verb can take has also been observed in

fluent aphasia (McCann & Edwards, 2001). Further, evidence for mapping deficits has also been reported in Wernicke's aphasia. Faroqi-Shah & Thompson (2004) investigated single word verb naming and comprehension along with sentence production in a number of tasks, examining the effects of lexical and syntactic cues of active and passive reversible and irreversible sentences. Based on each group's responses to cues and sentence type, the authors argued that Wernicke's aphasics may have a mapping deficit because, among other deficits, they produced many role reversal errors with reversible sentences. Further, they exhibited correct passive morphology in addition to the role reversal (indicating the problem was not due to a syntactic deficit). The authors argued that the participants with Broca's aphasia may have mapped correctly.

Identifying the Loci of Verb Deficits

The most comprehensive verb deficit studies to date examined persons with either Wernicke's or Broca's aphasia (Berndt et al., 1997a,b). Participants with each aphasia type exhibited similar verb deficits. However, extensive testing was needed to identify the nature of the verb deficit in each individual.

Berndt et al (1997a,b) enlisted 12 individuals with aphasia to perform a number of tasks involving nouns and verbs. Importantly, the participants were *not* pre-grouped by clinical classification (e.g., fluent vs. nonfluent); rather, based on their performance on noun and verb confrontation naming tasks, they were put into one of three groups: 1) verb impaired group (N = 5), 2) noun impaired group (N = 5), 3) no grammatical class deficit (N = 2). The authors further investigated each group relative to single word verb/noun tasks with verbs and nouns (Berndt et al., 1997a) and then in sentence level tasks (Berndt

et al., 1997b) in an attempt to identify the level(s) of deficit (lemma, lexeme, etc.) for each verb impaired participant.

Berndt argued that a deficit at the lemma level would have more devastating effects on sentence production than one at the lexeme level since it is at the lemma level where the sentence frame is specified with abstract lemmas of content words (nouns, verbs, etc.) (Bock & Levelt, 1994; Garrett, 1988). Because verb lemmas have a central role in the structure of a sentence, including the number of arguments, the entire sentence can theoretically break down without intact verb lemma representation or effective access to it. If there is a verb class deficit at the lexeme level, then a sentence may be produced without the verb, so that other sentential elements (i.e., the arguments) may be produced even though the verb is not present. This would not have as serious an impact on sentence production as a lemma level deficit.

In order to test this line of reasoning Berndt et al. (1997b) required participants to produce a sentence with 1) provision of a verb (e.g., *Make a sentence with the word "invent."*) and 2) provision of a noun (e.g., *Make a sentence with the word "dog."*). The authors reasoned that if the impairment was at the lemma level, provision of the verb would help sentence production, including the facilitation of production of the verb's arguments. The sentence production of some of the verb impaired participants did improve, indicating a lemma level deficit. Others did not improve, indicating a lexeme level deficit.

Berndt also investigated whether the verb deficit could result from syntactic deficits by conducting a picture description task where each picture contained two

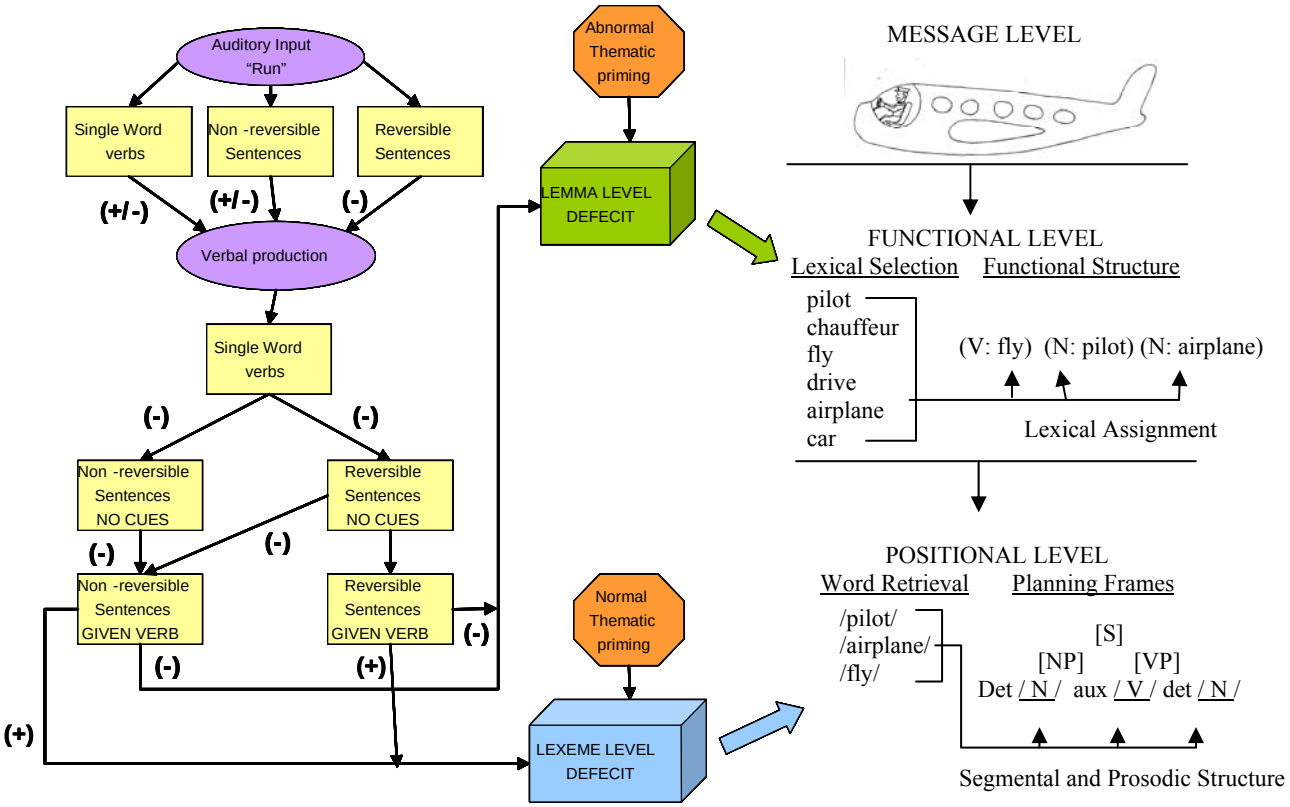
obligatory arguments. The participants were required to start with either the agent (for an active sentence) or the theme (for a passive sentence). Two of the participants produced the noun complement phrase correctly even though they omitted the verb half of the time. Therefore, their production of the noun was not dependent on their verb production, indicating a lexeme level impairment. The other two subjects could not produce the complement noun phrase when the verb was not present, indicating a lemma level deficit. The last subject performed well on the picture description task, and errors on the single verb naming task were primarily phonological, so the deficit was likely to be a lexical output deficit for verbs.

Comprehension is considered an indicator of whether or not a verb impairment is at the lemma level. However, this does not appear to be true of single word verb comprehension, since aphasics with verb impairments (and those with noun impairments) often have relatively intact single verb (or noun) comprehension. This may be due to only a minor semantic impairment that may spare comprehension of concrete, imageable verbs used in comprehension tasks (Silveri & Di Betta, 1997).

Poor comprehension of reversible sentences (active and passive) has also been considered an indicator of a lemma level impairment. However, the five participants in Berndt et al. (1997b) described above had impairments of reversible sentences, indicating that this measure is not exclusively an indicator of locus of impairment. Please see Figure 4.1 for a graphic representation of the tasks used to locate locus of deficit in Berndt et al., 1997a,b. Please note that this figure was not produced in Berndt's studies; rather, it was

inferred from their reasoning and created by this author to clarify the line of reasoning expressed in Berndt et al., 1997b.

Figure 4.1. Flowchart of the tasks used to locate locus of verb deficit in Berndt et al., 1997a, b.



(-) cannot identify locus of deficit

(+) can identify locus of deficit

The major findings of the Berndt studies are: 1) Verb deficits exist in participants with both Broca's aphasia and Wernicke's aphasia, 2) individuals with Broca's aphasia do not necessarily have verb deficits, 3) defining the locus of a verb deficit involves the scrutiny of the results of a number of carefully constructed tasks, and 4) performance on sentence production (not only single word production) is crucial to defining locus of deficit.

There is no clear pattern across subjects with a verb deficit, regardless of type of aphasia, perhaps due to the simple fact that the locus of deficit for each person may differ. Clearly there are multiple components of the cognitive-linguistic system that can be implicated in verb deficits in aphasia. Systematic evaluations of verb related behaviors need to be conducted for individual participants in order to identify patterns of deficits, dissociations, and possible loci of deficit. Over time, the results of these careful analyses will begin to reveal consistent patterns of verb deficits.

Before examining the specific questions and hypotheses of the current study, a review of online studies investigating the representation of verbs and their arguments/thematics in normal and aphasic individuals will be provided.

CHAPTER 5

ONLINE PROCESSING OF VERBS AND THEIR THEMATIC ROLES

Organization of Verbs and their Thematics

A number of priming studies have shown that a verb makes information available about its typical agents and patients. In four separate experiments, Ferretti et al. (2001) paired transitive verbs with related agents (e.g., *arresting/policeman*), patients (e.g., *arresting/criminal*), instruments (e.g., *cutting/scissors*), and locations (e.g., *skating/arena*) in addition to pairs that were not related (e.g., *parent/arresting*). A group of normal, young subjects read the verb (prime) silently, and then made a semantic (animacy) decision for each target (noun) (i.e., decided whether the noun was animate or not). Reaction times for decision of animacy were recorded after presentation of the noun. The results showed significantly faster reaction times when the prime (verb) was paired with typical agents (*policeman* after *arresting*), patients (*criminal* after *arresting*), and instruments (*scissors* after *cutting*) than when the verbs were paired with non-typical agents, themes, and patients. Typical locations (*arena*) for a verb (*skating*) did not show significantly faster reaction times than locations not typical for a particular verb to be acted in (*danced/court*). Verbs in isolation prime typical agents, patients, and instruments.

McRae, Hare, Elman, & Ferretti (in press) examined whether the reverse trend would be true, i.e., if thematic roles that are typically associated with a verb would prime the verb. In this study young subjects saw the prime (noun) and silently read the target (verb). As in Ferretti et al. (2001), they investigated typical agents (*nun/praying*), patients

(*dice/rolled*), instruments (*shovel/digging*), and locations (*arena/skating*) as well as non-typical noun/verb pairs and found that all of the nouns (including locations) primed related verbs (i.e., had significantly faster reaction times than nouns primes paired with unrelated verbs).

The authors of these related studies concluded that there appears to be neural co-activation whenever either a verb or its closely related noun are selected in a relevant context. The implication is that memory is structured so that when a verb is activated, generalized situation knowledge is also activated. Additionally, event memory appears to be organized so that nouns denoting entities and objects activate the class of events in which they typically play a role (Lancaster & Barsalou, 1997).

Verb Thematics in Sentence Processing

Event memory is not only organized around individual verbs and their typical arguments. There is also an inter-relationship between semantic organization and syntax in sentence processing and production. To investigate the nature of this inter-relationship, Ferretti et al. (2001, Experiment 4) examined whether verb-specific information is considered as part of thematic role knowledge during online sentence processing. Verbs were embedded in simple sentence fragments to test whether the knowledge they tap is used immediately to generate expectations for possible impending roles, a key aspect of thematic assignment. The working hypothesis was that if situation knowledge tapped by verbs interacts quickly with syntactic cues, then priming should be obtained when a noun (agent or prime) occurs in its congruent role (congruent agent = *She was arrested by the / cop.*) but not in its incongruent role (*She arrested the / cop*.). Unrelated verb/noun pairs in

congruent (*She was kissed by the / cop*) and noncongruent roles (*She kissed the / cop*) were also presented. Conversely, if situation knowledge is activated independently of syntactic processing, then priming should be found whenever a typical agent or patient closely follows a verb.

Participants heard sentence fragments (presented in the above examples before the backslash), and were required to name a picture presented visually (the word after the backslash). Ferretti found priming for related agents and patients when they appeared in a congruent role (*She was arrested by the / cop*) but not when they appeared in a noncongruent role (*She arrested the / cop*) and concluded that thematic roles enable syntactic-semantic interplay since related verbs (e.g., *arrest*) and thematics (e.g., *cop*) were used in both situations (which were both syntactically appropriate), yet priming occurred only when the verb and agent were arranged according to semantic expectations. (See McRae, de Sa, & Seidenberg, 1997 for similar conclusions).

Trueswell & Kim (1998) came to a similar conclusion based on the results of a priming study that investigated the activation of combinatory information (e.g., the possible complement a word might take) that is activated when a word is encountered in a sentence. Normal subjects engaged in two self-paced reading experiments where they silently read sentences containing ambiguous sentence complements (e.g., *The photographer accepted the fire could not be put out.*). The ambiguity lies in "the fire," which could be the direct object of "accepted" or the subject of a sentence complement. During testing, a verb prime was flashed on the screen immediately prior to reading "accepted" in order to disambiguate the meaning of the sentence. Reaction (reading)

times for each word were calculated. The authors found that priming the verb with a verb that tends to be used with the direct object (e.g., ”obtained”) resulted in increased reaction time (i.e., increased processing difficulty) at the word “could,” where the sentence is ambiguous. However, priming “accepted” with a verb that is used with a sentence complement (e.g., “realized”) resulted in significantly faster reaction times (less processing difficulty) in disambiguating the sentence. (McRae, Spivey-Knowlton, & Tannenhaus, 1998 reported similar findings.) Their results and conclusions are similar to and extend the conclusion of Ferretti et al. (2001). Trueswell and Kim propose a semantic combinatory system in which thematic roles are characterized as clusters of event properties and that argument structure is a central component of lexical processes in that this information is activated during the very early stages of encountering a word. Both syntactic and semantic combinatory information is activated in parallel during word recognition, which is consistent with similar results and conclusions in Nakano and Blumstein (2004) discussed below.

Novick, Kim and Trueswell (2003) investigated whether a verb’s arguments (nouns rather than verbs as in Trueswell & Kim, 1998) can disambiguate syntactic ambiguity in both a sentence reading and auditory sentence comprehension task (Experiment 1). In tasks similar to Trueswell & Kim (1998), they used three types of noun primes: 1) Nouns that tend to take a sentential complement (SC-bias nouns) (e.g., *opinion*), 2) Semantically abstract nouns that do not take sentential complements (e.g., *freedom*), and 3) Semantically concrete nouns that never take sentential complements (e.g., *machine*). It was argued that if SC-bias nouns (primes) yield an effect while abstract

primes do not, then combinatory knowledge is implicit over simple abstractness and this is in fact what they found. It was concluded that the processing of SC-bias nouns activates predictive knowledge about sentential complements and that the representation of nouns and verbs are related through shared representational mechanisms.

Online Sentence Processing of Verbs and Thematics in Aphasia

Number of Arguments

Behavioral data with individuals with aphasia strongly indicate that as the number of arguments a verb can potentially take increases, the more difficult (i.e., complex) production and comprehension tasks containing those verbs becomes. Online results have found a similar relationship such that the number of potential arguments a verb can take affects the length of time it takes to process that verb. Shapiro, Zurif and Grimshaw (1987) observed that an increased number of different argument structure possibilities for a verb (not syntactic subcategorization) increases sentence processing time so that the reaction time of naming a picture while hearing a verb within a sentence increases as the number of potential arguments that verb can take increases. The authors argued that when a verb is encountered, all possible arguments (e.g., obligatory two-place or optional three-place) are activated, resulting in greater processing demands for verbs that take more arguments. In a similar experiment, Shapiro and Levine (1990) examined a group of normals and a group of Broca's and Wernicke's aphasics and found the same pattern of increased processing for verbs with more potential arguments in the normal group and the Broca's aphasia group. However, they found no priming resulting from subcategorization of the verbs, as they were used in a variety of sentence types. The authors argued that the

lexicon may be organized primarily by representations related to argument structure and that argument structure holds a certain representational privilege over strict subcategorization information. (See Swinney, 1982 for similar idea). Regarding the group with Wernicke's aphasia, the authors argued that individuals with Wernicke's aphasia may have more of a deficit involved in activating the properties of the verb related to semantics. The authors cautioned that the fluent group was not homogenous (i.e., it contained participants with different types of fluent aphasia). Based on the results, the authors proposed a neurological dissociation between argument structure and strict subcategorization.

Real Time Processing of Verbs

After Shapiro and his colleagues discovered that the number of possible arguments a verb takes affects sentence processing, Shapiro, Gordon, Hack, and Killackey (1993) explored real-time access of verb-argument structures in active, passive, cleft-subject, and cleft-object sentences in three groups: normals, Broca's aphasics, and Wernicke's aphasics. Prior to the online task, the two groups with aphasia performed a sentence-picture matching task with 10 each of reversible active, passive, cleft-object, and cleft subject sentences. The participants with Broca's aphasia (N=6) scored above chance on active and cleft-subject sentences and at chance on passives and cleft-object sentences. Two of the four Wernicke's participants performed above chance on both actives and passives, with passives being worse than actives. One subject was at chance with all sentence types, and one performed above chance on actives and at chance on passives. Therefore, the Wernicke's participants were more heterogeneous in this task

than the Broca's group. The fluent group was more homogeneous than their last fluent group, but there are still clear differences based on each participant's results on sentence comprehension tasks.

The primary task involved cross-modal lexical decision where the target (word/nonword) was visually presented along with the verb or downstream during auditory sentence presentation. Reaction time between presentation of the word and the participant's response was recorded. The reaction time patterns observed (from fastest to slowest) for the normal group when the target was presented in the vicinity of the verb are as follows: transitive (e.g., *The woman peels the apple.*) > dative verbs (e.g., *The mailman gave the letter to the woman.*) = two-complement verbs (e.g., *I walked my dog home.*) > four-complement verbs (e.g., *I walked my dog home in the rain on Sunday*.) These trends were observed in all four sentence types. The results demonstrate that when a verb is encountered by normal individuals in a spoken sentence, its thematic properties are exhaustively activated, and that accessing a verb and its thematic properties appears to be independent of the type of sentence in which the verb is contained.

The Broca's group showed the exact same trends as the normal group in all sentence types. The authors argued that these participants must have activated the thematics of verbs even in sentences that they cannot normally comprehend, so that these mechanisms are dissociated. The Wernicke's group, however, did not show sensitivity to the thematic properties of verbs in any sentence type. The authors argue that perhaps the Wernicke's participants had a deficit in representing or accessing this information. They favored the argument that individuals with Wernicke's aphasia have trouble accessing the

information and that during online sentence comprehension, they are not provided with the set of lexical-conceptual roles associated with a verb that normal models of sentence processing require for further parsing and interpretation.

Nakano & Blumstein (2004) investigated incremental combinatorial thematics (syntactic, semantic, and pragmatic information that is combined during sentence comprehension) in normal participants and Broca's and Wernicke's aphasic participants. Participants were required to listen to active declarative sentences and make a lexical decision about the last word of the sentence. Four priming conditions were used: 1) Two real content words in prime (RRT) (e.g., *the bartender is kicking out the*), 2) a real word subject and a non-word verb were in the prime (RNT) (e.g., *the bartender is thazing out the*), 3) a non-word subject and a real word verb were in the prime (NRT) (e.g., *the quajeter is kicking out the*), and 4) two non-words were in the prime (NNT) (e.g., *the quajeter is thazing out the*) (served as control). The word "drunk" completed the sentences.

For the normal group, the authors found evidence for combinatorial thematics with significant facilitation for the RRT condition and a greater magnitude of priming than either the RNT or the NRT conditions. The authors then repeated the experiment but changed the word order of the sentences to make them ungrammatical. No priming took place in any condition for the normal group. Finally, the experiment was performed one additional time by changing the final word of the sentence from "drunk" to "witness" so that it was pragmatically and semantically reduced. There was no strong priming for any

condition when the target words were not pragmatically related to the thematics presented earlier in the sentence.

The results of the aphasic groups differed from those of the normal group and from each other. The group with Broca's aphasia failed to show priming in any of the three conditions (RRT, RNT, NRT) (compared to baseline) where nonwords were used in the subject and verb positions: when the sentences were produced in correct order, when they were produced out of order, or when the target was pragmatically incorrect (i.e., *witness* instead of *drunk*). Further, there were no differences in reaction times across the three conditions of interest for either syntax condition (syntactic or asyntactic). The authors compared the magnitude of priming across the three experimental conditions (syntactic, asyntactic, non-pragmatic) and reported a "non-significant but marginal effect" for the RRT condition between the syntactic and asyntactic experiments. They also examined the possible effect of pragmatics and found a significant interaction of the RRT condition and the syntactic and the non-pragmatic conditions. It was argued that this interaction indicates that pragmatic information was used to form a thematic structure in the syntactic condition. The authors conclude that Broca's aphasics have a deficit in combinatorial thematics, that they are unable to integrate information normally derived from syntax, and that they were only able to use pragmatic information weakly.

The group with Wernicke's aphasia, unlike the Broca's group or the normal group, showed significant priming in all three conditions for the syntactic condition, suggesting an impairment in the process of combinatorial thematics. In the asyntactic and non-pragmatic conditions, they showed no significant amount of priming, similar to the

normal group. The authors then conducted a number of *post-hoc* tests in order to understand the nature of the results in more detail. They concluded that Wernicke's aphasics are sensitive to syntactic and pragmatic information, but the abnormal pattern of priming observed in the syntactic experiment indicated that they were not building up thematic structures incrementally, like the normal group, but they were integrating information from a subject noun phrase and a verb. See Table 5.1 for a brief summary of online priming studies with individuals with aphasia.

Table 5.1. Brief summary of online findings for participants with Broca's and Wernicke's aphasia

Type of Processing	Participants with Broca's aphasia	Participants with Wernicke's aphasia
Number of arguments	Normal priming	No priming, possible deficit in semantic processing of verbs
Real time access of argument-verb structure	Normal priming, even on sentence types they do not comprehend	No priming, no sensitivity to thematic properties of verbs
Combinatorial thematics	No priming, unable to integrate information normally derived from syntax	Abnormal priming, impairment in combinatorial thematics, sensitive to syntax

(Nakano and Blumstein, 2004)

Conclusions

Regardless of the different methodologies used in the online studies discussed in this section, a number of important factors about verb representation and thematic activation during sentence processing have emerged. First, verbs prime their typical agents, patients and instruments, and typical themes prime a relevant verb, indicating that

the verbs contain typical thematics as part of their neural network and their core representation. This argument is further strengthened by the finding that activation of a verb activates not only the possible thematics that will follow in a sentence, but the *possible number* of arguments that verb can take, and this exhaustive activation occurs regardless of the complexity of the sentence.

Online processing tasks have also provided information about verb/thematic representation and processing in individuals with aphasia. Earlier studies indicated that Broca's aphasics have normal verb/thematic representation and Wernicke's aphasics do not. Broca's aphasics have exhibited normal priming patterns processing sentence types that they cannot comprehend. However, recent work (e.g., Nakamo & Blumstein, 2004) has shown that Broca's and Wernicke's aphasics are both impaired in their ability to integrate thematic/syntactic information, although the nature of their deficits appear to be different. There may be differences in verb/thematic priming within aphasia types rather than one particular profile for each clinical classification.

CHAPTER 6

TREATMENT OF VERB AND THEMATIC DEFICITS IN INDIVIDUALS WITH APHASIA

A number of treatment studies have attempted to remediate verbs and/or their thematics in order to improve single verb production, sentence comprehension or sentence production. Two prominent approaches have focused on improving mapping and verb retrieval and will be discussed in this chapter with particular focus on generalization results. Please note that there are a number of other treatment studies aimed at improving sentence production in aphasia (e.g., Ballard & Thompson, 1999; Thompson, Ballard, & Shapiro, 1998; Thompson & Shapiro, 1995; Thompson, Shapiro, & Roberts, 1993; Thompson, Shapiro, Kiran & Sobecks, 2003). However, they are different in their approach than the current study and will be not be discussed.

Mapping Therapy

Mapping therapy aims to clarify the connections between meaning (who is doing what to whom) and structure (syntax). A number of studies have used the Mapping Deficit theory to govern their therapy, but various techniques have been used to apply its principles. To train sentence comprehension, Jones (1986) developed an approach which involved teaching subjects how to analyze a sentence in order to understand the thematic roles. Subjects segmented written sentences into syntactic phrases and marked the verb after which the clinician would identify the theme and ask the subject "*What is he/she (verb)ing?"*. The agent was then identified with "*Who is (verb)ing?*." The thematic roles were then marked. Training moved from simple to more complex sentence structures.

Another method of training comprehension with mapping involves sentence-to-picture matching with a hierarchy of complexity, forced choices with pictures, and matching a spoken sentence with a choice of two pictures (Byng, 1988; Mitchum, Haendiges, & Berndt, 1995; Haendiges, Berndt, & Mitchum, 1996).

In general, generalization to untrained items has not been observed in mapping studies. For example, Marshall, Chiat, and Pring (1997) trained three argument verbs but did not see generalization to two argument verbs. Nickels, Byng, & Black (1991) trained two argument verbs, which improved, but there was no generalization to other types of verbs. In a review of the literature Marshall (2002) notes that the different outcomes that have been observed may be due to a number of reasons. For example, subjects had cognitive deficits such as working memory deficits (Mitchum et al., 1995) and event conceptualization difficulties (Byng, Nickels, & Black, 1994).

