INFLUENCE OF LINGUISTIC CONTEXT AND WORKING MEMORY ON AUDITORY COMPREHENSION IN YOUNG AND OLDER ADULTS WITH APHASIA

by

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July, 2010

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The purpose of the current investigation was to examine the influence of linguistic context on auditory comprehension in adults with aphasia, explore effects of the explanatory variables of age, working memory (WM), aphasia severity, and auditory comprehension relative to linguistic contextual influences, and investigate relationships among these explanatory variables.

Eight young (<60) and eight older (>60) individuals with aphasia as the result of a left hemisphere cerebrovascular accident (CVA) participated in the investigation. The participants underwent pre-experimental testing, including two subtests of the Boston Diagnostic Aphasia Examination-III to confirm presence of auditory comprehension impairment as well as ability to perform the experimental tasks. The Western Aphasia Battery-Revised also was administered to determine the presence and severity of aphasia. The participants were administered a series of experimental tasks, including listening span to measure WM capacity, modified Token Test to measure auditory comprehension, and a linguistic context task to examine the influence of predictive and non-predictive contexts on auditory comprehension of passive and active sentences.

Results indicated that age did not appear to influence WM, aphasia severity, and auditory

comprehension skills in this group of aphasic individuals. Thus, the persons with aphasia (PWA) had reduced WM capacity, regardless of age. However, decreased severity of aphasia was highly related to both increased WM capacity and auditory comprehension skills; that is, WM capacity as well as auditory comprehension increased as severity of aphasia decreased. Moreover, a strong relationship was observed between WM and auditory comprehension, indicating that auditory comprehension increased with increasing WM.

Non-predictive context facilitated comprehension of active sentences more than predictive context. Predictive context may have had an adverse influence on comprehension of active sentences, as the PWA may have "lost interest" as well as experienced decreased attention when they heard target sentences containing "old" information that was consistent and possibly repetitious of preceding linguistic context. Non-predictive context facilitated comprehension of active sentences because participants were presented with novel information that was not conveyed in target sentences. However, predictive context was more beneficial than non-predictive context in the comprehension of passive sentences. The PWA had difficulty with passive sentences possibly due to syntactic complexity and semantic reversibility of the sentence contexts. Predictive context facilitated comprehension of the passive sentences because it provided semantic constraints and made one interpretation of target sentences more plausible than the other. In contrast, the non-predictive context simply familiarized the participants with the lexical items of passive sentences; it did not provide the semantically supportive framework, thus making it more difficult to determine which interpretation of the passive sentences was more plausible. This latter result is a robust finding that is consistent with previous research and continues to require further exploration relative to its use in language treatment in aphasia.

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A Thesis

Presented to

The Faculty of the Department of Communication Sciences and Disorders

East Carolina University

In Partial Fulfillment

of the Requirements for the Degree

Master of Speech Language Pathology

by

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Acknowledgements

There are many people to thank for their assistance in the preparation, implementation and presentation of this study. First I would like to extend my thanks to Dr. Monica Hough. I would not have been able to do this without her instruction, guidance and help. Thanks to Dr. Paul Vos for his valuable advice. Thank you to Dr. Marianna Walker and Dr. Laura Ball for their assistance. A special thanks to Dr. Rose Allen for her support. My sincere appreciation and gratitude goes to my wonderful participants and their caregivers. Most importantly, I would like to thank my husband for his love.

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Chapter I

Review of the Literature

Introduction

In the past two decades, much research has addressed the influence of different types of context on the comprehension of persons with aphasia (PWA). Many adults with aphasia show deficits in auditory comprehension of language. Thus, research has been conducted to investigate the effect of linguistic context on PWA's understanding of language. Several investigators have found that linguistic context facilitates the language comprehension for PWA (Cannito, Jarecki, & Pierce, 1986; Cannito, Hough, Vogel, & Pierce, 1996; Hough, Pierce, & Cannito, 1989; Germani & Pierce, 1992; Nicholas & Brookshire, 1983).

Human memory has been extensively explored both at the neurophysiological level and the functional level. Specifically, the nature of working memory has been conceptualized as a memory system that appears to be essential to language understanding. Language processing requires allocation of working memory resources (Caplan & Waters, 1999). Thus, a limitation in working memory may lead to comprehension impairment; however, such an assumption is still controversial and requires further investigation (Caplan & Waters, 1999; Friedmann & Gvion, 2003). This impairment may be the result of the aging process, brain damage due to stroke, or both. Research has shown a notable age difference in working memory; that is, increased age is related to reduced working memory functioning (Byrne, 1998; Swanson, 1999; Wingfield, Stine, Lahar, & Aberdeen, 1988). As many individuals with aphasia have been found to demonstrate impaired verbal short-term memory (Albert, 1976; Burgio & Basso, 1997), it is possible that impaired short-term or working memory in conjunction with the aging process may contribute to difficulty in language understanding (Caplan & Walters 1999; DeDe, Caplan, Kemtes, & Waters, 2004; Hough, Vogel, Cannito, & Pierce, 1997).

The purpose of the current study is to determine the effect of linguistic context and working memory capacity on the auditory comprehension of younger and older adults with aphasia. The review of the literature will initially address the nature of aphasia and auditory comprehension in individuals with aphasia. This will be followed by a discussion on contexts and contextual influences on comprehension in aphasia. Next, information on working memory will be presented. Models of working memory will be discussed, as well as findings relative to working memory and aging. Available research regarding the interaction of working memory will be presented along with findings from aphasia. This will be followed by discussion of findings examining effects of working memory and contextual influences in aphasia. The review of literature will conclude with the summary and rationale, plan of study, and experimental questions for the current investigation.

Aphasia

One of the most influential definitions of aphasia was provided by Darley (1982) who indicated that aphasia is an impairment resulting from brain damage leading to deficit in the communicative modalities of speaking, writing, listening, and reading. PWA generally demonstrate deficits in word retrieval, syntactic rules, auditory attention span, and input and output channel selection. Another definition, proposed by Davis (2007), indicates that aphasia is "a selective impairment of the cognitive system specialized for comprehending and formulating language, leaving other cognitive capacities relatively intact" (p.15) and emphasized the "impairment of the language processing system" (p.15).

As mentioned previously, aphasia is a multimodality deficit; however, language skills in each modality are impaired to different degrees. Typically, production is more impaired than comprehension, and reading and writing are more impaired than speaking and listening (Davis, 2007; Duffy & Ulrich, 1976). However, occasionally comprehension may be poorer, better than, or commensurate with production (Helm-Estabrooks & Albert, 2004). In most cases of aphasia, there is at least some impairment in all language modalities (Hollowell & Chapey, 2008).

According to their verbal production, PWA may be classified into two groups: nonfluent aphasia and fluent aphasia. Individuals with nonfluent aphasia typically produce fewer words than typical adults, often omitting functor words, such as articles, prepositions, conjunctions, etc. and retaining content words. This agrammatic verbal behavior is often associated with Broca's aphasia, one of several nonfluent aphasias. On the contrary, individuals with fluent aphasia are able to produce fluent and complete sentences effortlessly; however, they may exhibit word retrieval deficits and use circumlocution to compensate or produce word substitution errors. Some individuals with fluent aphasia may produce jargon, which is perceptually like normal speech, but makes little sense (Berndt, Mitchum, & Haendiges 1996; Davis, 2007; Hallowell & Chapey, 2008).

Several different types of aphasia have been identified, related to fluency of verbal output and exemplified by a constellation of language behaviors that result in a particular and unique communication skill profile. The aphasia type can be related to a specific lesion site in the brain. Adults with Wernicke's aphasia demonstrate notable impairment in auditory comprehension as well as fluent but inaccurate verbal output, especially in spontaneous speech. Both their reading comprehension and writing are undermined. Their difficulty in comprehension may result from a deficit in semantic processing abilities. Furthermore, they may exhibit an excessive press for speech; that is, they may continue speaking without awareness of the other participants in a conversation. They have difficulty monitoring their speech output and are unaware of their nonsensical verbal production (Bartha & Benke, 2003; Davis, 2007; Caspari, 2005; Norman &

Baratz, 1979; Raymer, 2001). Adults with conduction aphasia typically exhibit a severe deficit in language repetition, possibly due to reduced verbal short-term memory. Furthermore, these individuals often make numerous phonological and lexical errors in spontaneous conversation, but generally show minimal deficits in auditory comprehension skill. These individuals are aware of their errors in production and will self-correct repeatedly (Davis, 2007; Norman & Baratz, 1979; Raymer, 2001; Simmons-Mackie, 2005). Communication skills for adults with anomic aphasia are typically characterized by slightly impaired comprehension, fluent, relatively coherent oral expression, and word retrieval problems (Davis, 2007; Norman & Baratz, 1979, Raymer, 2001).

Adults with Broca's aphasia often have decreased oral expression, which is nonfluent, often agrammatic and telegraphic. They usually have monotonous verbal output and slow speaking rate. Speech output consists of mostly content words; word-finding errors are occasionally evident. Individuals with Broca's aphasia typically have relative intact auditory comprehension skills but may have difficulty with the understanding of syntactically complex linguistic information. (Davis, 2007; Kearns, 2005; Norman & Baratz, 1979; Raymer, 2001). Adults with mixed aphasia often display significant deficits in both oral expression and auditory comprehension, yet may have relatively intact repetition skills for short utterances (Helm-Estabrooks & Albert, 2004; Norman & Baratz, 1979). Adults with global aphasia are severely impaired in all language modalities; they typically exhibit very limited auditory comprehension skills as well as severe oral expression deficits. Their preserved verbal output is restricted to automatisms, reactionary words and stereotypies, and meaningless syllables. (Collins, 2005; Davis, 2007; Norman & Baratz, 1979; Raymer, 2001).

Auditory comprehension and aphasia

PWA can show impairments in both comprehension and production. For many individuals, comprehension beyond the word level is impaired (Davis, 2007). Deficits of auditory comprehension are varied in individuals with aphasia, ranging from minimal difficulties understanding lengthy narrative speech in the presence of background noise to profound difficulties understanding short commands (Helm-Estabrooks & Albert, 2004).

Helm-Estabrooks and Albert (2004) suggested that auditory comprehension involves linguistic skills, but also attention, visual search and selection, and verbal memory. Murray, Holland and Beeson (1997) reported that individuals with mild aphasia caused by either frontal or posterior lesions showed deficits in attention and resources allocation, which negatively affected their auditory processing abilities.

One important factor that affects language comprehension in aphasia is the structural complexity of the sentences. Research has shown that it is difficult for some individuals with aphasia to understand complex sentences, such as passive sentences and embedded clause sentences (Shewan & Canter, 1971; Goodglass, Blumstein, Gleason, Hyde, Green, & Statlender, 1979). Davis (2007) stated that the language comprehension abilities of individuals with agrammatic aphasia are relatively preserved compared to their production. Individuals with agrammatic aphasic individuals demonstrate difficulty in understanding sentences of complex syntactic structures, particularly when there is no semantic support. Caramazza and Zurif (1976) found that both individuals with Broca’s and conduction aphasia had difficulty with the processing of certain syntactic structures. In their research, the comprehension of individuals with both Broca’s and conduction aphasia relative to reversible center-embedded sentences (e.g., The boy that the girl is chasing is tall.) and improbable center-embedded sentences (e.g., The boy that the dog is patting is fat.) was more significantly impaired than that of nonreversible center-embedded sentences (The apple that the boy is eating is red.). The results suggested that when the participants did not benefit from semantic plausibility and had to solely depend on syntax for understanding spoken sentences, their performance was significantly declined. Nicholas and Brookshire (1983) found that adults with mixed aphasia benefited from simplification of syntactically complex sentences, relative to auditory comprehension. For example, the adults with aphasia demonstrated better performance on expanded embedded clause sentences (e.g., The girl was eating an apple and she was pushed by the boy) than compact embedded clause sentences (e.g. The girl pushed by the boy was eating an apple).

Another factor that contributes to sentence comprehension is word order, which may help or impede PWA's ability to identify the thematic roles of nouns in a sentence. Passive sentences and object-relative sentences are more difficult than active sentences and individual-relative sentences to comprehend because the word order is no longer linear and the thematic role of the agent of the sentences cannot be assigned to the first noun (Davis, 2007). Thus, PWA will demonstrate chance-level performance in passive sentence comprehension (Berndt, Mitchum, & Haendiges, 1996) Researchers have found that semantically reversible sentences, in which both nouns can be the agent of a sentence, are more difficult than semantically irreversible sentences for individuals with aphasia, especially those with agrammatic or Broca's aphasia (Davis, 2007; Berndt et al., 1996). For example, "The boy kicked the girl" may be more difficult than "The girl picked a flower" to comprehend. When interpreting reversible sentences, PWA may rely on their world knowledge and consider the plausibility of the sentence rather than utilizing their impaired syntactic parsing skills (Deloche & Seron, 1981; Davis, 2007). For example, "The policeman arrests the thief" is more plausible based on our world knowledge. Berndt et al. (1996) investigated comprehension of individuals with agrammatic aphasia relative to both semantically reversible active and passive sentences. They obtained heterogeneous results: some participants demonstrated good comprehension of both active and passive sentences, some participants showed poor performance of both active and passive sentences, whereas others exhibited adequate understanding of active sentences but poor understanding of passive sentences. These mixed findings suggested that it is difficult to pinpoint causal factors that are responsible for sentence comprehension impairment in aphasia.

Language Context

The process of language comprehension is a process of interaction between contextual information and the input information (Hough & Pierce, 1993; Hough, Pierce & Cannito, 1989; Pierce & Beekman, 1985; Pierce & DeStefano, 1987). One type of context is linguistic context (Germani & Pierce, 1992; Hough & Pierce, 1993; Hough et al., 1989). Linguistic context can be a sentence containing the target word, a single sentence or a narrative paragraph preceding or following a target sentence. The linguistic context can be neutrally worded (e.g., The apple is good), or semantically supportive (e.g., The apple is sweet), or semantically contradictive (e.g., The apple is furry), or simply repeating the target words or target sentences (Brookshire, 1987; Germani & Pierce, 1992).

Another type of context is extralinguistic context, which includes an individual's prior knowledge, pictorial context, and situational context (Bransford & Johnson, 1972; Cannito, Hough, Vogel & Pierce, 1996; Hough & Pierce, 1993; Hough et al., 1997; Pierce & Beekman, 1985). World knowledge consists of knowledge of specific domains, which includes academic knowledge and procedural knowledge, and interpersonal knowledge, which includes knowledge of human needs, values, personality traits, etc. (Catts & Kamhi, 2005). An individual's world knowledge may determine the semantic plausibility of a sentence and thus facilitate his/her comprehension. Bransford and Johnson (1972) indicated that prior knowledge did not guarantee its facilitation for comprehension unless it became “an activated semantic context” (p. 724). In one of their experiments, the Context Before and Partial Context Before participants inspected the appropriate-context picture and the partial-context picture respective before listening to the recorded passage. It turned out that the Partial Context Before group’s performance was much worse than the Context Before group. The appropriate-context picture provided information that helped the participants to generate ideas that could have overlapped with the information in the passage, whereas the partial-context picture failed to provide such information although it contained the same elements as the appropriate-context picture (e.g., a man, a woman, a high building, a guitar, a loudspeaker, balloons, etc.) They suggested that the appropriate information must be present to create contexts during the ongoing process of comprehension.

The third type of context is paralinguistic context, which consists of prosody, stress, speech rate, prolongation of words, and intrasentence pauses (Brookshire, 1987; Kimelman, 1999; Wingfield, Peelle, & Grossman, 2003). Speech rate and prolongation of words both have an effect on auditory comprehension of listeners, particularly older adults, as auditory comprehension requires rapid processing of the speech input (Wingfield et al., 2003). Prosody can be addressed in different forms, including linguistic (e.g., He went home vs. He went home?), emotional (e.g., He went home vs. He went Home!), and emphatic (e.g., *Tom* stole the money vs. Tom stole the *money*) and it can be at word, sentence, or paragraph level (Kimelman, 1999).

Contextual influences on comprehension in aphasia

The facilitative effect of linguistic context is controversial relative to aphasia. Germani and Pierce (1992) reported that both predictive and non-predictive linguistic context aided comprehension with adults with aphasia relative to reversible passive sentences. These findings were consistent with those reported by Hough et al. (1989) who found that preceding narrative linguistic context, either predictive or non-predictive, facilitated the understanding of the target sentences for many individuals with aphasia. One explanation of the facilitative effect of linguistic context is that the context, particularly the predictive preceding narratives, limits the possibilities of events and makes one interpretation of a sentence more plausible than the other (Brookshire, 1987; Germani & Pierce, 1992; Hough et al., 1989). However, Cannito et al. (1996) found that predictive narrative context was beneficial to participants' understanding whereas non-predictive narratives produced no facilitative effect. They presented PWA with stimuli in each of three conditions: (1) reversible passive sentences in isolation, (2) reversible passive sentences following paragraphs not predictive of the individual/object relations of the target sentences, and (3) reversible passive sentences following paragraphs predictive of the individual/object relations of the target sentences. Black-and-white line drawings depicting two possible individual/object relations of the target sentence were shown to the participants either before or after the stimuli were presented and the participants were instructed to choose between the two pictures. They found that participants did not benefit from pictorial prestimulation, which may have been due to the low comprehension level of the individuals with aphasia; however, the participants did benefit from the predictive linguistic context, as indicated previously. The participants' performance was not facilitated by the non-predictive linguistic context, which might be a function of time post-onset of aphasia. Of interest, relative to the current investigation was that PWA in an acute recovery stage (1 week-1 month) did not benefit from predictive or non-predictive contexts whereas participants in a post-acute stage (1-6 months) were facilitated by predictive contexts. Furthermore, participants with chronic deficits

(6 months-5 years) benefitted from both predictive and non-predictive contexts.

Pierce and DeStefano (1987) reported that supportive context had a negative effect on the comprehension of PWA. They presented three-sentence narratives to eleven individuals with nonfluent aphasia. Either the entire signal or just the initial sounds of the target words, which were in the middle sentences, were presented. The narratives were divided into three groups: high context, medium context, and low context. Pierce and DeStefano (1987) found that the PWA performed more accurately when the auditory signal was intact and the context was not predictive. Unexpected, the adults with aphasia were significantly worse when the context was highly supportive regardless of whether the entire signal or just the initial sound of the target word was present. Thus, it appeared that the PWA depended on the context more than the auditory signals in language comprehension. The authors suggested that context may have a stronger influence on comprehension of PWA than the actual presence of auditory information.

Some researchers have suggested that linguistic context, even in its non-predictive form, may provide redundant information to help the comprehension of adults with aphasia. As the words appear repeatedly in the preceding paragraph, the individuals may become familiar with the words by the time they start to read the target sentence. While they read the target sentence, they can allocate minimal resources to word access; consequently, they have more processing resources to determine the relationship between the individual and the object of the sentence. (Cannito et al., 1986; Germani & Pierce, 1992; Hough et al., 1989).

When processing syntax, individuals with aphasia do not only infer the meaning from the target sentence per se; rather, their understanding also is based on world knowledge that tells them which interpretation of a sentence is plausible (Brookshire, 1987; Germani & Pierce, 1992). Jones, Pierce, Mahoney, and Smeach (2007) reported that individuals with aphasia were able to answer questions more accurately when the spoken paragraphs contained personally familiar contents (e.g., people, places). One reason might be that the individuals found the paragraphs containing familiar information interesting and thus, pay closer attention to them. Another interpretation is that familiar content could be viewed as a form of domain knowledge, facilitating integration of new information with prior knowledge, improving comprehension.

What is Working Memory?

The concept of working memory was developed from short-term memory. Short-term memory is defined as "a temporary storage component of working memory" (Davis, 2007, p. 78). The difference between working memory and short-term memory appears to be that working memory is involved with active manipulation of information in addition to storage function (Baddeley, 2003; Salthouse, 1994). Baddeley (1992) defined working memory as a system that provides temporary storage and manipulation of the information necessary for complex cognitive tasks, which includes language comprehension. Baddeley (1992; 1998) proposed a multi-component working memory system, comprising the central executive and two slave systems, the phonological loop, and the visuo-spatial sketchpad. The phonological loop, which holds and processes acoustic or speech-based information, is important to the comprehension of speech. The visuo-spatial sketch pad holds and processes visuo-spatial information, including features such as color, shape, and location of objects. The central executive is most important, responsible for coordinating resources between the two slave systems. More recently, Baddley (2003) suggested that working memory have a fourth component, the episodic buffer, which combines information from different modalities into chunks. He believed that working memory is of substantial importance to language processing.

Based on Baddeley's working memory model, Barrett, Tugade and Engle (2004) indicated that human behavior is individual to the interaction of automatic and controlled processing. They suggested that individuals with low working memory capacity have difficulty with complex sentences due to their inability to keep all necessary information in working memory. Furthermore, individuals with low capacity need longer time to respond to syntactically ambiguous questions.

Caplan and Waters (1999) found no connection between short-term memory impairment and sentence comprehension difficulty. They concluded that the resources used for syntactic processing in sentence comprehension are separate from verbal working memory capacity. Similarly, Friedmann, and Gvion (2003) found that the comprehension of the participants with aphasia related to relative clauses was not impaired by limited verbal working memory. They suggested that there were two types of working memory involved in sentence processing; that is, one syntactic WM for sentence comprehension and another phonological WM that is responsible for reactivation of word forms. In processing a sentence containing a lexically ambiguous word, all meanings of the word will be activated when the word is first encountered and only the meaning that appears to be appropriate for the context remains activated. As the sentence reaches the disambiguous point, the previous meaning will be discarded and another meaning will be reactivated. This should involve both semantic reactivation as well as reactivation of the word form. The phonological component of working memory is needed in reactivation of the word form. Therefore, reduced phonological working memory will hamper comprehension only when phonological reactivation is needed.