There is some evidence that treating mapping deficits with comprehension tasks may generalize to production. Jones (1986) and Byng (1988) treated comprehension and reported minor generalization to production. However, Mitchum and colleagues (1995) suggested that the therapy itself may have had a production component, and that some of the improvements may have been with verb arguments rather than actual mapping improvements. Byng (1988) treated preposition types of verbs only but showed generalization of production and comprehension to other verb types, suggesting that mapping therapy may target a common mechanism between production and comprehension and between different verb types (Marshall, 2002).

Therapies Promoting Verb Retrieval

A number of treatment studies have attempted to improve verb retrieval with the intention of improving sentence production. One approach is called *verb as core* (Loverso, Prescott, & Selinger, 1986), and theorizes that access to verbs is often disrupted in agrammatism and that verbs are central to sentence production. Therefore, patients were trained to produce verbs along with specific sentence constituents (e.g., noun phrases (NP)) that are assigned various thematic roles by the verb (e.g., *agent, theme*) in simple, active sentences. Loverso reported improvement in verbal scores on the *Porch Index of Communicative Abilities* (Porch, 1973) but did not investigate generalization to other sentences types with varying complexity in constrained tasks or in discourse.

Marshall et al. (1998) trained verb retrieval in one subject with a selective verb impairment that appeared to be due to a phonological deficit. It was found that with improved verb retrieval the subject's sentence structure also improved. In addition, they found an improvement in retrieval of semantically related verbs (e.g., change of possession/communication verbs) and their associated argument structure. This finding was unexpected as these verbs were control items. There were no improvements to abstract verbs which were also not theorized to improve. The authors concluded that an inability to access a verb's phonological representations can severely impair sentence formulation and that sentence production is aided by access to the prosodically specified verb phrases which mark elements within those phrases that are necessary for sentence production.

Raymer & Ellsworth (2002) compared semantic, phonologic, and rehearsal treatments within one nonfluent subject with mild verb retrieval impairment related to semantic dysfunction. Each approach used a picture as the central stimuli and the subject was required to name it. The phonologic treatment consisted of teaching the subject self cueing techniques and phonological awareness tasks. The semantic treatment consisted of increasing semantic knowledge of the verb such as asking if a verb is similar to another verb, etc. The rehearsal treatment consisted of repeating the word three times, rehearsing silently, reattempts at naming, and repeating the word three times again. Significant improvement in picture naming for all treatments and minimal generalization to sentence production with pictures containing the trained verbs was reported, but there was *no* generalization to untrained verbs. The lack of generalization could be due to the fact there was no attempt to "match" trained verbs to untrained verbs by meaning or semantic verb structure (e.g., motion verbs → other motion verbs). Argument structure was controlled for across trained sets (2-place obligatory and 2-place optional verbs), but there were no other controls in place with respect to stimuli selection.

Schneider & Thompson (2003) conducted a well-controlled verb retrieval treatment study in terms of design and stimuli with the purpose of examining generalization of verb retrieval within and across verb classes and to sentence production. Argument structure, verb semantic category (Change of State and Motion), frequency, phonology, and imageability were controlled for. A single subject crossover design in combination with a multiple baseline across subjects and behaviors was used in order to evaluate the effects of semantic treatment and argument structure treatment on verb type

and semantic class. Minimal generalization (based on 30% improvement over baseline) to sentence production was reported in trained verbs but no improvement in naming or in picture description occurred in untrained semantically related items, perhaps due to poorly conceptualized treatment. In both treatment protocols the subjects were required to repeat the target word after the clinician, but they were never engaged in any task that required them to process the stimuli at a higher level. Rather, they were simply provided definitions and thematic information. It follows that generalization to untrained verbs within or across semantic verb class or argument structure was not observed.

Edwards, Tucker, and McCann (2004) provided treatment focused on verb retrieval for three fluent aphasics with verb deficits. Therapy tasks included sentence completion, naming to definition and picture naming with hierarchical cueing. Each participant also engaged in daily home practice. The authors reported improvement on trained items but limited generalization to untrained verbs. However, 1/3 of the subjects showed an increased number of verbs (and their arguments) and an increased proportion of grammatical utterances in a connected speech sample. Similar to previous studies (e.g., Marshall et al., 1998; Raymer & Ellsworth, 2002), the untrained items were not matched semantically or phonologically to the trained stimuli, so the lack of generalization is not surprising. Further, participants' deficits were not characterized; they were simply described as being "fluent." The semantic nature of treatment may have fit the theoretical model but not the subjects' deficits.

Important lessons can be learned from these verb treatment studies. First, when generalization to untrained verbs is a primary goal, the untrained verbs must be matched

to the trained items based on some theoretical principle. For example, if semantic treatment is provided, then semantically-related verbs would theoretically improve (as in Marshall et al. (1998) with improvement to control items semantically related to trained items). Second, treatment must be theoretically motivated, and the methodology of treatment must logically follow. Third, subject deficit characterization is crucial, and the participants' deficits must be related to the theoretical motivation of treatment.

CHAPTER 7

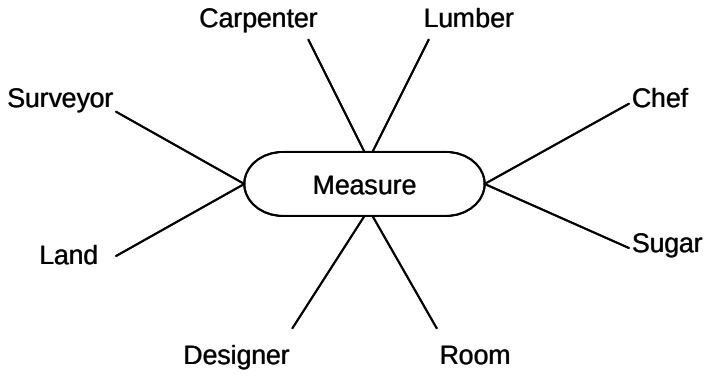
PURPOSE, RATIONALE AND RESEARCH QUESTIONS

A selective verb deficit is not restricted to one type of aphasia, and the level of sentence processing at which the deficit occurs differs across individuals regardless of aphasia type. Impairment at the functional level (e.g., Bock & Levelt, 1994) can produce deficits in word retrieval if the lemmas for the target content words (agent-verb-patient) are not strongly activated. If reduction of activation is due to weak semantic representation of the verb, then sentence production can be impaired since the verb is central to the semantics and syntax of a sentence. The semantic-syntactic interface refers to a verb's relationship with its arguments/thematics in that the verb's arguments fill the syntactic slots of subject and object, and those same words serve as thematic roles in that they refer to who does what to whom in the sentence.

Online studies examining verb-thematic relationships have shown that when a verb is activated, closely related agents and patients are activated. Likewise, related agents and patients activate the verb (Feretti et al. (2001); McRae et al. (in press)). The implication is that a verb has connections to and from its thematic roles, which can be considered as a network with the verb as the core (see Figure 7.1 for a simplified schematic of a proposed network for the verb measure). Part of a verb's representation is dependent on its thematic roles. Some researchers have even argued that a verb's meaning is more dependent on the meaning of the nouns that fill its thematic roles than the other way around (Ferretti et al., 2001). The verb-thematic relationship is so unique that it has been described as another level of representation (Jackendoff, 1972).

Consistent with this idea, but considered at a more general level, verbs are represented as schemas/event roles that develop through experience and knowledge (Bock & Levelt, 1994; Ferretti, et al., 2001; Lancaster & Barsalou, 1997; Levelt 1989), and thematics are essential to defining schemas for individuals verbs.

Figure 7.1. Schematic of verb-thematic network for the verb *measure*



To illustrate different schemas surrounding a verb and the importance of the thematic roles to the meaning to those schemas, consider the verb *measure.* In general it means to ascertain the length, size, or amount of something. However, by presenting the verb in multiple contexts (i.e., verb schemas), the multi-dimensional meaning of the verb becomes evident. Consider the following:

The *carpenter* is measuring the *lumber*.

The *baker* is measuring the *sugar*.

The *surveyor* is measuring the *land.*

The *interior designer* is measuring the *room*.

In each example the verb and the syntax are the same. What changes are the thematic roles, and each thematic pair conjures a different scenario. By presenting multiple scenarios related to the verb by changing its thematic pairs, the basic meaning of the verb becomes clearer.

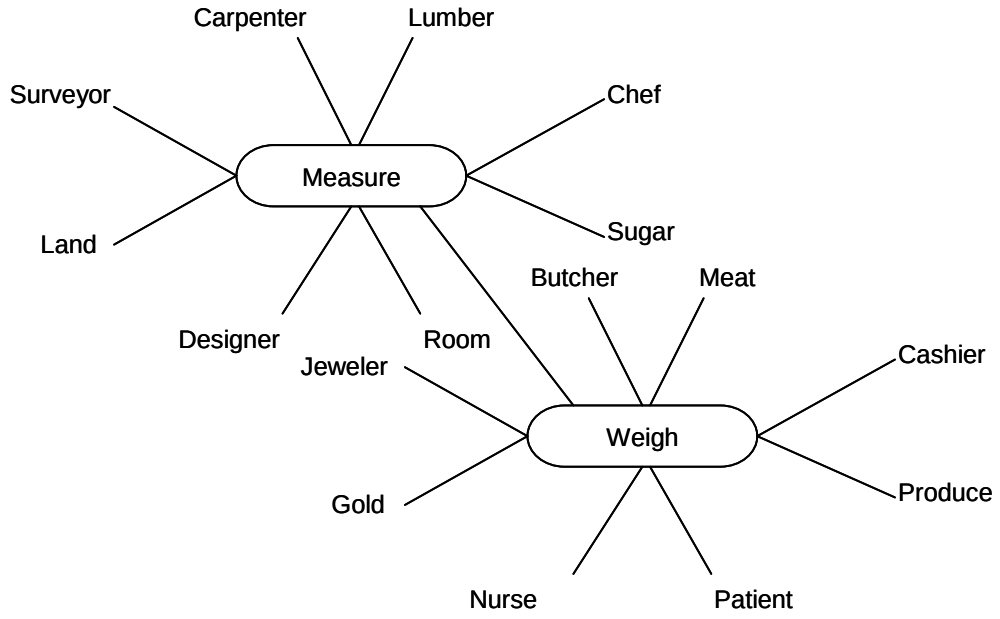
A number of verb treatment studies have attempted to strengthen verb representation using definitions, sentence completion, and pictures. For example, to train the thematics of the verb *drive* participants were shown a picture depicting a woman driving a car, and the patient was supposed to clarify "who" was driving and "what" was being driven. In this case, the thematic roles of that one picture were being trained instead of different thematic roles that make up the thematic grid (e.g., c*hauffeur/limousine, paramedic/ambulance, soldier/tank*), which may explain the reported lack of generalization to sentences and untrained.

Alternatively, if treatment were focused on strengthening the verb-thematic network at the functional level (Bock & Levelt, 1994), then activation of the verb and patient for sentence production would be increased. Once the verb and its thematic roles are activated and assigned grammatic roles, this information can be sent to the positional level where the structural frame is created, lexical items are inserted, and morphology is added (Bock & Levelt, 1994; Thompson & Faroqi-Shah, 2002). Targeting the verb-thematic network at the functional level is the treatment approach of the current study, hereafter referred to as Verb Network Strengthening Treatment (VNeST). The first goal of the treatment is to strengthen verb-thematic networks sufficiently to improve the ability to retrieve the *main content words* (agent (*carpenter*)-verb (*measure*)-patient

(*stairs*)) in sentences containing trained verbs. Assuming target content words are sufficiently activated, an appropriate sentence frame should be assembled for those words (*Carpenter measure stairs*) (based on Bock & Levelt, 1994). Improvement in the ability to produce bound and unbound morphology (*The* carpenter is measur*ing* *the* stairs.) would not *necessarily* improve since treatment is not targeted at the positional level where morphological elements are added.

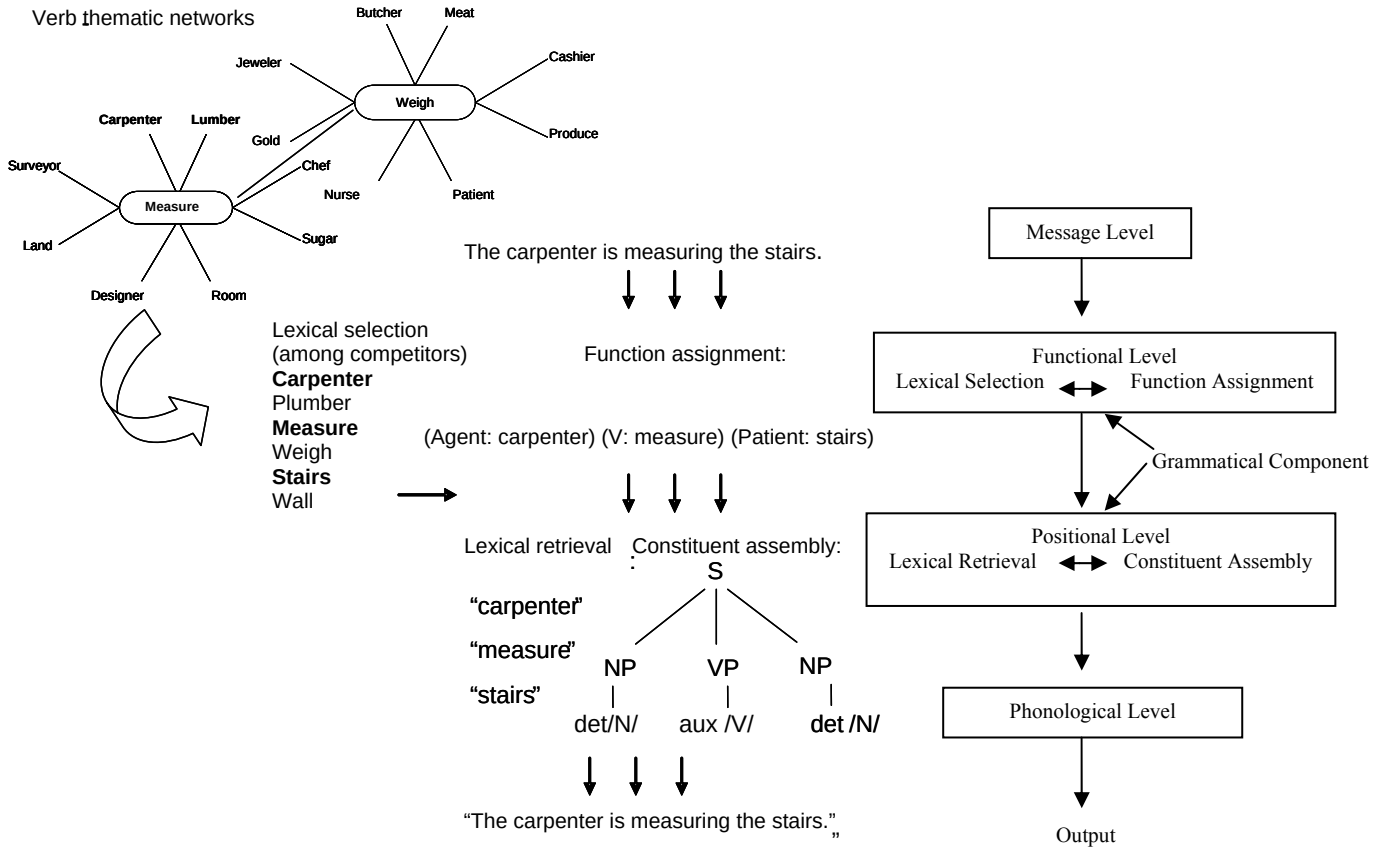
The second goal of VNeST is to strengthen verbs semantically related to trained verbs so that sentence production with those verbs will also improve. This goal is consistent with Bock and Levelt (1994) who argue that multiple lemmas within a semantic category are co-activated at the functional level and that activation can spread from one lemma to another. For example, activation of the verb *measure* should co-activate the verb *weigh*, and if the concept of *measure* is strengthened through treatment, so too will the concept of *weigh* be strengthened, resulting in the ability to retrieve the untrained word. Generalization to semantically related items is well-established in semantic treatment of nouns (Drew & Thompson, 1999; Edmonds & Kiran, submitted; Kiran & Thompson, 2003b) with some evidence in verbs (e.g., Marshall et al., 1998). Finally, if the untrained concept is strengthened sufficiently, co-activation with its thematics should also result (e.g., *nurse-weigh-baby*) so that production of the verb and its thematics should occur in sentence production. See Figure 7.2 for a schematic of the relationship between the two verb-thematic networks and Figure 7.3 for a schematic of the verb networks integrated with Bock and Levelt's (1994) levels of sentence production.

Figure 7.2. Schematic of the relationship between the verb-thematic network of *measure* and *weigh*



Treatment of agent-patient pairs in Verb Network Strengthening Treatment (VNeST) (e.g., *carpenter/lumber* and *chef/sugar*) relative to their relationship to the trained verb *measure* will strengthen the connections the between each agent-patient pair and the verb itself. Further, the semantic representation (meaning) of the verb will be strengthened in a multidimensional way since multiple verb schemas are activated. By extension, the semantic representation of the closely related verb *weigh* will also be strengthened as well as the connections to its thematic pairs (e.g., *butcher/meat*), since they are thought to be a part of a verb's representation. Retrieval of the trained or untrained verb and related thematics should be facilitated.

Figure 7.3. Schematic of verb-thematic network in relation to Bock & Levelt model



Thus far, verb networks have been simplified to include one verb (e.g., *measure*) connected to multiple thematic pairs and to a semantically related verb (e.g., *weigh*). Other verbs related to the trained verb will be activated, but to a lesser degree than the untrained semantically related verb since unrelated verbs will have less semantic similarity to the target verb. Nonetheless, assuming improvements in sentences containing untrained semantically related verbs, increased single verb naming and sentence production on the *Northwestern Verb Production Battery* (Thompson, 2002b) is predicted since verbs on that test are common and imageable, similar to the trained and untrained semantically related verbs. Since retrieval of verb thematics (nouns) is the primary treatment task, noun retrieval is expected to improve as tested by the *Boston Naming Test* (Goodglass, Kaplan, & Weintraub, 1983). Activation from retrieval of thematic roles is expected to spread to related concepts, but that activation should not be as strong as spreading activation from the trained verbs to other verbs since there is no systematic relationship between the retrieved nouns and other concepts, whereas all nouns are related to the verb. If all above predictions are realized, then improvements in the ability to produce content words in sentences in connected speech tasks should occur as long as the tasks are constrained and related to sentence production tasks in terms of sentence complexity and lexical retrieval requirements.

One final note of import about the most fundamental assumption of VNeST and the networks it targets: *the networks being targeted are assumed to have existed prior to stroke*. The treatment is not *teaching* the definition of new verbs or concepts. Rather, it is

attempting to re-activate and/or re-route pre-existing connections related to verb schemas that developed over time through experience and knowledge. This will be done through retrieval of thematic pairs related to the verb (e.g., an author writes stories) and through retrieval of thematic pairs that are personally relevant to each participant (e.g., their cousin writes an editorial for a local newspaper. (See Chapter 8 for methodology.). If the networks did not previously exist, improvement to untrained tasks or words would not be expected.

A number of goals have been outlined for VneST in persons with aphasia with semantic level verb deficits. The goals are hierarchical in nature and relate to a gradient of spreading activation from trained verb networks to semantically related networks and related concepts. In order to examine systematically the effect of VNeST on these tasks, the following questions and predictions were tested (see Figure 7.4 for a schematic.):

I. Does VNeST increase the ability of a person with semantic verb deficits to do the following for trained verbs?:

   a) Retrieve verbs in a confrontation naming task and a naming to definition task.

      Hypothesis: Assuming the verb lemma has been strengthened, naming an action depicted in a picture and in a naming to definition task will improve.

   b) Produce the content words of a sentence (agent-verb-patient) in a picture description task.

      Hypothesis: Retrieval of an appropriate verb and its thematic roles will improve due to improvement in semantic representation and stronger connections between verbs and their thematic roles.

II. Will improvement occur on the above tasks in untrained semantically related verbs? For example, if the verb *measure* is trained, will improvement occur with the verb *weigh*?

Hypothesis: Generalization to semantically related items will occur due to the semantic nature of the treatment and the close semantic relatedness of the trained and untrained verb pairs. Additionally, previous verb (Marshall et al., 1997; Raymer, Thompson, Jacobs, & leGrand, 1993; Thompson, Raymer, and leGrand , 1991) and noun (Drew & Thompson, 1999; Kiran & Thompson, 2003b) treatment studies have reported semantic generalization.

III. Will improvement be observed in a single word adjective sentence completion task that requires the ability to generate an adjective synonym (control task)?

Hypothesis: Even though this task requires production of a lemma level item and involves use of the semantic system, adjective retrieval is not hypothesized to improve with treatment since the adjectives are not related to the treated verbs.

IV. Will retrieval of unrelated single verbs (*Northwestern Sentence Production Battery* (*NVPB*) (Thompson, 2002b)) and single nouns (*Boston Naming Test*, Goodglass, et al. (1983)) improve?

Hypothesis: Single verb retrieval will improve due to spreading activation received from trained verbs. Nouns will improve, perhaps to a lesser degree than verbs, due to less systematic activation from thematic roles to other nouns during treatment.

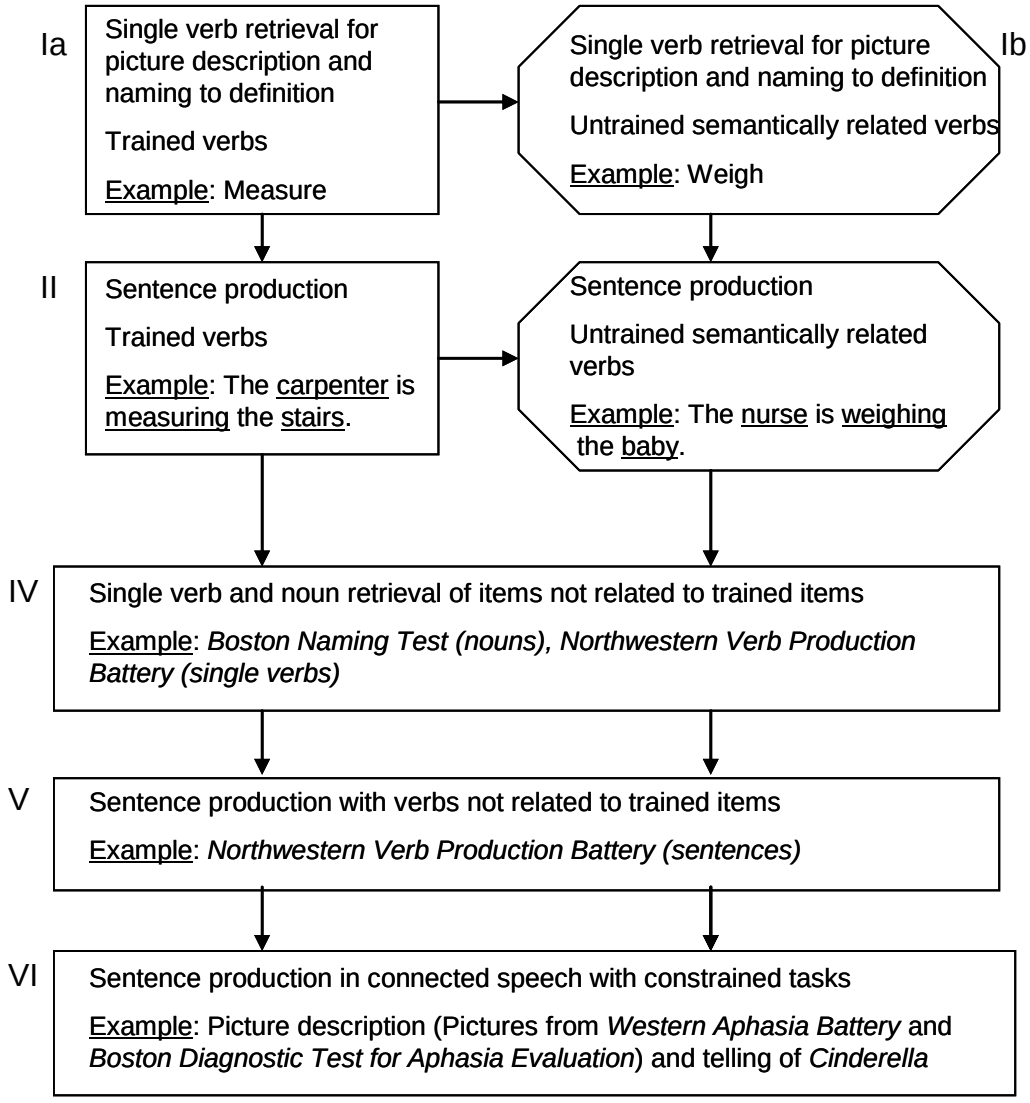
V. Will Sentence production improve as tested by the *Northwestern Sentence Production Battery*?

Hypothesis: If single verbs retrieval improves on the *NVPB*, then sentence production will also improve since the verbs are the same.

VI. Will sentence production (i.e., retrieval of content words in sentences) improve in connected speech in constrained tasks (Picture description: *Western Aphasia Battery* picture (Kertesz, 1982), Cookie Theft (Goodglass & Kaplan, 1983) picture and a Cinderella narrative)?