Aging and Working Memory

It is well established that working memory capacity declines with age (Byrne, 1998; Swanson, 1999; Wingfield, Stine, Lahar, & Aberdeen, 1988); however, the nature of the memory decline within the working memory system is still at debate. Wingfield et al. (1988) found that a loaded span test used to measure working memory capacity demonstrated remarkable age-related differences for a young group (20-40 years old) versus a young-old group of participants (elderly individuals below age 70) and between the young-old participants versus a group of old-old participants (elderly individuals of 70 and above). Salthouse, Babcock, and Shaw (1991) reported that young and older adults had similar structural and operational capacities for working memory. They explained that the age differences observed may lie in the notion that older adults were deficient in the process of stimulus encoding as compared to young adults. However, once information was encoded, this information is preserved and processed to the same degree in older adults and young adults. Another interpretation proposed by Salthouse et al. (1991) is that an age discrepancy in operational capacity may exist only when the internal representation becomes more complex or more abstract.

Salthouse (1994) suggested that working memory involves three components: storage capacity, processing efficiency, and coordination effectiveness. He proposed that speed of processing played a key role in the age differences in working memory. Fisk and Warr (1996) reported similar findings. They did not find any obvious age deficits in the phonological loop relative to Baddeley's model, nor did they find any evidence showing any specific age-related breakdown in the central executive. Instead, they proposed that age differences are ascribed to the speed or rate at which information is activated in the working memory system. Dobbs and Rule (1989) reported that aging had a considerable effect on the processes of working memory while it had lesser effect on storage. Contrary to Salthouse's notion (1994), they suggested that reduced working memory capacity was due to the agility of making changes in processing instead of the speed of processing per se.

Working Memory and Aphasia

Albert (1976) found that PWA have a general deficit in auditory verbal short-term memory as well as a selective deficiency in short-term memory for sequences. Peach, Rubin, and Newhoff (1994) analyzed the mismatch negativity (MMN) waveform latencies in participants with aphasia relative to examining attention skills and working memory capacity. They found that the PWA spent more time allocating fewer attention resources in detecting changes in auditory signals than a control group. Murray, Holland, and Beeson (1997) investigated attention and resource allocation impairments in individuals with mild aphasia. Sixteen adults with aphasia and eight control individuals were asked to complete verbal and nonverbal tasks in an isolation condition and in competition with a secondary task. It was found that the individuals with mild aphasia performed the listening tasks in a similar manner as the control group under optimal environmental conditions; however, they exhibited poorer performance under focused and divided attention conditions. This intermittent performance pattern exhibited by the individuals with mild aphasia indicated a deficit in attention and resource allocation rather than fatigue or comprehension deficit.

More recently, there appears to be a general consensus that many PWA have reduced working memory capacity (Caspari, Parkinson, PaPointe, & Katz, 1998; Francis, Clark, & Humphreys, 2003; Friedmann & Gvion, 2003; Haarmann, Just, & Carpenter, 1997; Wright, Downey, Gravier, Love, & Shapiro, 2007). Wright, Newhoff, Downey, and Austermann (2003) measured working memory skills of fluent and nonfluent adults with aphasia adults using a listening span task. They found that the PWA made significantly more errors than neurologically-intact adults, suggesting reduced working memory ability. In a review of neuroimaging studies, Wright and Shisler (2005) stated that as individuals with aphasia often have brain-damage affecting the left frontal or left parietal cortices, or have damage in pathways to these areas, this pattern of disruption may contribute to impairment in working memory capacity.

Working Memory and Comprehension in Aphasia

Working memory impairment appears to be one of the factors contributing to the comprehension deficits in aphasia (Caplan & Walters, 1997; Caspari et al, 1998; Davis, 2007; Hough et al., 1997). Miyake, Carpenter, and Just (1994) investigated the performance of typical individuals in a rapid serial visual presentation experiment. As word input rate increased, working memory capacity was reduced and fewer resources could be devoted to sentence comprehension. Therefore, when facing an exceptionally rapid word input rate, typical individuals demonstrated difficulty in syntactic comprehension similar to those experienced by individuals with aphasia. These findings led to the suggestion that reduced working memory capacity may contribute syntactic comprehension deficits in aphasia. Cannito et al. (1996) investigated comprehension of sentences under isolation conditions and in linguistic contexts with twenty-eight adults with aphasia. They suggested that limited availability of memory resources may have contributed to inaccurate syntactic interpretations. The PWA did not appear to have difficulty in determining the meaning of lexical items or assigning thematic roles. Thus, their comprehension deficits may be attributed to slow and effortful syntactic processing, which requires more allocation of processing resources. Thus, limited resources led to these individuals' reduced comprehension of complex sentences.

Hough et al. (1997) studied the performance of PWA when they were presented with sentences in isolation and in contexts. It was found that an older subgroup of individuals with aphasia demonstrated more accurate performance on passive sentences and poor performance on active sentences. They suggested that such findings may result from reduced working memory capacity, thus having a negative impact on auditory comprehension. As older individuals with aphasia may have reduced working memory capacity, they tend to pick the last noun as the agent of the target sentence. This is called the "immediacy effect".

Caplan and Waters (1997) studied sentence comprehension in PWA using sentence-picture matching tests. They found that determinants of sentence complexity were canonical order relative to the expected sequence of words and the number of propositions in a sentence. Therefore, they suggested that an important determinant of syntactic comprehension in individuals with aphasia was reduced resources available to process the task. Caspari et al. (1998) investigated the relationship between working memory and reading comprehension in aphasia. A listening span task and a reading span task were administered to 22 aphasic individuals to measure working memory capacity of the PWA. WM scores were then compared to reading comprehension ability as measured by the Reading Comprehension Battery for Aphasia (RCBA) (LaPointe & Homer, 1979). Results indicated that participants with smaller working memory capacities performed more poorly than those with larger working memory capacities in complex sentence comprehension. Martin and Feher (1990) posited that reduced short-term memory played an influential role in the comprehension of sentences with simple syntactic structure containing a large number of content words, but did not affect the processing of complex sentences.

Summary and Rationale

Research has shown that there is an association between working memory limitation and language comprehension difficulty in typical adults. Working memory is involved with temporary storage and active manipulation of information needed for complex cognitive tasks. It has been found that many individuals with aphasia show a deficiency in auditory comprehension, which may be influenced by decreased working memory capacity. Aging may be associated with reduced working memory functioning, regardless of pathology. As language processing requires adequate working memory resources, WM capacity reductions may contribute to comprehension deficits. Therefore, deficits in auditory comprehension for PWA may result from combined decreases in working memory as the result of the aging process, as well as linguistic deficits that are the basis of aphasia. On the other hand, linguistic context, either predictive or non-predictive, has been found to facilitate comprehension for individuals with aphasia. This is because context provides redundant information and allows for more allocation of their limited processing resources to determining the relationship of the agents and actions in the information. Furthermore, context may limit the possibilities of events and make one interpretation of a linguistic unit more plausible than the other in reversible sentences.

Understanding language comprehension abilities in PWA plays an important role in clinical decisions relative to both assessment and treatment. Investigating language performance variability in aphasia relative to age, working memory capacity, and utilization of linguistic context to enhance auditory comprehension may provide more insight into the ability to process information in daily listening situations relative to adults with aphasia. However, few studies have been conducted that specifically examines the effects of both age and working memory capacity on auditory comprehension abilities with aphasia. Information is needed to understand to what extent aging affects working memory capacity and to understand the effects of different severity level of aphasia on working memory capacity. The degree to which working memory capacity affects various modalities is unknown. Moreover, the influence of different linguistic contexts on auditory comprehension in adults with aphasia and the effects of working memory capacity on these individuals' ability to take advantage of different contextual conditions in auditory comprehension have yet to be examined. In order to help PWA improve their language performance in their daily life, an investigation of the effect of linguistic context, age, and working memory on auditory comprehension of individuals with aphasia is needed. The results of this study may provide clinicians with further knowledge to help individuals with aphasia become better communicators.

Plan of Study and Experimental Questions

The primary purposes of this investigation are to explore: (1) the influence of age on working memory capacity in individuals with aphasia; (2) the extent to which working memory capacity impacts auditory language comprehension in young and older adults with aphasia; (3) the effect of linguistic context on the auditory comprehension of young and older individuals with aphasia; and (4) the influence of working memory capacity on ability to utilize context as a means of improving auditory comprehension in PWA. In the current investigation, two groups of adults with aphasia, one group younger than 60 years and one older than 60, completed tasks investigating working memory capacity (Listening Span Task), comprehension ability (Token Test), expression level (Reporter's Test), grammatical competence, and contextual influences on auditory linguistic comprehension. Performance on these tasks will be examined relative to ability to use linguistic contexts in the comprehension of auditory information, specifically, passive and active sentences presented with context (predictive and non-predictive) and without context in isolation. The following experimental questions will be answered:

1) Is there an effect of working memory as measured by accuracy performance on a listening span task as a function of age for the PWA?

2) Is there an effect of aphasia severity as measured by the Western Aphasia

Battery –Revised Aphasia Quotient (WAB-R AQ) as a function of age for the PWA?

3) Is there an effect of auditory comprehension as measured by accuracy on the modified Token Test as a function of age for the PWA?

4) Is there an influence of aphasia severity on working memory and/or comprehension?

5) Is there an influence of working memory on comprehension?

6) Is there a difference between accuracy on active versus passive sentences for the three context conditions (isolation, predictive, and non-predictive) on the Linguistic Context Task? Relative to WM? Comprehension? Aphasia severity? Age?

7) Is there a difference between accuracy on predictive versus non-predictive conditions for both active and passive sentences on the Linguistic Context Task? Relative to WM? Comprehension? Aphasia Severity? Age?

8) Is there an effect of the differences between predictive or non-predictive linguistic context versus isolation for passive and active sentences (Linguistic Context Task) as a function of working memory, comprehension, age, or aphasia severity for the PWA?

Chapter II

Method

Participants

Sixteen adults with aphasia were recruited from eastern North Carolina to participate in this investigation. All were aphasic as the result of a left hemisphere cerebrovascular accident (CVA). These individuals were divided into two groups based on age. The older group consisted of eight adults older than age 60; the younger group consisted of eight adults younger than 60. All individuals were asked to fill out a questionnaire to ensure that they were free of a history of any pre-existing stroke communication problems, alcoholism, substance abuse, dementia, or psychosis prior to participation in the study. A copy of the questionnaire can be found in Appendix A.

All participants passed a modified hearing screening with at least 40 dB HL at 1000 Hz in their better ear. All individuals were native speakers of English. All participants had a minimum of a 4^{th} grade education level to ensure that they could comprehend all pre-experimental and experimental stimuli. Although time post-onset stroke were not controlled, this variable was considered relative to any remarkable differences between the younger and older groups with aphasia. An independent t-test conducted on these data yielded no significant difference between the groups ($p>.05$). Participant demographic data are summarized in Table 1.

Pre-experimental Testing

Two subtests of the *Boston Diagnostic Aphasia Examination-III* (BDAE III) (Goodglass, Kaplan & Barresi, 2000), Oral Commands and Complex Ideational Material, were administered to all of the individuals with aphasia. Oral Commands tests an individual's ability to carry out one- and multiple-step directions presented auditorily. In the Complex Ideational Material

Table 1. Demographic information and pre-experimental test scores of participants

Name	Gender	Age	Months Post-stoke	Education level	BDAE (Max=27)
Young					
1	M	54	56	Graduate school	15
2	M	56	56	High school	18
3	M	53	29	College	5
4	M	58	60	Graduate school	20
5	F	46	140	High school	7
6	F	54	7	High school	9
7	M	58	3	High school	21
8	F	45	3	High school	22
Mean		53	44.25		14.66
SD		4.99	45.85		6.74
Range		45-58	3-140		5-22
Old					
9	M	74	91	Graduate school	6
10	M	73	12	High school	4
11	M	61	57	College	6
12	M	63	197	College	18
13	F	63	59	College	14
14	F	69	15	College	16
15	F	84	115	High school	18
16	F	86	6	5th grade	21
Mean		71.63	69.00		12.25
SD		9.53	64.77		7.50
Range		61-86	6-197		4-21

subtest, the individual is asked to respond yes or no to questions presented orally, relative to information illustrated in a short vignette. To be eligible for participation in the current investigation, each individual had a combined auditory comprehension score on these two subtests of no greater than 22 but no less than 4 (max =27) to ensure presence of impairment as well as ability to perform the experimental tasks, respectively. Similar BDAE criteria for these two subtests have been used in previous research (Cannito et al., 1996; Hough et al., 1989; 1997; Pierce, 1988; Pierce & Beekman, 1985). Data are in Table 1.

The *Western Aphasia Battery-R* (WAB-R) (Kertesz, 2006) was administered to all participants to determine the presence and extent of aphasia. Severity of aphasia is provided on the test through the Aphasia Quotient (AQ). As aphasia severity is one of the explanatory variables for this investigation, these data are presented in Table 3 in the Results section.

General Procedures

Participants were recruited from the University Health Systems of Eastern North Carolina, including East Carolina University (ECU) Speech-Language and Hearing Clinic, Pitt County Memorial Hospital, Pitt Regional Rehabilitation Facility, and other rehabilitation facilities throughout eastern North Carolina. The majority of testing was conducted individually by the primary investigator in a quiet clinic room at the ECU Speech-Language and Hearing Clinic in Greenville, NC; however, some participants were tested in other health facilities or their home as they could not travel to this facility.

This study was approved by University and Medical Center Institutional Review Board of East Carolina University. A copy of the UMCIRB HIPAA Authorization Checklist/Approval Form can be found in Appendix B. A written copy of the UMCIRB Informed Consent form (Appendix C) was presented to each participant prior to testing. The form was read to the participants by the primary investigator and the benefits of this investigation were discussed. Additional time and explanation were provided as needed. The Informed Consent form needed to be understood and signed by each participant.

The pre-experimental tests, including hearing screening, parts of the BDAE-III, WAB-R, and the five experimental tests, including listening span, comprehension task, production task, sentence assembly, and the contextual influence task, were administered in the same order to each participant in a consecutive manner. Task administration took from two to three hours for each participant on average and was conducted in one or two sessions.

Experimental Testing

Measurement of Working Memory Capacity

Listening span task A listening span task was administered to measure each individual's working memory resource capacity. The task was a modified version of Daneman and Carpenter's (1980) reading span task with modifications by LaPointe and Engle (1990) and Caspari (1998). The task included sentences of six levels, whose difficulty increased by adding one more sentence than the previous level. For example, each stimulus trial at level one included one sentence whereas each trial at level two included two sentences. Sentences were approximately five to six words in length including a to-be-recalled word. They were active declarative sentences (e.g., "Bob rode his bike"). The terminal words were either nouns or verbs that occurred frequently in English and that were concrete in nature (e.g., "apple", "walk"). Words with frequency of occurrence in the English language ranging from 8/million to 2110/million with a mean of 156/million (Francis & Kucerra, 1982) were placed in categories in accordance with their frequency of occurrence value. Words were then selected randomly from the categories and paired with sentences to which the terminal words were not related. Foils presented along with the terminal words were selected randomly from a pool of words with similar frequency and ranking of imageability as the terminal words, but were unrelated to the terminal words. Each time that the target word was presented, an additional foil was presented, in the form of a picture, to ensure that guessing would be lower than 50%. Participants were able point to pictures demonstrating the target words in any order relative to accuracy. A copy of all stimuli used in the Listening Span task can be found in Appendix D.

All pictures were pre-tested by four judges who were typically aging adults with no history of neurological impairment and were within the same age range as the aphasic individuals. Judges were asked to point to the pictures representing the terminal words. Ambiguous pictures were replaced and new pictures were used in the task.

Each individual was presented with a series of sentences and then a separate word immediately after the sentence, both visually and orally; after reading the sentences, the participant was asked to recognize the word that was presented right after the sentence by pointing to the corresponding picture. This picture was presented at the same time with two foils, so the selection was from a field of three items. The participant was asked to answer one or two randomly determined comprehension questions about the presented sentences. A recognition response was chosen instead of spoken recall to ensure that the individuals' performance was not be affected by their impaired verbal skills.

Procedure Participants were asked to listen to a sentence or sentences, to remember the terminal word(s) for later recall, and to answer questions about the sentences after the recognition task. The task consisted of both visual and auditory presentation of the sentences in order to facilitate each participant's comprehension. The sentences were presented auditorily with normal intonation and at a rate of approximately 3-4 words per second. The terminal word was presented immediately after the sentence without a pause. Three practice trials were conducted to make sure that the participants understood the task requirements.

At the first level, there were three trials; each trial had one sentence and one terminal word. Each participant was presented with a 3x5 white index card with one typed sentence and one terminal word, which were read orally. Immediately after the oral presentation, the index card was flipped over to show the picture corresponding to the target word and two foils. The participant was asked to identify the target picture by pointing. This was considered one trial. The participant had to select the target pictures correctly in two of the three trials in order to proceed to the next (second) level. At the second level, the participant was presented with an index card containing two sentences and two terminal words, which were sequentially read orally. The card was designed in such a way that only one sentence and terminal word would be shown at a time. The participant needed to store both terminal words in working memory for subsequent recall. Immediately after the oral presentation of both sentences and terminal words, the index card was turned over to show pictures representing both target words and foils. The participant was asked to point to both target pictures, regardless of order. Again, the participant had to select the correct target pictures for at least two of the three trials in order to proceed to the next level. Each level included three trials, which had an additional sentence and terminal word to be retained for later recognition than the previous level. Testing was discontinued when the participant failed to select the correct target pictures in at least 2 out of 3 trials at any level.

One random comprehension question was asked about the sentences presented per trial. Questions were of the forced alternative type (e.g., a forced alternative question about the sentence “He drank some milk” was “Did he go drink some milk or juice?”). A copy of the task instructions for the Listening Span task can be found in Appendix D.

Scoring procedure A listening span measurement of 1.0 would be given if a participant identified the correct target pictures on all three trials at level one and a measurement of 2.0 would be given if the participant selected the target pictures on all three trials at level two. Partial credit (0.5) would be given if a participant correctly selected the target pictures on two of the three trials at a level. A measurement of less than 1.5 was considered as low span measurement whereas a measurement of 3.0 or above was considered high span working memory.

Post hoc test A post hoc test was administered to ensure that memory failure was the only reason accounting for error responses on the listening span task. The participant was asked to point to the target pictures corresponding to the terminal words they missed in the testing as the examiner presented the words orally. Criterion for passing was 80%.

Measurement of Performance Variability in Language

A series of modified tasks examining comprehension, production, and sentence assembly tasks were constructed to examine language performance in individuals with aphasia.

Comprehension task A modified version of the Token Test (Caspari, 1998) was administered to measure the individuals' comprehension level and investigate the influence of WM on comprehension in aphasia. The tokens included five different colors, including blue, black, yellow, white and red, two shapes, circle and rectangle, and two sizes, large and small. There were three levels of this test, each level having ten commands structured in increasing length and difficulty.

In comprehension task 1, only the large tokens were used. Participants were required to point to or place one or more tokens that were different in color and shape. This task was designed for participants with WM spans of two or less. In comprehension task 2, which was designed for participants with WM spans of three or more, all twenty tokens (both large and small) were used. The participants were required to point to or place one or more tokens that were different in color, shape, and size. The commands in comprehension task 2 were longer and more difficult than those in comprehension task 1. Comprehension task 3 was designed for participants who were unable to perform comprehension task 1. In this task, five tokens of different colors and different shapes were used and the individuals were required to point to one token that was referred to by color. A copy of the stimuli and task instructions for the comprehension task can be found in Appendix E.

In comprehension task 1, the 10 large tokens were arranged in two rows; in comprehension task 2, the tokens were arranged in four rows; in comprehension task F, the tokens were arranged in one row. Instructions and commands were presented auditorilly with normal intonation contours at the rate of 3-4 words per second. The researcher repeated sentences upon request by the participants.

Scoring procedure A comprehension measurement of 0.5 was given if a participant identified the correct color, shape, size, or position for each stimulus item. For example, when being instructed to "put the little red circle on top of the big blue rectangle", if a participant followed the direction accurately, a measurement of 3.5 would be given; if the participant instead put the big red circle under the little blue rectangle, a measurement of 2 would be given. The data used in statistical analysis was the overall score on the task.

Production task The production task was a revised version of the Reporter's Test (De Renzi & Ferrari, 1978), modified by Caspari (1998). It utilized tokens of five different colors, blue, black, yellow, white, and red, two shapes, circle and rectangle, and two sizes, large and small. The task consisted of three levels, each level including ten actions to be performed by the investigator, which differed in terms of length and difficulty.

In production task 1, only the large tokens were utilized. The individuals were required to describe actions performed by the investigator after the examiner pointed to or moved one or more tokens that were different in color and shape. This task was designed for participants with a WM span of two or less. Production task 2 utilized all twenty tokens. The participants were required to describe the actions of the examiner after the investigator pointed to or moved one or more tokens that were different in color, shape, and size. This task was constructed for individuals with a WM span of three or more. In production task 3, five tokens of different colors and different shapes were used. Participants were asked to describe the actions of the examiner only in terms of color while they pointed to or moved one or more of five tokens according to instruction of the task.

In production task 1, the 10 large tokens were arranged in two rows; in production task 2, the tokens were arranged in four rows; in production task 3, the tokens were arranged in one row. The researcher repeated actions upon request by the participant.

A pre-test was conducted and if necessary, training was provided to ensure that participants could match and identify the colors, shapes, and sizes used in this task with at least 80% accuracy. Practice trials were conducted to ensure that each participant understood the requirements of the task. A copy of all stimuli and task instructions for the production task can be found in Appendix F. All participant data for this task are presented in Appendix G.

Scoring procedure A production measurement of 0.5 was given if a participant identified the correct color, shape, size, or position for each stimulus item. For example, when the examiner performed the action of "placing the little red circle on top of the big blue rectangle", if a participant reported the correct action, a measurement of 3.5 was given; if the participant reported that "the big red circle was placed under the little blue rectangle", a measurement of 2 was given.

Sentence assembly task The sentence assembly task was administered to all individuals to measure their grammatical competence. It was a modified version of a sentence assembly task (Kolk & Van Grunsven, 1985), modified by Caspari (1998). It consisted of ten sentences, including five active and five passive sentences. For each sentence, there was a black-and-white line drawing describing the subject-object relation of the sentence. All the subjects and objects in the pictures were animate. Each sentence was broken into its component parts, which were typed on three separate white cards (e.g., The farmer/ hit/ the boy) or four separate white cards (e.g., The man/ was kissed/ by/ the woman). Each picture was presented with its sentence component cards. The cards were arranged in a randomized order in front of the participant, who was required to put the parts together according to the picture he was shown. The examiner could help read the words upon request. A pre-test was administered to ensure that the participant was able to accurately identify all the nouns used in the sentences. The participant was asked to select the correct pictures as the examiner named the nouns. A copy of the stimuli and task instructions for the sentence assembly task can be found in Appendix H. All participant data for this task are presented in Appendix I.

Scoring procedure A measurement of 0.5 was given if a participant put a card in the right position. For example, if a participant rearranged the cards to form a sentence of "The girl chases the boy", a measurement of 1.5 was given; if a participant rearranged the cards to form a sentence of "Chases the girl the boy", a credit of 0.5 was given. The overall score on the task was used in statistical analysis.

Contextual Influences task

Materials Materials for this task were originally developed by Hough et al. (1989), with additions by Cannito et al. (1996) and Hough et al. (1997). The task consisted of 13 items and 2 practice items, in each of six conditions:(1) reversible passive sentences presented in isolation; (2) reversible active sentences presented in isolation; (3) reversible passive sentences preceded by paragraphs that predict the specific subject-object relations of the target sentence; (4) reversible active sentences preceded by paragraphs that predict the specific subject-object relations of the target sentence; (5) reversible passive sentences preceded by paragraphs that do not predict the specific subject-object relations of the target sentence; and (6) reversible active sentences preceded by paragraphs that do not predict the specific subject-object relations of the target sentence. Example stimuli are provided in Table 2. All stimulus items were randomized within the task. For each stimulus item, four pictured response choices were presented. The pictured choices were black-and-white line drawings that depicted the two possible subject-object relationships of the target sentences, the subject-object relationship of a related sentence, and the subject-object relationship of an unrelated sentence. A copy of all stimuli for the contextual influence task is presented in Appendix J.

Instrumentation The linguistic context task was recorded into SuperLab Pro 4.0 software (Cedrus Corporation, 2006) on a Dell X12-04660 laptop. The task stimuli were presented digitally through the auditory channel with picture choices presented visually. The stimuli were divided into 4 blocks, each of which ran for approximately 15 minutes. A response pad Cedrus RB-530 was used for participant response entry.

Procedure A pre-test was administered to ensure that all participants were able to identify the nouns used in this experimental test by choosing between two picture choices with at least 80% accuracy. Four pictures were presented to the participant visually and a noun was presented digitally via the computer. The participant was asked to point to the picture that

Table 2. Sample paragraphs of active and passive sentences

Isolated context for active sentences The nurse called the doctor.
Predictive context for active sentences Both nurses and doctors work in a hospital. This hospital was overrun by patients. A nurse began checking on the condition of a patient whose heart monitor was buzzing. Suddenly, there was a frantic call through the ward. The nurse called the doctor.
Non-predictive context for active sentences Both nurses and doctors work in a hospital. This hospital was overrun by patients. A nurse began checking on the condition of a new patient. Suddenly, there was a frantic call through the ward. The doctor called the nurse.
Isolated context for passive sentences The doctor was called by the nurse.
Predictive context for passive sentences Both nurses and doctors work in a hospital. This hospital was overrun by patients. A nurse began checking on the condition of a patient whose heart monitor was buzzing. Suddenly, there was a frantic call through the ward. The doctor was called by the nurse.
Non-predictive context for passive sentences Both nurses and doctors work in a hospital. This hospital was overrun by patients. A nurse began checking on the condition of a new patient. Suddenly, there was a frantic call through the ward. The nurse was called by the doctor.

matched the target word. Stimuli could be repeated upon request directly after the item was presented. If the participant failed to identify the correct picture, the examiner would identify it. The participant would be asked to try again. The task would be discontinued if the participant scored less than 80% after training.

Relative to practice items for the experimental task, two practice stimuli were administered to ensure that participants understood the task procedure. After a practice item was presented digitally via the computer, participants were asked to choose between the four pictures, one of which represented the target stimuli. If there was no response after 30 seconds or the participant chose an incorrect picture, the examiner would present the stimulus item again and had the participant try to choose the picture that represented the target. If the participant still chose an incorrect picture or did not respond, the examiner would point to the correct picture and show the participant which picture went with the particular stimulus item. Then the second practice stimulus would be presented. The task would be discontinued if the participant failed to respond accurately for the two practice items. A copy of the task instructions for the Contextual Influence task is presented in Appendix K.

In the experimental test, the stimulus items mentioned previously were presented digitally via SuperLab Pro 4.0 (Cedrus Corporation, 2006) on the Dell computer. Participants were instructed to “show me what happened” by choosing between the four pictures, which were presented visually via the Dell computer. Instructions and/or stimuli were repeated upon request or if participants did not respond after 20 seconds; however, oral feedback was not be provided if the participant failed to respond or chose the wrong picture. The time interval between presentation of the auditory stimuli and presentation of the stimuli pictures was 4 seconds.

Scoring Procedure A score of 1 was given if a participant chose the correct picture corresponding to the auditory stimulus item. No credit was given if a participant chose the wrong picture or did not make a choice. Error choices were noted and recorded. Each of the items was scored separately and overall performance on the task was used in data analysis.

Data Analysis

Group means, standard deviations, and ranges for working memory capacity, comprehension, production, sentence assembly, and the contextual influences tasks were compiled. Tables were constructed to illustrate performance of the younger and older groups relative to working memory capacity, severity of aphasia, auditory comprehension, and accuracy performance relative to the different linguistic contexts. Paired sample t-tests and multiple regression analysis and/or correlations were conducted to analyze the influence of working memory capacity, age, comprehension, and severity of aphasia on aphasic individuals' ability to use linguistic context in auditory comprehension within and between the two groups.

Chapter III

Results

The purposes of this study were as follows: to investigate the influence of linguistic context on auditory comprehension in individuals with aphasia; to explore these influences considering the effects of age, working memory, aphasia severity, and auditory comprehension; and to examine the relationships among age, working memory, aphasia severity, and auditory comprehension in adults with aphasia.

The first set of experimental questions addressed the effects of the explanatory variables of interests upon one another, including age, working memory capacity as measured by the Listening Span task, comprehension ability as measured by the modified Token Test, and severity of aphasia as determined by the Aphasia Quotient on the WAB-R. Scatter plots were produced to examine the relationships between these variables. Descriptive statistics, in the form of means, standard deviations, and ranges for these variables are in Table 3. Individual scores for Listening Span (Working Memory), modified Token Test (Auditory Comprehension), and WAB-R AQ (Aphasia Severity) are presented in Appendices L, M, and N, respectively.

Age and Working Memory

The first experimental question specifically addressed the effect of age as a continuous variable on WM as measured by accuracy on the Listening Span task. A scatter plot depicting the relationship between age and working memory is displayed in Figure 1. The plot revealed no apparent relationship between age and working memory capacity. Table 4 provides Pearson Product Moment correlation values between working memory, age, severity of aphasia and auditory comprehension. As can be seen in Table 4, a Pearson Product Moment correlation conducted between working memory and age yielded no significant findings. A score of less

Table 3. Means, standard deviation, and ranges for age, aphasia severity, working memory, and auditory comprehension

Groups	Age	Aphasia severity (WAB-R AQ) (Max=100)	Working memory (Max=21)	Auditory comprehension (Max=29)
Old				
Mean	71.63	54.00	0.88	14.63
SD	9.53	32.38	0.44	12.21
Range	61-86	3.00-89.30	0-1.50	0-28
Young				
Mean	53.00	62.30	1.31	17.31
SD	4.99	26.04	0.92	7.79
Range	45-58	13.30-88.60	0.5-3.5	0-26
Combined				
Mean	62.31	58.18	1.09	15.97
SD	12.10	28.70	0.74	9.99
Range	45-86	3.00-89.30	0-3.50	0-28

Working Memory: measured by Listening Span
Aphasia Severity: measured by the Western Aphasia Battery-Revised Aphasia Quotient
Comprehension: measured by modified Token Test

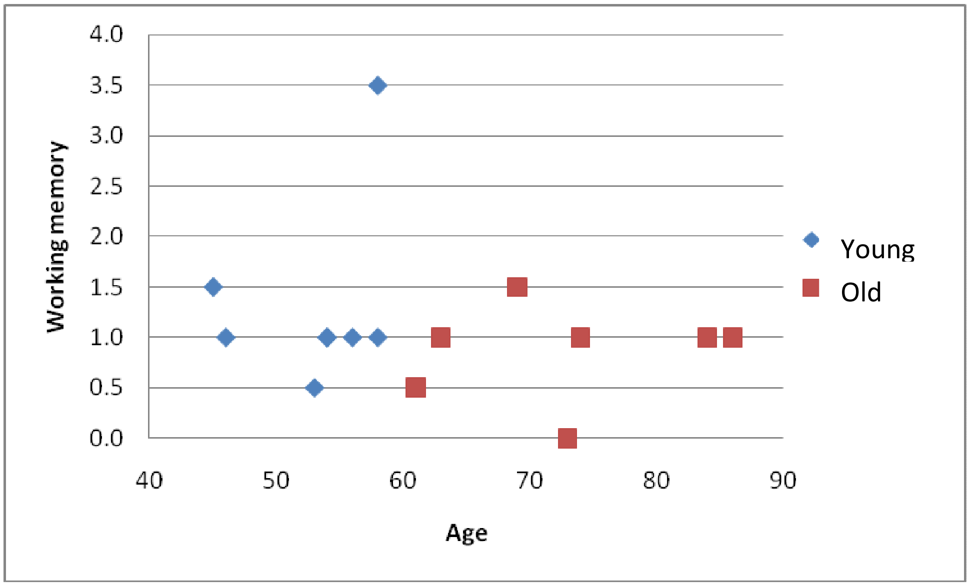

Figure 1. Scatter plot: Relationship between age and working memory

Table 4. Pearson Product Moment Correlations (r-values) among age, working memory, aphasia severity, and auditory comprehension

	Aphasia Severity	Comprehension	Working memory
Auditory comprehension			
Young	0.81*		
Old	0.84**		
Combined	0.83**		
Working memory			
Young	0.45	0.65	
Old	0.67	0.66	
Combined	0.50*	0.57*	
Age			
Group	0.05	0.10	-0.16

Note. *p<.05. **p<.01.

than 1.5 was considered as low working memory span whereas a score of 3.0 or above was considered as high working memory span. Among the 16 participants, ranging from 45 to 85 years of age, only one young participant scored 3.5 on the WM measure, while the other young participants and all older participants scored 1.5 or below.

Age and Aphasia Severity

The second experimental question addressed the effect of aphasic severity as measured by the Aphasia Quotient (AQ) on the WAB-R as a function of age as a continuous variable. A scatter plot displaying the relationship between age and aphasia severity is presented in Figure 2. Results indicated no observed relationship between age and aphasia severity. Pearson Product Moment correlation between these variables (Table 4) yielded no significant findings. On the WAB-R, the higher the AQ, the less severe the aphasic impairment. Among the young group, one patient was very severely impaired (0-25), one was severe (26-50), four were moderate (51-75) and two were mild (≥76); among the older group, two were very severe, two were severe, one was moderately and three were mildly impaired relative to aphasia severity.

Age and Auditory Comprehension

The third experimental question addressed the effect of age as a continuous variable on auditory comprehension as measured by accuracy on the modified Token Test. A scatter plot depicting the relationship between age and auditory comprehension is displayed in Figure 3. No apparent relationship was observed between age and auditory comprehension. Pearson Product Moment correlations between these variables (Table 4) yielded no significant findings. Comprehension scores for the young group ranged from 0 to 26.5; comprehension scores for the older group ranged from 0 to 29.

Working memory, Auditory Comprehension, Aphasia Severity

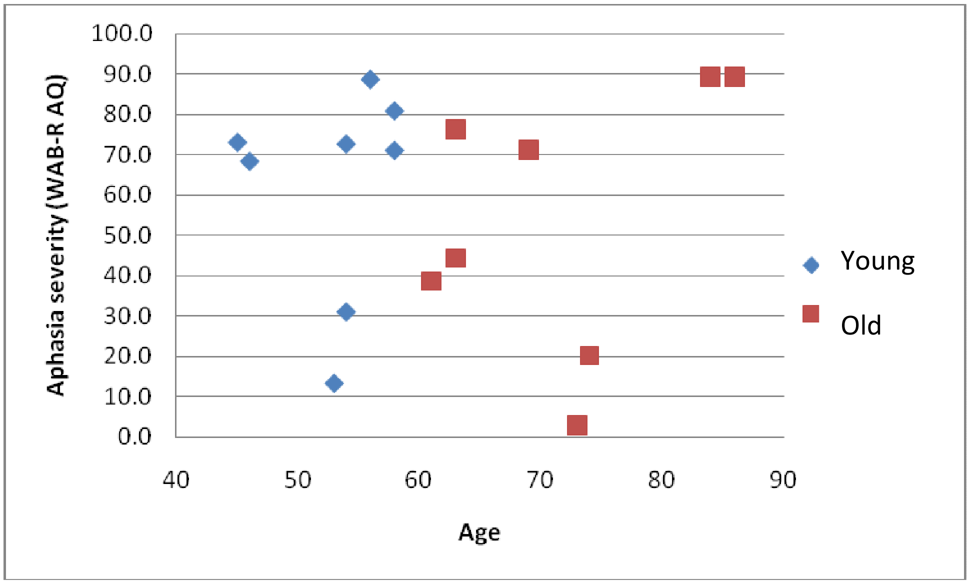

Figure 2. Scatter plot: Relationship between age and aphasia severity

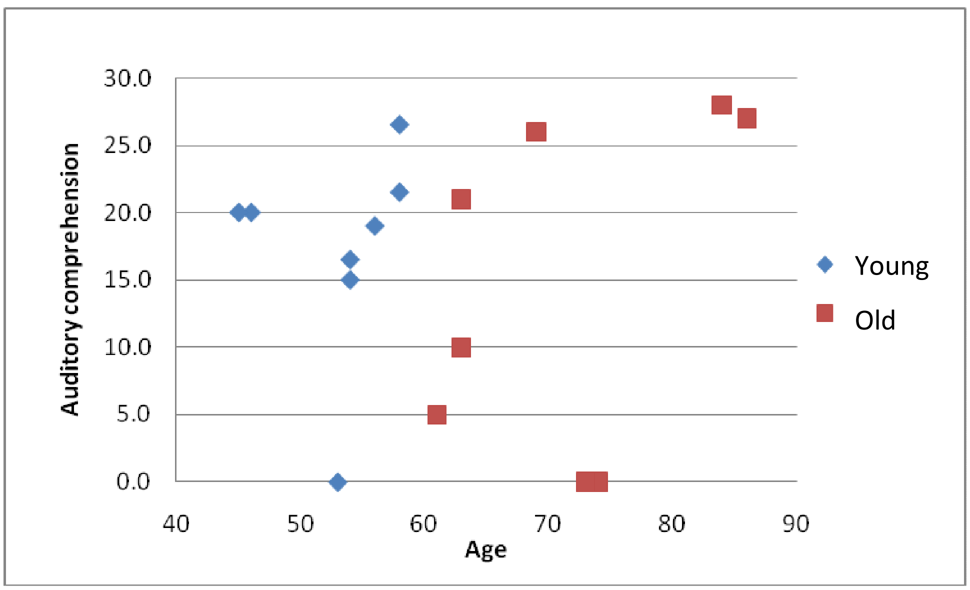

Figure 3. Scatter plot: Relationship between age and auditory comprehension

Relationships between WM capacity and auditory comprehension, WM capacity and aphasia severity, and comprehension and severity of aphasia were examined. Scatter plots depicting these relationships are displayed in Figures 4-6, respectively. Slopes for linear regression lines were calculated. For auditory comprehension and WM, the slope of regression line was 7.74 ($p=0.021$). These findings indicate that auditory comprehension scores on the modified Token Test increased as WM capacity as indicated on Listening Span, increased. Similarly, for WM and aphasia severity (WAB-R AQ), the slope of regression line was 0.01 ($p=0.049$), suggesting that working memory capacity was decreased with increasing severity of aphasia. For auditory comprehension and aphasia severity, the slope of regression line was 0.28 ($p<0.0001$), indicating that auditory comprehension performance decreased with increased severity of aphasia. Pearson Product Moment Correlation coefficients were calculated for all participants to examine the strength of the relationship among these explanatory variables. Correlations coefficients are displayed in Table 4. Statistically significant positive correlations were observed between: auditory comprehension and WM capacity, WM and severity of aphasia, and severity of aphasia and auditory comprehension.

Effect of Linguistic Context on Auditory Comprehension

The next set of experimental questions addressed the influence of linguistic context on comprehension as determined by accuracy performance on the Linguistic Context task. Mean performance for each of the three conditions for both the young and older groups as well as combined performance on this task are presented in Table 5. Individual performance for each participant on the linguistic context task for all conditions is presented in Appendix O.

For the Linguistic Context task, the experimental questions addressed examination of performance differences for the predictive and non-predictive contexts relative to the isolation

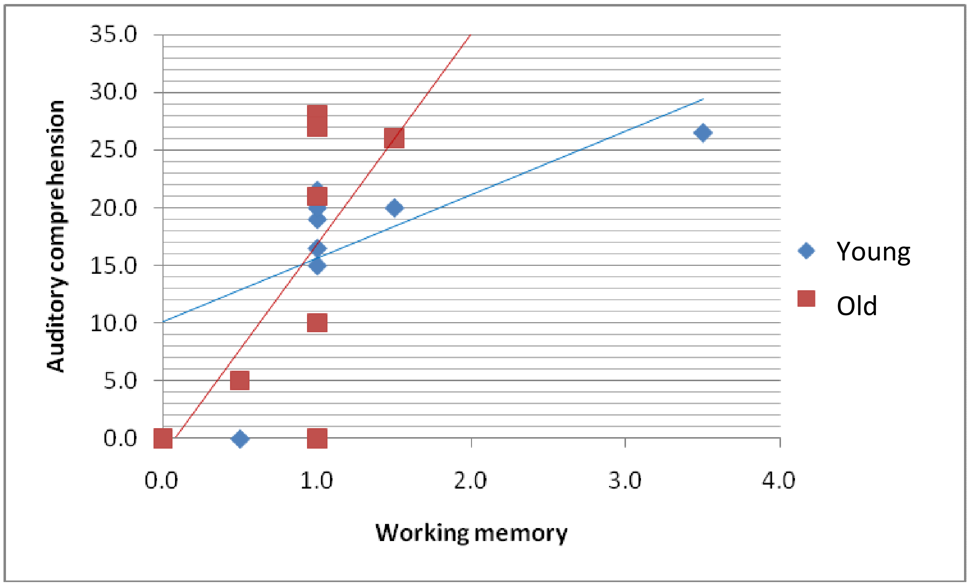

Figure 4. Scatter plot: Relationship between auditory comprehension and working memory.

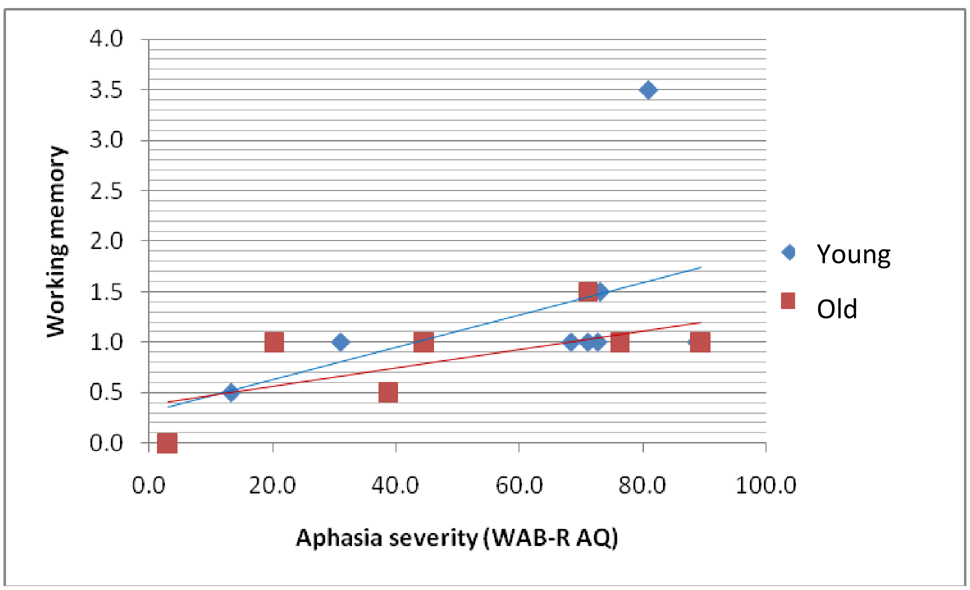

Figure 5. Scatter plot: Relationship between severity of aphasia and working memory.