Hypothesis: If improvement occurs on the above-mentioned sentence production tasks, then improvements to the connected speech tasks will follow since they are constrained and similar to the other sentence production tasks in terms of lexical items and sentence structure.

Figure 7.4. Hierarchical representation of tasks hypothesized to improve with VNeST treatment. Roman numerals I, II, IV, V, and VI correspond with predictions and hypotheses. Control adjective task (III) not represented.



CHAPTER 8

METHODOLOGY FOR STIMULI DEVELOPMENT

The purpose of this chapter is to detail the rationale and methodology used to develop testing and treatment materials. The first section will discuss stimuli, and the second section will discuss normative data.

Verb, noun, and adjective stimuli were compared on a number of variables known to affect word retrieval, including frequency, imageability, and familiarity. Word frequencies refer to the number of times a word appeared in a sample of over 1 million words gathered from a variety of written sources such as newspapers and magazines (Kucera and Frances, 1967 from Wilson, 1987). Imageability and familiarity ratings ranked by normal individuals were derived from three merged sets of familiarity norms: Gilhooly and Logie (1980), Pavio (unpublished, expansion of Pavio, Yuille and Madigan, 1968), and Toglia and Battig (1978). The familiarity scale ranges from 100 to 700 with a maximum score of 657 (minimum score not available) (mean = 488, standard deviation (SD) = 99). Imageability ratings range from 100 to 700 with minimum and maximum ratings of 129 and 669 (mean = 450, SD = 108).

Stimuli Development for Testing Materials

Verb Pairs

Twenty four verbs served as the basis for the primary tasks in this study. The verbs were divided into two sets (verb set 1 and verb set 2) resulting in 12 verb pairs matched for semantic relatedness. Semantic relatedness was determined from the responses on a questionnaire by a normal group of individuals. (See Appendix A for a

copy of the questionnaire). Ten females and 1 male (average age = 36.4, average education = 17.2 years) with no history of neurological problems/diagnoses filled out a questionnaire that required them to rate 16 verb pairs on a scale of 1 (not related) to 7 (highly related) for semantic relatedness. Only verb pairs with a rating of > 4.5 were selected for this study, and the average rating was 5.53 (SD = 0.94) (see Table 8.1).

Table 8.1. Semantic relatedness ratings for verb pairs

Verb set 1	Verb set 2	Average Rating	SD
Bake	Fry	5.54	0.52
Throw	Kick	5.18	0.75
Sew	Knit	5.82	0.87
Read	Write	5.54	1.13
Fly	Drive	5.0	0.77
Measure	Weigh	5.64	1.21
Watch	Examine	5.0	1.41
Tow	Push	4.64	1.80
Chop	Slice	6.0	0.89
Scrub	Wash	7.0	0.0
Deliver	Send	4.7	1.27
Mix	Shake	6.27	.65
	TOTAL	5.53	0.94

In addition to semantic relatedness, each pair shared at least one verb class (e.g., *measure* and *weigh* are both Measure verbs (major class) and Register verbs (subclass)) (Levin, 1993). Number of arguments were optional 2-place (e.g., *bake*), obligatory 2-place (e.g., *examine*), or optional 3-place (e.g., *deliver*). Semantically "heavy" verbs with relatively specific semantic meanings (e.g., *bake, drive*) were used rather than "light" verbs (e.g., *make, go*). Additional factors were matched across sets as determined by a paired t-test: Frequency ($t(11) = 0.17$, $p = 0.87$), imageability ($t(5) = 0.68$, $p = .53$),

familiarity ($t(5) = 0.90$, $p = 0.40$), and number of syllables: Range = 1-3 syllables, $t(11) = 0.32$, $p = .75$) (Wilson, 1987). Ratings for some words were not available (see Table 8.2).

Table 8.2. Trained and untrained verb sets compared on a number of variables

Verb Set 1	# Syl	Freq	Image	Fam	Verb Set 2	# Syl	Freq	Image	Fam
Bake	1	12	495	549	Fry	1	2	n/a	n/a
Throw	1	42	477	548	Kick	1	16	551	563
Sew	1	6	478	517	Knit	1	10	n/a	n/a
Read	1	173	499	568	Write	1	106	548	560
Fly	1	33	582	537	Drive	1	105	n/a	n/a
Measure	2	91	379	555	Weigh	1	4	411	536
Scrub	1	9	n/a	n/a	Wash	1	37	522	632
Watch	1	81	525	576	Examine	3	33	341	549
tow	1	1	406	468	Push	1	37	341	549
chop	1	3	575	487	Slice	1	13	507	540
Deliver	3	18	n/a	n/a	Send	1	74	n/a	n/a
Mix	1	13	n/a	n/a	Shake	1	17	n/a	n/a
Avg	1.1	45.1	490.7	533.9	Avg	1.2	36.3	460.1	561.3
SD	0.3	55.3	67.7	36.5	SD	0.6	38.7	93.8	32.7

syl: syllables, freq: frequency, image: imageability, fam: familiarity, n/a: not available

Actions were depicted in pictures to elicit single verbs or complete sentences. For sentence production, the agents and patients portrayed had specific titles (e.g., *nurse*, *carpenter*) to promote specific language use instead of generic words (e.g., *lady*, *man*). Table 8.3 provides examples of target sentences in present progressive tense; however participants were not required to produce present progressive sentences. Any tense could be used and morphology could be omitted (e.g., plural markers). There was no significant difference between the agents and patients as determined by Student's t-test for verb set 1 ($t(24) = 0.35$, $p = 0.73$) or verb set 2 ($t(23) = 0.57$, $p = 0.57$) or between the two agent ($t(25) = 1.36$, $p = 0.19$) and patient ($t(22) = 0.48$, $p = 0.63$) lists (Wilson, 1987). The

pictures were 5”x7” hand-colored drawings centered on 8-1/2” x 11” white paper. See Figure 8.1 for a black and white example.

Figure 8.1. Example of picture to elicit sentence production (*The pilot is flying the airplane.*)

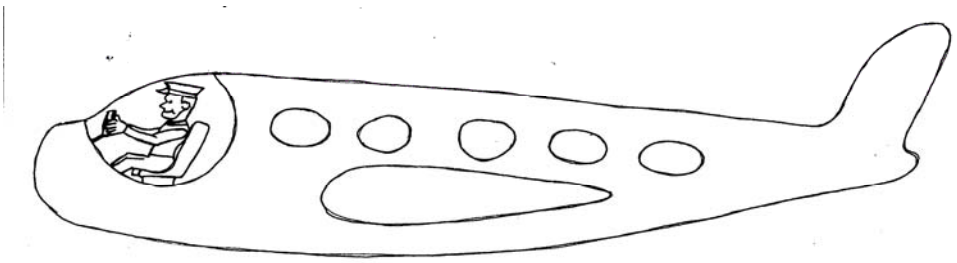


Table 8.3. Example sentences for sentence production task

Verb Set 1	Target Sentence	Verb Set 2	Target Sentence
Bake	The chef is baking a pie.	Fry	The cook is frying eggs.
Kick	The soccer player is kicking the ball.	Throw	The tennis player is throwing his racquet.
Knit	The mother is knitting a sweater.	Sew	The tailor is sewing a jacket.
Write	The policeman is writing a ticket.	Read	The student is reading a book.
Drive	The chauffeur is driving a limousine.	Fly	The pilot is flying an airplane.
Weigh	The nurse is weighing a baby.	Measure	The carpenter is measuring the stairs.
Wash	The zoo keeper is washing an elephant.	Scrub	The maid is scrubbing the floor.
Examine	The veterinarian is examining the dog.	Watch	The audience is watching the play.
Push	The gardener (landscaper) is pushing the lawnmower.	Tow	The farmer is towing the (horse) trailer.
Slice	The father is slicing a ham.	Chop	The boy (scout) is chopping wood.
Deliver	The mailman is delivering the letter.	Send	The woman is sending a package.
Mix	The bartender is mixing the drink.	Shake	The baby is shaking the rattle.

Note: Participants were not required to produce present progressive sentences.

Naming to Definition Task

Verb definitions were developed for a naming to definition task (NTD) used as a pre- and post-treatment measure. The NTD task was developed to compare verb retrieval performance across modality of presentation (i.e., visual presentation of picture compared to oral presentation of verb definition). In order to reduce working memory demands and provide a grammatical framework to an artificial task, the definitions were constructed in a sentence completion format (e.g., *To put words on paper with an instrument is to (write)* as opposed to *What do you call it when you put words on paper with a pen*? (as in Zingeser & Berndt, 1990)). An attempt was made not to include the instrument of the verb in the definition (e.g., *knife* in the definition of the verb *slice*) since there is a strong association between an action and its instrument (Ferretti, et al., 2001). The only definition that contained the instrument was "bake" because without inclusion of "oven," the definition was awkward. See Appendix B for the NTD score sheet.

Nouns

Twenty nouns were chosen for a confrontation naming task designed to determine if participants had a grammatical class deficit for naming (i.e., verbs named worse than nouns). The nouns were compared to the verbs discussed above on the following parameters: Frequency ($t(42) = 0.02$, $p = 0.98$), imageability ($t(33) = 6.18$, $p = 0.0002$), familiarity ($t(33) = 0.375$, $p = 0.71$), and number of syllables: Range = 1-3 syllables, ($t(42) = 0.35$, $p = .72$) (Wilson, 1987) (see Table 8.4). It is not unexpected that nouns and verbs were significantly different in terms of imageability. However, normal individuals were able to name the nouns and verbs with greater then 95% accuracy.

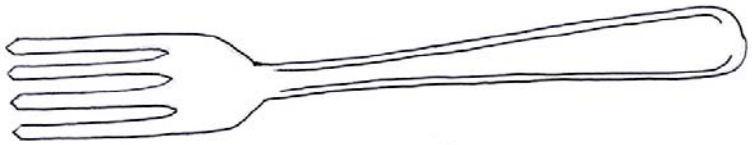
Noun pictures were hand-drawn by the same artist who drew the verb pictures and were colored with similar color complexity. The drawings were approximately 4" x 6" and centered on 8-1/2" x 11" white paper. See figure 8.2 for a black and white example.

Table 8.4. Verb and noun stimuli compared on a number of variables

Verb	Freq	Image	Fam	Noun	Freq	Image	Fam
Bake	12	495	549	Fork	14	598	584
Throw	42	477	548	Queen	41	612	527
Sew	6	478	517	Clown	3	589	511
Read	173	499	568	Heart	173	617	578
Fly	33	582	537	Barn	29	589	466
Weigh	4	411	536	Wrench	1	n/a	n/a
Scrub	9	n/a	n/a	Pillow	8	624	602
Watch	81	525	576	Boat	94	593	608
tow	1	406	468	Frog	1	617	507
Chop	3	575	487	Grapes	3	591	532
Fry	2	n/a	n/a	Butterfly	2	624	481
Kick	16	551	563	Lamp	18	575	578
Knit	10	n/a	n/a	Leaf	8	584	531
Write	106	548	560	Pool	94	593	608
Drive	105	n/a	n/a	Mouth	103	613	572
Measure	91	379	555	Key	88	618	603
Wash	37	522	632	Fence	30	611	526
Examine	33	341	549	Belt	29	494	550
Push	37	341	549	Corn	34	601	548
Slice	13	507	540	Stool	12	608	556
Deliver	18	n/a	n/a	Avg	39.3	597.4	550.9
Mix	13	n/a	n/a				
Send	74	n/a	n/a				
Shake	17	n/a	n/a				
Avg	39.0	477.3	545.9				

freq: frequency, image: imageability, fam: familiarity, n/a: not available

Figure 8.2. Example of noun picture to elicit single noun production (*fork*)



Adjective control task

A single word adjective retrieval task was developed as a control task. Since performance on this task was compared to single verb retrieval, the adjectives were compared to the 24 verbs on frequency ($t(34) = 0.18$, $p = 0.86$), imageability ($t(24) = 0.71$, $p = 0.48$), and familiarity ($t(22) = 1.22$, $p = 0.23$) with no significant difference in any variable as determined by Student's t-test (see Table 8.5). An adjective task was chosen rather than a verb task because a sufficient number of semantically unrelated verbs matched on all of the control factors could not be generated. In addition, adjectives, like verbs, are content words with high semantic meaning. However, because the adjective task is one step removed from verbs, a simple synonym task in the form of sentence completion was chosen so that difficulty would not be a confounding factor. In fact, some of the items have more than one acceptable response, providing more opportunity for success. See Appendix B for a copy of the score sheet with examples and instructions.

Table 8.5. Verbs and adjectives compared on a number of variables

Verb	Freq	Image	Fam	Adjective	Freq	Image	Fam
Bake	12	495	549	Ill	39	n/a	n/a
Throw	42	477	548	Cruel	15	521	422
Sew	6	478	517	Chilly	5	536	460
Read	173	499	568	Rich	74	n/a	n/a
Fly	33	582	537	Huge	54	n/a	n/a
Weigh	4	411	536	Hungry	23	503	591
Scrub	9	n/a	n/a	Loud	20	577	448
Watch	81	525	576	Strange	84	378	606
tow	1	406	468	Rapid	43	387	524
Chop	3	575	487	Funny	41	468	617
Fry	2	n/a	n/a	Brave	24	426	474
Kick	16	551	563	Disgusting	n/a	n/a	n/a
Knit	10	n/a	n/a	Annoying	n/a	n/a	n/a
Write	106	548	560	Weary	17	n/a	n/a
Drive	105	n/a	n/a	Avg	36.58	474.5	517.75
Measure	91	379	555				
Wash	37	522	632				
Examine	33	341	549				
Push	37	341	549				
Slice	13	507	540				
Deliver	18	n/a	n/a				
Mix	13	n/a	n/a				
Send	74	n/a	n/a				
Shake	17	n/a	n/a				
Avg	40.7	477.31	545.88				

Freq: Frequency, Image: Imageability, Fam: Familiarity, n/a: not available

Methods for Development of Normative Data

This section details the methods used to gather and interpret normative data for developed tasks.

Participants

A normal group age-matched to treatment participants (8 females, 2 males; average age = 59.6 years) was recruited from the Austin, TX area to perform the sentence production, naming to definition, noun naming and adjective production tasks to determine if the desired targets were produced and to identify problems with stimuli.

Normal participants met the same criteria as the treatment participants (e.g., right handed, monolingual English speakers, etc.) except that normal participants had negative neurological histories.

Single Verb Naming and Sentence Production – Results from Older Normal Group

For the sentence production task participants were shown the sentence probe pictures in random order and instructed to produce a sentence describing what was happening in the picture. They were specifically told to include the elements pointed to by the examiner. For every picture the examiner said, "Please make a sentence and include this (pointed to the agent), the action (pointed if relevant), and this (the patient) (e.g., for the target *The pilot is flying the plane*, the pilot and the airplane were pointed to). Participants were instructed to use specific words to describe the people and items in the picture and to avoid pronouns (e.g., *he/she*) and general terms (e.g., *the man*). In some cases 1 or 2 prompts were needed. These prompts occurred if participants produced a general word for the target (*slice* → *cut; tennis player* → *boy*) or if they produced a relevant target that was not the intended target (e.g., *The policeman is writing a ticket* → *The policeman is giving a ticket*). The specific prompts were *Can you think of a more specific word for the person/action?* and *The specific action of interest is this one* (at which point the examiner would specifically point to the action (e.g., the policeman writing)). The first response produced after the prompt was recorded, and no additional prompts were given. Since the same pictures were used to elicit single verbs and complete sentences, the normal group was only asked to produce complete sentences. The verb produced in the sentence was considered the response for single verb naming.

All verbs and sentences (i.e., all content words were correct) were produced with at least 95% and 90% accuracy, respectively.

Naming to Definition – Results from Older Normal Group

For the naming to definition task, participants were instructed to identify the action that went with the definition read to them by the examiner. Two practice items with feedback were provided to ensure task comprehension. Definitions were repeated at the participant's request, or if they appeared to need a repetition. If participants provided more than one response, they were asked to choose. The response chosen was scored. Four items (*deliver, send, shake, mix*) were poorly named (< 75% accuracy) and were not included in the naming to definition task for the treatment participants. The remaining definitions (N = 20) were named with at least 85% accuracy across normal participants and were used with treatment participants. See Appendix E for Naming to Definition score sheet.

Confrontation Naming of Nouns – Results from Older Normal Group

In order to ensure that noun pictures elicited the desired target, normal participants were asked to name the pictures depicting nouns. Noun pictures were named with at least 99% accuracy.

Adjective control task – Results from Older Normal Group

The instructions for the adjective control task were to complete a sentence read aloud by the examiner. For example, *Someone who is sick is also said to be <u>ill</u>* (target word). Participants were then given two practice items with feedback. Sentences were

repeated at the participants' request or if they appeared to need a repetition. Adjectives were produced with a minimum accuracy of 85%.

Development of Treatment Stimuli

Each participant received treatment for 10 verbs. Treatment stimuli consisted of the following: 1) 10 cards containing the names of the 10 trained verbs (e.g., *write*), 2) 8 cards for each verb containing 4 agents and 4 patients that form 4 pairs related to each verb (e.g., *author/story, mother/to-do list, poet/poem, journalist/article*) chosen to represent a range of possibilities to expand the variety of scenarios related to each verb, 3) 5 cards containing the following words (*who, what, where, when, why*), and 4) 12 sentences containing the target verb divided into four categories: 1) correct (*The author writes a novel.*), 2) inappropriate agent (*The infant writes a poem.*), 3) inappropriate patient (*The journalist writes the television.*), 4) thematic reversal (*The novel writes the author*.). Participants were required to decide whether the sentences were semantically correct or not. Some of the agents and patients in the sentences matched those used in treatment and some were novel. However, none was the same agent-patient pair represented in the probe pictures.

CHAPTER 9

METHODOLOGY FOR TREATMENT STUDY

The purpose of this chapter is to detail the methodology used to select, describe and test treatment participants. In addition, details related to scoring, probe administration, treatment protocol, experimental design, and reliability are provided.

Participants

Four participants (3 females, 1 male, average age = 61.5 years) with aphasia were recruited from local area hospitals and the University of Texas Speech and Hearing Clinic. There were several inclusion criteria: (a) diagnosis by a neurologist of a stroke in the left hemisphere (encompassing the gray/white matter in and around the perisylvian area) confirmed by a CT/MRI scan, (b) onset of stroke at least nine months prior to participation in the study, (c) no history of learning disorder, psychological disorder, alcoholism, or dementia, (d) right-handed prior to stroke, (e) adequate hearing, vision, and comprehension to engage fully in testing and treatment (see Table 9.1 for demographic information). Participants that met these criteria underwent language testing to determine if they exhibited a verb deficit to qualify them for enrollment in the study.

Western Aphasia Battery (Kertesz, 1982) scores between 50 and 85 were required, excluding individuals with severe and mild deficits. Scores of 0-75% on the sentence production subtest of the *Northwestern Verb Production Battery* (Thompson, 2002b) were required to ensure sentence production deficits. Individuals with apraxia of speech were included if they exhibited no worse than mild-moderate deficits as determined by the *Apraxia Battery for Adults* (Dabul, 2001). Performance on single noun

and verb naming on stimuli developed for this study required noun naming to be at least 15 percentage points greater than verb naming. Sentence production on developed stimuli was required to be no more than 40% to allow room for improvement. Treatment participants met these requirements.

Table 9.1. Demographic information for participants

Participant	M/F	Age	Education (years)	Occupation	Site of lesion	MPO	Type of aphasia	*WAB* AQ
1	M	52	10	Body mechanic	Left MCA	10	TMA	76.4
2	F	63	16	Computer programmer	Left MCA	96	TMA	78.5
3	F	75	16	Retired school teacher	Left MCA	22	Conduction	73.8
4	F	56	14	Musician	Large L MCA	21	Conduction	70.6

M: Male; F: Female; MPO: Months post onset; WAB AQ: *Western Aphasia Battery* Aphasia Quotient; TMA: Transcortical motor aphasia

Participants' Performance on Standardized Tests

Type and severity of aphasia was determined by administration of the *Western Aphasia Battery* (*WAB*) (Kertesz, 1982), administered one week before the beginning of treatment. The *WAB* was Participants 1 and 2 exhibited moderate transcortical motor aphasia (aphasia quotient for P1 = 76.4 and P2 = 78.5) characterized by relatively intact comprehension and repetition with nonfluent often telegraphic speech. P1's fluency rating was 5 on the *WAB*, with 4 as the cut-off for nonfluent aphasia. He received a rating of 5 because he produced a few propositional phrases in his speech sample, but other aspects of production on that sample and in other contexts were consistent with nonfluent aphasia. Participants 3 and 4 exhibited moderately severe conduction aphasia (P3 = 73.8,

P4 = 70.6) characterized by fluent speech containing circumlocutions, phonemic paraphasias, aspects of paragrammatism (e.g., pronoun reference errors) and impaired comprehension.

The *Boston Naming Test* (*BNT*) (Goodglass, Kaplan, & Weintraub, 1983) was administered to evaluate single word noun retrieval. Participants with nonfluent aphasia performed better (P1 = 71.7%; P2 = 86.7%) than those with fluent aphasia (P3 = 40.7%; P4 = 42%). Single verb production was evaluated by the *Northwestern Verb Production Battery* (Thompson, 2002). Verbs identical to treatment verbs were omitted (e.g., *fry, bake, read, write*). Participants showed deficits in single verb production (P1 = 72.7%; P2 = 63.6%; P3 = 80.9%; P4 = 52%).

Sentence production was evaluated with the *Northwestern Verb Production Battery (NVPB)* (Thompson, 2002b). The test was administered two times under different conditions. In the first administration, the verb was *not* provided in any form. During the second administration, the participant read the verb written under the picture to be described (all participants were able to read single words). To prevent syntactic priming, the clinician did not produce the example sentences (e.g., *The boy is zipping his coat.*) in either condition when describing the task (as in standard administration), as the goal was to test participants' abilities without modeling. Instead, the clinician instructed the participant to produce a sentence containing the person or object indicated by the arrows. For example, for the picture of the man shaving his face, the clinician would say, "Please make a sentence and include him (pointed to man), the action, and this (pointed to face). Participants understood the instructions as evidenced by their productions of two example

sentences. Sentence production was poorer on the no-verb (NV) condition (Verb - No-verb condition: P1: 73.9 - 54.2 = 19.7%; P2: 91.3 - 56.5 = 34.8%; P3: Did not test Verb-only, 76.2% for NV condition; P4: 80 – 30.6 = 49.4%) indicating that the inability to produce a verb was detrimental to sentence production.

Finally, the *Apraxia Battery for Adults (ABA-2)* (Dabul, 2001) was administered to P1 and P2 who presented with signs and symptoms of apraxia of speech (AOS) (e.g., effortful speech with groping articulation and variable articulation errors). The test was administered by a speech-language pathologist specializing in AOS who concluded that P1 had mild AOS and P2 had mild-moderate AOS. See Table 9.2 for pre-treatment results of standardized tests for participants.

Table 9.2 Pre-treatment scores on standardized tests

TEST	P1	P2	P3	P4
Western Aphasia Battery (AQ)	76.4	78.5	73.8	70.6
Information (raw score)	7	8	9	8
Fluency (raw score)	5	4	8	7
Comprehension (%)	86.0	93.5	81.0	77.0
Repetition (%)	94.0	96.0	39.0	49.0
Naming (%)	82.0	83.0	79.0	77.0
Boston Naming Test (%)	71.7	86.7	40.7	42.0
Sentence Comprehension Test for Aphasia (Single verbs) (%)	100	100	100	100
Northwestern Verb Production Battery (Single verbs) (%)	72.7	59.1	80.9	52.0
Northwestern Verb Production Battery (Sentence production with verbs) (%)	73.9	91.3	DNT	80.0
Northwestern Verb Production Battery (Sentence production without verbs) (%)	54.2	56.5	76.2	30.6
Apraxia Battery for Adults	Mild AOS	Mild-mod AOS	n/a	n/a

AOS: Apraxia of speech

Sentence Production Error Analysis

Sentence production was poorer in the no-verb condition of the *NVPB* compared to the verb-provided condition. An error analysis was performed on the no-verb condition

to determine if verb errors were more prominent than noun (i.e., subject, object) errors. Incorrect sentences were assigned to one of 3 categories: 1) verb error only (incorrect or omitted verb with correct noun(s)), 2) noun error only (incorrect or omitted noun with correct verb), 3) verb and noun error. No participant showed noun-only errors as the predominant error type. Three participants showed verb-related errors as the predominant error type (P2 = 90%; P3 = 80%; P4 = 80%). P1 showed the most errors in the verb + noun error category (54.55%) followed by verb only errors (27.27). See Table 9.3 for a breakdown of errors.

Table 9.3. Errors on *Northwestern Sentence Production Battery* sentence production subtest under no-verb provided condition

Participant	Total number of errors	Verb only error	Noun only error	Verb + noun error
1	11	27.27%	18.18%	54.55%
2	10	90.0%	0%	10.0%
3	5	80.0%	0.0%	20.0%
4	15	80.0%	13.33%	6.67%

Verb error type was also analyzed to understand better the nature of the verb deficits (see Table 9.4). Verb errors in the verb-only error category and the verb + noun error category were categorized as: 1) semantic/general verb errors (i.e., are semantically related to the verb or are more general ways to describe the action) (e.g., *carry* → *handle* (semantic error); *deliver* → *give* (general error)), 2) other verb errors (includes unrelated verbs and neologisms) (e.g., *deliver* → *look at*; *pour* → *clay*), or 3) verb omission (e.g., *The boy on the horse someplace* (target verb = *ride*)). If a sentence included an auxiliary verb *only*, it was considered a verb omission error (e.g., *The boy he's box in his arms.* (target verb = *carry*). P1 and P4 produced errors across all error categories

(semantic/general error (P1 = 22.3%, P4 = 23.0%); other verb error (P1 = 33.3, P4 = 38.5%); verb omissions (P1 = 44.4%, P4 = 38.5%)), so the majority of sentences contained verbs, but the verbs were only related to the target 25% of the time (semantic/general errors). In contrast, P2 and P3 predominantly showed semantic/general errors (P2 = 88.9%, P3 = 80.0%).

Table 9.4. Types of verb errors on *Northwestern Sentence Production Battery* sentence production subtest under no-verb provided condition

Participant	Total number verb errors	Semantic/General error (%)	Other verb error (%)	Verb omission (%)
1	9	22.3	33.3	44.4
2	9	88.9	0.0	11.1
3	5	80.0	20.0	0.0
4	13	23.0	38.5	38.5

Participants' Performance on Developed Tasks

Single Word Retrieval for Noun and Verbs and Sentence Production

Standardized test results indicated that participants had verb level deficits, and additional tasks were developed in order to characterize the verb deficit more thoroughly. Participants' performances on single verb naming on *The Northwestern Verb Production Battery* (Thompson, 2002b) and noun naming on *The Boston Naming Test* (Goodglass, et al, 1983) could not be compared to determine if a verb deficit existed since the stimuli are not balanced for frequency. In order to examine the difference between noun and verb naming abilities, participants named 20 nouns and 20 verbs matched for frequency, familiarity, and number of syllables. Participants were able to name nouns better than

verbs by a minimum difference of 45% (Noun naming - Verb naming on last baseline: P1: 85 - 30 = 55%; P2: 100 - 35 = 65%; P3: 95 - 50 = 45%; P4: 90 - 25 = 65%).

Naming to definition was tested for the same 20 verbs used in the single verb naming task to examine lexical access differences across modalities (visual for confrontation naming vs. auditory for NTD). All participants except P3 had similar scores across tasks (5 -10% difference). Participant 3 showed the largest difference (naming = 50%, NTD = 12.5) (P3 received 16 rather than 20 NTD items because two of her treatment verbs were omitted from the NTD task due to poor naming by the normal group).

Sentence production was tested with the same protocol used with the normal older group. Participants were asked to describe a picture in one sentence (e.g., *The nurse is weighing a baby.*). A correct response not only had to include a subject, verb, and object (S-V-O), but each content word had to be specific (e.g., *nurse* instead of *she* or *the woman* and *baby* instead of *him* or *it* in addition to correct production of the verb, *weigh*). Participants exhibited a maximum of 40% accuracy on sentence production.

Based on the results of verb-related tasks, participants exhibited a verb deficit, producing fewer verbs than nouns in single word and sentence contexts. The inability to retrieve correct verbs negatively affected sentence production (as in the NV condition of the *NVPB*). See Table 9.5 for pre-treatment results for tasks developed for this study.

Table 9.5. Pre-treatment scores on tasks developed for this study

Test	P1	P2	P3	P4
Single Noun Naming (%)	85	100	95	90
*Single Verb Naming (%)	30	35	50	25
Naming to Definitions of Treatment Verbs				
Trained verbs (%)	30.0	30.0	12.5	20.0
Untrained verbs (%)	30.0	20.0	0.0	30.0
*Sentence Production				
Trained verbs (%)	0	40	20	0
Untrained verbs (%)	0	30	10	0
*Adjective control task	40	40	50	30

*Scores from last probe session before treatment.

Participants' Performance on Connected Speech Samples

Stimuli were not developed to elicit connected speech samples. Rather, picture description of the *WAB* (Kertesz, 1982) and Cookie Theft pictures (*Boston Diagnostic Aphasia Examination,* Goodglass & Kaplan, 1983) in addition to a narrative (Cinderella) were used. For picture description participants were instructed to describe what was happening in the pictures and to use complete sentences. For the Cinderella task, participants reviewed the story by looking at the pictures in a book (without words), and then they told the story without the book. No prompts were provided by the clinician except occasional encouragement.

Three connected speech samples were elicited to evaluate sentence production in a variety of contexts while maintaining topic constraint. Further, there is a gradient of sentence production demands across the tasks (*WAB* < Cookie Theft < Cinderella), allowing for a controlled range of output. Specifically, the *WAB* picture requires mostly S-V (*The dog is* running.) or S-V-O sentences (e.g., *The boy is flying a kite*) with familiar and imageable lexical items. The Cookie Theft picture is still constrained in topic, but it contains more complex elements (e.g., *The boy is standing on a stool. He is stealing a*

cookie. He is going to fall. The mother is not paying attention.) with familiar and imageable items (e.g., *boy*, *girl*, *steal*, *woman*, *wash*, *cookie*, *water*, etc.). The Cinderella story is still more complex, but the participants were able to choose the elements they wanted to produce and use word retrieval strategies.

In order to have a large speech sample, the responses for all three tasks were combined into one sample (except for P3, for whom the *WAB* picture was not included due to audiotaping problems during pre-treatment testing.). The samples were transcribed by the author and a trained Communication Sciences and Disorders undergraduate in accordance with the *Quantitative Production Analysis* (Berndt, Sloan, Wayland, Rochon, Saffran, & Schwartz, 1999). The analyzed transcript included abandoned utterances and utterances with unintelligible words, but repeated utterances were not included. If two examples of similar consecutive utterances occurred, the best formed utterance was analyzed.

A standard measures analysis was conducted in order to determine total number of utterances and mean length of utterance (MLU). However, of primary interest was whether the participants showed an increase in the proportion of *complete utterances* in their post-treatment samples. *Complete utterances* consist of two elements: 1) A sentence containing an appropriate subject and verb (and objects when necessary) with grammatical and/or morphological errors allowed, and 2) relevant meaning to a listener aware of the topic being discussed. Acceptable errors included grammatical, morphological, reference, and phonemic errors as well as circumlocution. However, a complete utterance *could not* be an abandoned utterance (although if the final sounds

were unintelligible (indicated by *xxx* on transcript) it was not considered abandoned) or a fragment, even if part of the utterance was correct (e.g., utterances with embedded phrases had to be completely correct in order to be deemed correct even if one phrase was correct). For example, the utterance *While she has her back to them her two children (xxx)* was not a complete utterance even though *she had her back to them* is correct. The criteria used to determine a complete utterance allowed for grammatical and/or morphological errors because the focus of treatment was retrieval of content words, not syntax and morphology.

The following are examples of sentences that represent all possible scoring combinations. The end of each utterance is marked with a + or – to indicate whether an utterance contained required content words (+/-SV) and relevant meaning (+/-RELEVANT).

P1: The tree is open [+SV][-RELEVANT]. (Not complete utterance)

P2: The tree stands with the people under it [+SV][+RELEVANT]. (Complete utterance)

P3: He's the top of the cookie (car car) jar (xxx) [-SV][-RELEVANT]. (Not complete utterance)

P4: A little guy with some sand on the shore with his hands the sand [-SV][+RELEVANT].

After the utterances were coded as either complete or incomplete, the number of complete utterances was divided by total number of utterances to determine the percentage of complete utterances. Pre-treatment, participants showed deficits in

producing complete utterances (range = 48.1% to 62.5% of total utterances) (see Table 9.6).

After initial scoring was performed by the author, reliability of scoring was conducted by a licensed speech-language pathologist who rated one complete, randomly chosen transcript for each participant. Reliability (expressed as agreement between each scorer's count of complete utterances) was 93% for coding of complete utterances.

Table 9.6. Pre-treatment results for connected speech samples

Participant	Total # utterances	MLU	% Complete utterances
1	25	4.79	52.0
2	54	5.48	48.1
3	48	8.62	64.6
4	121	6.99	50.4

Experimental Design

A single subject experimental design in combination with a multiple baseline across subjects design (Connell & Thompson, 1986; McReynolds & Kearns, 1983) was used to evaluate the effects of VNeST on single verb naming and sentence production. A single subject design was chosen because it employs evaluation of repeated measurements taken before, during, and after treatment. Repeated measures allow for inspection of performance throughout the course of the study to determine sources of variability while maintaining experimental control.

Another advantage of single subject experimental design is the ability to analyze generalization as it emerges. This is crucial, as generalization to untrained items and/or tasks determines the effectiveness of treatment. Further, examining generalization over time provides a timeframe of improvement, another important factor in determining

overall effectiveness of treatment. Finally, the interaction of improvement of trained and untrained items over time provides insight into the organization of the mental lexicon, which can inform models of lexical-semantic processing (Thompson, Kearns, & Edmonds, in press).

The design consisted of three phases: 1) baseline; 2) treatment of trained items with weekly administration of probes to monitor effects of treatment on untrained tasks/stimuli; 3) maintenance (1 month post-treatment when possible). The baseline phase measured the primary dependent variables monitored throughout treatment (single verb naming, sentence production) over multiple sessions. Participants were administered either 2 or 3 baselines which were counterbalanced across diagnosis class. For example, P1 received 2 baselines and P2 received 3 baselines (both had nonfluent aphasia). The same was done for P3 (3 baselines) and P4 (2 baselines).

Treatment

Treatment Protocol

The following section discusses treatment-related topics, including treatment protocol, probe administration, and scoring and analysis of probe results. Reliability methods and results for dependent and independent variables are also discussed.

A detailed description of the treatment protocol is provided in Table 9.7 with additional information in Figure 9.1. However, a brief synopsis of the treatment steps is provided in this section. Treatment step 1 required production of 3 agent-verb pairs for a verb (e.g., *author/story, journalist/article, mother/to-do list* for the verb *write*). A range of pre-determined agent-verb-patient triads were provided in written form if the

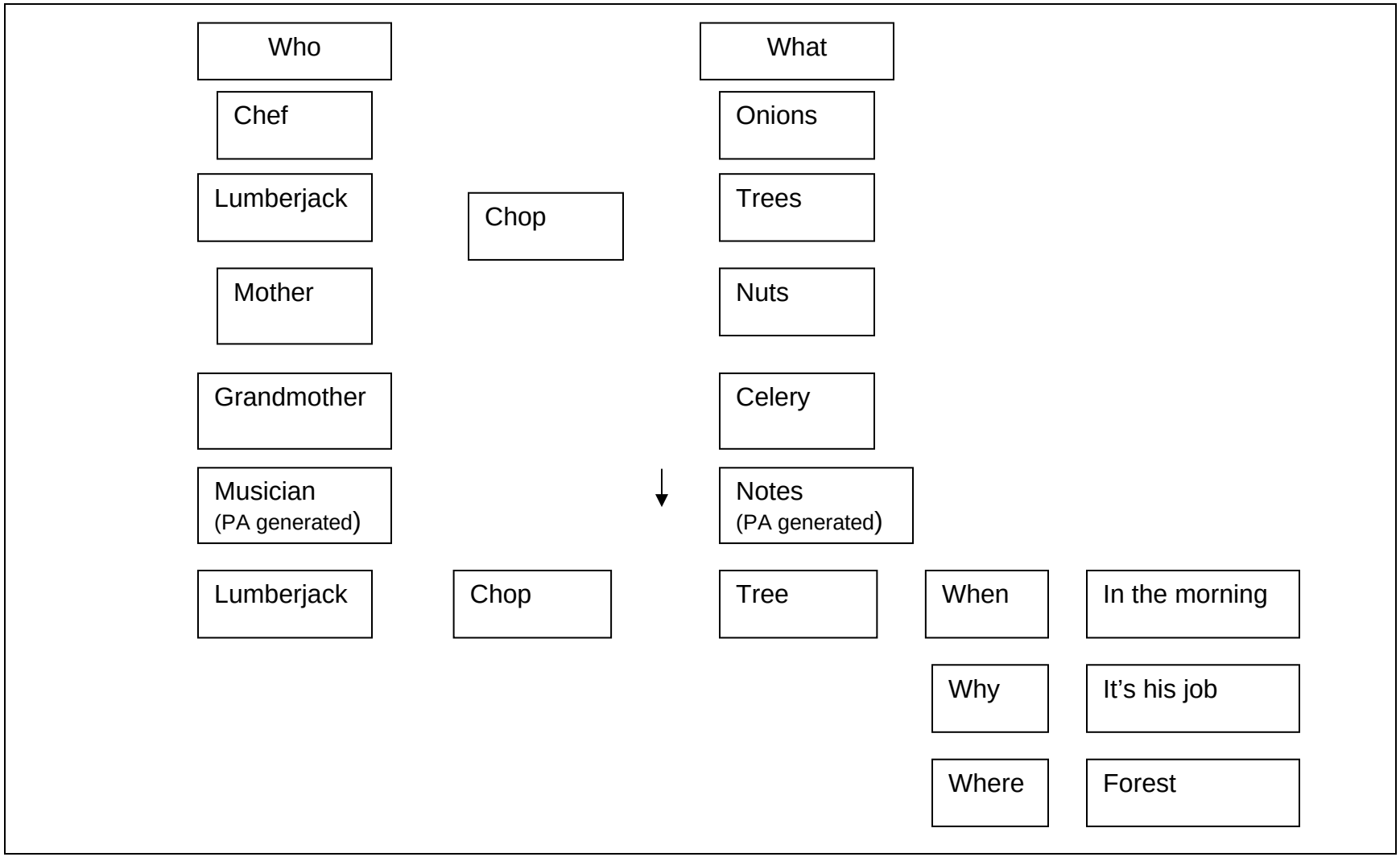
participant could not independently retrieve agents and/or patients. However, participants were encouraged to generate their own responses for each verb, allowing the treatment to be more personally relevant, functional, and interesting. Development of personalized stimuli has been used with success in semantic feature analysis treatment for noun retrieval (e.g., Boyle, 2004; Kiran & Thompson, 2003b) and allows an individual to re-activate his/her own verb schemas relative to each trained verb in order to re-strengthen pre-existing connections. Then the participant chose one agent-patient pair (e.g., *journalist/article*) and answered the questions *where, when, and why* (e.g., *Why does a journalist write?*). Then 12 sentences containing the target verb (e.g., *The infant writes a poem.*) were read by the clinician, and the participant decided if they were semantically correct or not. Finally, treatment step 1 was repeated. Treatment was provided two times per week for two hours (1 hour/week was dedicated to probes).

Table 9.7. Therapy Protocol

Therapy step	Purpose	Feedback/ Adjustments	Example
"Tell me *who* (or *what*, to be alternated throughout a session) can verb (can be verbed).** (Verb heard by PA.)	To elicit thematic information	If PA responds appropriately, then ask for the *who* or *what* that corresponds to the response.	CL: Tell me someone who chops something. PA: Chef CL: Good, what does a chef chop? PA: Onions. CL: Good. Who else chops?
Put written verb down with the PA's correct responses. (PA sees verb.) Give PA the remaining stack of *who* possibilities with an equal number of foils and ask them to choose who can verb.	To help to define and distinguish the meaning(s) of the verb by choosing and rejecting possible thematics. To strengthen connections between verb and thematics	Positive feedback with appropriate selections and rejections. Will discuss any incorrect choices to help the PA understand why it is not correct.	PA: Accepts *lumberjack*, *cook, mother,* CL: Provides positive reinforcement.
After all the choices are made, the CL will ask the PA to say *what* is *verbed* by each agent	To promote creation of verbs schemas (agent-verb-patient)	Same as above.	CL: (Isolates *lumberjack* and asks PA *"What does a lumberjack chop?"*) PA: "Wood" CL: Good. (Isolates another one until PA can generate no further.)
If PA was unable to generate all the agents or patients, then provide stack of written words (with equal number of foils) so PA can match appropriately	To promote creation of verb schemas (agent-verb-patient)	Same as above.	PA: Puts *onions* with *cook,* etc. Rejects *book, lamp,* etc.
Have PA choose one agent and theme pair.			PA: [Chooses *lumberjack* and *wood*]
Ask PA to provide answers to appropriate "wh" questions regarding those arguments.	To realize more fully the semantics/event roles of the verbs.	Prompts will be given if this is difficult at first.	CL: *Where does a lumberjack chop wood?* PA: Forest CL: *Good. Why does he chop wood?*
Ask PA to decide if 12 Y/N questions containing the trained verb are correct or incorrect.	To provide the PA the opportunity to discern appropriate semantic/thematic use of the verb in sentence context.	Positive feedback if he chooses correctly. Explanation of why he was wrong if he chooses incorrectly.	CL: Reads sentence: *The cook chopped slippers.* PA: No

CL: Clinician, PA: Participant. **Step measured for 80% accuracy as criterion to terminate treatment

Figure 9.1. Example stimuli (on table) after completion of the verb *chop*



Probe Sessions

Administration

Probes were administered at the beginning of every second session. Participants performed the following three tasks for each probe session: 1) single verb naming for both verb sets, 2) sentence production for both verb sets, 3) sentence completion/synonym generation with adjective control task. The order of administration of the verb tasks was counterbalanced across sessions with the adjective task given last.

Instructions for single verb naming were to name the action in the picture and to be as specific as possible. The clinician always pointed to the action. If the participant named an action in the picture other than the target action, the participant was given one prompt emphasizing the verb of interest. Prompts generally resulted from some ambiguity in the picture (as also occurred with the normal group). For example, for the verb *push* the picture depicts a person pushing a lawnmower. However, *mow* was often a response, so the clinician would point to where the person was holding the lawnmower in order to ensure that the participant understood the action of interest. The next response was recorded, and no more prompting occurred. Other instances of prompting occurred if a general form of the verb was used. For example, if the participant said *cut* instead of *slice,* they were prompted to provide a more specific action, if possible.

Instructions and prompts for sentence production are the same as those detailed in the stimuli development section of this chapter and will not be repeated here. The adjective control task instructions were the same as those given to the normal controls (see Appendix B for more information).

Scoring

For single verb naming, the last verb produced was scored. A correct response could take any form (e.g., infinite, present progressive) and acceptable alternatives were scored as correct. For sentence production, the best response (containing the most correct content words) was scored. The agent, verb, and patient had to be specific and correct for the sentence to be scored as correct. However, there could be grammatical and/or morphological errors. A few alternative responses were considered correct based on responses from the normal older group and picture ambiguity (e.g., *tow* and *pull* were both correct for *The farmer is towing/pulling the trailer*.). Correct responses for the adjectives were single words in the form of an adjective consistent with responses provided by the normal group and/or listed in a standard American English dictionary as synonyms. The final adjective produced was scored.

In addition to scoring probe sentences as correct or incorrect, the clinician also evaluated each response on a 7-point scale to evaluate changes in sentence production from baseline through maintenance that may not have been evident from the strict scoring criteria for correct sentences. The following elements were considered in the ratings: 1) Correctness and inclusion of content words, 2) type of content word errors (e.g., phonemic and semantic paraphasias v. neologisms), 3) grammar and morphology, and 4) amount of circumlocution.

The more succinct and correct the content, grammar, and morphology of the sentence, the higher the sentence rating. A sentence received a 6 or 7 if the sentence contained *all* of the correct content words for the sentence. A correct sentence could have

a rating of 5 if it contained more than minor grammatical/morphological problems and/or significant circumlocution. However, most sentences with a 5 rating were completely correct with the exception of one semantic paraphasia. A rating of 3-4 was given to sentences containing a S-V-O with reduced specificity, grammatical/morphological errors, or increased circumlocution. Sentences with ratings of 1 or 2 contained 1 or 2 relevant words. A score of zero indicated a response of "I don't know." (IDK) or no correct items (see Table 9.8). Initial scoring was performed by the author. Scoring reliability by a trained Communication Sciences and Disorders undergraduate was performed on 33% of the sentences for each participant with 90% agreement on ratings given for sentences.

Analysis of Probe Data

Acquisition of Treatment Items

Treatment step 1 required the production of 3 agent-patient pairs related to the verb. Ten verbs were trained, so 30 agent-verb pairs could be produced. Production of a minimum of 24 agent-patient pairs (80% accuracy) was required to terminate treatment. Participants achieved criteria before the last administered probe except for P2 who achieved criteria before the penultimate probe.

Table 9.8. Criteria used to rate sentences for content, grammaticality, and morphology and succinctness

Rating	Criteria	Example
0	NR/IDK/No correct items	IDK. Happening. Car.
1	Not grammatical, 1 correct item. Can be general (e.g., "he").	Cop. Writing. Ticket.
2	Two elements with some grammaticality. One of the elements can be a pronoun (e.g., "he.") or general (e.g., "thing").	He writes. Cop writes. Writes thing.
3	1) Same as 4, but not necessarily grammatical or with incomplete morphology. Same as 4 with gender error ("she" instead of "he.") 2) S-V-O with two general/pronoun items.	He will writes ticket. She writes the ticket. He writes it.
4	1) Contains S-V-O with **one** general/pronoun item (e.g., man/he or thing/it.). Intact morphology. 2) Same as 5 with some grammatical and/or morphological errors.	The man is writing the ticket. The cop writes the thing. Fireman is wrote ticket.
5	1) Contains S-V-O, but one is incorrect due to a semantic error. Intact morphology. Grammatical. 2) Correct content words with moderately reduced grammar.	The fireman is writing the ticket. The policeman is writing the memo. The fireman he write there the ticket.
6	1) Same as 7 but minor morphological and/or grammatical errors. 2) Correct content words with minor morphological and/or grammatical errors.	The policeman write ticket. Policeman writes a ticket.
7	1) Contains all target content words. 2) Correct grammar and morphology	The policeman is writing a ticket.
To account for **circumlocution:** After scoring the sentence based on the above criteria, subtract one point if the sentence includes circumlocution of more than 5 words.		

Generalization of Probe Tasks

During weekly probe sessions performance on single verb naming (trained/untrained), sentence production (trained/untrained), and the adjective task was tested and graphed for visual inspection of changes. Sentence ratings were conducted after each probe session and were also graphed. See Figures 10.1 to 10.4.

Sentence production was the dependent variable of primary interest for the trained and untrained verb sets. Improvement of 40 percentage points over the highest baseline for trained and untrained verbs was considered an indication of generalization, which is the minimum criterion for successful results in this study.

Results of the single verb production task were not evaluated for generalization because baseline 1 may have been contaminated. Two online priming studies containing the treatment verbs as well as other unrelated verbs were administered to participants approximately 5 minutes prior to the first verb naming baseline and may have resulted in inflated scores. Nonetheless, the results of the single verb naming task are reported in the results section, but no claims of generalization will be made.

Treatment and Probe Results Reliability

In order to ensure that the independent variable, treatment, was conducted in a consistent manner within and across participants, a trained Communication Sciences and Disorders undergraduate observed 25% of the sessions live and ensured that the steps were conducted properly. Treatment protocol was followed with a reliability of 98% (determined by comparing the observed treatment steps to the written protocol).

In order to ensure consistency in recording the dependent variables, single verb naming and sentence production, the same undergraduate observed 25% of probes live and recorded the participants' responses online. Agreement in responses and scoring was 95%.

CHAPTER 10

RESULTS FOR TREATMENT STUDY

Results for each participant will be discussed in turn. Probe data, including sentence ratings, are presented in Figures 10.1 through 10.4 in a multiple baseline format.

Participant 1

Pre-treatment Results Summary

P1 had a diagnosis of moderately-severe transcortical motor aphasia with mild apraxia of speech, more difficulty producing single verbs than nouns, and more difficulty producing sentences on the *Northwestern Verb Production Battery* (*NVPB*) without provision of the verb (54.2%) than with the verb (73.9%). Errors for the without-verb condition were primarily verb errors (81.82%) with types of errors spread across all verb error categories: semantic/general (22.3%), other verb (33.3%), and verb omissions (44.4%). P1 was impaired at naming to definition of treatment verbs (30%) and sentence production of treatment items (0%). A connected speech sample consisted of 25 utterances, an MLU of 4.79, and 52% complete utterances.

Probe Results

Single verb naming accuracy. Two baselines were administered to P1, with a 40 percentage point decrease from baseline 1 (B1) (70%) to baseline 2 (B2) (30%) for trained (TR) and untrained (UT) word sets. P1 received 4 probe sessions with linear improvement in both verb sets from B2 to 90% (TR) and 70% (UT) on the last probe.

Maintenance probes conducted 1 month following treatment revealed a minimal decrease from 90% to 80% on trained items with an increase from 70% to 90% on untrained items.

Adjective control task. As predicted, no improvement over baseline occurred for P1.