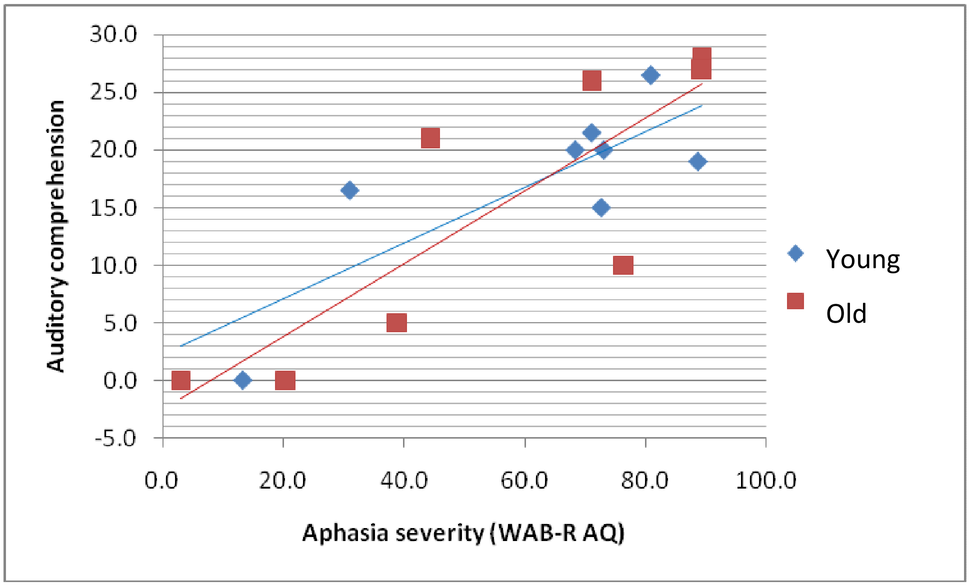

Figure 6. Scatter plot: Relationship between severity of aphasia and auditory comprehension.

Table 5. Mean performance on contextual conditions for the Linguistic Context task

Groups	Active sentences (Max=30)			Passive sentences (Max=30)		
	Isolated	Predictive	Non-predictive	Isolated	Predictive	Non-predictive
Young	18.50	19.50	23.75	15.50	18.50	18.25
Old	14.50	14.75	16.25	13.13	15.25	14.50
Combined	16.50	17.13	20.00	14.31	16.88	16.38

condition for both active and passive sentences. Furthermore, differences on active versus passive sentences relative to the three conditions of isolation, predictive, and non-predictive contexts were examined as well as differences between predictive and non-predictive conditions for both active and passive sentences. Differences in these comparisons were examined in regard to relationships to WM (Listening Span), auditory comprehension (modified Token Test), aphasia severity (WAB-R AQ), and age. Additionally, amount of benefit or decrement relative to improvement in performance on predictive and non-predictive paragraph contexts in comparison to isolated sentences was computed as difference scores for both groups.

Group performance with the predictive and non-predictive preceding paragraphs relative to the sentences in isolation was compared for both active and passive sentences using paired samples T-Tests. These results are indicated in Table 6. For the active sentences, the results revealed a significant difference between accuracy performance on the non-predictive context verses isolated sentences ($p<.05$). These findings indicate significantly better comprehension for non-predictive context than for sentences in isolation for active sentences. No significant differences were found between accuracy performance on predictive context and sentences in isolation for the active sentences. For the passive sentences, results revealed significant differences between performances for both predictive and non-predictive contexts versus isolated sentences ($p<.05$). Thus, for passive sentences, comprehension performance was significantly better for either context condition than sentences in isolation, with greater facilitation for predictive context.

The differences for comprehension of predictive contexts for active sentences were compared to differences for comprehension of non-predictive active sentences for each participant. A scatter plot depicting the relationship between these variables is displayed in

Table 6. Paired differences between isolated and predictive/non-predictive contexts for active and passive sentences

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference: Lower	95% Confidence Interval of the Difference: Upper			
Isolated active – predictive active	-.62500	3.94757	.98689	-2.72851	1.47851	-.633	15	.536
Isolated active – nonpre[1] active	-3.50000	3.50238	.87560	-5.36629	-1.63371	-3.997	15	.001*
Isolated passive – predictive passive	-2.56250	4.47167	1.11792	-4.94528	-.17972	-2.292	15	.037*
Isolated passive – nonpre passive	-2.06250	3.66003	.91501	-4.01279	-.11221	-2.254	15	.040*

Note. $p<.05$
[1]Non-predictive context

Figure 7. Examination of the data indicated that 8 out of 16 participants demonstrated improvement relative to predictive contexts for active sentences whereas most participants (n = 13) benefited from non-predictive contexts for active sentences.

The differences for predictive contexts for passive sentences were compared to differences for comprehending non-predictive contexts for passive sentences for all participants. A scatter plot depicting the relationship between these variables is displayed in Figure 8. For passive sentences, 12 participants benefited from predictive contexts while 11 participants exhibited improvement for non-predictive contexts relative to sentences in isolation.

Results indicated no apparent relationships between performance differences for predictive and non-predictive context for active sentences and between performance differences for predictive and non-predictive contexts for passive sentences. Pearson Product Moment Correlations are displayed in Table 7, yielding no significant findings.

Paired Sample T-Tests were conducted on the accuracy data on the linguistic context task to compare performance between comprehension of isolated active and passive sentences, predictive contexts for active and passive sentences, and non-predictive contexts for active and passive sentences. Age was a continuous variable with no group division for this analysis. The scores between predictive and non-predictive contexts for active sentences, and predictive and non-predictive contexts for passive sentences also were compared. The t-test analyses data are presented in Table 8. Significant differences were observed between isolated active and passive sentences, non-predictive contexts, and between predictive and non-predictive contexts for active sentences ($p<.05$). Mean performance on isolated active sentences was significantly higher than on isolated passive sentences. Similarly, mean performance for non-predictive context for active sentences was significantly higher than non-predictive context for passive sentences.

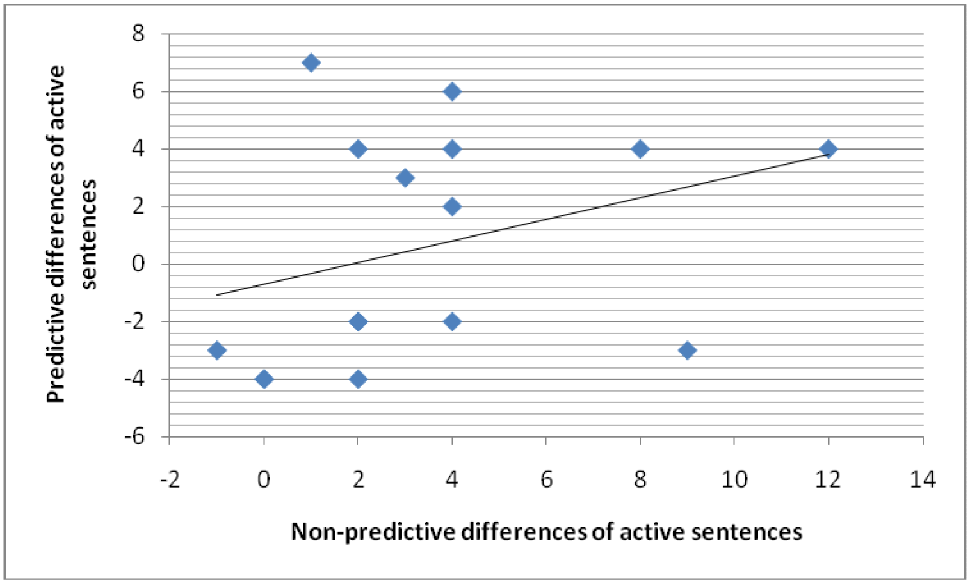

Figure 7. Scatter plot: Relationship between predictive and non-predictive differences for active sentences

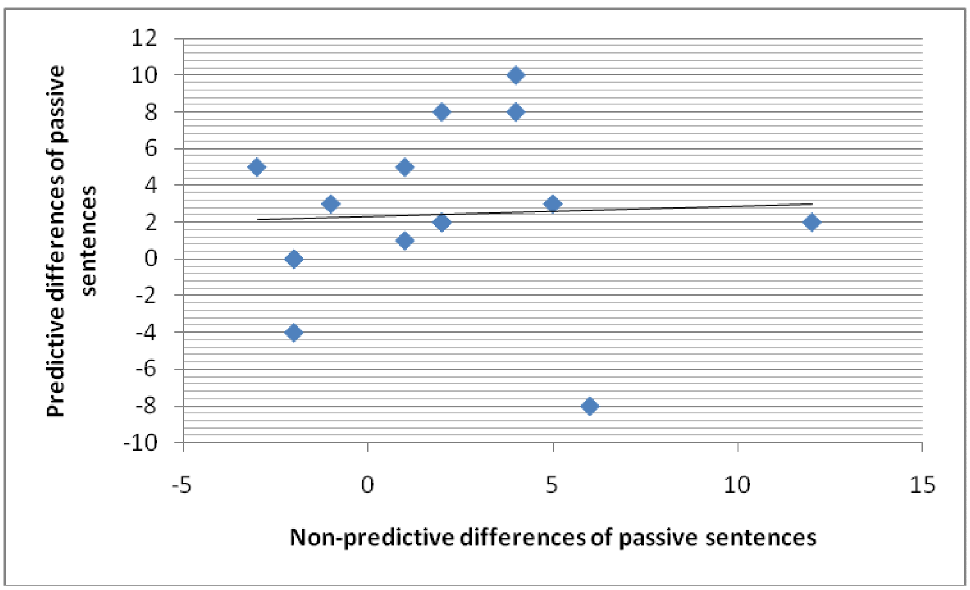

Figure 8. Scatter plot: Relationship between predictive and non-predictive differences for passive sentences

Table 7. Pearson Product Moment Correlations (r values) between predictive and non-predictive difference scores relative to active and passive sentences

	Predictive differences for active sentences	Predictive differences for passive sentences
Non-predictive differences for active sentences	0.33	
Non-predictive differences for passive sentences		0.04

Table 8. Paired differences between isolated active and passive sentences, predictive active and passive context, non-predictive active and passive context, predictive active and non-predictive active context, and predictive passive s and non-predictive passive context

	Paired Differences							
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	Df	Sig. (2-tailed)
				Lower	Upper			
Iso[1] active – Iso passive	2.18750	3.03795	.75949	.56869	3.80631	2.880	15	.011*
Pre[2] active – Pre passive	.25000	5.55578	1.38894	-2.71047	3.21047	.180	15	.860
Non-pre[3] active – Non-pre passive	3.62500	5.37742	1.34436	.75957	6.49043	2.696	15	.017*
Pre active – Non-pre active	-2.87500	4.31856	1.07964	-5.17620	-.57380	-2.663	15	.018*
Pre passive– Non-pre passive	.50000	5.34166	1.33542	-2.34637	3.34637	.374	15	.713

Note. *$p<.05$
[1] Isolated. [2] Predictive. [3] Non-predictive.

Additionally, for active sentences, mean performance was significantly higher for non-predictive than predictive contexts.

Relationships between the explanatory variables (WM, comprehension, aphasia severity) and active/passive differences relative to isolated, predictive, and non-predictive contexts were examined (active/passive differences = active-passive). Scatter plots depicting relationships specifically between aphasia severity and the active/passive differences are displayed in Figures 9-11. Pearson Product Moment Correlations calculated between these variables are displayed in Table 9. Results revealed positive correlations with a trend toward significance at the $p<.10$ level between severity of aphasia and active/ passive differences for isolated sentences and non-predictive context.

Scatter plots depicting the relationships between WM capacity (listening span) and differences for active and passive sentences relative to isolated, predictive, and non-predictive contexts are displayed in Figure 12-14. An examination of these plots revealed an outlier relative to working memory performance. Pearson Product Moment Correlations were conducted between these variables (Table 9) with and without the outlier. A positive correlation with a trend towards significance at the $p<.10$ level was observed between WM capacity and active/passive differences for isolated context without the outlier.

Scatter plots depicting the relationships between auditory comprehension and active/passive differences relative to isolated, predictive and non-predictive contexts are displayed in Figure 15-17. Results revealed no apparent relationships between auditory comprehension and active/passive differences for any contextual conditions. Pearson Product Moment Correlations between these variables are displayed in Table 9 and yielded no significant relationships.

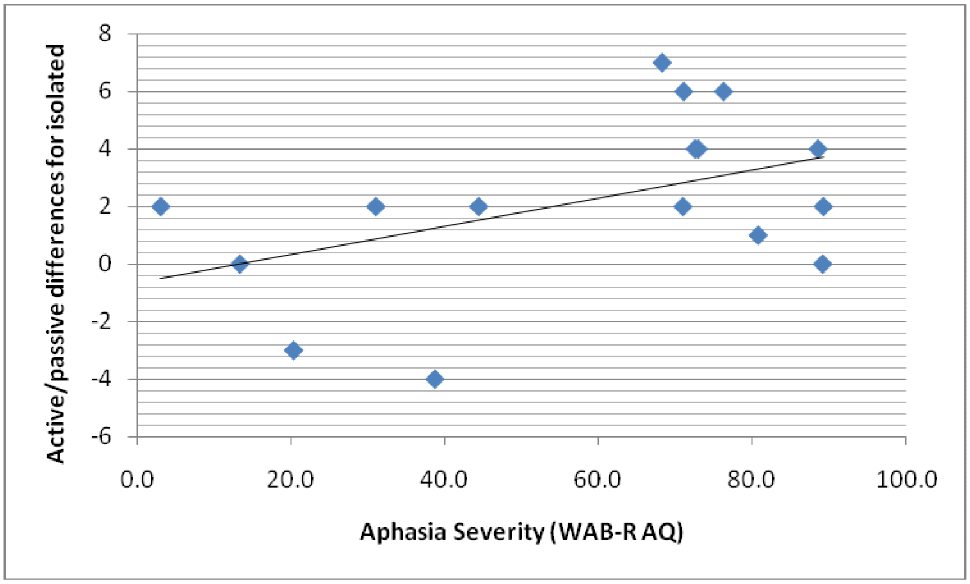

Figure 9. Scatter plot: Relationship between severity of aphasia and active/passive differences for isolated context

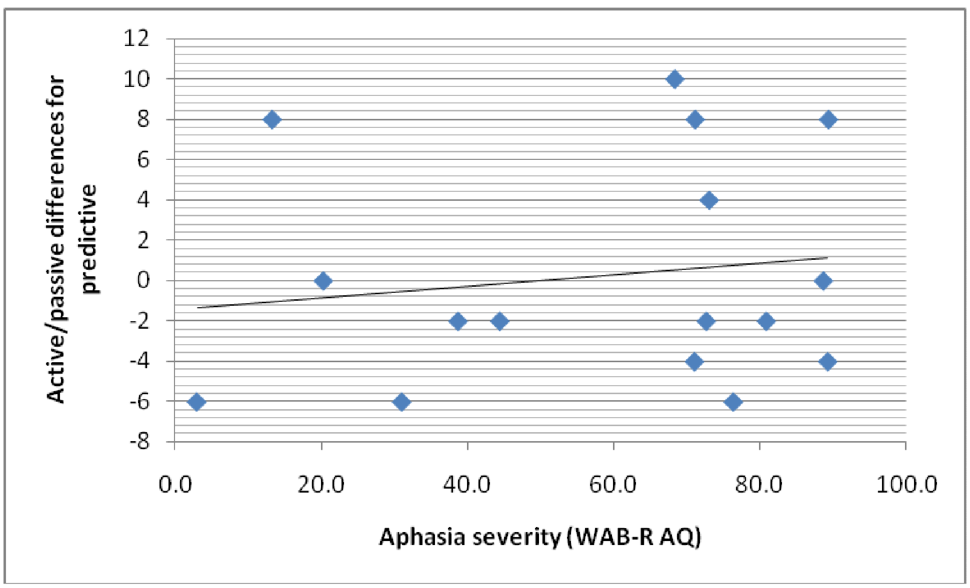

Figure 10. Scatter plot: Relationship between severity of aphasia and active/passive differences for predictive context

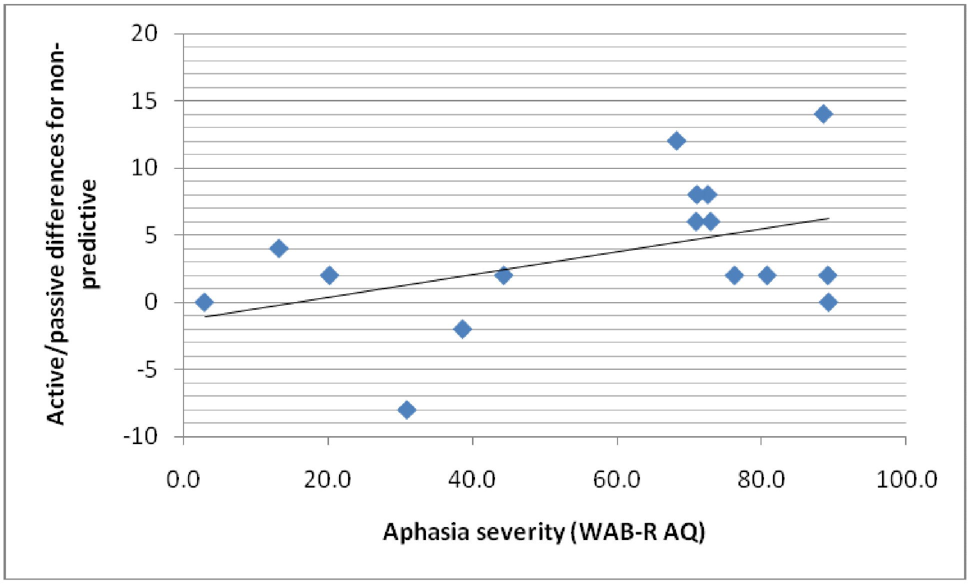

Figure 11. Scatter plot: Relationship between severity of aphasia and active/passive differences for non-predictive context

Table 9. Pearson Product Moment correlations (r values) between severity of aphasia, WM, auditory comprehension, and active/passive differences relative to isolated, predictive and non-predictive contexts, and predictive/non-predictive differences for active and passive sentences

	Active/passive differences for isolated	Active/passive differences for predictive	Active/passive differences for Non-predictive	Pre/Non differences for active	Pre/Non differences for passive
Aphasia severity	0.463	0.149	0.453	-0.386	-0.011
Working Memory	0.447	0.316	0.337	0.009	0.019
Auditory comprehension	0.425	0.192	0.228	-0.347	-0.251

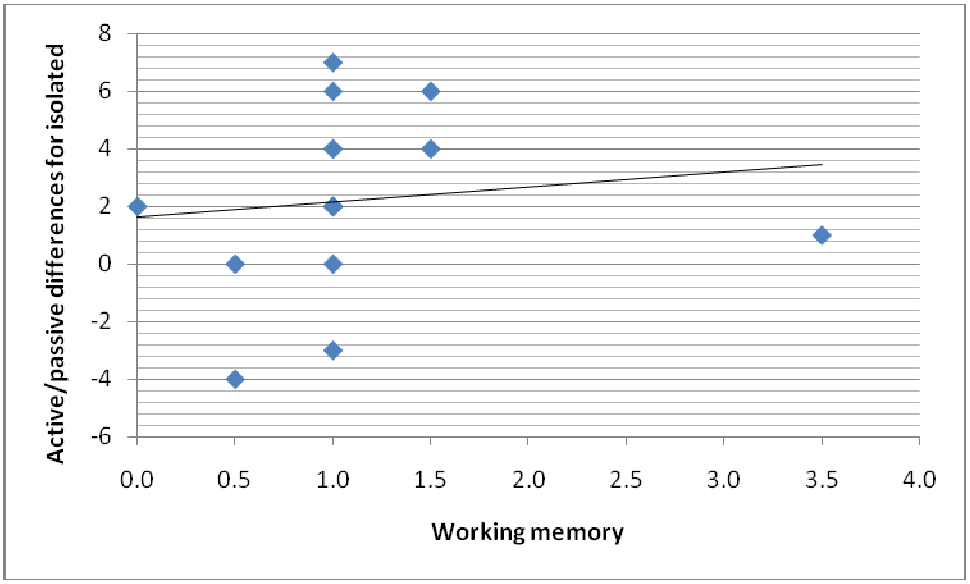

Figure 12. Scatter plot: Relationship between WM and active/passive differences for isolated context

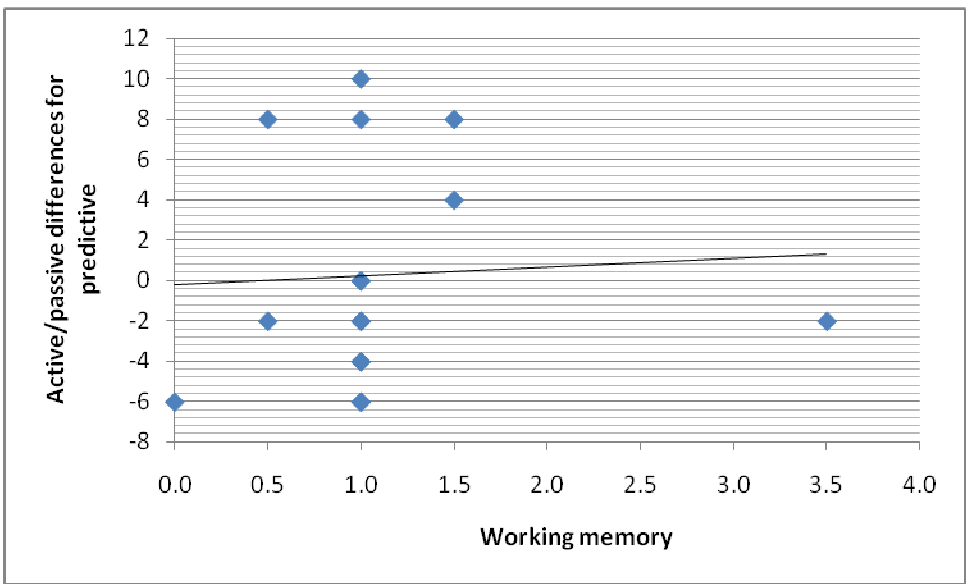

Figure 13. Scatter plot: Relationship between WM and active/passive differences for predictive context

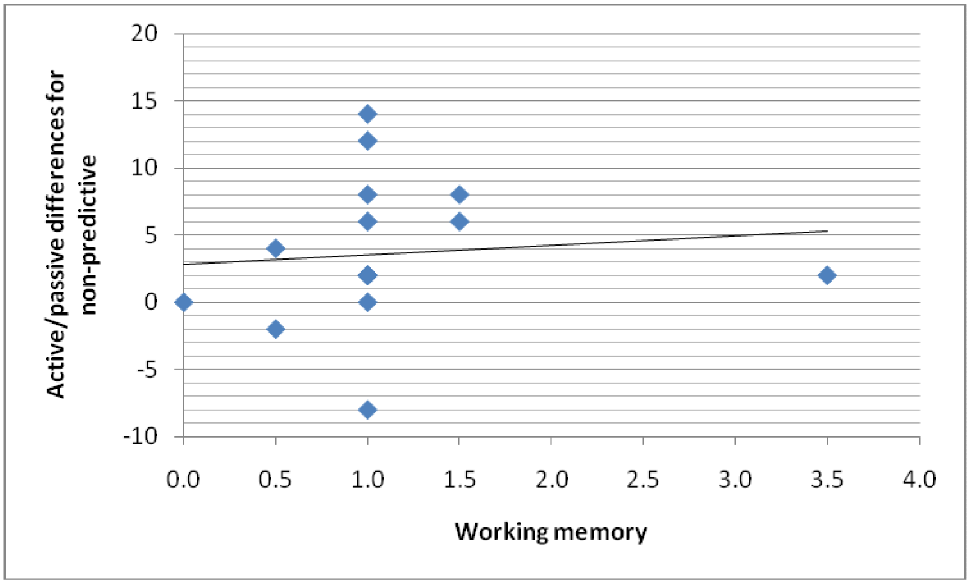

Figure 14. Scatter plot: Relationship between WM and active/passive differences for non-predictive context

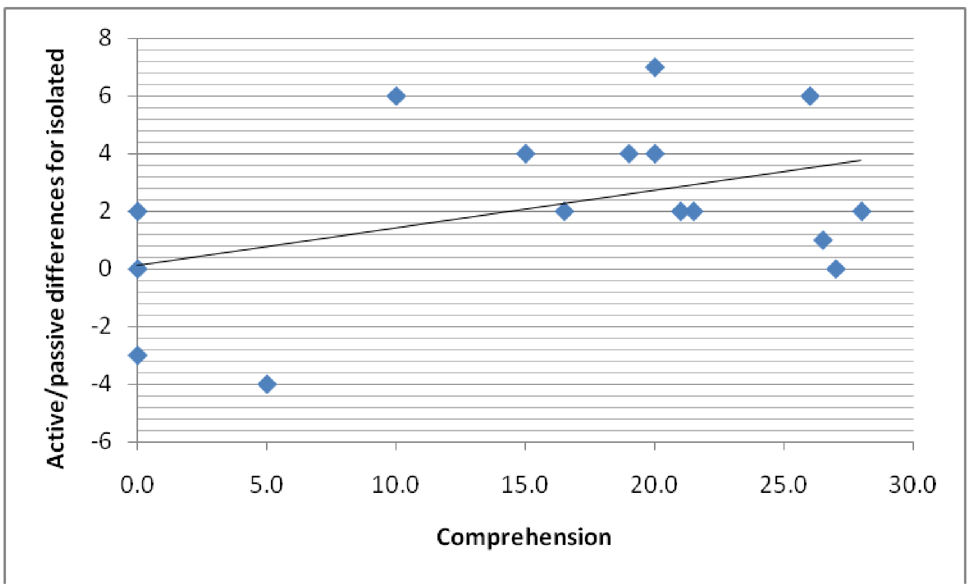

Figure 15. Scatter plot: Relationship between auditory comprehension and active/passive differences for isolated context

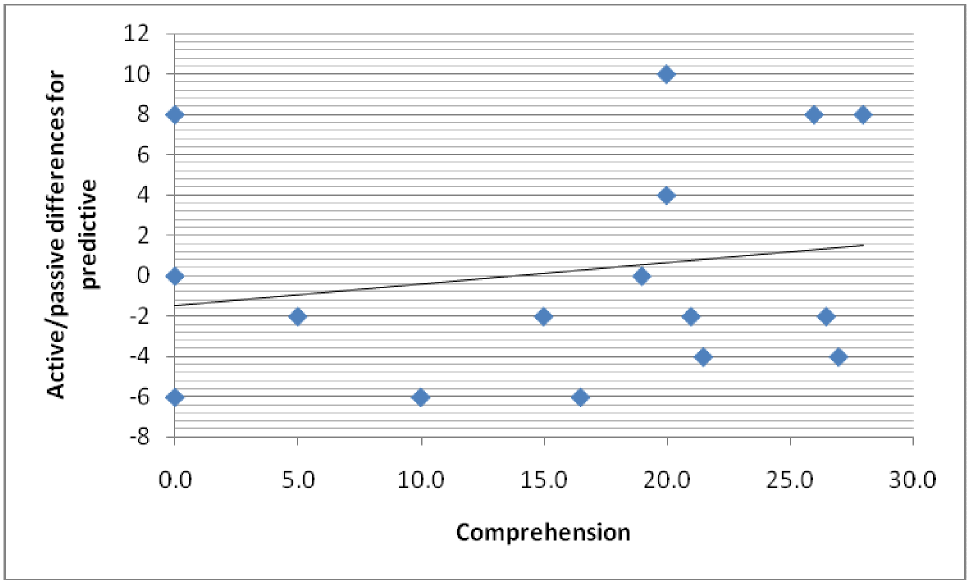

Figure 16. Scatter plot: Relationship between auditory comprehension and active/passive differences for predictive context

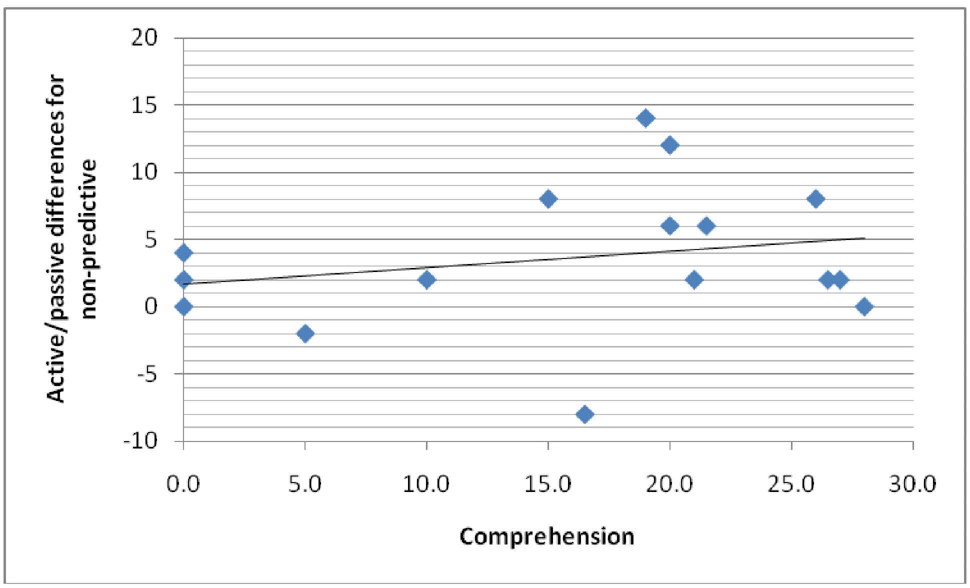

Figure 17. Scatter plot: Relationship between auditory comprehension and active/passive differences for non-predictive context

Relationships between severity of aphasia, WM capacity, auditory comprehension and predictive/non-predictive differences relative to active and passive sentences also were explored (predictive/non-predictive differences = predictive-non-predictive) for the entire 16 participants with age as a continuous variable. Scatter plots depicting these relationships are displayed in Figures 18-23. No apparent relationships between severity of aphasia, WM capacity, auditory comprehension, and predictive/non-predictive differences for either active or passive sentences were observed. Pearson Product Moment Correlations between these variables are displayed in Table 9 and revealed no significant findings.

The amount of benefit or decrement relative to improvement in accuracy performance on the comprehension of predictive and non-predictive paragraph contexts in comparison to isolated sentences was computed as difference scores (Predictive differences =predictive context - isolated context; non-predictive differences = non-predictive context – isolated context). Mean differences are presented in Table 10 for the younger and older groups and all participants combined. Scatter plots depicting relationships between predictive/non-predictive differences for active and passive sentences on the linguistic context task and each of the explanatory variables were developed. Pearson Product Moment Correlations conducted among the data for these explanatory variables are displayed on Table 11.

Scatter plots depicting relationships between contextual differences and severity of aphasia are displayed in Figures 24-27. Pearson Product Moment correlations among these variables for both groups (Table 11) revealed the following findings. Among the young group, a positive correlation with a trend towards significance at the $p<.10$ level was observed between aphasia severity and predictive differences for passive sentences. However, an examination of this scatter plot for predictive passive sentences revealed one influential point. This argues for

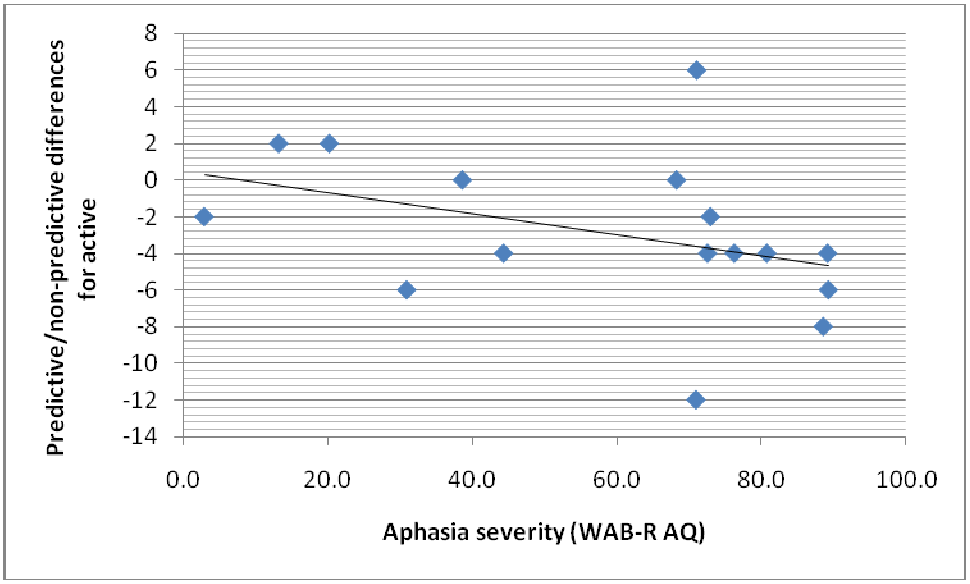

Figure 18. Scatter plot: Relationship between aphasia severity and predictive/non-predictive differences for active sentences

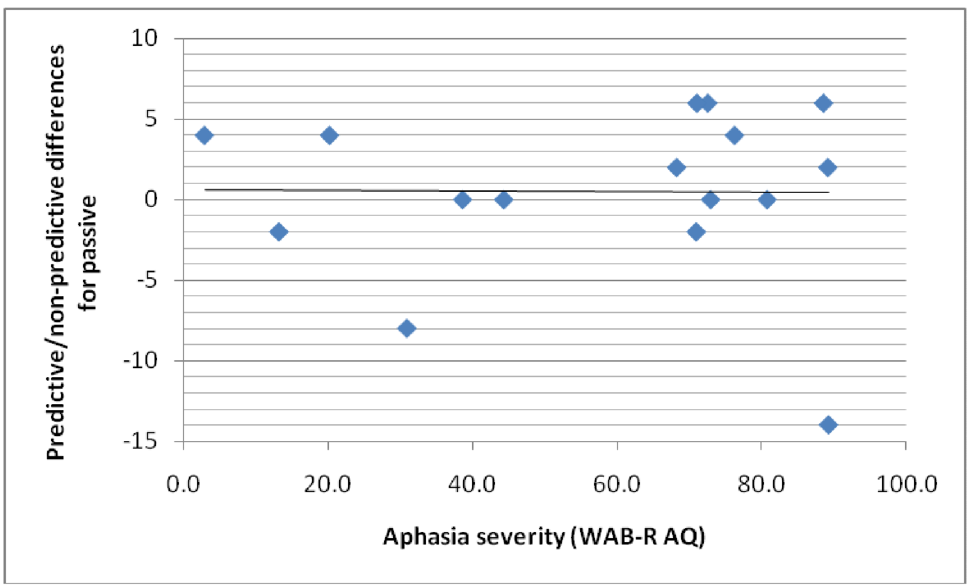

Figure 19. Scatter plot: Relationship between aphasia severity and predictive/non-predictive difference scores for passive sentences

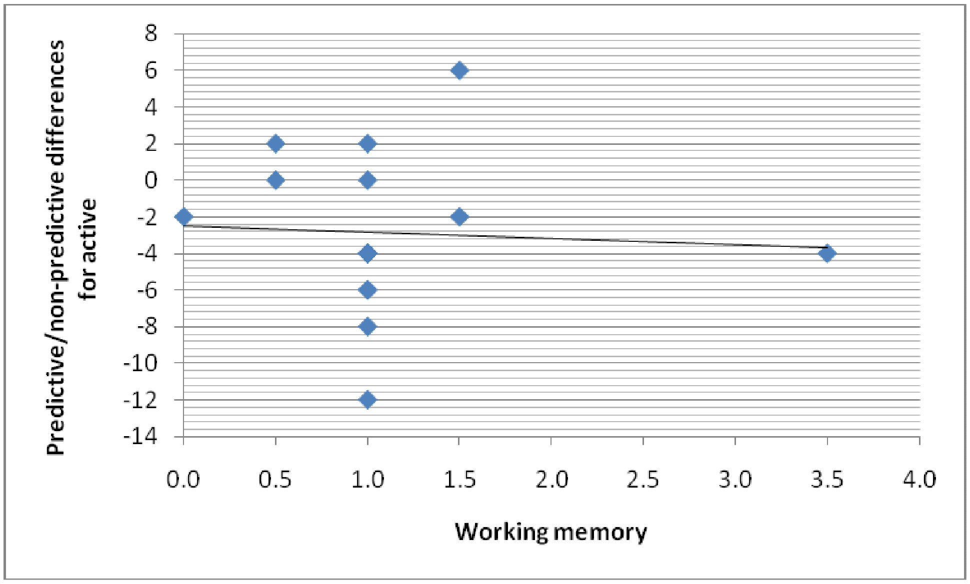

Figure 20. Scatter plot: Relationship between WM and predictive/non-predictive difference scores for active sentences

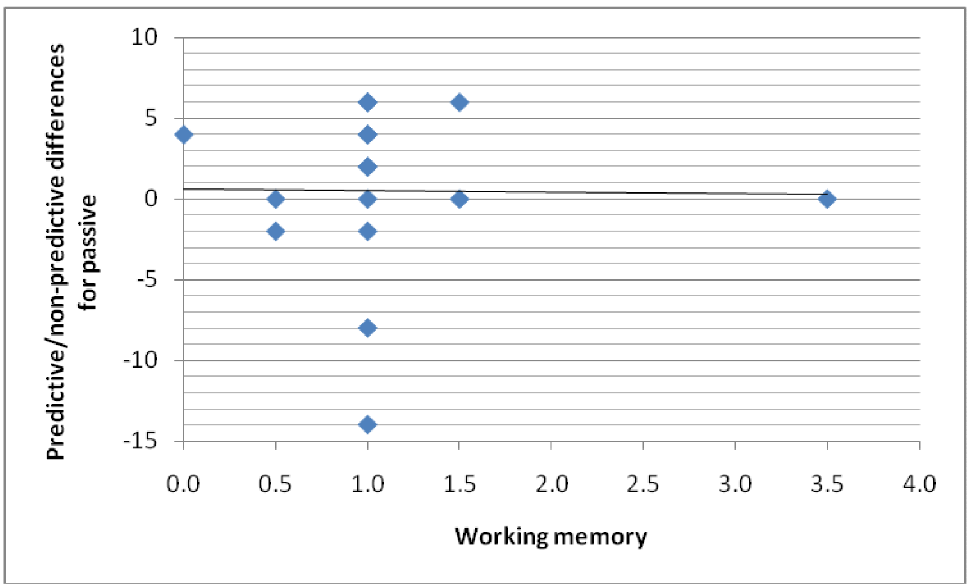

Figure 21. Scatter plot: Relationship between WM and predictive/non-predictive difference scores for passive sentences

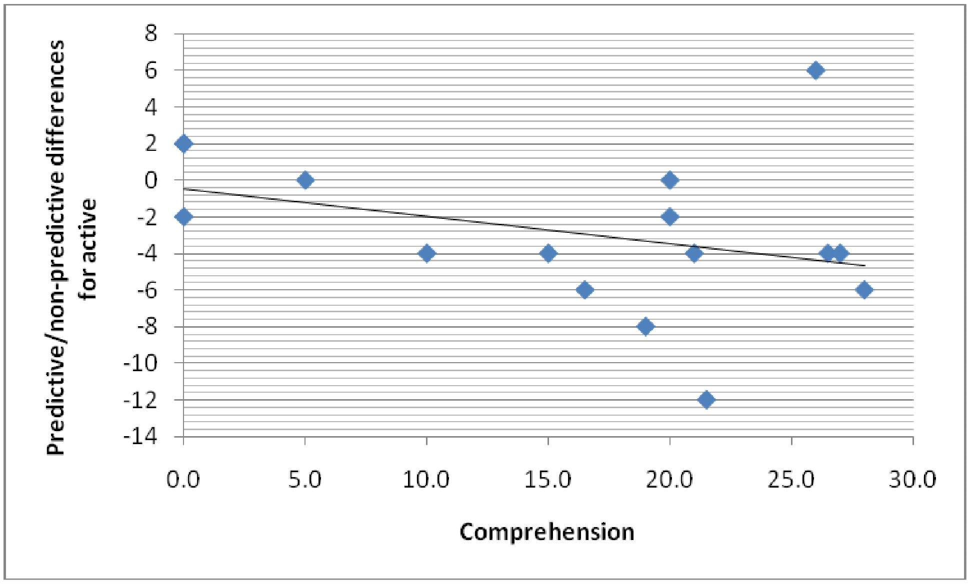

Figure 22. Scatter plot: Relationship between auditory comprehension and predictive/non-predictive difference scores for active sentences

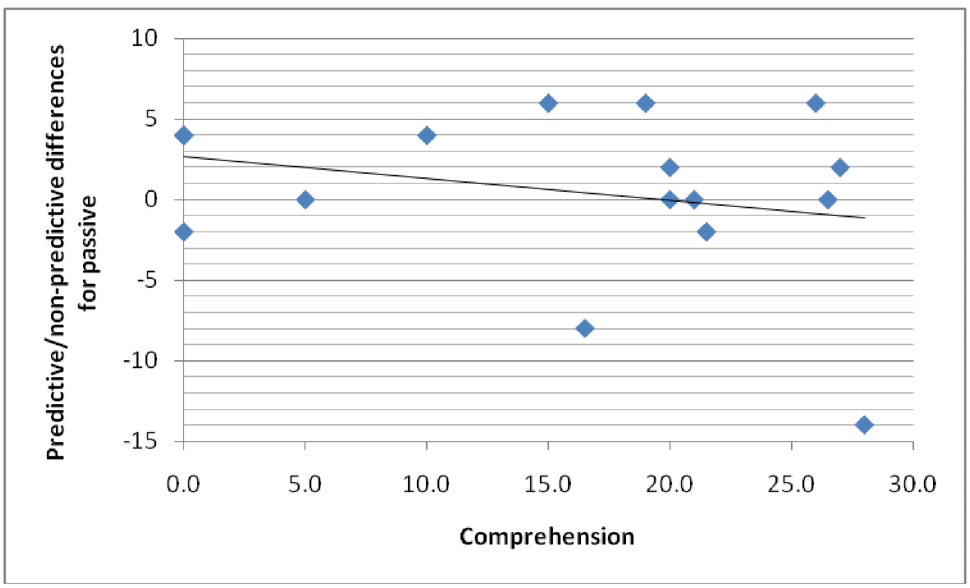

Figure 23. Scatter plot: Relationship between auditory comprehension and predictive/non-predictive difference scores for passive sentences