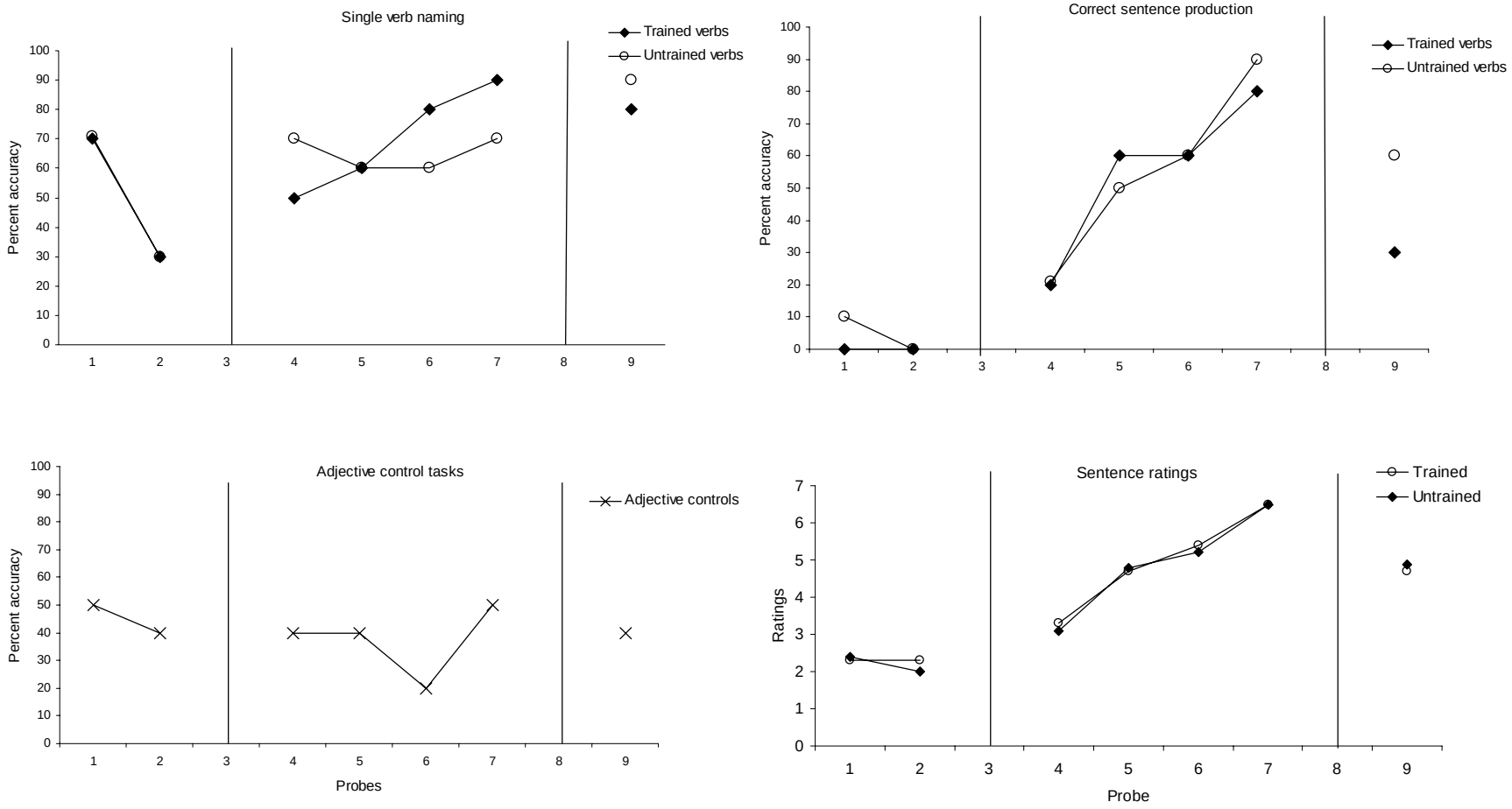
Sentence production accuracy. Sentence production baselines were stable across two probe sessions for sentences containing trained verbs (0% for both baselines) and untrained verbs (decreased from 10% to 0% across baselines). Four probe sessions were conducted during treatment. Sentence production with trained and untrained verbs increased linearly to a high of 80% and 90% respectively in the last probe session. Maintenance probes were 30 and 60 percentage points over the last baseline for sentences with trained and untrained verbs, respectively.

Sentence production ratings. The highest ratings for baseline probes of the trained and untrained verb sets were 2.3 and 2.4 respectively, representing responses containing an average of two words relative to the target sentence. For example, the target sentence *The carpenter is measuring the stairs*. → *He is mapping staircase*. During treatment, sentences containing trained and untrained verbs received a maximum rating of 6.50, so sentences contained correct content words and intact grammar and morphology with occasional minor errors.

P1's sentence ratings provide insight into sentence production maintenance results. Even though there was a 30% difference between sentence sets (untrained set higher), sentence ratings were nearly identical (TR = 4.7, UT = 4.9). Ratings near 5 represent relevant and well-constructed S-V-O sentences with reduced content word

specificity. For example, *The policeman is writing a ticket*. → *The policeman gave a ticket to the owner of the car*. In addition, maintenance sentence ratings are more than double baseline ratings (2.3).

Figure 10.1. Results of single verb naming, adjective control task, sentence production, and sentence ratings for Participant 1



Participant 2

Pre-treatment Results Summary

P2 began treatment with a diagnosis of moderately severe transcortical motor aphasia with mild-moderate apraxia of speech and a semantic level verb deficit. Specifically, P2 had more difficulty producing single verbs than nouns, and more difficulty producing sentences on the *Northwestern Verb Production Battery* without provision of the verb (63.6%) than with the verb (91.3%). On the no-verb condition, the majority of errors were verb errors (90%), of which and 89% were semantic/general errors. P2 was also impaired at naming to definition (30%) and sentence production (30%) on treatment items. A connected speech sample consisted of 53 utterances, an MLU of 5.48, and 48.1% complete utterances.

Probe Results

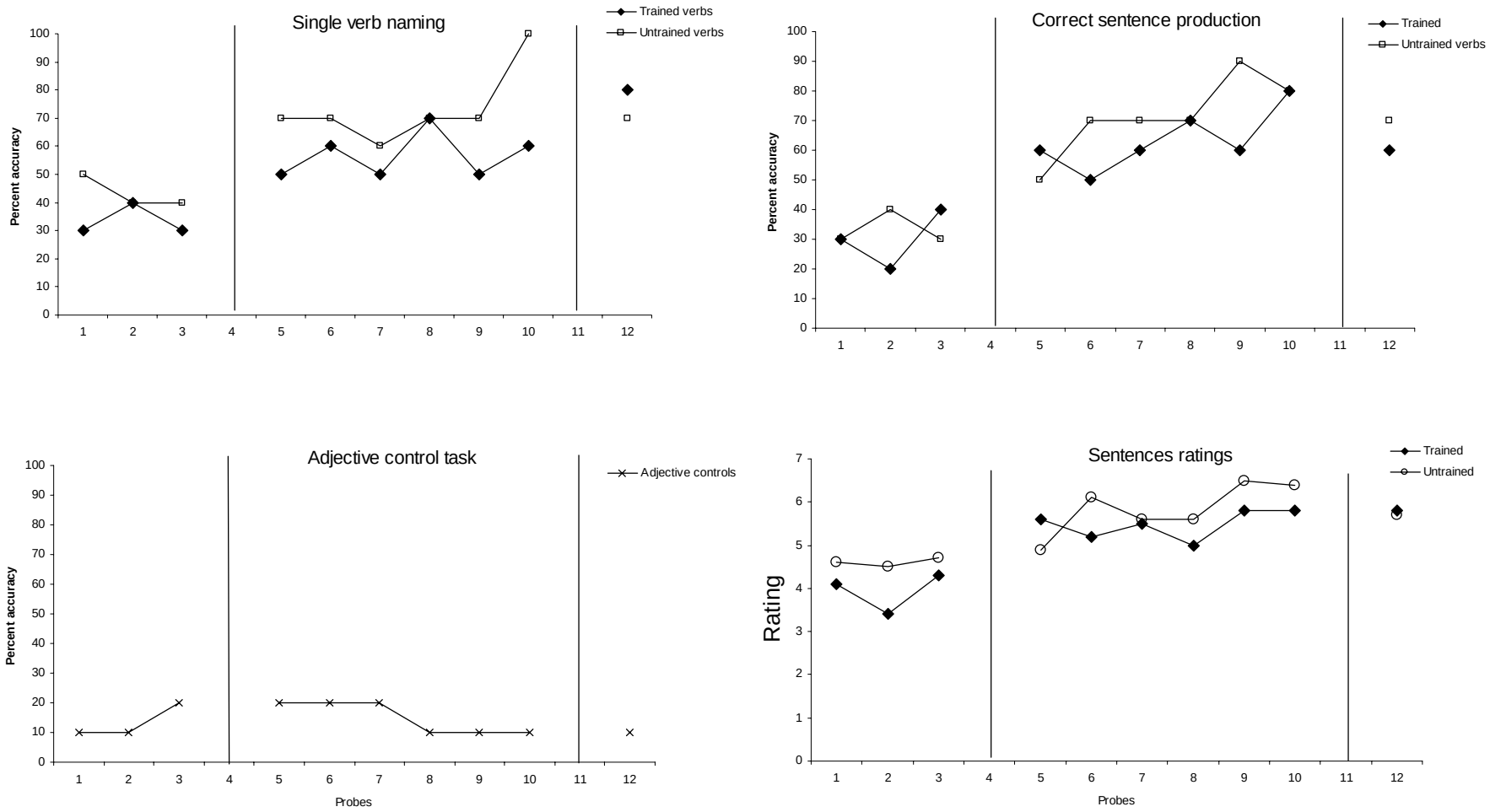
Single verb naming accuracy. After three stable baselines, six treatment probes were administered to P2. The pattern of change for the trained verb set was variable with a high of 70% on probe 4, an improvement of 30 percentage points over baseline. Untrained verb set probes had a flat learning slope fluctuating between 70% and 60% until the last probe session (100%). Improvement from baseline to the highest probe was 60 percentage points. In maintenance probes conducted 1 month following treatment, trained items improved to 40 percentage points over baseline while untrained items dropped to 20 percentage points over baseline.

Adjective control task. As predicted, no improvement over baseline occurred for P2.

Sentence production accuracy. During sentence production baselines the trained verb set fluctuated between 20% and 40%, and the untrained verb set fluctuated between 30% and 40%. Six treatment probes were administered. The highest probes for sentences containing trained and untrained verbs were 80% and 90% respectively. Increases were 40 and 50 percentage points over baseline, satisfying generalization criteria for trained and untrained sentence sets. Maintenance probes conducted 1 month following treatment revealed better maintenance of untrained items (30 percentage points above baseline) than trained items (20 percentage points above baseline). However, maintenance sentence ratings were similar for the trained and untrained verb sets.

Sentence production ratings. The highest baseline sentence ratings for trained and untrained sets baselines were 4.3 and 4.7 respectively, representing S-V-O sentences with reduced specificity and/or minor grammatical or morphological errors. For example, *The soccer player is kicking the ball.* → *Soccer player and the ball are going to be in the court*. During treatment, the highest sentence ratings for the trained and untrained sets were 5.8 and 6.5 respectively, representing correct sentences with highly specific content words and minor, if any, errors. Although accuracy decreased in both sets of maintenance probes, sentence ratings for the trained set remained the same as treatment ratings (5.8), with nearly identical ratings for the untrained set (5.7).

Figure 10.2. Results of single verb naming, adjective control task, sentence production, and sentence ratings for Participant 2



Participant 3

Pre-treatment Results Summary

Participant 3 began treatment with a diagnosis of moderately-severe conduction aphasia, characterized by fluent speech with paragrammatic and phonemic errors, as well as a semantic level verb deficit. Specifically, P3 was impaired on sentence production on the *NVPB* without provision of the verb (76.2%) (the with-verb condition was not tested) and treatment sentence probes for trained and untrained items (30%). All errors on the *NVPB* were verb errors, and 80% of those errors were semantic/general errors. P3 was also impaired at naming to definition of treatment verbs (12.5%). A connected speech consisted of 48 utterances with an MLU of 8.62 for two connected speech tasks (the *WAB* picture description was not included due to technical difficulties in pre-test recording). Although MLU was near normal length (8.17) (for the Cinderella narrative, Berndt et al., 1999), only 64.6% of utterances were complete.

Probe Results

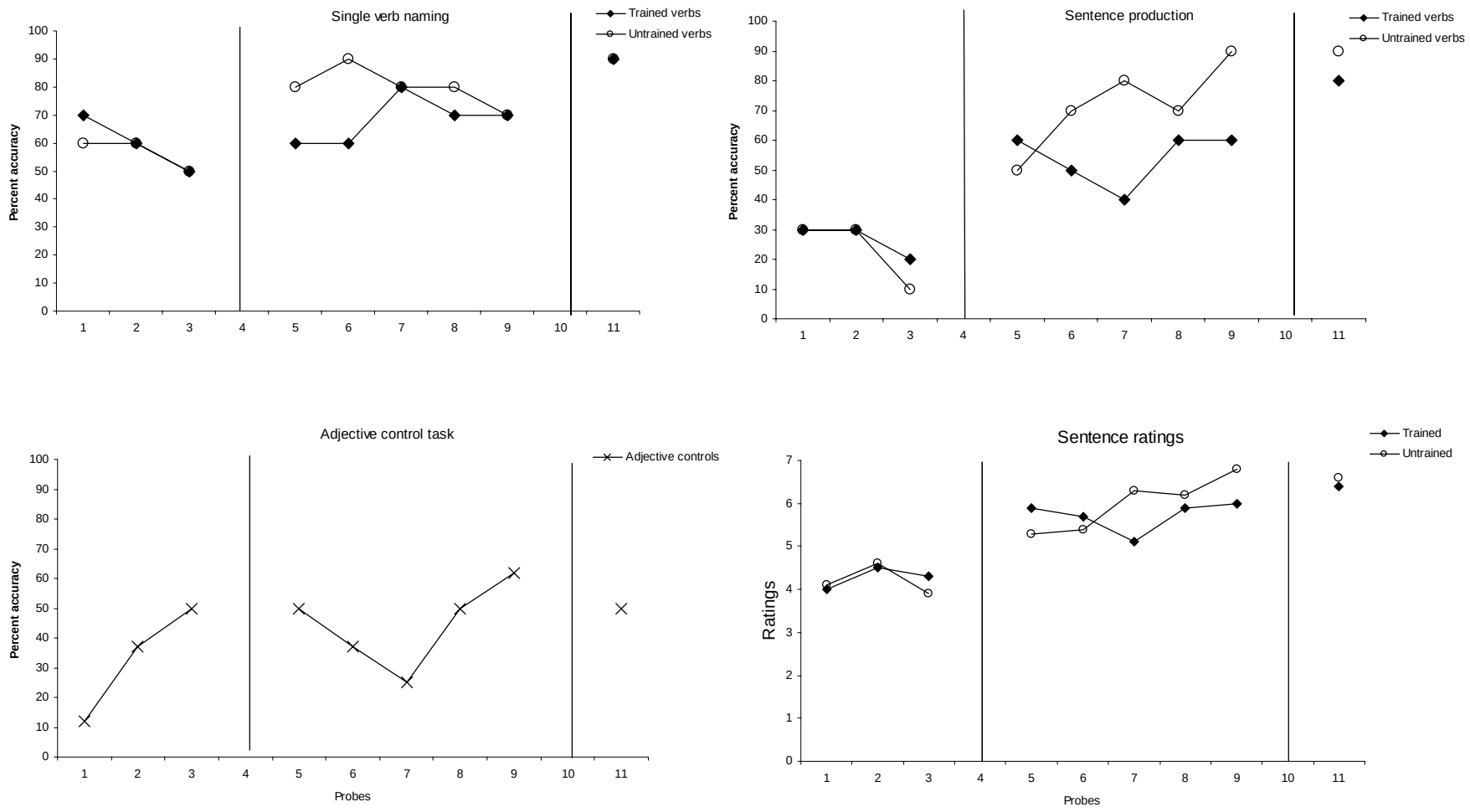
Single verb naming accuracy. P3 was administered 3 baselines with a declining trend from 70% to 50% for trained verbs and from 60% to 50% for untrained verbs. Five treatment probes were administered. Improvement on the trained verb set was variable with a high of 80% on probe 3, an improvement of 10 percentage points over the highest baseline. The results of the untrained verb set were variable with a high of 90% on probe 2, an improvement of 30% over B3. Maintenance probes administered 1 month post-treatment increased 20% over the final treatment probe for both verb sets (70% to 90%).

Adjective control task. As predicted, no generalization during treatment occurred for P3 (10 percentage point increase over baseline).

Sentence production accuracy. Over three baselines, sentence production for items containing trained and untrained verbs decreased from 30%, to 20% and 10%, respectively. Five treatment probes were administered. Improvement of the trained verb set was variable, with a high of 60% occurring multiple times, a 30% increase over the highest baseline. The untrained verb set also improved with a high of 90% on the last treatment probe, a 60 percentage point increase over baseline. The trained set showed continued improvement to 80% at the 1 month maintenance probe, 50 percentage points over the highest baseline, while the untrained set was maintained at 90%, a difference of 60 percentage points over baseline. The increased accuracy in trained items after treatment was terminated is of interest and will be considered in the discussion.

Sentence production ratings. The highest baseline ratings for sentences containing trained and untrained verbs were 4.5 and 4.6 respectively, representing S-V-O sentences with nonspecific/incorrect words and/or grammatical or morphological errors. For example, *The student is reading a book.* → *A boy is looking at the book.* During treatment, ratings for the trained set reached a high of 6.0 and the untrained set reached a high of 6.8. The trained set continued to improve to 6.4 at the maintenance probes while the untrained set remained extremely high at 6.6, indicating correct sentences that contained specific content words with minor, if any, problems.

Figure 10.3. Results of single verb naming, adjective control task, sentence production, and sentence ratings for Participant 3



Participant 4

Pre-treatment Results Summary

Participant 4 began treatment with a diagnosis of moderately severe conduction aphasia, characterized by phonemic paraphasias, with severely impaired sentence production and a semantic verb deficit. P4 had more difficulty producing single verbs than nouns and more difficulty producing sentences on the *NVPB* without provision of the verb (30.6%) than with the verb (80%). The majority (86.7%) of sentence production errors were verb errors, with error types ranging across categories (semantic/general = 23.0%; other verb = 37.5%; verb omission = 38.5%). P4 was also impaired at naming to definition (25%) and sentence production (0%) on treatment items. Sentence ratings were very low on both trained (1.90) and untrained (2.80) items, representing utterances with 1-2 relevant words. A connected speech sample contained 121 utterances, an MLU of 6.99, and 50.4% complete utterances.

Probe Results

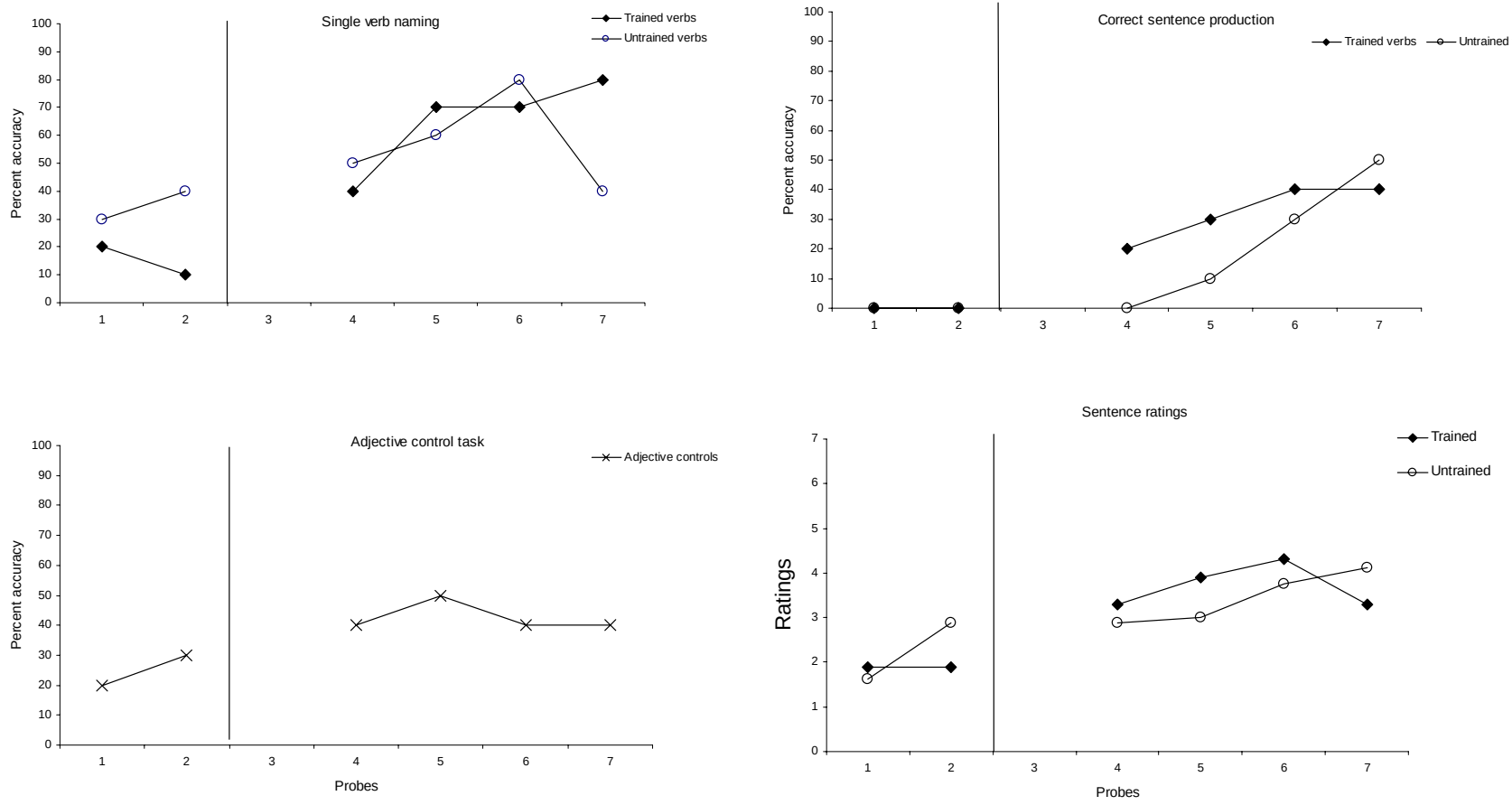
Single verb naming accuracy. P4 was administered 2 baselines, with the trained verb set decreasing from 20% to 10% and the untrained verb set increasing from 30% to 40%. The upward trend of improvement on the untrained set was undesirable; however, it was decided to begin treatment since sentence production baselines (the dependent variable of greatest interest) were stable. Four treatment probes were conducted. The trained verb set showed an ascending trend with a high of 80% on the last probe, an increase of 70 percentage points over B2. The untrained showed a high of 80% on probe 3, an improvement of 40 percentage points.

Adjective control task. As predicted, no generalization during treatment occurred for P4 (20 percentage point increase over baseline).

Sentence production accuracy. Sentence production was at 0% accuracy for trained and untrained verb set baselines. Four treatment probes were conducted. Trained and untrained sets improved linearly to a high of 40% and 50% respectively, indicating generalization in both sentence sets. P4 was unable to continue with treatment, so probes were discontinued and no maintenance probes were conducted.

Sentence production ratings. The highest baseline ratings for the trained and untrained verb sets were 1.90 and 2.88 respectively, indicating sentences that were impoverished both in meaning and grammar (e.g., *The boy (scout) is chopping the wood*. → *The boy has an ax on the and very nice one*). During treatment, ratings for the trained set reached a high of 4.3, and the untrained set reached a high of 4.1. P4's improvement was qualitatively different from the other participants in that she improved on word retrieval of content words but sentence quality and succinctness were compromised (e.g., *He is a girl scout with an axe chop the wood*). Nonetheless, there was improvement in sentence ratings over baseline.

Figure 10.4. Results of single verb naming, adjective control task, sentence production, and sentence ratings for Participant 4



Pre- and Post-treatment Test Results

This section details pre- to post-treatment changes on standardized tests and tasks developed for this study. Improvements of at least 10 percentage points over pre-testing for standardized tests will be discussed except for *WAB* results, where improvements > 5% are clinically significant (Katz & Wertz, 1997). Results for tasks developed for this study will be discussed in their entirety. Please see Table 10.1 for pre- and post-treatment scores for standardized tests and Table 10.3 for results on developed tasks and connected speech samples. See Appendices F through I for complete pre- and post-treatment connected speech transcripts.

Participant 1

Standardized Tests

P1 improved 6.1 points (76.4 to 82) on the *WAB* (improvement spread across multiple subtests). Noun naming improved on the *BNT* by 10 percentage points from 71.7% to 81.7%. Single verb naming on the *NVPB* increased 13.7 percentage points (72.7% to 86.4%), and sentence production with provision of verbs increased 21.7 percentage points (73.9% to 95.6%), a post-treatment result within normal range. Sentence production on the *NVPB* without provision of the verbs improved 37.1 percentage points (54.2% to 91.3%). An analysis of pre- and post-treatment verb errors on the *NVPB* no verb condition shows a decrease in errors (9 pre to 3 post) and a shift in verb error type. Pre-treatment, P1 exhibited difficulty retrieving verbs (44.4% verb omissions), and only 22.3% of verb errors were related to the target verb. Post-treatment 2/3 (66.7%) of verbs were related to the target, and 1/3 was an incorrect unrelated verb.

There were no verb omissions. Post-treatment results indicate an increased ability to retrieve and use verbs and nouns different from treatment items in sentence production.