Table 10. Means, standard deviations, and ranges for predictive and non-predictive differences for active and passive sentences relative to sentences in isolation

Groups	Active sentences		Passive sentences	
	Predictive differences	Non-predictive differences	Predictive differences	Non-predictive differences
Old				
Mean	0.250	1.750	2.125	1.125
SD	4.621	2.053	4.764	3.044
Range	-4-7	-1-4	-8-8	-3-6
Young				
Mean	1.000	5.250	2.750	2.750
SD	3.423	3.882	4.432	4.496
Range	-4-4	2-12	-4-10	-2-12
Combined				
Mean	0.625	3.500	2.438	1.938
SD	3.948	3.502	4.457	3.803
Range	-4-7	-1-12	-8-10	-3-12

Table 11. Pearson Product Moment correlations (r values) between severity of aphasia, age, WM, auditory comprehension, and difference scores for predictive and non-predictive contexts relative to active and passive sentences

		Active sentences		Passive sentences	
		Predictive differences	Non-predictive differences	Predictive differences	Non-predictive differences
Severity of aphasia (WAB-R AQ)	Young	0.08	0.58	0.63	-0.14
	Old	-0.26	-0.01	-0.39	0.16
	Combined	-0.12	0.35	0.06	0.03
Age	Young	-0.42	0.35	0.26	0.32
	Old	-0.26	-0.04	-0.65	-0.10
	Combined	-0.26	-0.34	-0.26	-0.13
Working memory	Young	-0.38	-0.28	-0.05	-0.08
	Old	0.33	0.19	-0.09	-0.25
	Combined	-0.06	0.01	-0.03	-0.05
Auditory comprehension	Young	-0.35	-0.27	-0.58	-0.46
	Old	-0.19	-0.03	-0.52	-0.01
	Combined	-0.26	0.14	-0.18	0.11

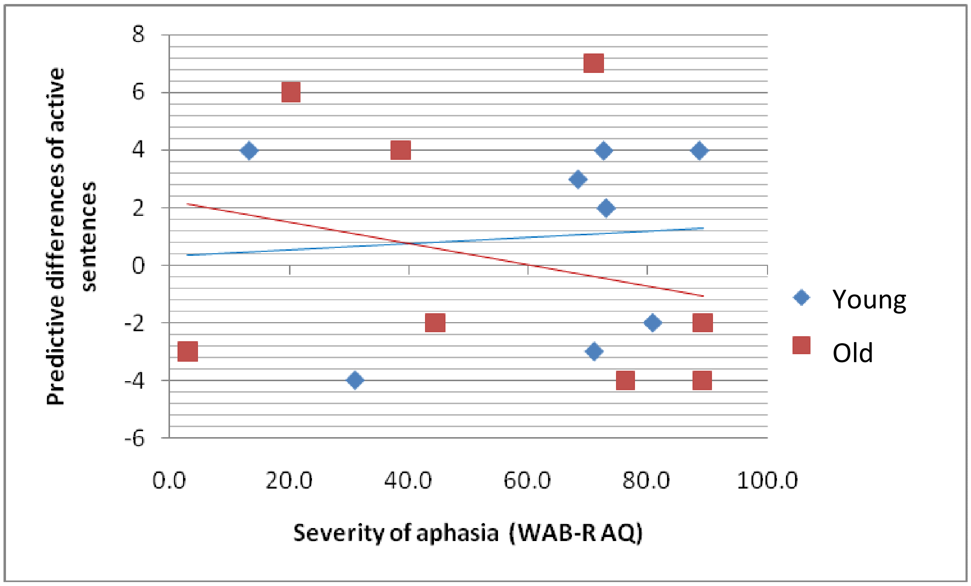

Figure 24. Scatter plot: Relationship between severity of aphasia and differences for predictive active context

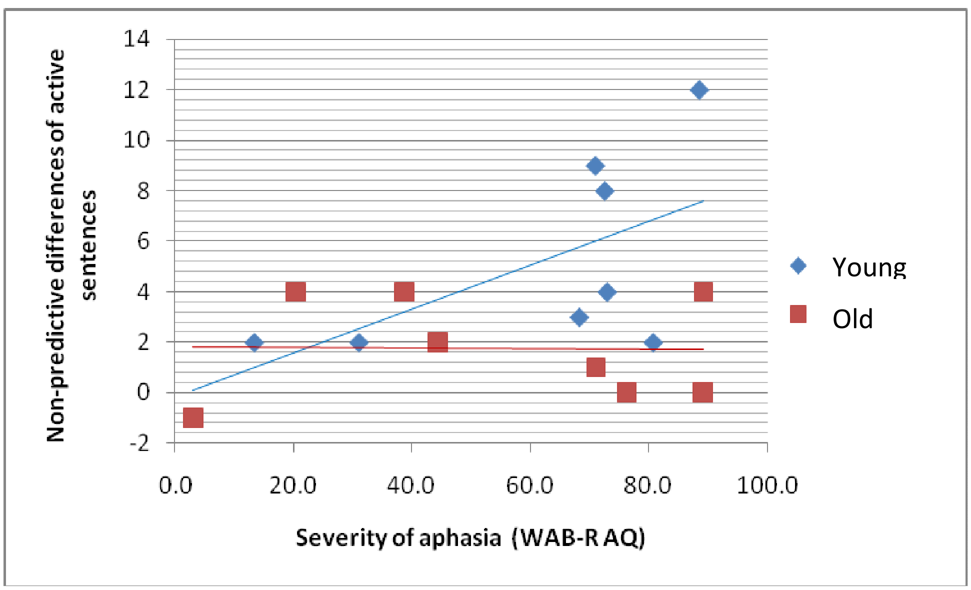

Figure 25. Scatter plot: Relationship between severity of aphasia and differences for non-predictive active context

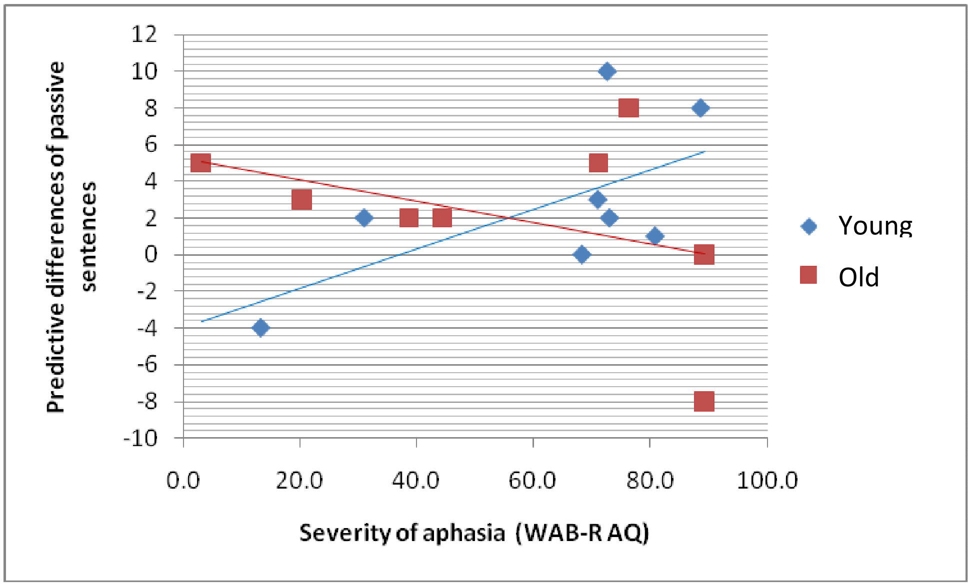

Figure 26. Scatter plot: Relationship between severity of aphasia and differences for predictive passive context

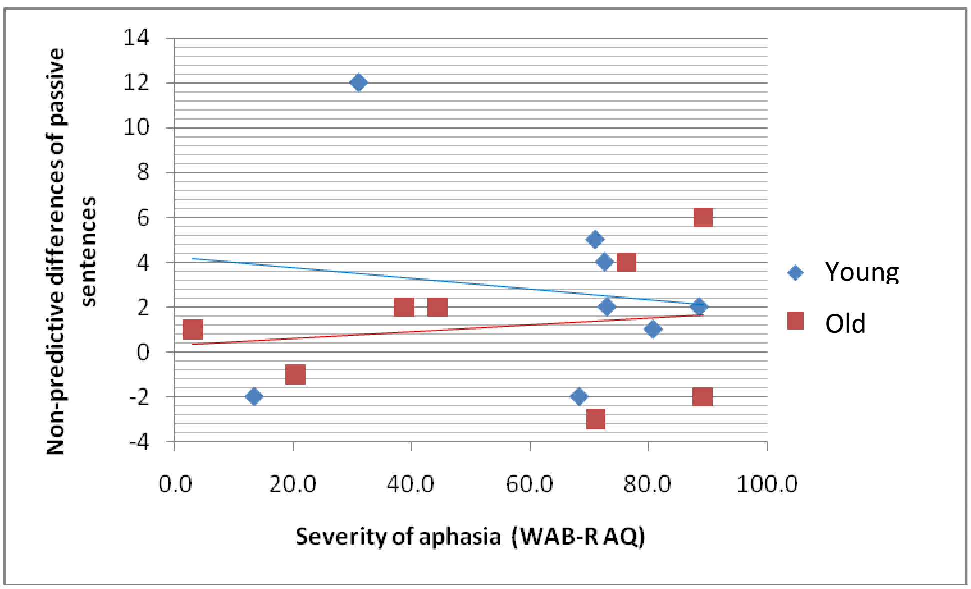

Figure 27. Scatter plot: Relationship between severity of aphasia and differences for non-predictive passive context

cautious interpretation. No significant findings were observed for the older group or data for the two groups combined.

Scatter plots depicting relationships between age and difference scores for predictive and non-predictive contexts relative to active and passive sentences are displayed in Figure 28-31. Pearson Product Moment Correlations calculated between these variables are displayed in Table 11. Results revealed a negative correlation with a trend towards significance at the $p<.10$ level between age and difference scores for predictive passive context versus isolation for the older group. However, an inspection of the scatter plot revealed an influential point that skewed the data to some degree. Thus, cautious interpretation is suggested. No other significant findings were observed.

Scatter plots depicting the relationship between WM (Listening Span) and predictive/non-predictive differences for active and passive sentences on the linguistic context task are displayed in Figure 32-35. An inspection of the plots revealed an outlier relative to WM performance for the younger group, as mentioned previously. Pearson Product Moment Correlations between these variables were conducted (Table 11) with and without an outlier. Results revealed no significant findings between working memory capacity and the ability to utilize paragraph context in comprehension of active and passive sentences for either the young or the older group, regardless of inclusion/exclusion of the outlier.

Scatter plots depicting the relationship between auditory comprehension as measured by the modified Token Test and predictive/non-predictive differences of active and passive sentences on the linguistic context task are displayed in Figure 36-39. An examination of the plots revealed an outlier for the young group. Pearson Product Moment correlations (Table 11) between these variables were conducted with and without an outlier. A negative trend towards significance was

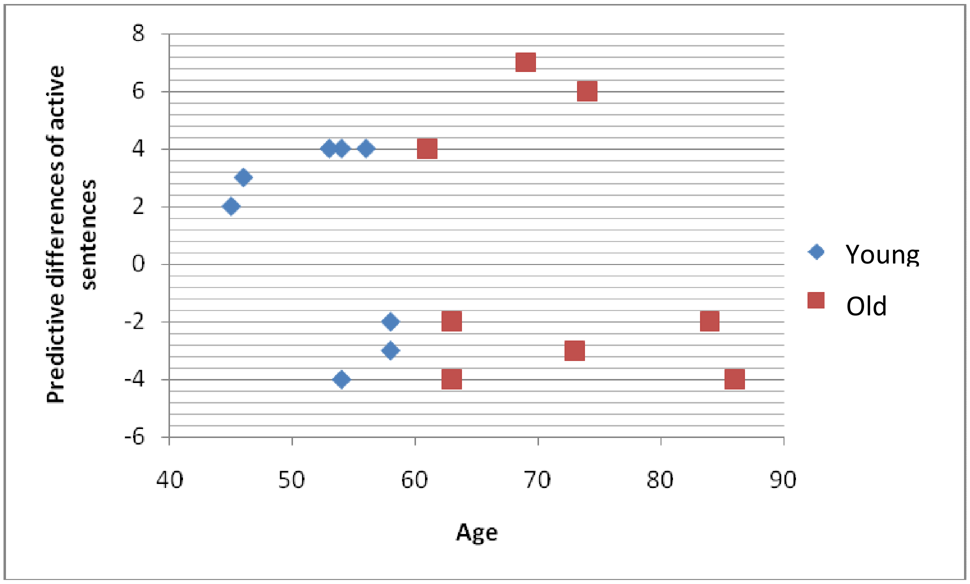

Figure 28. Scatter plot: Relationship between age and differences for predictive active context

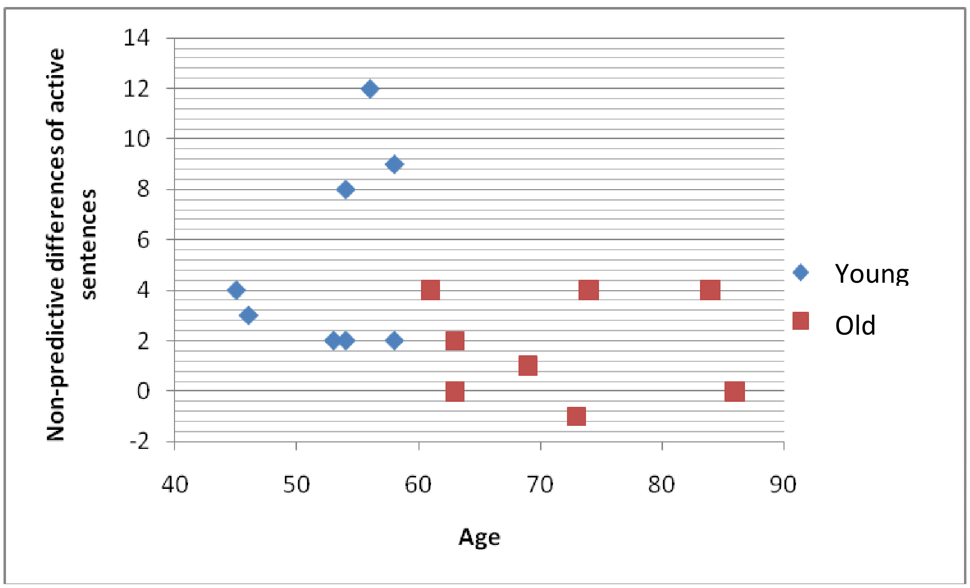

Figure 29. Scatter plot: Relationship between age and differences for non-predictive active context

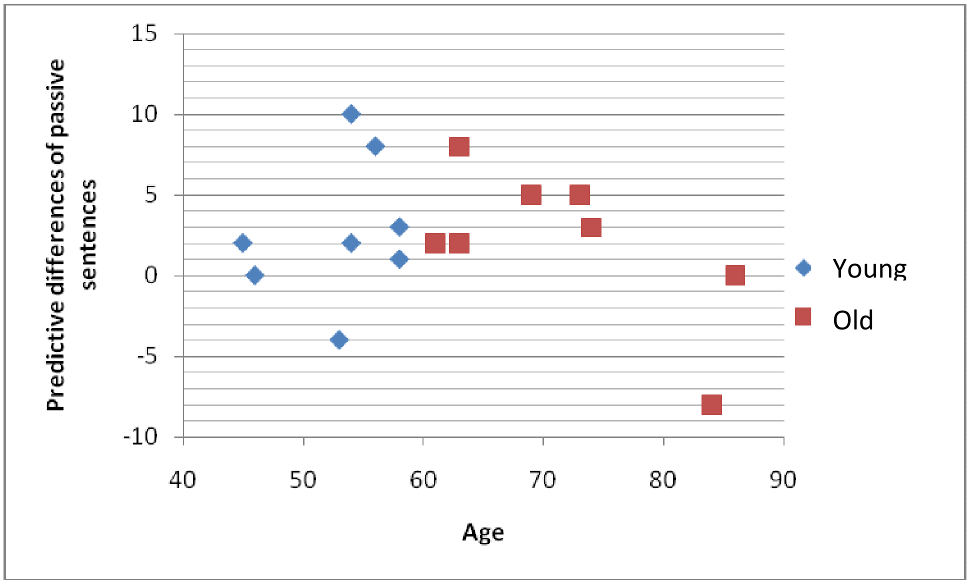

Figure 30. Scatter plot: Relationship between age and differences for predictive passive context

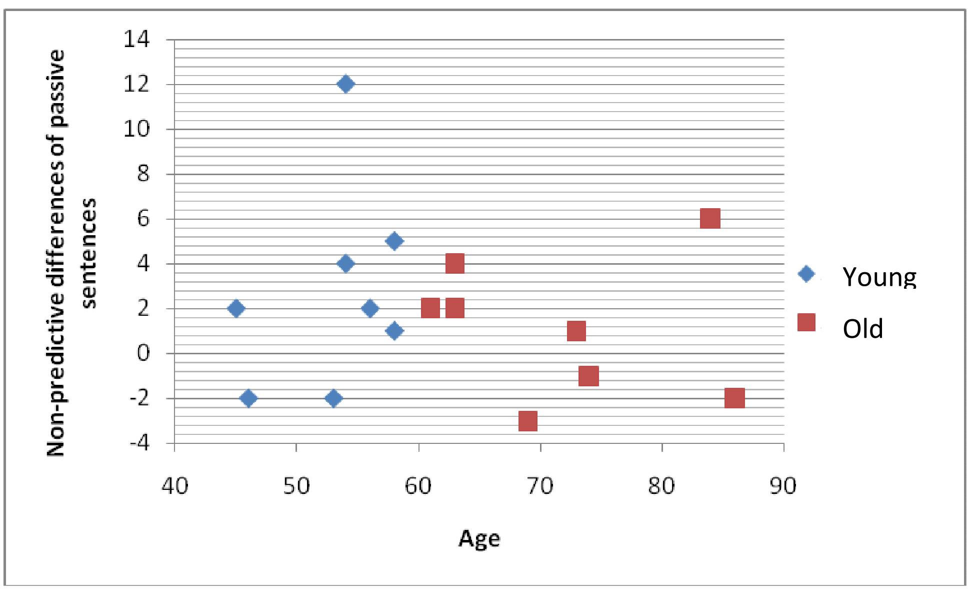

Figure 31. Scatter plot: Relationship between age and differences for non-predictive passive context

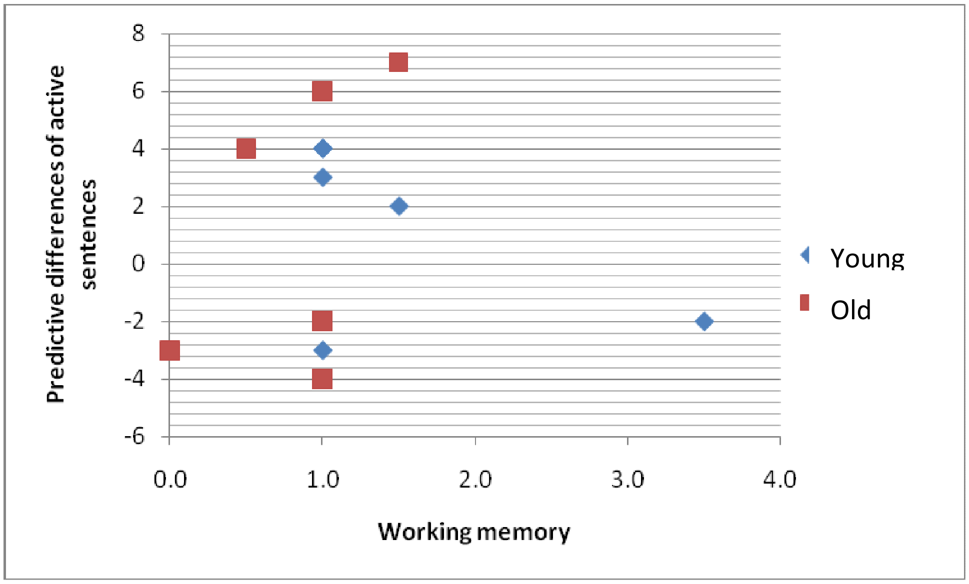

Figure 32. Scatter plot: Relationship between working memory and differences for predictive active context

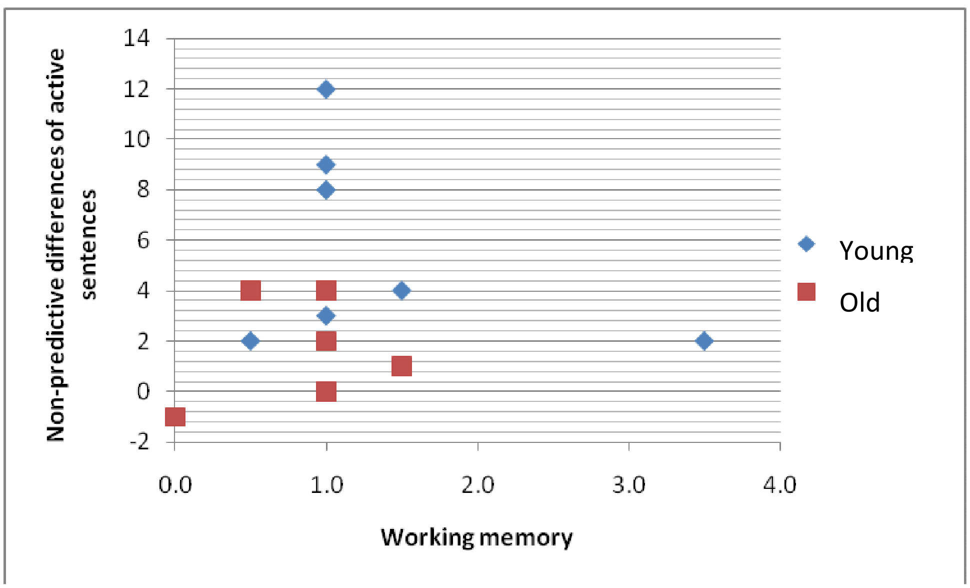

Figure 33. Scatter plot: Relationship between working memory and differences for non-predictive active context

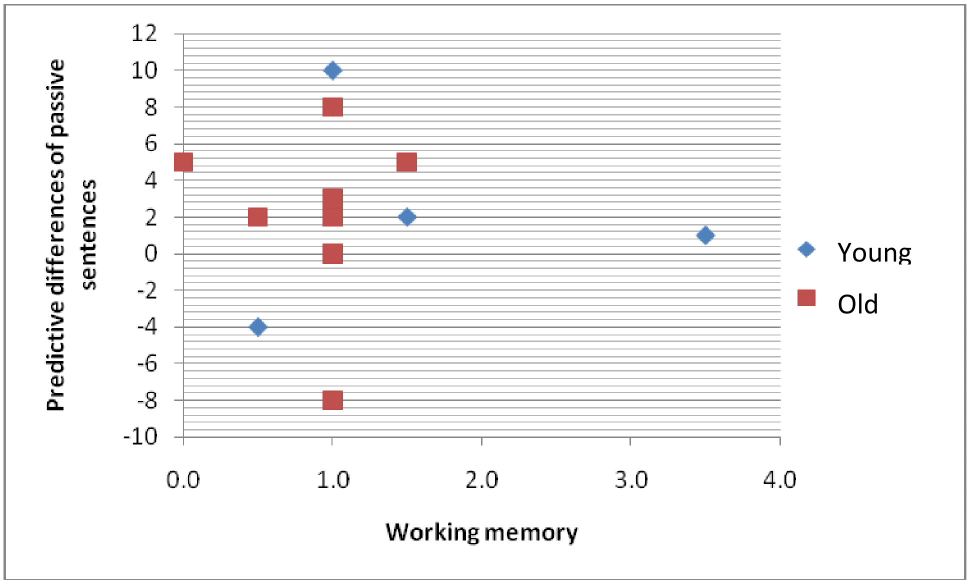

Figure 34. Scatter plot: Relationship between working memory and differences for predictive passive context

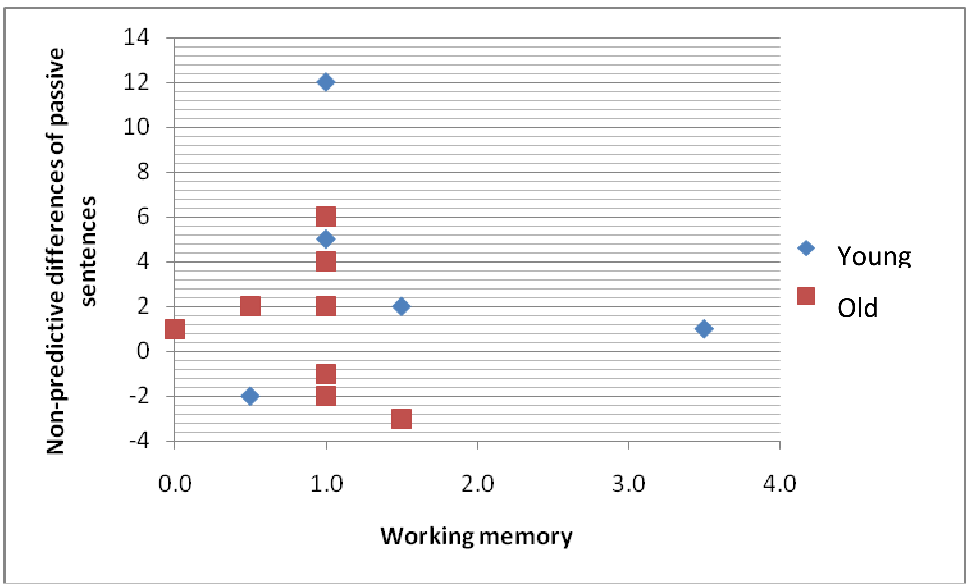

Figure 35. Scatter plot: Relationship between working memory and differences for non-predictive passive context

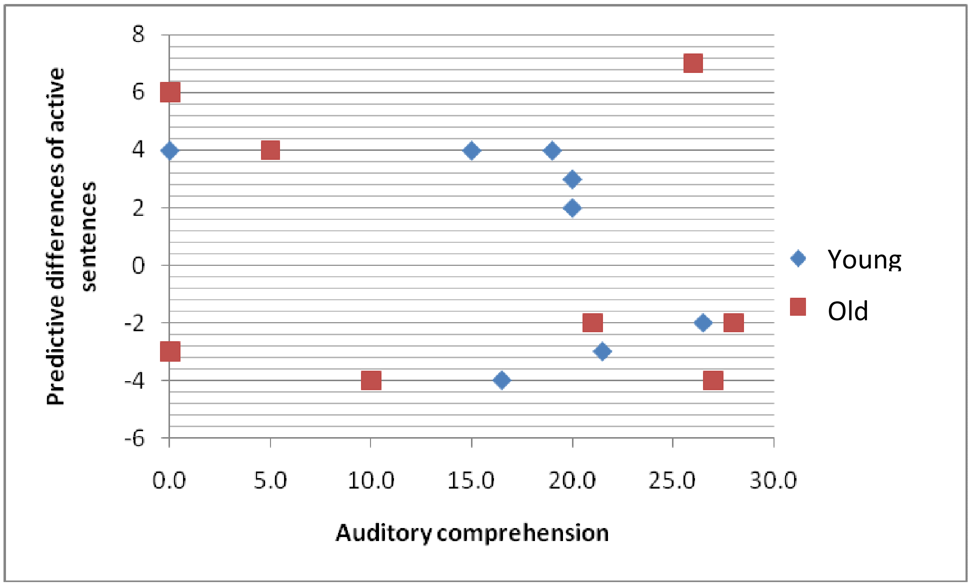

Figure 36. Scatter plot: Relationship between auditory comprehension and differences for predictive active context

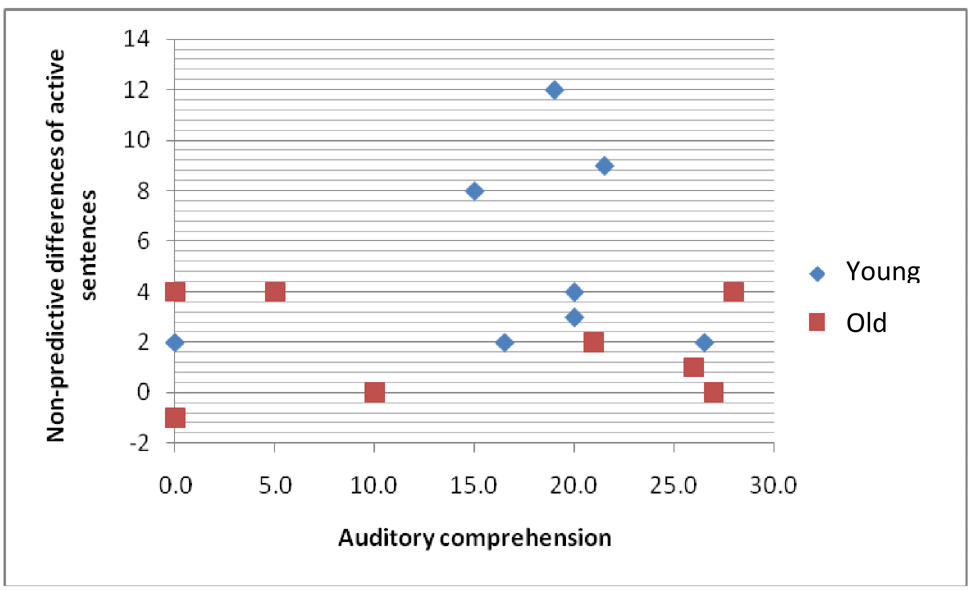

Figure 37. Scatter plot: Relationship between auditory comprehension and differences for non-predictive active context

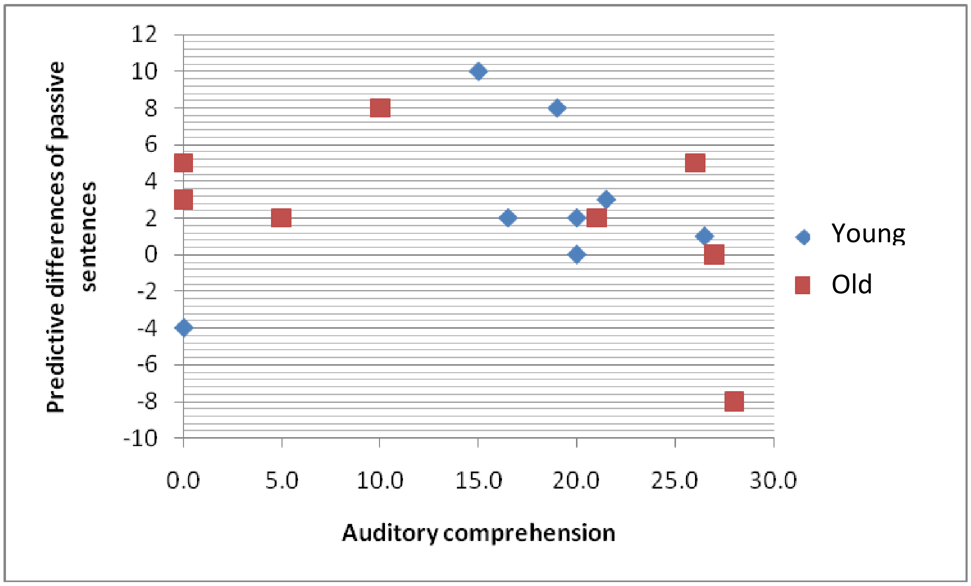

Figure 38. Scatter plot: Relationship between auditory comprehension and differences for predictive passive context

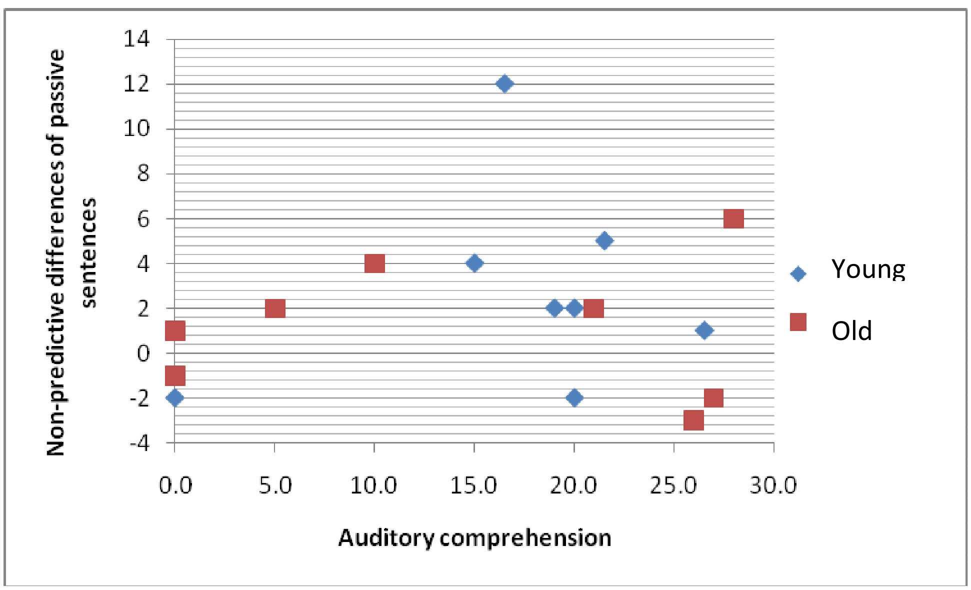

Figure 39. Scatter plot: Relationship between auditory comprehension and differences for non-predictive passive context

observed between auditory comprehension level and the participants' ability to utilize predictive context to facilitate comprehension of passive sentences for the young group. No other significant findings were observed.

Inspection of the graph displaying the relationship between age and differences for predictive active sentences revealed two distinctive groups (Figure 28): one benefitting from predictive context (n=8) and the other exhibiting decrement for predictive context relative to active sentences in isolation (n=8). Scatter plots comparing the two groups relative to the explanatory variables, including age, severity of aphasia, WM capacity, and auditory comprehension, are displayed in Figure 40-43. Pearson Product Moment correlations between these variables are displayed in Table 12. A highly significant positive correlation was observed between age and the difference score for predictive active sentences for the improvement group. No other significant correlations were observed between the two groups in terms of severity of aphasia, working memory, and auditory comprehension.

The two groups mentioned above also were examined relative to relationships between predictive and non-predictive differences for active sentences, predictive differences for active sentences and non-predictive differences for passive sentences, and predictive active and passive sentences. Scatter plots depicting these relationships are displayed in Figures 44- 46. No apparent relationship was observed for either group. Pearson Product Moment Correlations were conducted between the above mentioned variables and are displayed in Table 13, yielding no significant findings.

The gender makeup of the two groups also was examined. A scatter plot depicting the gender proportion for the two groups is presented in Figure 47. No relationship relative to gender was observed for either group.

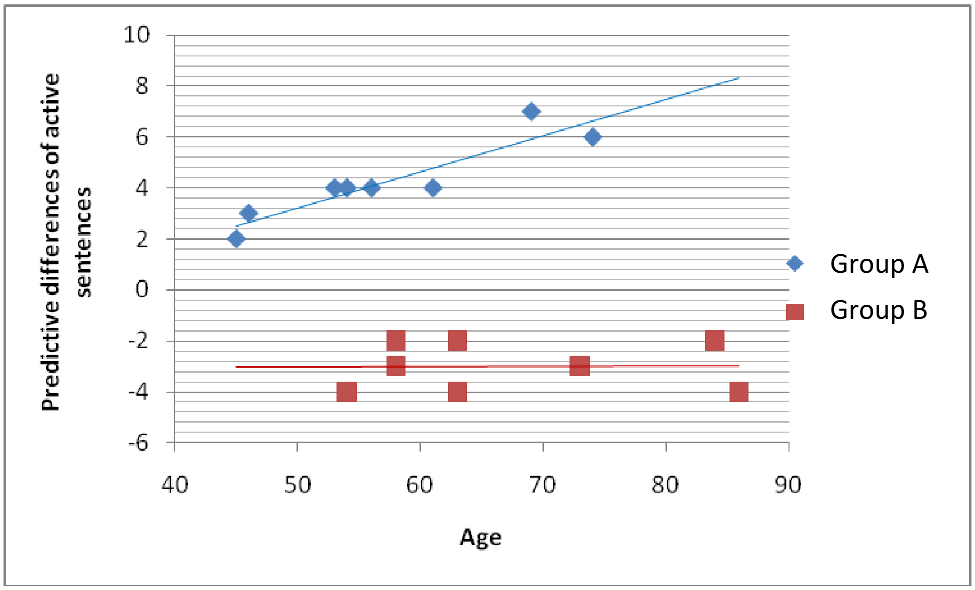

Figure 40: Scatter plot: Comparison of the improvement group and the decrement group relative to age

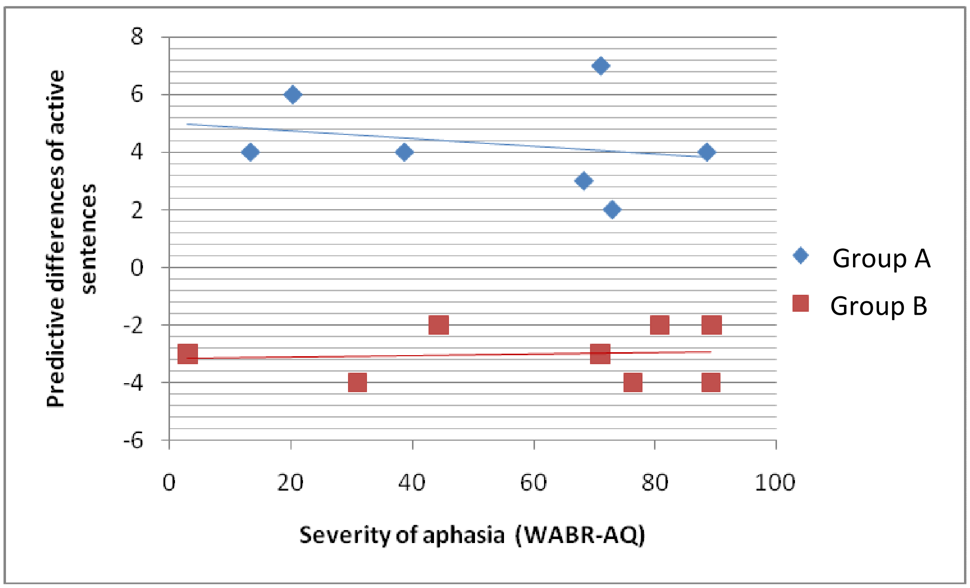

Figure 41: Scatter plot: Comparison of the improvement group and the decrement group relative to severity of aphasia

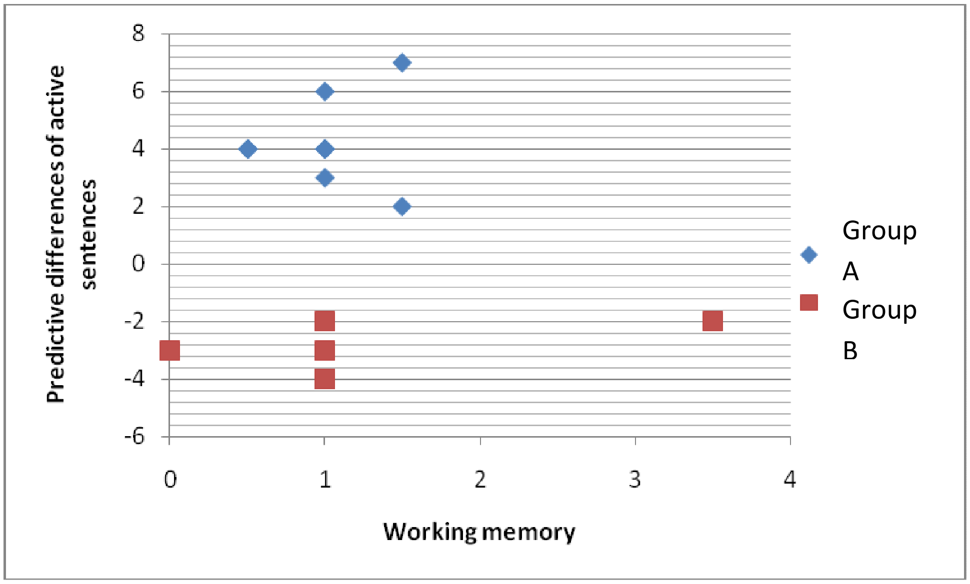

Figure 42: Scatter plot: Comparison of the improvement group and the decrement group relative to working memory

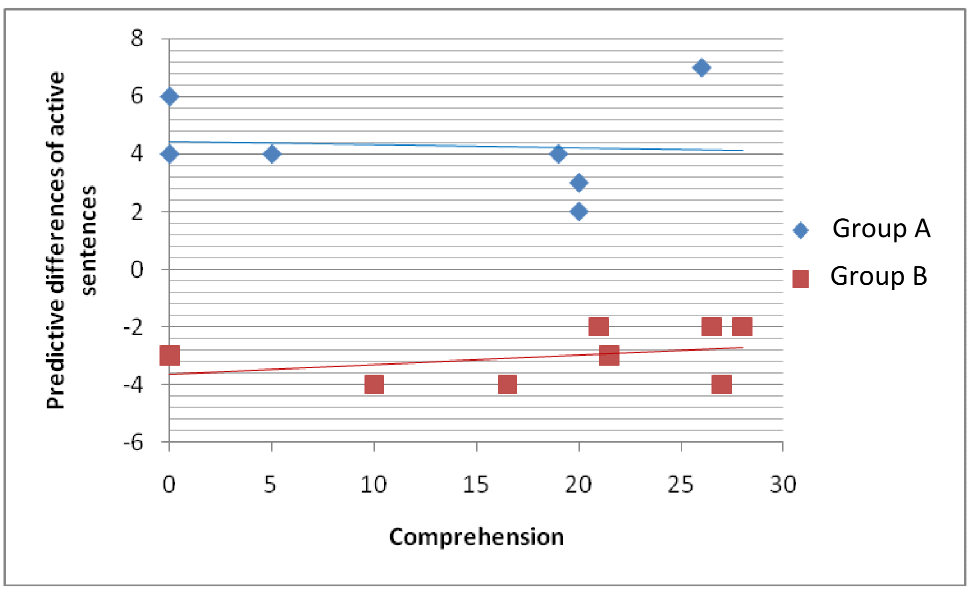

Figure 43: Scatter plot: Comparison of the improvement group and the decrement group relative to auditory comprehension

Table 12. Pearson Product Moment correlations (r values) between age, aphasia severity, working memory, auditory comprehension, and predictive differences of active sentences for improvement and decrement group.