Naming to Definition with Trained and Untrained Items

Naming to definition for trained items increased from 30% to 80%, and the untrained items increased from 30% to 60%. Generalization occurred for the trained set only, with improvement in untrained items.

Connected Speech Results

In the pre-treatment connected speech sample P1 produced 25 utterances with an MLU of 4.79 and 52% complete utterances. Post-treatment improvements occurred in number of utterances (39), MLU (6.29) and percentage of complete utterances (82.1%). A chi-square analysis comparing the number of pre- and post-treatment complete utterances revealed a significant post-treatment increase ($\chi^2(1) = 6.59$, $p < .025$).

Participant 2

Standardized Tests

P2 improved 7.9 points on the *WAB* from 78.5 to 86.4 (improvements spread across various subtests). Single verb naming improved 13.6 percentage points to 72.7%. Sentence production on the *Northwestern Verb Production Battery (NVPB)* without the verb improved by 30.4 percentage points (56.5% to 86.9%). A pre- to post-treatment analysis of verb errors on the *NVPB* no-verb condition showed a decrease in number of errors (9 pre to 3 post) with an elimination of verb omission errors (11.1% to 0%) and 2/3 errors related to the target verb.

Naming to Definition with Trained and Untrained Items

Naming to definition for trained items increased from 30% to 70% (generalization), and the untrained items increased from 20% to 40%.

Connected Speech Results

In the pre-treatment connected speech sample P2 produced 53 utterances with an MLU of 5.48 and 50.9% complete utterances. Post-treatment, the number of utterances (59), MLU (5.98), and percentage of complete utterances (67.8%) increased. A chi-square analysis comparing the number of pre- and post-treatment complete utterances revealed a significant increase ($\chi^2(1) = 4.48$, $p < .05$).

Participant 3

Standardized Tests

Participant 3's *WAB* AQ increased 7.4 points from 73.8 to 81.2, with most improvement on the comprehension and repetition subtests. *BNT* results increased 17.6 percentage points from 40.7% to 58.3%. Single verb naming on the *NVPB* increased 14.3 percentage points from 80.9% to 95.2%. Sentence production without provision of verbs increased 14.3% (76.2% to 90.5%). Pre- to post-treatment verb errors on the *NVPB* no-verb condition decreased from 5 to 2, with post-treatment errors related to the target verb 100% of the time (up from 80%), indicating a post-treatment ability to produce a complete sentence with the correct verb on untrained stimuli.

Naming to Definition with Trained and Untrained Items

Naming to definition increased 25 percentage points for trained (12.5% to 37.5%) and untrained items (0% to 25%). No generalization occurred in either set.

Connected Speech Results

In the pre-treatment connected speech sample P3 produced 47 utterances with an MLU of 8.62 (only 2/3 connected speech tasks were analyzed for P3). More than half of the utterances were complete utterances (62.5%). Post-treatment P3 produced more utterances (65) with a similar MLU (8.71). The quality of utterances improved, with 90.8% of the utterances considered complete. A chi-square analysis comparing the number of pre- and post-treatment complete utterances revealed a significant increase of complete utterances ($\chi^2(1) = 11.68$, $p < .001$).

Participant 4

Standardized Tests

P4 made improvements on the *WAB* and the *BNT*. The *WAB* AQ increased 12.8 points from 69.5 to 82.3, with most improvement on comprehension and repetition, and the *BNT* score increased 26 percentage points from 42% to 68%. Sentence production with provision of verbs increased by 20 percentage points (80% to 100%), and sentence production without provision of verbs increased by 26 percentage points (30.6% to 56.6%). A pre- to post-treatment verb error analysis revealed a shift toward producing more words related to the target verb (semantic/general 23% to 37.5%) with a decrease in verb omissions (38.5% to 25.0%).

Naming to Definition with Trained and Untrained Items

Naming to definition results were equivocal with trained verbs increasing 10 percentage points (20% to 30%) and untrained verbs decreasing 10 percentage points (30% to 20%).

Connected Speech Results

In the pre-treatment connected speech sample P4 produced 121 utterances with an MLU of 6.99. Half of the utterances were considered complete (50.4%). Little change occurred in the post-treatment sample that contained 159 utterances with an MLU of 6.90 and 52.8% complete utterances. A chi-square analysis comparing the number of pre- and post-treatment complete revealed no significant difference ($\chi^2(1) = 0.16$, $p < 1$).

Table 10.1. Pre- and post treatment scores for standardized tests

	Participant 1		Participant 2		Participant 3		Participant 4	
Test	pre-tx	post-tx	pre-tx	post-tx	pre-tx	post-tx	pre-tx	post-tx
STANDARDIZED TESTS								
Western Aphasia Battery (AQ)	76.4	82.5	78.5	86.4	73.8	81.2	70.6	82.3
Information	7	9	8	9	9	9	8	9
Fluency	5	6	4	6	8	9	7	8
Comprehension	86.0	81.5	93.5	99	81.0	89.0	77.0	98.5
Repetition	94.0	98.0	96.0	95	39.0	62.0	49.0	64.0
Naming	82.0	83.0	83.0	88	79.0	75.0	77.0	79.0
Boston Naming Test	71.7	81.7	86.7	91.7	40.7	58.3	42.0	68.0
Sentence Comprehension Test for Aphasia (Single verbs)	100	100	100	100	100	100	100	DNT
Northwestern Verb Production Battery (Single verbs)	72.7	86.4	59.1	72.7	80.9	95.2	52.0	53.3
Northwestern Verb Production Battery (Sentence production with verbs)	73.9	95.6	91.3	100	DNT	100	80.0	100
Northwestern Verb Production Battery (Sentence production without verbs)	54.2	91.3	56.5	86.9	76.2	90.5	30.6	56.6

tx: treatment

Table 10.2. Pre- and post treatment scores for naming to definition task developed for this study

	Participant 1		Participant 2		Participant 3		Participant 4	
	pre-tx	post-tx	pre-tx	post-tx	pre-tx	post-tx	pre-tx	post-tx
NAMING TO DEFINITION OF TREATMENT VERBS								
Trained verbs	30.0	80.0	30.0	70.0	12.5	37.5	20.0	30.0
Untrained verbs	30.0	60.0	20.0	40.0	0.0	25.0	30.0	20.0

Table 10.3. Pre- and post-treatment verb errors on *Northwestern Sentence Production Battery* sentence production subtest under no-verb provided condition

	total # verb errors		Semantic/General errors (%)		Other verb errors (%)		Verb omissions (%)	
	Pre-tx	Post-tx	Pre-tx	Post-tx	Pre-tx	Post-tx	Pre-tx	Post-tx
P1	9	3	22.3	66.0	33.3	33.0	44.4	0.0
P2	9	3	88.9	66.0	0.0	33.0	11.1	0.0
P3	5	2	80.0	100	20.0	0.0	0.0	0.0
P4	13	8	23.0	37.5	37.5	38.5	38.5	25.0

P: Participant

CHAPTER 11

DISCUSSION FOR TREATMENT STUDY

Results of VNeST revealed expected improvements for participants. The discussion will consider issues raised by the data, in particular that sentences containing untrained verbs showed greater improvement than sentences containing trained verbs. Trends of data improvement will be discussed (with the exception of single verb naming probe results) with consideration of pre- and post-treatment sentence production error analyses and individual participants' unexpected results. Results will also be examined relative to previous verb treatment studies and clinical classifications of aphasia. Finally, clinical implications and future research directions are discussed.

Predicted improvements for the current study were hierarchical, in that strengthening of trained verbs would generalize to sentence production with these verbs, followed by sentence production with untrained semantically related verbs. Downstream improvements would occur on sentence production tests administered pre- and post-treatment, and finally, in connected speech. A hierarchical pattern of generalization is directly related to a theoretical gradient of spreading activation initiated by treatment-related activation of the trained verb network.

Verb Network Strengthening Treatment (VNeST) produced predicted generalization on weekly probe tasks for all participants and generalization to pre- and post-treatment tasks for 3/4 participants, an indication that the expected treatment-induced gradient of spreading activation occurred. However, an unexpected finding was that probe sentences containing untrained verbs improved to a greater degree than those

with trained verbs. Overactivation of trained verb networks during probes may have resulted in interference that could not be inhibited.

Typically in treatment trained items improve at a greater rate and to a greater degree than related untrained items. It was expected that results of the current study would follow a similar pattern with small differences between sentences containing trained and untrained verbs because probes were generalization measures for both sets of verbs (probe stimuli and tasks differed from treatment stimuli and tasks). However, *greater* improvement on and maintenance of probe sentences containing untrained verbs was not expected. Although the improvement pattern was unexpected, this phenomenon has been reported in two participants in a previous semantic treatment study (Edmonds & Kiran, submitted).

Edmonds and Kiran reported patterns of generalization similar to those found in the current study in two participants with bilingual aphasia who received semantic naming treatment. The aim of that study was to promote within-language and crosslinguistic generalization to semantically related nouns. The expected gradient of generalization was: Trained noun in trained language (e.g., apple) = translation of trained noun in untrained language (e.g., *manzana*) >/= semantically related noun in trained language (e.g., orange) > semantically related noun in untrained language (e.g., *naranja*), so that the least amount of improvement was predicted for the item expected to receive the least amount of spreading activation (*naranja*) from the treatment item (apple). However, the opposite trend occurred in two participants: The semantically related item in the *untrained* language improved more than the other sets of generalization items. The

untrained item (*manzana*) that shared the most semantic information with the trained item (apple) improved the least. The counterintuitive results in Edmonds and Kiran can be explained by treatment-induced semantic interference that increased over the course of treatment, so that during naming of trained items, connections stimulated repeatedly in treatment were activated, resulting in interference that could not always be inhibited. In contrast, presentation of the semantically related item in the untrained language would not activate the trained connections as strongly, reducing potential interference and allowing for improvement resulting from spreading activation from trained items.

The findings in the current study can be explained by a similar mechanism even though the participants were not bilingual. Trained verb networks were extensively activated during treatment with the retrieval of 8 nouns related to each trained verb in addition to other tasks. During sentence production probes, overactivation of a trained network in response to presentation of a picture depicting the action may have occurred, resulting in activation of multiple lemmas corresponding to the agent, verb and patient slots of the sentence. If the extraneous activation was not inhibited, a lexical competitor would likely have been produced in error. Reduced inhibition of overlearned behaviors has been documented in older individuals (e.g., Langenecker, Nielson, & Rao, 2004) and in persons with brain damage (e.g., Brass, Derrfuss, & von Cramon, 2005). Further, semantic interference has been documented in picture naming where naming a picture is slower when semantically unrelated words are presented with the picture compared to semantically related words (e.g., Hermans, Bongaerts, de Bot, & Schreuder, 1998; Vigliocco, Vinson, & Siri, 2005).

Support for the interference explanation comes from sentence ratings and maintenance data. For P3, sentences containing trained verbs were 30 percentage points above baseline, and sentences containing untrained verbs were 60 percentage points above baseline, the largest discrepancy for any participant. However, the sentence ratings for both sentence sets were above 6.0, indicating that errors on the trained set were lexical items related to the target, which was confirmed by further investigation of responses (e.g., *fly → drive; watch → listen; deliver → give*). The other participants also had discrepant sentence production scores with similar sentence ratings, most notably observed in P1's maintenance. P3's maintenance probes showed 20 percentage point improvement on the trained set with maintenance of the untrained set. This may indicate that overactivation of trained verb networks decreased with termination of treatment, allowing for retrieval of the target verbs.

Performance trends suggest that treatment resulted in less improvement of the trained sentence set than the untrained sentence set, a counterintuitive finding. However, initial probes exhibited expected patterns of improvement (i.e., trained sentence sets were higher than untrained) but over time the trend switched. Probe results in Edmonds and Kiran followed the same trend, suggesting semantic interference in the bilingual study and the current study. Overall, probe results indicate that activation of the trained verb networks occurred, and spreading activation to the untrained network was sufficient to improve retrieval of untrained verbs and related thematic roles in sentence production. Treatment effects were well-maintained one month post-treatment.

Improvement of single verb retrieval and sentence production on pre- and post-treatment tests was predicted contingent on improvement to sentences containing trained and untrained verbs (i.e., probe sentences). This contingency was due to the assumption that treatment effects of spreading activation needed to be optimal in order to extend to items further from the trained targets. Improvement was predicted on the *Northwestern Verb Production Battery* (*NVPB*) (2002) for verbs and sentences because treatment items represent common actions, similar to those tested on the *NVPB*. For example, training the verb *scrub,* could have strengthened verbs such as *sweep* and *erase* on the *NVPB*. Three of four participants improved on *NVPB* single verb production, and all participants improved on sentence production with and without provision of the verb. Performance on the with-verb condition continued to be better than the without-verb condition. However, improvement on the without-verb condition, of more interest since it is a more functional task, improved an average of 29 percentage points (range = 14.3 to 37.1) across participants, indicating that benefits of treatment generalized beyond probe sentences.

Pre-treatment error analyses of *NVPB* sentences (Thompson, 2002b) showed that participants' errors in sentence production were primarily due to verb errors, although some incorrect sentences were caused by noun and verb errors. Post-treatment, no participant exhibited noun errors except P4. The lack of post-treatment noun errors (with a concurrent improvement in verb retrieval) likely reflects strengthened verb-thematic networks that enabled improved access and retrieval of the verb *and* its thematics. Notable in this regard was P1, for whom more than 50% of pre-treatment errors contained noun errors. Post-treatment three sentences were in error, all of which

contained a verb and appropriate arguments, and errors were close to the target meaning of the sentence. For example, pre-treatment the target sentence *The man is delivering a package to the woman* → *He is driving the IDK.* Post-treatment the same target sentence → *The UPS man is letting the woman check out the package.*

Participant 2's post-treatment *NVPB* results differed from the other participants because sentence production was noticeably better than single verb naming. P2's improved performance on sentences was due to improved verb retrieval since 90% of her pre-treatment errors were verb errors, so it is curious that post-treatment single verb naming was worse than sentence production. A closer examination of post-treatment single verb naming errors revealed that all additional errors made (i.e., were incorrect in naming and correct in sentence production) were on 3-place verbs. Inability to name 3-place verbs in single verb retrieval may have occurred because there was not an effort to retrieve the subject, object, and object of prepositional phrase (e.g., *The <u>woman</u> is putting the <u>box</u> on the <u>shelf</u>.*) as in the sentence condition. Since a verb's representation includes the potential number of arguments it can take (i.e., the syntactic slots of the sentence), perhaps the verb's representation was not strong enough post-treatment to allow for retrieval without concurrent activation and retrieval of the nouns. P2's improvement on the no-verb sentence production condition of the *NVPB* appears to be due to an increased ability to retrieve verbs, but that retrieval was dependent on concurrent activation and retrieval of the verb's thematics. This hypothesis is consistent with online studies of verb-thematic co-activation in word pairs (Ferretti et al., 2001; McRae et al., in press) and

sentence production (Ferretti, et al., 2001; Novick, Kim & Trueswell, 2003; Trueswell & Kim, 1998).

Participant 4's *NVPB* (Thompson, 2002b) sentence production improved despite no improvement on single verb retrieval. To understand the limited improvement seen in P4's post-treatment sentence production (and connected speech performance), pre-treatment sentence production was examined in more detail.

On the *NVPB*, P4 scored by far the lowest (30.6%) of all participants. Sentence production failures were not due to an inability to produce the target verb since she was able to produce an equal number of the *same* verbs (52.0%) in the single verb naming subtest. Nearly one-third (5/16 = 31.25%) of errors on the sentence production task revealed correct or reasonably close verb production. However, only 2/5 of those sentences consisted of a correct sentence frame. Thus, retrieval of a lexically correct verb did not necessarily result in a correct frame. This is unusual, especially in the case of 1-place verbs where only a pronoun and verb need to be produced (e.g., *She is swimming*. → *The swimming down the pool*.). Among the 11 (68.75%) incorrect sentences that did not contain reasonable verbs (i.e., neologisms, omitted, unrelated), 5 (45.5%) consisted of intact sentence frames (e.g., *The man is erasing the board.* → *The man is shraving the stuff on the board with a kind of like a sponge*), so a sentence frame could be constructed without a correct verb. Other sentences with verb errors (6/11 = 54.5%) contained no verb or a verb unrelated to the target with an incorrect sentence frame (e.g., *The woman is riding the horse.* → *The boy on the horse someplace*.).

An examination of sentence probes revealed similar trends. Pre-treatment P4 could not produce any sentences, and sentence ratings ranged from 0 to 5 (with only one 5). Post-treatment she was able to retrieve more target words in the sentences, resulting in 40 and 50 percentage point increases in production of sentences with both trained and untrained verbs, respectively. However, the quality of her sentences was still poor (range = 2 to 7 (with only one 7)).

Even though P4 was able to produce more lexical items related to the target post-treatment (e.g., in sentence probes), she had difficulty in constructing an appropriate sentence frame. In addition, P4 exhibited word retrieval difficulties and failures. There appeared to be a combination of word retrieval problems and impaired sentence construction abilities at the positional level so that sentences lost cohesiveness in both meaning and in form. A dual-level deficit could explain why her improvement in sentence probes was modest when compared to other participants *and* when compared to her single word retrieval gains.

Predicted improvement on the *Boston Naming Test* (*BNT*, Goodglass et al., 1983) occurred (average gain = 14.7 percentage points), with greatest improvements for P3 and P4. Improvement in single noun retrieval is consistent with the treatment paradigm of noun retrieval. It was expected that activation from the thematic roles generated in treatment would spread to related concepts, but that the activation would not be as strong as spreading activation from the trained verbs to other verbs. Verb to verb activation would be greater since treatment was designed to strengthen the verb's representation,

and while many nouns surrounding the verbs were retrieved, there was no systematic relationship between those nouns.

It is evident that treatment effects extended to sentence production, and the mechanism for improvement was spreading activation from trained verb networks to related verbs and, to a lesser extent, to nouns. Improvement in the connected speech samples (P1, P2, P3) occurred for the same reasons. Although connected speech is more demanding than producing isolated sentences, the linguistic demands of the individual sentences in the connected speech sample for 2/3 tasks is not higher than the sentence probes or the *NVPB* (Thompson, 2002). In addition, the scoring system to determine a complete utterance was consistent with treatment goals and was sensitive to improvements similar to those seen on probe sentences and the *NVPB* (Thompson, 2002).

The effect of improved word retrieval in connected speech is well-illustrated in P3's pre- and post-treatment Cookie Theft descriptions. Pre-treatment P3 produced many abandoned utterances, as she was not able to retrieve the core components of an utterance (e.g., *The sink and pouring over the sink* does not contain the subject, *water*). Post-treatment she was able to retrieve required content words (*Water was pouring from the sink and pouring over all the way to the floor*.), resulting in no post-treatment abandoned utterances. She was also able to produce 10 additional utterances. (See Appendix H for details.). Even though retrieval of content words improved, other errors such as incorrect pronoun usage (*she* → *he*), for which she did not receive treatment, did not improve, an indication that improvements resulted from treatment intervention and not overall language stimulation.

The naming to definition (NTD) task was administered pre- and post-treatment to examine lexical access of probe verbs in an auditory modality (NTD). P1 and P2 showed the most improvement, with generalization seen on trained items. P3 showed improvement in both sets, but no generalization. P4 showed no improvement. Expected improvement on this task may not have occurred since NTD is a more difficult task than confrontation naming (Berndt et al., 1997a,b). Further, the comprehension deficits of P3 and P4 may have impaired their ability to understand the definition well enough in order to provide a correct response. NTD does not appear to be highly sensitive to improvement since it is clear that semantic representation of trained and untrained verbs was strengthened in all participants (as evidenced by improvement on sentence production probes for both verb sets).

Verb Deficits and Clinical Classifications of Aphasia

Pre-treatment characterization of participants' deficits illustrated that verb deficits cross clinical classifications of aphasia, a finding consistent with a growing consensus in the aphasia literature (e.g., Berndt et al., 1997a,b; Faroqi-Shah & Thompson, 2004; McCann & Edwards, 2001). Further, when controlled for aphasia severity, clinical classification does not impact improvement in treatment, since both nonfluent and fluent participants exhibited generalization to probe tasks and other sentence production tasks. However, differences in improvement across clinical classification could conceivably be observed if syntactic demands were increased, so that persons with agrammatic aphasia may not perform as well as fluent participants.

Improvement patterns on the *WAB* (Kertesz, 1982) differed to some extent across aphasia type, but these findings are not unexpected. If participants are exposed to treatment tasks that target a deficit (e.g., comprehension tasks such as answering *wh*-questions for participants with CA or fluency for persons with TMA), then improvement may be detected on the *WAB*.

Results Compared to Previous Verb Treatment Studies

VNeST resulted in more consistent generalization patterns for more participants than other verb treatment studies that have targeted verb retrieval and/or verb thematic deficits to improve sentence production. Every participant in the current study met generalization criteria for probe items and showed extensive generalization to other relevant post-treatment measures. Not only was generalization seen, it was replicated across four participants with verb deficits (and across and within aphasia type).

Previous verb treatment studies that have attempted to improve verb retrieval and/or thematic deficits have fallen short of finding generalization to untrained sentences and/or semantically related items (Edwards et al., 2004; Raymer & Ellsworth, 2002; Schneider & Thompson, 2003). Two of these studies were interested in the relationship between increased verb retrieval and improvement to sentence production containing trained and untrained verbs (Edwards et al., 2004; Raymer & Ellsworth, 2002). In Edwards et al. (2004), a cueing hierarchy was used as the treatment method. This method may be useful in reducing the number of cues on trained items such as naming, but it is not theoretically designed to target a particular linguistic deficit so that generalization to semantically similar items may be achieved, as was done in the current treatment. The

lack of generalization to untrained items (that were not matched to the trained items) across three participants is not surprising. Raymer and Ellsworth (2004) examined different treatment approaches (phonological, semantic, repetition) on verb retrieval in one person with semantic deficits. Improvement occurred on retrieval of trained verbs and on sentence production with those verbs with no generalization to untrained verbs. The results of these two studies emphasize that generalization measures should be theoretically derived.

Unlike the previous two studies, Schneider and Thompson (2003) carefully controlled trained and untrained items and provided strong theoretical rationale for treatment of four participants. Similar to the current study, Schneider and Thompson were interested in promoting verb retrieval and thematics knowledge (in two different treatment conditions). Unlike the current study only limited generalization occurred in sentences containing trained verbs with no generalization to single verb retrieval of semantically related verbs. As with the other studies, treatment was limited to repetition of target items and instruction related to who does what to whom (thematics) in static pictures. Unlike the current treatment, there was no engagement of the participants' own verb schemas so that previous connections could be activated and re-strengthened.

One previous study showed improvements in verb retrieval in trained and semantically related verbs as well as in sentences including those verbs in one participant (Marshall et al., 1998). However, the improvement to semantically related verbs was unexpected since they were control items. The results were counter to the theoretical

premise that phonological treatment would generalize to phonologically related words only.

Previous verb treatment studies have used traditional methods of treatment that rely on techniques, teaching, or cueing focused on a single result (e.g., word retrieval) rather than designing theoretically based treatments to specifically target a key deficit. The main difference between the above studies and VNeST is that VNeST was designed (using theories of normal language representation and sentence processing and behavioral data) to target a specific deficit (compromised verb-thematic connections) so that related behaviors (verb-thematic retrieval and sentence production) could improve in trained and semantically related untrained items.

Conclusions

The results of this study were consistent with the predictions. Stimulation of a verb network in persons with semantic level verb deficits resulted in improved sentence production in sentences containing trained and semantically related untrained verbs. These findings are consistent with the principles of spreading activation that posit that stimulation of a word node co-activates related nodes (Bock & Levelt, 1994). Thus, the trained verb-thematic connections described by Ferrettii et al. (2001) and McRae et al. (in press) were stimulated during treatment, which improved retrieval of the relevant agent, verb, and patient in sentence production of trained items. Improvement to sentences containing semantically related verbs indicates that stimulation of the trained verb network co-activated and strengthened the related untrained verb network.

A spreading activation gradient was predicted to activate verbs unrelated to the trained verbs to a lesser degree than semantically related verbs, but sufficient activation occurred to improve verb retrieval and sentence production on the *NVPB* (Thompson, 2002), which contained verbs similar to the probe verbs in terms of familiarity and imageability. Improvement on more abstract words would not be predicted because abstract words would not receive systematic activation with the current treatment stimuli. Nouns were assumed to receive less systematic spreading activation than verbs even though noun retrieval was the primary treatment task. This is because noun retrieval was focused on strengthening the verb, so verb-verb spreading activation would be strongest since the trained verb received the most focused attention. The mechanism for improvement on the connected speech task was proposed to be similar to that for sentence production improvement of non-probe sentences. Generalization to connected speech are not often reported in treatment research, so improvement in 3/4 participants in the current study suggests effective treatment and emphasizes the need for choosing generalization measures and scoring procedures carefully. Improvements were achieved with only 4 to 6 weeks of treatment, a relatively short period of time for such gains. This is very encouraging, as the number of treatment sessions is often limited in rehabilitation settings.

Clinical implications

Verb deficits and treatments are typically associated with persons with nonfluent aphasia. However, the results of the current study illustrate that persons with fluent aphasia also exhibit verb deficits and can benefit from treatment. Descriptive testing

measures should include noun and verb naming as well as sentence production with an error analysis for all clinical classification types to determine if a grammatical class deficit exists.

Regarding treatment, verbs from different semantic categories should be targeted rather than multiple verbs from the same category since generalization to semantically related items is likely to occur. This is consistent with previous semantically based treatment studies with nouns (e.g., Drew & Thompson, 1999; Edmonds & Kiran, submitted; Kiran & Thompson, 2003b). Finally, training verbs in context with related thematic pairs may be more efficient than traditional methods of semantic treatment or cueing hierarchies.

Future research directions

The current results are encouraging, but they are preliminary, and additional research is needed to pursue issues raised by the data. Investigations into the phenomenon of better performance on sentences containing untrained verbs compared to trained verbs are warranted. One method of testing the hypothesis of treatment-related interference would involve a treatment study with VNeST using 3 groups of generalization sentences containing verbs with a gradient of semantic relatedness to the trained verbs. One group would be highly related, a second group would be moderately related, and the third group would be unrelated. If interference of semantically related items occurs, then the moderately related group (with less interference) would generalize as much or more than the highly related group, with little to no improvement in the unrelated group.

Another way to address possible overtraining and to collect valuable treatment data would be through a software program designed to deliver VNeST with a mechanism to adapt difficulty, type and rate of stimuli presentation online in response to a participant's performance. Such a program could reduce overtraining by introducing variety, allowing participants choices of task (with constraint), and preventing repetition of well-learned stimuli. Valuable data regarding reaction times, accuracy patterns, error types and strategies could be accumulated and used to interpret treatment effectiveness beyond test situations (i.e., probes).

The benefits of VNeST should also be evaluated in production of different types of sentences (e.g., wh-questions, passive sentences, reversible sentences). Testing of active sentences in the current study was intentional, as the primary question was related to whether improved lexical retrieval would benefit sentence production. Introducing more linguistic difficulty would have added an unwanted confound. However, language is composed of more complex grammatical structures, and thus future investigations into the interaction between those structures and the effects of VNeST are warranted. Similarly, treatment of other verb types (e.g., experiencer verbs) is necessary to examine effectiveness in verbs with different types of thematic roles.

Finally, there is a paucity of treatment studies investigating crosslinguistic generalization in Spanish/English bilingual aphasia, particularly for sentence production. Semantic naming treatment has resulted in crosslinguistic generalization in persons with Spanish/English bilingual aphasia (Edmonds & Kiran, submitted), so generalization to

sentence production may be possible with VNeST since word retrieval in sentences, not syntax (which differs across languages), is of primary interest.

These are only examples of the many directions the current line of research could follow. However, the original question that inspired the current study is the one that will remain fundamental to the overall pursuit: How can we help persons with aphasia to produce more meaningful sentences so that they enjoy more communicative success?

APPENDIX A

Verb relatedness task for “The effect of treatment of verbs and their thematics on sentence production in persons with aphasia”
IRB #2004-06-0064

Date: DOB: Age: Participant #:

Education: Gender:

You will see multiple pairs of verbs. Please rate on a scale from 1 to 7 how related in meaning you think the each pair of words is. Because verbs can have multiple meanings, some pairs of words have a context provided. Please consider that context when deciding how similar the pair of words is in meaning.

Bake – Fry (food)

1	2	3	4	5	6	7
Not related at all						Highly related

Throw – Kick (something not someone)

1	2	3	4	5	6	7
Not related at all						Highly related

Sew – Knit

1	2	3	4	5	6	7
Not related at all						Highly related

Read – Write (as in transferring a message)

1	2	3	4	5	6	7
Not related at all						Highly related

Drive (something) – Fly (something)

1 2 3 4 5 6 7
Not related at all Highly related

Send – Deliver

1 2 3 4 5 6 7
Not related at all Highly related

Weigh (something) – Measure (something)

1 2 3 4 5 6 7
Not related at all Highly related

Sew – Build

1 2 3 4 5 6 7
Not related at all Highly related

Steal – Buy (as in change of possession)

1 2 3 4 5 6 7
Not related at all Highly related

Scrub – Wash (as a type of wiping)

1 2 3 4 5 6 7
Not related at all Highly related

Mix – Blend

1 2 3 4 5 6 7
Not related at all Highly related

Decorate – Paint

1 2 3 4 5 6 7
Not related at all Highly related

Bake – Eat (food)

1 2 3 4 5 6 7
Not related at all Highly related

Watch – Examine

1 2 3 4 5 6 7
Not related at all Highly related

Tow (something) – Push (something)

1 2 3 4 5 6 7
Not related at all Highly related

Chop – Slice (as ways to cut)

1 2 3 4 5 6 7
Not related at all Highly related

Sell – Donate (as in change of possession)

1 2 3 4 5 6 7
Not related at all Highly related

Thank you VERY MUCH for your participation!

APPENDIX B

Adjective retrieval task

Instructions: I am going to read you the beginning of a sentence. Your job is to complete the sentence

Subject id #: _____ Date: _____ Examiner: _____

Part ID # _____

Examples: 1) Someone who is skinny is also said to be thin.
2) Someone who is boring is also said to be dull.

DEFINITION	TARGET	RESPONSE
Someone who is **sick** is also said to be	ill	
Someone who is **mean** is also said to be	cruel	
Weather that is **cold** is also said to be	chilly	
Someone who is **wealthy** is also said to be	rich	
Something **gigantic** is also said to be	huge	
Someone who is **famished** is also said to be	hungry	
Something that is **noisy** is also said to be	loud	
A person who is **odd** is also said to be	strange/weird	
Something that is **fast** is also said to be	rapid/quick/ speedy	
Something that is **hilarious** is also said to be	funny	
Someone who is **courageous** is also said to be	brave	
Something that is **repulsive** is also said to be	disgusting	
Something **irritating** is also said to be	annoying	
Someone who is **tired** is also said to be	Weary/fatigued	
	Total correct	
	Percentage correct	

APPENDIX C

VERB NAMING TO DEFINITION TASK

Part #: _____ Examiner: _____ Date: _____

Examples: 1) to move from one place to another using your legs is to walk.
2) to put liquid in your mouth and swallow it is to drink.

TARGET	DEFINITION	RESPONSE
Fry	to cook over heat especially with the use of fat is to	
Sew	to put pieces of fabric together with thread is to	
Read	to look at words and to get meaning from them is to	
Drive	to operate the controls and direct the course of a vehicle is to	
Throw	To send something through the air from your hand is to	
Wash	to clean something with water soap and water is to	
Examine	To look at something thoroughly in order to understand something about it is to	
Chop	To cut something into little pieces is to	
Push	To move something forward along the ground is to	
Bake	to cook food by dry heat in an oven is to	
Fly	To operate the controls of a vehicle in the air is to	
Slice	To cut something into thin regular sized pieces is to	
Write	To put words on paper with an instrument is to	
Scrub	To clean something by hand with a good deal of effort is to	
Knit	To make things out of yarn using two stick-like objects is to	
Measure	To find the length of something by using a special instrument is to	
Watch	To look at something happening is to	
Tow	To pull something heavy with a vehicle is to	
Weigh	To put something on a scale is to	
Kick	To strike something with the foot is to	
	Total correct	
	Percentage correct	

APPENDIX D

Pre-treatment connected speech sample for Participant 1

All three samples are combined in the following order: *WAB* picture, Cookie Theft picture, *Cinderella* story

Words with () are omitted from the analysis because they represent repeated information.

[+SV] = Contains subject and verb (and object, if appropriate). Grammar and/or morphology not necessarily correct.
[+RELEVANT] = Meaning is relevant to topic.

BEGIN PICTURE DESCRIPTION FOR *WAB* PICTURE
P There's a man reading a book [+SV][+RELEVANT].
P There hammer [-SV][-RELEVANT].
P He made a (pip) basket [+SV][+RELEVANT].
P She is making a drink with her [+SV][+RELEVANT].
P A fellow is flying a kite and watching the dog [+SV][+RELEVANT].
P And arm [-SV][-RELEVANT].
P He's watching a [-SV][-RELEVANT].
P He's driving a boat [+SV][+RELEVANT].
P (He's driving a car.) (Not included in analysis because previous sentence is correct, and this is an incorrect repetition of previous sentence.)
P A tree and a boat [-SV][-RELEVANT].
BEGIN PICTURE DESCRIPTION FOR COOKIE THEFT PICTURE
P This kid stand on the stool having cookies [+SV][+RELEVANT].
P That her teacher is not learning [-SV][-RELEVANT].
P The mother is washing the dishes and overspilling water [+SV][+RELEVANT].
P She's stepping on water [+SV][+RELEVANT].
BEGIN TELLING OF CINDERELLA
P They had a mother that was bad [+SV][+RELEVANT].
P Two of the kids were good [+SV][+RELEVANT].
P One was bad [+SV][+RELEVANT].
P They (they) formed a group [+SV][+RELEVANT].
P They bad versus good [-SV][+RELEVANT].
P The carried the [-SV][-RELEVANT].
P Made a mistake [-SV][-RELEVANT].
P Might have [-SV][-RELEVANT].
P Made into the box [-SV][-RELEVANT].
P They play around [+SV][-RELEVANT].
P They find the shoe that fit [+SV][+RELEVANT].

# of complete utterances /total # of utterances = 13/25 (100) = 52.0%

Post-treatment connected speech sample for Participant 1

All three samples are combined in the following order: *WAB* picture, Cookie Theft picture, *Cinderella* story

Words with () are omitted from the analysis because they represent repeated information.

[+SV] = Contains subject and verb (and object, if appropriate). Grammar and/or morphology not necessarily correct.
[+RELEVANT] = Meaning is relevant to topic.

BEGIN PICTURE DESCRIPTION FOR *WAB* PICTURE
P The kid is flying a airplane [+SV][+RELEVANT].
P The kid is flying a kite [+SV][+RELEVANT].
P There's a pole [+SV][+RELEVANT].
P The other dude is fishing [+SV][+RELEVANT].
P Mother is pouring a drink, listening to the radio [+SV][+RELEVANT].
P Dad is reading a book [+SV][+RELEVANT].
P There's a picnic basket there [+SV][+RELEVANT].
P The car is parked [+SV][+RELEVANT].
P The tree is open [+SV][-RELEVANT].
P The dog [-SV][+RELEVANT].
P The boat is two people [-SV][-RELEVANT].
P Some people are flying an airplane [+SV][+RELEVANT].
P The person was sitting on a log [+SV][+RELEVANT].
BEGIN PICTURE DESCRIPTION FOR COOKIE THEFT PICTURE
P Mom washing dishes [+SV][+RELEVANT].
P The dishes is overflowing [+SV][+RELEVANT].
P The kids are raiding the cookie jar [+SV][+RELEVANT].
P The young boy is stepping on the ladder [+SV][+RELEVANT].
P The young girl is eating a cookie [+SV][+RELEVANT].
P Mom's washing a dish [+SV][+RELEVANT].
P The pans are stitch [+SV][-RELEVANT].
P It's nice day outside [+SV][+RELEVANT].
BEGIN TELLING OF CINDERELLA
P In the story of Cinderella and the magic slippers, you got the sister and three sisters and the mother [+SV][+RELEVANT].
P Cinderella is the youngest sister [+SV][+RELEVANT].
P The other sisters are mean to her [+SV][+RELEVANT].
P They have animals who run around making sure that they're doing their work and everything [+SV][+RELEVANT].
P The mother has Cinderella their different costumes for her sisters [-SV][-RELEVANT].
P They make [-SV][-RELEVANT].
P Well they're having a ball, dance hall stuff [+SV][+RELEVANT].

P Her fairy godmother is right around the corner [+SV][+RELEVANT].
P She's a fairy godmother [+SV][+RELEVANT].
P The fairy godmother is arranging her way to the dance [+SV][+RELEVANT].
P She has stagecoach and horses [+SV][+RELEVANT].
P Cinderella has a good dress [+SV][+RELEVANT].
P She's at the ball [+SV][+RELEVANT].
P They plan on losing after midnight [+SV][-RELEVANT].
P They're late getting back home [+SV][+RELEVANT].
P The mother is trying to find the other sisters [+SV][+RELEVANT].
P And they try on the slippers [+SV][+RELEVANT].
P Cinderella tried on the slippers [+SV][+RELEVANT].

# of complete utterances /Total # of utterances = 32/39 (100) = 82.1%

APPENDIX E

Pre-treatment connected speech sample for Participant 2

All three samples are combined in the following order: *WAB* picture, Cookie Theft picture, *Cinderella* story

Words with () are omitted from the analysis because they represent repeated information.

[+SV] = Contains subject and verb (and object, if appropriate). Grammar and/or morphology not necessarily correct.
[+RELEVANT] = Meaning is relevant to topic.

BEGIN PICTURE DESCRIPTION FOR *WAB* PICTURE
P The tree is going to the car [+SV][-RELEVANT].
P House and shrubbery and trees [-SV][+RELEVANT].
P And fige [flag] pole and kite and dog and pail and circle board [-SV][-RELEVANT].
P Boy and kite and pier and fishing and boating and picnic [-SV][+RELEVANT].
P Need a drink? [+SV][-RELEVANT]
P Parents [-SV][+RELEVANT].
P Reading a book [-SV][+RELEVANT].
P Sandals [-SV][+RELEVANT].
P Radio [-SV][+RELEVANT].
P Bare feet? [-SV][-RELEVANT]
P A boy and two gentlemen [-SV][+RELEVANT].
BEGIN PICTURE DESCRIPTION FOR COOKIE THEFT PICTURE
P Mother and two children are going to cookie jar [+SV][+RELEVANT].
P The stool is going to crash [+SV][+RELEVANT].
P Water is going to the sink is overflowing down to the linoleum [+SV][+RELEVANT].
P The dishes are [-SV][+RELEVANT].
P The rag going to the dish [+SV][-RELEVANT].
P Outside [-SV][+RELEVANT].
P Curtains and windows and outside there [-SV][+RELEVANT].
P Bushes and trees and inside [-SV][-RELEVANT].
P Cabinet [-SV][+RELEVANT].
P Cups and saucers [-SV][+RELEVANT].
P Shorts [-SV][+RELEVANT].
P Dress and shirt and apron [-SV][+RELEVANT].
P Mama's got shoes [+SV][+RELEVANT].
P Daughter has shoes and socks on [+SV][+RELEVANT].
P The boy his shoes and socks.
BEGIN TELLING OF CINDERELLA
P Cinderella, Drosila, and and Drasila and the mother going to the ball [+SV][+RELEVANT].

P Drasila and Anastasia and mother the go off and leave the Cinderella and the cinders [+SV][+RELEVANT].
P Mice and the Brone [-SV][-RELEVANT].
P The horse and the dog and the mice excited fairy godmother [+SV][+RELEVANT].
P She decides to make the dress and going to the ball [+SV][+RELEVANT].
P Brunu the horseman are lovely coach [-SV][+RELEVANT].
P Fire godmother put them in it [+SV][+RELEVANT].
P Cinderella is going to the ball [+SV][+RELEVANT].
P (Them in it) (repetition)
P (Cinderella is going to the ball) (repetition)
P Drasila and Anastasia not going to the prince [+SV][+RELEVANT].
P Cinderella is going to the prince [+SV][+RELEVANT].
P He falls in love [+SV][+RELEVANT].
P Had to be home by midnight [-SV][+RELEVANT].
P They went to the ball [+SV][+RELEVANT].
P They danced and danced [+SV][+RELEVANT].
P Midnight came [+SV][+RELEVANT].
P Cinderella going to the ball [+SV][+RELEVANT].
P Horses and mice came back to the pumpkin and slipper [+SV][+RELEVANT].
P The slippers were sent to the prince [+SV][+RELEVANT].
P The slippers was Cinderella [+SV][+RELEVANT].
P They had to get out of the kingdom [+SV][+RELEVANT].
P Two persons [-SV][+RELEVANT].
P They were going to see Drosilla and Anastasia [+SV][+RELEVANT].
P Two women and they didn't fit [+SV][+RELEVANT].
P Cinderella went to the closet [+SV][+RELEVANT].
P Present the other slipper [-SV][+RELEVANT].
P She married the prince [+SV][+RELEVANT].

# of completed utterances /total # of utterances = 26/54 (100) = 50.9%

Post-treatment connected speech sample for Participant 2

All three samples are combined in the following order: *WAB* picture, Cookie Theft picture, *Cinderella* story

Words with () are omitted from the analysis because they represent repeated information.

[+SV] = Contains subject and verb (and object, if appropriate). Grammar and/or morphology not necessarily correct.
[+RELEVANT] = Meaning is relevant to topic.

BEGIN PICTURE DESCRIPTION FOR *WAB* PICTURE
P The tree stands with the people under it [+SV][+RELEVANT].
P The girl and boy and under it [-SV][+RELEVANT].
P The drink and a basket and sandals and books and glasses and shirt [-SV][+RELEVANT].
P A lay [-SV][-RELEVANT].
P People are going to have a picnic [+SV][+RELEVANT].
P The son is flying is a kite [+SV][+RELEVANT].
P The dog and the people are fishing [+SV][+RELEVANT].
P Sunbathing [-SV][+RELEVANT].
P People are going to sail the boat [+SV][+RELEVANT].
P The car is in the garage [+SV][+RELEVANT].
P The house [-SV][+RELEVANT].
P Trees are circling it [+SV][+RELEVANT].
P The flag is in the flagpole [+SV][+RELEVANT].
P The bucket and the shovel are on the shore [+SV][+RELEVANT].
P The radio is playing [+SV][+RELEVANT].
P It seems like it's suit on [-SV][-RELEVANT].
BEGIN PICTURE DESCRIPTION FOR COOKIE THEFT PICTURE
P The (the) mother is going to wash the dishes [+SV][+RELEVANT].
P The sink is going to overflow [+SV][+RELEVANT].
P The cookie jar is going to be robbed by the junior [+SV][+RELEVANT].
P The girl is going to make the [-SV][-RELEVANT].
P The cookie jar is going to meet the match [+SV][+RELEVANT].
P The boy is falling down [+SV][+RELEVANT].
P The cabinet is going to waste [+SV][-RELEVANT].
P The curtains and the path and the neighbor's house and the window and the apron and the shoes and the sneakers [-SV][+RELEVANT].
P The cups and saucers [-SV][+RELEVANT].
P The trees [-SV][+RELEVANT].
P The off and on [-SV][+RELEVANT].
P Cold and hot [-SV][+RELEVANT] .
P The dress that wearing [-SV][+RELEVANT].

BEGIN TELLING OF CINDERELLA

P Cinderella was alone [+SV][+RELEVANT].
P She had mother and two sisters [+SV][+RELEVANT].
P She did the laundry and did chickens [+SV][+RELEVANT].
P The prince wanted to get them together and the ball [+SV][+RELEVANT].
P The sisters went [+SV][+RELEVANT].
P Cinderella didn't go [+SV][+RELEVANT].
P But the fairy godmother had a coach and a footman and horses [+SV][+RELEVANT].
P The mice were first (when mice first) [+SV][+RELEVANT].
P Cinderella [-SV][+RELEVANT].
P They had [-SV][+RELEVANT].
P (The mice first and) (repetition)
P Two sisters didn't want her to go [+SV][+RELEVANT].
P But Cinderella fairy godmother [-SV][+RELEVANT].
P She had a coach and footman and horses and made her the dress [+SV][+RELEVANT].
P The two sisters come up to the palace [+SV][+RELEVANT].
P They were rejected [+SV][+RELEVANT].
P Cinderella was not and danced [+SV][+RELEVANT].
P The bong bong [-SV][+RELEVANT].
P They danced until midnight [+SV][+RELEVANT].
P She had to go home at midnight [+SV][+RELEVANT].
P The horses came to the dog [+SV][+RELEVANT].
P The mice came to the rescue [+SV][+RELEVANT].
P Cinderella came to the coach [+SV][+RELEVANT].
P Cinderella went down [+SV][+RELEVANT].
P The coach was dead [+SV][+RELEVANT].
P Cinderella was happy to find her slippers [+SV][+RELEVANT].
P The prince found it [+SV][+RELEVANT].
P The king ordered the knight to find the shoes fit [+SV][+RELEVANT].
P The daughters came and couldn't fit it [+SV][+RELEVANT].
P Cinderella did fit it [+SV][+RELEVANT].

# of completed utterances /total # of utterances = 40/59 (100) = 67.8%

APPENDIX F

Pre-treatment connected speech sample for Participant 3

Only two samples are combined in the following order: Cookie Theft picture and *Cinderella* story

Words with () are omitted from the analysis because they represent repeated information.

[+SV] = Contains subject and verb (and object, if appropriate). Grammar and/or morphology not necessarily correct.
[+RELEVANT] = Meaning is relevant to topic.

BEGIN PICTURE DESCRIPTION FOR COOKIE THEFT PICTURE
P A mother is working in the kitchen [+SV][+RELEVANT].
P While she has her back to them her two children (xxx).
P The boy is standing on the top (of a xxx).
P (But) he's standing up [+SV][+RELEVANT].
P It's tilting [+SV][+RELEVANT].
P He's almost starting to fall [+SV][+RELEVANT].
P He's the top of the cookie (car car) jar (xxx) [-SV][-RELEVANT].
P He has a cookie xxx [+SV][+RELEVANT].
P Looking for a cookie while his sister is reaching (xxx) [-SV][+RELEVANT].
P His last cookie [-SV][+RELEVANT].
P While they're doing that the mother is drying a plate [+SV][+RELEVANT].
P He's not paying attention to the water that's coming [+SV][+RELEVANT].
P The sink and pouring over the sink [-SV][+RELEVANT].
P And he has a (xx xx) for get that [-SV][-RELEVANT].
P The mother is standing with curtains folded on each side [+SV][+RELEVANT].
P (So) she can look through the window [+SV][+RELEVANT].
P To walk through the step [-SV][-RELEVANT].
P There's some plants near there [+SV][+RELEVANT].
P Back in the kitchen again he's standing with two cups and a plate over there [+SV][+RELEVANT].
BEGIN TELLING OF CINDERELLA
P This is the story of Cinderina [+SV][+RELEVANT].
P Mother there her sing [-SV][-RELEVANT].
P The two girls who were hers too [+SV][+RELEVANT].
P The stepsisters [-SV][+RELEVANT].
P His friends were the mice and the birds and the animals the dogs and the horse [+SV][+RELEVANT].
P At one time the word came (to give a) [-SV][-RELEVANT].
P They had a word asking them the girls to come to the ball [+SV][+RELEVANT].
P When the prince was going to be there [-SV][+RELEVANT].

P All the woman in the place could were to come and seen to meet him [+SV][+RELEVANT].
P That day he looked at all these different ones [+SV][+RELEVANT].
P Then he had said that he wanted to go [+SV][+RELEVANT].
P But Cillinjo was told that she could not go [+SV][+RELEVANT].
P Then her good woman who save thing for her sent her with a pretty dress to take [-SV][+RELEVANT].
P Then the other animals came and helped her go to the popkin [+SV][+RELEVANT].
P Was the car [-SV][+RELEVANT].
P That was taken [+SV][+RELEVANT].
P When it arrives the prince saw her and immediately loved her [+SV][+RELEVANT].
P They were dancing [+SV][+RELEVANT].
P Then when the clock struck twelve she had to run away [+SV][+RELEVANT].
P She dropped one shoe [+SV][+RELEVANT].
P Then word was sent to the world that the men who worked for the prince were going to take the shoe for all the women to try them on to see if this is the one that they had lost [+SV][+RELEVANT].
P So everyone tried [+SV][+RELEVANT].
P The stepmother took her locked away from the place where the people to look for the shoe [+SV][-RELEVANT].
P But (the mice) the little mice lived in there and got the key that they took in and unlocked it [+SV][+RELEVANT].
P She could go in and try on the shoe too [+SV][+RELEVANT].
P Of course it was exactly right [+SV][+RELEVANT].
P They took her then away (to the) [-SV][+RELEVANT].
P He went to his home [+SV][+RELEVANT].
P They were to be married [+SV][+RELEVANT].

# of complete utterances /total # of utterances = 31/48 (100) = 64.6%

Post-treatment connected speech sample for Participant 3

Only two samples are combined in the following order: Cookie Theft picture and *Cinderella* story

Words with () are omitted from the analysis because they represent repeated information.

[+SV] = Contains subject and verb (and object, if appropriate). Grammar and/or morphology not necessarily correct.
[+RELEVANT] = Meaning is relevant to topic.

BEGIN PICTURE DESCRIPTION FOR COOKIE THEFT PICTURE
P Mother and two of her children were in the kitchen [+SV][+RELEVANT].
P The children were not looking at mother [+SV][+RELEVANT].
P They were trying to find some cookies [+SV][+RELEVANT].
P The girl was standing on the floor [+SV][+RELEVANT].
P She was reaching with one hand to reach a cookie [+SV][+RELEVANT].
P Her brother was handing her a cookie [+SV][+RELEVANT].
P The boy was standing on a stool [+SV][+RELEVANT].
P It was beginning to fall [+SV][+RELEVANT].
P (As) he hit with two hands [+SV][-RELEVANT].
P One hand was leaning over [+SV][+RELEVANT].
P He was beginning to fall [+SV][+RELEVANT].
P With his other hand he was reaching for the cookie jar [+SV][+RELEVANT].
P He had the cupboard [+SV][-RELEVANT].
P He had it opened [+SV][+RELEVANT].
P (So) the top part was beside it [+SV][-RELEVANT].
P He was picking up a cookie with the other hand [+SV][+RELEVANT].
P He had one door that he had opened of the cabinet [+SV][+RELEVANT].
P While he was on that, mother was standing on the kitchen where the sink was [+SV][+RELEVANT].
P Evident she was not looking [+SV][+RELEVANT].
P Water was pouring from the sink and pouring over all the way to the floor [+SV][+RELEVANT].
P The mother was drying a (a) plate [+SV][+RELEVANT].
P And he had one pool in front [+SV][+RELEVANT].
P He was wearing an apron [+SV][+RELEVANT].
P He possibly was looking toward the window [+SV][+RELEVANT].
P It looked like the bottom window was open [+SV][+RELEVANT].
P The other side you could see the window and part of a house and some plants beside that [+SV][+RELEVANT].
P He had curtains on the side of the window [+SV][+RELEVANT].
P Beside the kitchen was two cups [+SV][+RELEVANT].
P There was one glass [+SV][+RELEVANT].

BEGIN TELLING OF CINDERELLA

P Cinzerella lived in a big house with her stepmother and the stepmother's two girls [+SV][+RELEVANT].
P (And) they were cruel to her [+SV][+RELEVANT].
P Cristella's friends were the birds and the mice [+SV][+RELEVANT].
P She had to work inside the house [+SV][+RELEVANT].
P One time a man came who's from prince [+SV][+RELEVANT].
P The man came for the prince to give all the girls in the area to come to the ball for the prince to look for the woman he wants to marry [+SV][+RELEVANT].
P Cillerena wants to go also [+SV][+RELEVANT].
P So was helping the girls [-SV][+RELEVANT].
P She had to help them [+SV][+RELEVANT].
P The girls make the dresses [+SV][+RELEVANT].
P The friends, the birds and the mice made a dress for Cillerena [+SV][+RELEVANT].
P They saw that the bad stepmother and her two daughters came and ripped away Cinderella's dress [+SV][+RELEVANT].
P She was lying beside a tree outside [+SV][+RELEVANT].
P She was so sad about she couldn't get to go [+SV][+RELEVANT].
P Her good magic woman and she had had the dress made and had a thing to ride through [+SV][+RELEVANT].
P They were getting to do that [+SV][+RELEVANT].
P They went into the palace [+SV][+RELEVANT].
P The prince was walking along through all the women who came in [+SV][+RELEVANT].
P He was looking at them [+SV][+RELEVANT].
P Then he saw Cillerena coming by [+SV][+RELEVANT].
P She looked beautiful with her new dress and her hair fixed and also her foot [+SV][+RELEVANT].
P They were dancing together when all of a sudden it went bong bong [+SV][+RELEVANT].
P The clock stopped at twelve [+SV][+RELEVANT].
P Cillerena ran away and left the room immediately [+SV][+RELEVANT].
P Then the prince sent her helpers to go around looking for the girl who had lost one of her shoes and try the different ones [+SV][+RELEVANT].
P Cinderena had wanted to go [+SV][+RELEVANT].
P Stepmother locked the door [+SV][+RELEVANT].
P The men couldn't call her in [+SV][+RELEVANT].
P He was trying his daughters to try on the shoes [+SV][-RELEVANT].
P These good little mice came over and pulled the key and opened it [+SV][+RELEVANT].
P As she (xxx) the steps [-SV][-RELEVANT].
P The man called her to come and try the shoes on too [+SV][+RELEVANT].
P Of course other one just fit right [+SV][+RELEVANT].
P They carried her over to the prince [+SV][+RELEVANT].

P They moved [+SV][+RELEVANT].
P We saw a picture with her nice dress when she left for the wedding [+SV][+RELEVANT].

# of complete utterances /total # of utterances = 59/65 = 90.8%

APPENDIX G

Pre-treatment connected speech sample for Participant 4

All three samples are combined in the following order: *WAB* picture, Cookie Theft picture, *Cinderella* story

Words with () are omitted from the analysis because they represent repeated information.

[+SV] = Contains subject and verb (and object, if appropriate). Grammar and/or morphology not necessarily correct.
[+RELEVANT] = Meaning is relevant to topic.

BEGIN PICTURE DESCRIPTION FOR *WAB* PICTURE

P There is a tree [+SV][+RELEVANT].
P Below the tree there's a house with car down the garage [+SV][+RELEVANT].
P There's two people are down the tree [-SV][-RELEVANT].
P They sit there on the blanket with a radio [+SV][+RELEVANT].
P They have a coke or something [+SV][+RELEVANT].
P The woman likes that [+SV][+RELEVANT].
P She (xxx) almost to drink it. [+SV][-RELEVANT]
P They have a basket for lunch [+SV][+RELEVANT].
P The man is book [-SV][-RELEVANT].
P His shoes down his feet [-SV][-RELEVANT].
P There's a flag almost the lake [+SV][+RELEVANT].
P There's a boat on there [+SV][+RELEVANT].
P It has two people on that [+SV][+RELEVANT].
P Look the (the) kite up [-SV][+RELEVANT].
P The man on the [-SV][-RELEVANT].
P Almost but with the [-SV][-RELEVANT].
P Anyway she's got the kite above him on the floor [+SV][+RELEVANT].
P He's on the ground out there [+SV][+RELEVANT].
P He has a dog with him [+SV][+RELEVANT].
P There is a woman sitting on the has a on a trying to fish down her on the pole with it really [-SV][-RELEVANT].
P Fish for her [-SV][-RELEVANT].
P There's (a guy) people on the boat out there [+SV][+RELEVANT].
P They are someplace to the people (on the) [-SV][-RELEVANT].
P A little guy with some sand on the shore with his hands the sand [-SV][+RELEVANT].
P There's a shovel and a bell for that in the sand [+SV][+RELEVANT].

BEGIN PICTURE DESCRIPTION FOR COOKIE THEFT PICTURE

P This is the kitchen [+SV][+RELEVANT].
P The woman is [-SV][-RELEVANT].

P She's brushed the dishes [+SV][-RELEVANT].
P She has a sink [+SV][+RELEVANT].
P Then too much it get on the floor that water all the place [+SV][+RELEVANT].
P It's just silly that he's nothing with that [+SV][-RELEVANT].
P You know she's I like her very much [+SV][-RELEVANT].
P She's the dishes [-SV][-RELEVANT].
P It doesn't see that the water is getting on the floor and everything [+SV][+RELEVANT].
P She has two and a plate on the counter top to get each of them [-SV][-RELEVANT].
P Maybe she get them first [+SV][+RELEVANT].
P She has two tops and one plate (to) [-SV][-RELEVANT].
P Washes them I guess [-SV][+RELEVANT].
P She is looking out the window [+SV][+RELEVANT].
P Something out there (I think) [-SV][+RELEVANT].
P But something down her she has [-SV][-RELEVANT].
P There children [-SV][+RELEVANT].
P She got a boy and girl [+SV][+RELEVANT].
P They are looking to a cookie jar down in (c) [-SV][+RELEVANT].
P The guy has on top of a stool and get the cookies [+SV][-RELEVANT].
P She has one on her [+SV][-RELEVANT].
P One jar and then she has one on the other side and one to the girls [+SV][-RELEVANT].
P But the stool is (almost to the) (is going is on is the on) is to fall [+SV][+RELEVANT].
P Is almost to the boy onto the floor but oh well [+SV][+RELEVANT].
P The woman nothing about anything [-SV][+RELEVANT].
P He's looking for the cookie [+SV][+RELEVANT].
P For the one he's the one hers [-SV][-RELEVANT].
P She likes them [+SV][+RELEVANT].
P She's eating one now [+SV][+RELEVANT].
P She has a nice skirt [+SV][+RELEVANT].
P She has nice shoes and socks and everything [+SV][+RELEVANT].
P The guy ok [-SV][-RELEVANT].
P He has shoes and everything [+SV][+RELEVANT].
P He's shorts and a shirt [-SV][+RELEVANT].
P So they like the [-SV][-RELEVANT].
P They like the [-SV][-RELEVANT].
P They liked the where they are [+SV][+RELEVANT].
P (Because) they don't have the sense that they can't get a cookie on the floor [+SV][+RELEVANT].
P (Because) they're not good with that [+SV][+RELEVANT].
P Nothing about them [-SV][-RELEVANT].
P I think she's deaf or something [+SV][+RELEVANT].

P She don't [-SV][-RELEVANT].
P They don't [-SV][-RELEVANT].
P She know they it not see (the) [-SV][-RELEVANT].
P Don't the children know that the woman is silly [+SV][+RELEVANT].
P (Because) it (xx) off has the water down off the down the to the floor [-SV][+RELEVANT].
P (So) they can do what they want to [+SV][+RELEVANT].

BEGIN TELLING OF CINDERELLA

P She was with a maid at somebody's house [+SV][+RELEVANT].
P There's sisters and a woman [+SV][+RELEVANT].
P Very nice were those people [+SV][-RELEVANT]. (Stereotyped response and the people were not nice.)
P They had a castle [+SV][+RELEVANT].
P They liked there much [-SV][+RELEVANT].
P (Because) they liked the birds and mice and everything [+SV][+RELEVANT].
P (They liked them all the time). (Repetition)
P One day a guy one the prince was going to see if they want to [-SV][+RELEVANT].
P He wants he can ride a woman [+SV][-RELEVANT].
P He want a guy he can xx xxx [-SV][-RELEVANT].
P He wants a woman he can xxx and xxx guy [+SV][-RELEVANT].
P He has to each woman and love it when he finds it [-SV][+RELEVANT].
P She said there all [-SV][-RELEVANT].
P (So) they come in the house and said how he has a beautiful a nice thing [-SV][-RELEVANT].
P Get them come too so they and everything [SV][-RELEVANT].
P But this cat she got it from a beautiful fur [+SV][-RELEVANT].
P Her (xxx) this nice was very nice [+SV][-RELEVANT].
P With the birds and mice for her when he's going stuff [-SV][-RELEVANT].
P They like her at all [+SV][-RELEVANT].
P They get off it [+SV][-RELEVANT].
P They terrible so you can't do that [+SV][-RELEVANT].
P (So) they sit down [+SV][+RELEVANT].
P She went cried on this stone trunk the tree actually downstairs [+SV][+RELEVANT].
P Now when she sitting right there the grandmember can see her [+SV][+RELEVANT].
P He's has wings and everything (xxx) [+SV][+RELEVANT].
P I guess so he says you and horse can get you to the place [+SV][+RELEVANT].
P This horse was stand there [+SV][+RELEVANT].
P (But) these two how four horses exactly [-SV][+RELEVANT].
P They're very nice [+SV][-RELEVANT]. (Stereotyped)
P Get a big pumpkin on a beautiful thing first [-SV][+RELEVANT].
P A guy drive it for her [+SV][+RELEVANT].
P (So) she's beautiful, wonderful had a wonderful dress now [+SV][+RELEVANT].
P She's and the guy seen his sisters [-SV][-RELEVANT].
P When she saw this guy he loved her very much [+SV][+RELEVANT].

P She said him that night [+SV][-RELEVANT].
P Then she's oh I guess it's time I go now [+SV][+RELEVANT].
P Goes now down the stairs [-SV][+RELEVANT].
P She slipped on hers shoes off of one right there [+SV][+RELEVANT].
P Go anyway quick [-SV][+RELEVANT].
P She got home [+SV][+RELEVANT].
P Well after that a guy come to their house and says I have some a guy could slip this shoe somebody at their house [+SV][+RELEVANT].
P This one mother says yes and see my sisters first [+SV][+RELEVANT].
P (So) they got her (xx) first [+SV][+RELEVANT].
P She couldn't (with their) [-SV][-RELEVANT].
P But when they were doing that a mouse was getting that key out that mother his pocket right there [+SV][+RELEVANT].
P They got the cat [+SV][+RELEVANT].
P This woman upstairs and got cilerretta [+SV][+RELEVANT].
P Said her first so he got on her shoes [+SV][+RELEVANT].
P It was wonderful [+SV][+RELEVANT].
P She's loves her (xx) [+SV][+RELEVANT].
P (And she is (xx))
P (And) she has a wonderful life [+SV][+RELEVANT].

# of complete utterances /total # of utterances = 61/121 (100) = 50.4%

Post-treatment connected speech sample for Participant 4

All three samples are combined in the following order: *WAB* picture, Cookie Theft picture, *Cinderella* story

Words with () are omitted from the analysis because they represent repeated information.

[+SV] = Contains subject and verb (and object, if appropriate). Grammar and/or morphology not necessarily correct.
[+RELEVANT] = Meaning is relevant to topic.

BEGIN PICTURE DESCRIPTION FOR *WAB* PICTURE
P There is a lake and a cabin [+SV][+RELEVANT].
P It's a home actually [+SV][+RELEVANT].
P People are on the grass [+SV][+RELEVANT].
P Somebody with a kite and a dog [-SV][+RELEVANT].
P This boy and his out with the sand down in the shore [-SV][+RELEVANT].
P There is two people out there on a boat [+SV][+RELEVANT].
P There too so anyway there is a [-SV][-RELEVANT].
P First with guy jeep jester with a kite [-SV][+RELEVANT].
P He's (xxxx) with his plog right there [-SV][-RELEVANT].
P Then the people on the boat they (xxxx) hello to the first [-SV][-RELEVANT].
P He likes them (I guess) [+SV][+RELEVANT].
P One person on the it down into the water [-SV][-RELEVANT].
P But is wood and everything [-SV][-RELEVANT].
P This all the (xx) he's sitting on it [+SV][+RELEVANT].
P He has a pole for he could get a fish some time [+SV][+RELEVANT].
P The flag was (then on the) on their (on the xxx) [-SV][+RELEVANT].
P It was on top of the people that he it was very nice [+SV][-RELEVANT].
P It was a little bit (xxx) in for maybe from south something [+SV][-RELEVANT].
P People down of the (sxx) down below they have a forest [+SV][-RELEVANT].
P A house was down for the xxx [-SV][-RELEVANT].
P (There is a car)
P There's a big car [+SV][+RELEVANT].
P (I want to say not a car but is down in the xxx though)
P Anyway the car sitting anybody [-SV][-RELEVANT].
P Nobody in it [-SV][+RELEVANT].
P There is a big tree [+SV][+RELEVANT].
P Two people sit on each other on a blanket [+SV][+RELEVANT].
P (And) they look (their xx) [-SV][-RELEVANT].
P They get something to eat out of their basket [+SV][+RELEVANT].
P Something to eat maybe and a guy is on [-SV][-RELEVANT].
P He has off with his shoes [+SV][+RELEVANT].
P He's lookin a book [+SV][+RELEVANT].

P The woman is getting for him [-SV][+RELEVANT].
P He's reading for something [+SV][+RELEVANT].
P No people down the tree first [-SV][-RELEVANT].
P People no [-SV][-RELEVANT].
P Well they maybe have [-SV][-RELEVANT].
P They had [-SV][-RELEVANT].
P Boy is the kite somebody [-SV][+RELEVANT].
P They have a little boy down in the shores and the sand and everything [+SV][+RELEVANT].
P He has a shovel and a (pxx) with a shovel that basket I guess down there [+SV][+RELEVANT].
P They like the people on the boat [+SV][+RELEVANT].
P They thought (xxx) guy with the kite [-SV][+RELEVANT].
P (They like each other people).
P All the guy two women the men and women are set there probably [+SV][+RELEVANT].
P It's not their house maybe [+SV][+RELEVANT].
P (It's not theirs home or anything)
P They're sitting next to the tree [+SV][+RELEVANT].
P The guy doesn't like them [+SV][-RELEVANT].
P He likes his kite [+SV][+RELEVANT].
P With the dog and the boy down with his sand down the shore for the fall [-SV][+RELEVANT].
P The water down there [-SV][+RELEVANT].
P I don't know if the people like each other though [+SV][-RELEVANT]. (Stereotypic phrase)

BEGIN PICTURE DESCRIPTION FOR COOKIE THEFT PICTURE

P They're family in the kitchen [-SV][+RELEVANT].
P The mother was washing the dishes [+SV][+RELEVANT].
P But she [-SV][-RELEVANT].
P The water off down the sink and is going off the top of the on the floor (where is) [-SV][+RELEVANT].
P There is with his shoes and everything [-SV][+RELEVANT].
P Look at that it's silly [+SV][-RELEVANT]. (Unclear what is being referenced)
P There is the [-SV][-RELEVANT].
P He's washes the dishes (and nothing that) [-SV][-RELEVANT].
P Water down the floor that's oh well [-SV][+RELEVANT].
P She's looking the down the window down the sit outside [+SV][+RELEVANT].
P Now is a house down their members (I guess) [-SV][-RELEVANT].
P Two of her children are getting some stuff down there [+SV][+RELEVANT].
P Camping they have a chair that get up [-SV][+RELEVANT].
P The boy gets on top of the stair [+SV][+RELEVANT].
P The stool and get off of it [-SV][+RELEVANT].
P Get cookies for him and the girl. [-SV][+RELEVANT]

P She is almost off on the (the) stool and almost [-SV][+RELEVANT].
P He's flipping (with) [-SV][-RELEVANT].
P Its is off of it in a minute [+SV][-RELEVANT].
P He's getting two cookies for who her him and the girls [+SV][+RELEVANT].
P The girl is like the cookie for him [+SV][+RELEVANT].
P See on the thing off of the his chair kind of with him [+SV][+RELEVANT].
P The mother does see the cat [+SV][-RELEVANT].
P He is a kitten snow white [+SV][-RELEVANT].
P The mother can't [+SV][+RELEVANT].
P His boy and girl [-SV][+RELEVANT].
P They're not good right now [+SV][+RELEVANT].
P But she he can't anything [-SV][+RELEVANT].
P She didn't look anything bad today [-SV][+RELEVANT].
P She's lying about the juices or the girl or boy either [-SV][-RELEVANT].
P They things [-SV][-RELEVANT].

BEGIN TELLING OF CINDERELLA

P There's the woman [+SV][+RELEVANT].
P Her name Cinderella [-SV][+RELEVANT].
P She was a beautiful maid [+SV][+RELEVANT].
P She (xxx) have any clothes or anything like that [-SV][+RELEVANT].
P It likes the (pounds) mouse [+SV][+RELEVANT].
P They like her and the birds (like who) [-SV][+RELEVANT].
P They like her too [+SV][+RELEVANT].
P There is a beautiful down to the [-SV][+RELEVANT].
P She's this woman lived into a castle [+SV][+RELEVANT].
P It has no clothes [+SV][+RELEVANT].
P It everything get a place clean [+SV][+RELEVANT].
P There were two maids like her were her big sister they act her [+SV][+RELEVANT].
P Is sisters.
P (They like her very much). (Stereotypic response)
P (They like her ever) (Repetition)
P They has a woman who was their mother right there [+SV][+RELEVANT].
P They like this child either [+SV][+RELEVANT].
P Cinderella (xxx) that woman they like her at all [-SV][+RELEVANT].
P So it sits and goes out with the chickens and goes outside and each at time with the eat and everything they like him too [+SV][+RELEVANT].
P Somebody come there to the house [+SV][+RELEVANT].
P They were someplace else [+SV][+RELEVANT].
P They want man (woman) wants woman [+SV][+RELEVANT].
P It's gonna beautiful have a wonderful dance and everything [+SV][+RELEVANT].
P They want his woman to go [+SV][+RELEVANT].
P His sisters wanted to go in sit some type of grass [+SV][+RELEVANT].
P Upstairs they made a dress for her [+SV][+RELEVANT].
P They got her on (xxx) was pink and beautiful [-SV][+RELEVANT].

P The birds like it too [+SV][+RELEVANT].
P They put (beau, xxx) on her [-SV][+RELEVANT].
P Then his sisters called that they hated her [+SV][+RELEVANT].
P They hurt her [+SV][+RELEVANT].
P They took her off her dress [+SV][+RELEVANT].
P She couldn't go to that place [+SV][+RELEVANT].
P She had to stay cried [+SV][+RELEVANT].
P They xxx place to it [-SV][-RELEVANT].
P Then well a woman one xxx [-SV][-RELEVANT].
P Cinderella was crying [+SV][+RELEVANT].
P Want a came to her [-SV][+RELEVANT].
P It was his mother [+SV][+RELEVANT].
P Anyways her it was in an old kind of like has wings [-SV][+RELEVANT].
P It was someplace [+SV][+RELEVANT].
P She is something with wing her that night [+SV][+RELEVANT].
P She says if you want a place you can go great everything [+SV][+RELEVANT].
P There's a guy right here with a horse [+SV][+RELEVANT].
P He will carriage your and (xxx) it will get each [-SV][-RELEVANT].
P On the beautiful your have a beautiful thing with get [-SV][-RELEVANT].
P It's kind of like almost a pumpkin [+SV][+RELEVANT].
P It's beautiful [+SV][+RELEVANT].
P This guy was three or four horse [-SV][-RELEVANT].
P He became everything [+SV][+RELEVANT].
P Each on so she had the most beautiful dress ever [+SV][+RELEVANT].
P She was beautiful [+SV][+RELEVANT].
P She right there [+SV][+RELEVANT].
P There the guy loved her very much [+SV][+RELEVANT].
P It got beautiful slippers [+SV][+RELEVANT].
P So it beautiful in one [-SV][-RELEVANT].
P Had one of the place at the ball that night [-SV][+RELEVANT].
P She danced the woman the man liked her [+SV][+RELEVANT].
P Then quick she remembered [+SV][+RELEVANT].
P The woman told her go home [+SV][+RELEVANT].
P She goes (xxx) the woman right there [-SV][+RELEVANT].
P She hurt no look go to the house right now [-SV][-RELEVANT].
P One of her slippers on the stairs before she there beautiful house going to her probably pumpkin kind of carries [-SV][+RELEVANT].
P She get it she quick (and she's) [-SV][+RELEVANT].
P Now she got the house [+SV][+RELEVANT].
P She was maid again [+SV][+RELEVANT].
P So she had one slipper though [+SV][+RELEVANT].
P She liked it very much for her [-SV][-RELEVANT].
P She doesn't want that anyway [+SV][-RELEVANT].
P She love this old slipper [+SV][+RELEVANT].

P The guy knew that the man was (tump) their house [-SV][-RELEVANT].
P Because (xxx) knew had a (had a) slipper for that woman [+SV][+RELEVANT].
P They then they know that it is the slipper it had [+SV][+RELEVANT].
P She was it went on the stairs that night [+SV][+RELEVANT].
P She comes to their house [+SV][+RELEVANT].
P Each one on her slippers [-SV][+RELEVANT].
P No on each one (xxx) sisters [-SV][+RELEVANT].
P And they (xxx) close with her [-SV][-RELEVANT].
P They were too big for that slipper [+SV][+RELEVANT].
P So then he says well that man this woman first right now [-SV][RELEVANT].
P They put her shoes down the beautiful slipper and say fit [+SV][+RELEVANT].
P They like that [+SV][+RELEVANT].
P (But) he wanted the man to come with him [+SV][+RELEVANT].
P She marry him and that's all [+SV][+RELEVANT].

# of complete utterances /total # of utterances = 84/159 (100) = 50.9%

APPENDIX H

Pre- and post-treatment Cookie Theft picture description for P3

Utt	Pre-treatment	Post-treatment
1	A mother is working in the kitchen.	Mother and two of her children were in the kitchen.
2	While she has her back to them her two children (xxx).	The children were not looking at mother.
3	The boy is standing on the top (of a xxx).	They were trying to find some cookies.
4	(But) he's standing up.	The girl was standing on the floor.
5	It's tilting.	She was reaching with one hand to reach a cookie.
6	He's almost starting to fall.	Her brother was handing her a cookie.
7	He's the top of the cookie (car car) jar (xxx).	The boy was standing on a stool.
8	He has a cookie xxx.	It was beginning to fall.
9	Looking for a cookie while his sister is reaching (xxx).	(As) he hit with two hands.
10	His last cookie.	One hand was leaning over.
11	While they're doing that the mother is drying a plate.	He was beginning to fall.
12	He's not paying attention to the water that's coming.	With his other hand he was reaching for the cookie jar.
13	The sink and pouring over the sink.	He had the cupboard.
14	And he has a (xx xx) for get that.	He had it opened.
15	The mother is standing with curtains folded on each side.	(So) the top part was beside it.
16	(So) she can look through the window.	He was picking up a cookie with the other hand.
17	To walk through the step.	He had one door that he had opened of the cabinet.
18	There's some plants near there.	While he was on that, mother was standing on the kitchen where the sink was.
19	Back in the kitchen again he's standing with two cups and a plate over there.	Evident she was not looking.
20	n/a	Water was pouring from the sink and pouring over all the way to the floor.
21	n/a	The mother was drying a (a) plate.
22	n/a	And he had one pool in front.
23	n/a	He was wearing an apron.
24	n/a	He possibly was looking toward the window.
25	n/a	It looked like the bottom window was open.
26	n/a	The other side you could see the window and part of a house and some plants beside that.
27	n/a	He had curtains on the side of the window.
28	n/a	Beside the kitchen was two cups.
29	n/a	There was one glass.

Utt: Utterance; n/a: not applicable

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