	Age		Aphasia severity		Working memory		Auditory comprehension	
	Group A	Group B	Group A	Group B	Group A	Group B	Group A	Group B
Predictive differences of active sentences	0.92*	0.03	-0.23	0.08	0.12	0.39	-0.07	0.35

Note. *p<.01

Table 13. Pearson Product Moment Correlations (r values) between difference scores for predictive and non-predictive contexts relative to active and passive sentences for the improvement and decrement group

	Non-predictive differences active sentences		Predictive differences passive sentences		Non-predictive differences passive sentences	
	Group A	Group B	Group A	Group B	Group A	Group B
Predictive differences active sentences	-0.24	0.29	0.21	-0.50	-0.48	-0.18

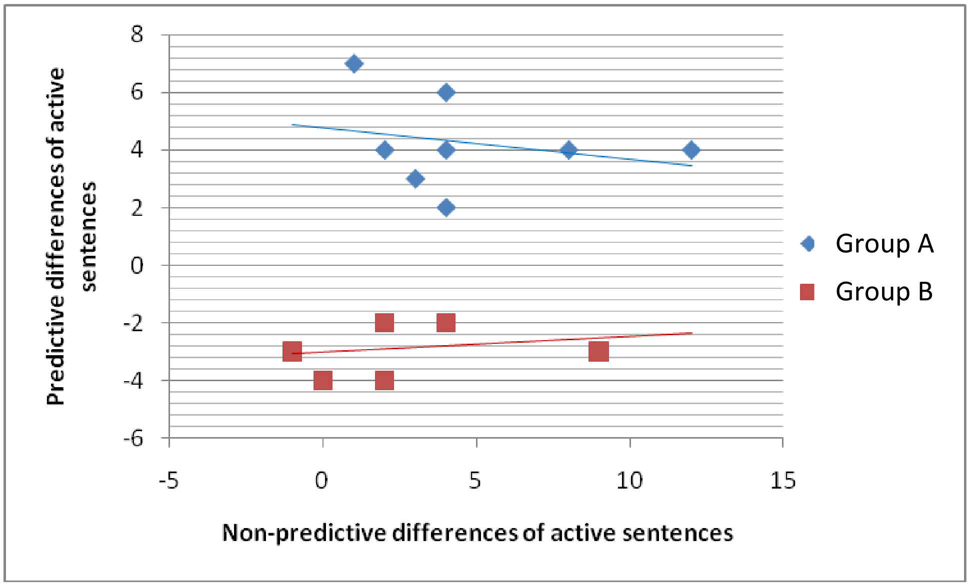

Figure 44. Scatter plot: Relationship between predictive and non-predictive differences of active sentences

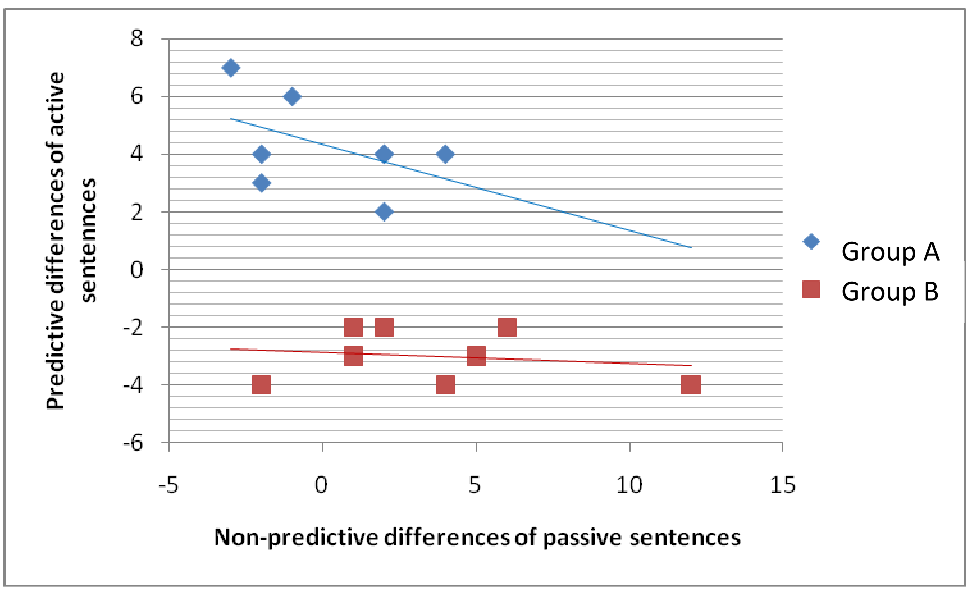

Figure 45. Scatter plot: Relationship between predictive differences of active sentences and non-predictive differences of passive sentences

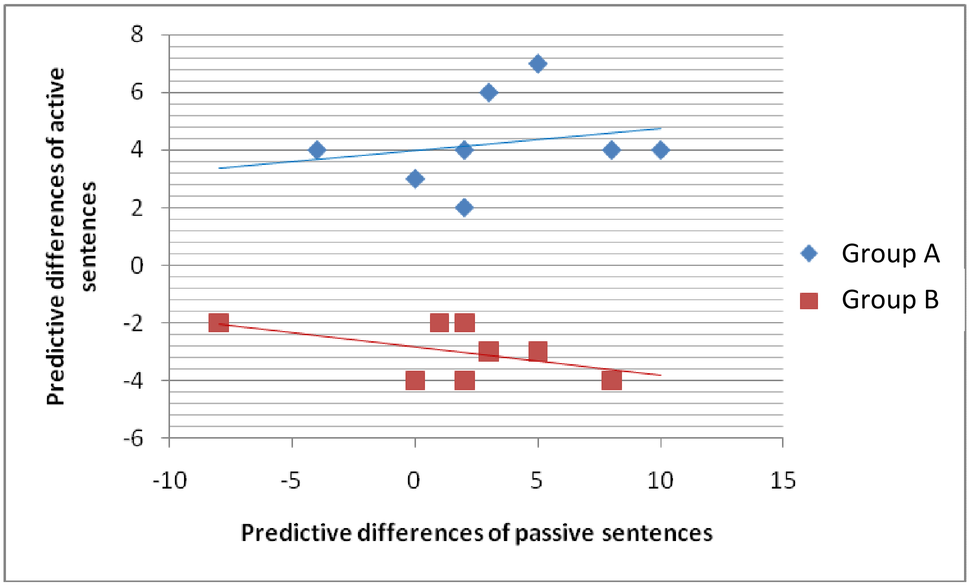

Figure 46. Scatter plot: Relationship between predictive differences of active and passive sentences

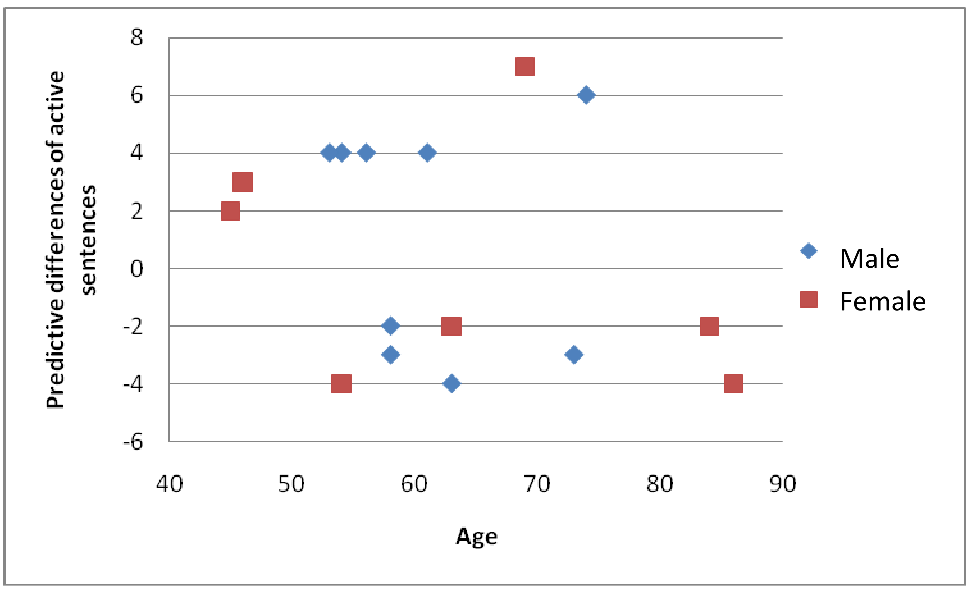

Figure 47. Scatter plot: Gender proportion relative to the improvement group and decrement group

Chapter IV

Discussion

The overall purpose of this study was to explore the impact of age and working memory capacity on the utilization of linguistic context to aid auditory comprehension in aphasia. Focus included investigation of relationships among specific explanatory variables, including age, working memory, aphasia severity, and auditory comprehension in a group of PWA and exploring the influence of predictive and non-predictive linguistic contexts on auditory comprehension with the adults with aphasia considering the effects of these explanatory variables.

Age and Working Memory

The first experimental question addressed the effect of age as a continuous variable on WM as measured by the Listening Span task. For this group of PWA, no significant relationship was observed between age and WM. Wingfield et al. (1988) found large age differences in working memory capacity for typically aging older adults relative to younger adults. Dobbs and Rule (1989) also found significant declines in working memory capacity between the ages of 60 to 69 and 70+ in typically aging individuals. Therefore, it had been hypothesized that WM capacity also declines with increasing age in aphasic adults and subsequently may additionally impact language processing in an adverse manner. However, the current results indicated that age was not an influential variable relative to WM functioning. The present results should be considered with caution due to the limited sample size. Furthermore, WM span may have been underestimated relative to the assessment tool utilized in the study; specifically, the Listening Span task used to measure WM was linguistically loaded; thus, the participants may have been at a disadvantage relative to performing this task because of their obvious language impairment.

Age and Aphasia Severity

The second experimental question addressed the effect of aphasia severity as measured by the Aphasia Quotient (AQ) on the WAB-R as a function of age as a continuous variable. Results revealed no significant relationship between age and severity of aphasia. Participants in both the young and older groups consisted of individuals with different levels of aphasia severity. In an investigation of age and aphasia type and severity, Obler, Albert, Goodglass, and Benson (1978) reported that typically severity of aphasia did not increase with age. Results of the current study are in congruence with Obler et al.'s findings. Thus, severity of aphasia may not be affected by increased age, but location and size of the brain lesion due to a stroke have been found to have an impact on aphasia severity (Pedersen, Jørgensen, Nakayama, Raaschou, & Olsen, 1995; Pedersen, Vinter, Olsen, 2004).

Age and Auditory Comprehension

The third experimental question addressed the effect of age as a continuous variable on auditory comprehension as measured by the modified Token Test. Davis and Ball (1989) have reported that comprehension abilities decline after age 60 in typically aging individuals. Obler, Fein, Nicholas, and Albert (1991) also observed that comprehension accuracy decreased with age, particularly for structurally more complex sentences in normal adults. Thus, it also can be hypothesized that auditory comprehension may decrease as age increases in individuals with aphasia. However, no significant relationship between age and auditory comprehension was observed in the current investigation, indicating that auditory comprehension was not affected by increasing age in this group of PWA.

Working Memory, Aphasia Severity, Auditory Comprehension

Relationships between WM capacity and auditory comprehension, WM capacity and aphasia severity, and comprehension and aphasia severity were investigated. The results revealed significant positive relationships between all of these explanatory factors. Thus, for this group of individuals, as WM capacity increased, auditory comprehension skills increased. These results are consistent with those of Cannito et al. (1996), who suggested that reduced WM capacity might lead to difficulty understanding sentences in individuals with aphasia. Current results also support those of Hough et al. (1997) who speculated that limited working memory capacity had a negative impact on auditory comprehension of sentences in adults with aphasia. Furthermore, decreased severity of aphasic impairment (higher WAB-R Aphasia Quotient) yielded increased WM capacity. The results of the current study are consistent with those of Caspari et al. (1998) who reported strong positive relationships between WM capacity and aphasia severity as measured by WAB AQ in their sample of adults with aphasia under investigation. Thus, these findings suggest that WM capacity may be one predictor of aphasia severity. Additionally, results indicated that as severity of aphasia increased, auditory comprehension abilities decreased. This finding is not surprising as auditory comprehension ability is a pivotal skill used to determine severity of impairment in aphasia (Davis, 2007; Goodglass, Kaplan, & Barresi, 2000; Helm-Estabrooks & Albert, 2004; Kertesz, 1982; 2006).

Effect of Linguistic Context on Auditory Comprehension

For the linguistic context task, the participants' comprehension of active and passive sentences was examined in the three contextual conditions of sentences in isolation, preceding predictive context, and preceding non-predictive context. Specifically, performance on predictive and non-predictive contexts was compared to isolated context for active and passive sentences. Moreover, performance on active sentences was compared to passive sentences relative to isolated, predictive, and non-predictive contexts. Relationships between age, WM, aphasia severity, auditory comprehension, and differences between active and passive sentences in the three contextual conditions were analyzed. Furthermore, relationships between age, WM, aphasia severity, auditory comprehension and predictive and non-predictive differences for active and passive sentences were examined.

Performance differences for accuracy of comprehension on predictive and non-predictive contexts relative to the isolation condition for both active and passive sentences yielded a significant increase in performance with non-predictive context for active sentences and significant performance increases in both non-predictive and predictive contexts for passive sentences. This latter facilitative effect was greater for predictive than non-predictive context. These results support those of Pierce and Wagner (1985) who reported that predictive context did not facilitate aphasic individuals' comprehension of reversible active sentences whereas it aided comprehension of reversible passive sentences. However, results of the current study are not congruent with Pierce and Wagner's (1985) finding that individuals with aphasia did not benefit from non-predictive context in comprehension of passive sentences. As Pierce (1991) pointed out, it is possible that in Pierce and Wagner's (1985) research, there was only a single sentence in the non-predictive context and the participants did not have enough exposure to the lexical items by the time the target sentence was presented; thus, single non-predictive contextual sentence contexts did not facilitate comprehension of passive sentences. These results are consistent with previous reports that individuals with aphasia benefited from both predictive and non-predictive linguistic contexts in comprehension of reversible passive sentences (Germani & Pierce, 1992; Hough & Pierce, 1989).

Performance of the participants with aphasia relative to differences between isolated active and passive sentences, predictive active and passive contexts, and non-predictive active and passive contexts were examined. The performance differences between predictive and non-predictive active context and predictive and non-predictive passive context also were compared for the participants with age as a continuous variable. The results revealed significant accuracy differences between the comprehension of isolated active and passive sentences, non-predictive active and non-predictive passive contexts, and predictive and non-predictive active contexts. Relative to the sentences in isolation, the participants demonstrated significantly better accuracy performance in the comprehension of isolated active than passive sentences. This finding is consistent with previous reports indicating that passive sentences are more difficult than active sentences for individuals with aphasia to comprehend (Berndt, Mitchum, & Haendiges, 1996; Davis, 2007; Shewan & Canter, 1971). Moreover, all target sentences on the linguistic context task were reversible in nature. Reversible sentences do not provide internal semantic constraints; thus, the individuals with aphasia had to rely on syntactic structure to comprehend the sentences. Consequently, the participants' auditory comprehension may have been adversely impacted because word order in passive sentences is not linear and thematic role could not be assigned to the first noun of the sentences.

Regarding the non-predictive contexts, participants performed significantly better on non-predictive active than passive contexts. The active sentences were relatively easy for the individuals with aphasia to comprehend compared to the passive sentences. Thus, the participants may have not required the additional redundancy and semantic support of the predictive contexts; consequently, they may have "lost interest" when they heard target sentences which provided "old" information consistent with the preceding predictive context. In the non-predictive context for active sentences, participants may have been more linguistically engaged as they heard target sentences which provided "new" information not alluded to in preceding paragraphs. However, when comparing predictive active and passive context, there was no significant difference in performance. As the individuals with aphasia had difficulty understanding isolated passive sentences, they took advantage of semantic supports of predictive context to facilitate comprehension of passive sentences.

Performance on non-predictive context was significantly better than predictive context for active sentences. This is partly because participants utilized the non-predictive context to understand active sentences due to the "new information". Furthermore, non-predictive context may be less facilitative than predictive context in comprehension of more complex passive sentences, which is consistent with Cannito et al.'s (1996) results.

Relationships between aphasia severity, WM, age, auditory comprehension, and the differences for active and passive sentences relative to performance on the sentences in isolation, predictive, and non-predictive contexts were examined. The results revealed a trend towards a significant relationship between aphasia severity and active/passive differences for sentences in isolation. Specifically, reduced severity of aphasia yielded increasingly better performance on isolated active than passive sentences. As found, the participants with reduced severity of aphasia were found to have higher WM spans; thus, they may have had more processing resources to effectively comprehend the active sentences. However, comprehension ability was constrained by the syntactic complexity of passive sentences; thus, the increased difficulty that most PWA experience with comprehending passive sentences may not be influenced by severity of their aphasic impairment. Similarly, a trend towards a significant relationship was obtained between aphasia severity and active/passive differences for non-predictive contexts, indicating that decreased aphasia severity leads to better utilization of non-predictive context for active than passive sentences. As mentioned, participants with decreased aphasia severity had higher WM spans; thus, they may have been able to take advantage of limited redundancy of objects and actions in the non-predictive contexts to facilitate comprehension of the active sentences. However, the non-predictive contexts did not provide semantic linguistic support predicting the relationship between objects and actions. Thus, these contexts did not facilitate comprehension of syntactically complex passive sentences, even for the participants with reduced aphasia severity.

A trend towards a significant positive relationship was observed between WM and active/passive differences for isolated context, indicating that individuals with aphasia with higher WM span demonstrated increasingly better performance on isolated active than passive sentences. Hough et al. (1997) reported that younger participants demonstrated more accurate performance on active sentences whereas older participants had better performance on passive sentences in isolation. They speculated that older participants, with more impaired WM capacity, tended to choose the last nouns they heard in passive sentences as the agent and thus performed more accurately. Younger participants, with higher WM, might be able to retain both nouns in passive sentences but have to choose between the two nouns at chance level; therefore, their performance on passive sentences was worse. The current results are in congruence with those of Hough et al.'s (1997).

For the linguistic context task, the amount of improvement or decrement relative to performance on the predictive and non-predictive contexts in comparison to the isolated context was computed as difference scores. As indicated, a trend towards a significant positive relationship was observed between severity of aphasia and predictive differences for passive sentences for the young group. These findings indicate that the young participants with decreasing severity of aphasia (higher WAB-R scores) performed better with predictive context than sentences in isolation for passive sentences. The young individuals with decreasing aphasia severity had better performance on predictive passive context than isolated passive sentences. As mentioned, passive sentences are typically more difficult for aphasic adults to comprehend and posed more difficulty for more severely impaired adults with aphasia. Thus, the predictive context was more facilitative for adults with more severe aphasia. This has been observed previously by Hough et al. (1997) and others (Cannito et al., 1996; Germani & Pierce, 1992; Hough et al., 1989).

Although no significant relationships were observed between auditory comprehension and predictive or non-predictive differences for active or passive sentences, the correlation between auditory comprehension and predictive context differences for passive sentences for the young group yielded a trend towards significance and implications for clinical significance. Thus, although young participants with less aphasic involvement overall were aided by predictive contexts for passive sentences, it appears that the predictive context was less facilitative to comprehension if they showed increasing auditory comprehension skills on a task like the Token Test. It is possible that the young participants with better auditory comprehension ability were able to process the passive sentences adequately and did not need the predictive context to facilitate comprehension (Pierce, 1991). The predictive context provided redundant as well as semantically supportive information relative to agent-action relationships that was consistent with the target sentences; thus, the young individuals with aphasia with increased auditory comprehension skills may have “lost interest” when they heard the target sentences because they already comprehended the stimuli.

For the older group, a trend towards a significant negative relationship was observed between age and predictive differences for passive sentences. Older participants showed a decreasing benefit from predictive context in the comprehension of passive sentences with increasing age. The older participants may have had decreased attention resources and were unable to utilize the predictive context effectively whereas the younger participants could benefit from the predictive context. Perbal, Droit-Volet, Isingrini, and Pouthas (2002) have reported that older adults exhibited slower processing speed than younger adults in a time reproduction task and a time production task in a counting and a concurrent reading condition. In the present investigation, participants were allowed 20 seconds to respond on the linguistic context task after a stimulus item was presented. It is possible that the older participants in the current investigation were unable to utilize the predictive context effectively within a time constraint due to reduced processing speed whereas the younger participants who required less response time could benefit from the predictive context.

As indicated previously, a subgroup of participants across the young and older groups demonstrated improvement for predictive context whereas a subgroup exhibited decreased performance for predictive context relative to isolated active sentences. Relationships for the improvement group and the decrement group were examined between age, severity of aphasia, WM, and auditory comprehension skills. The only significant finding for these analyses was a significant positive relationship between age and predictive context differences for active sentences for the improvement group. This result suggests that for individuals with aphasia who benefited from predictive context in the comprehension of active sentences, this contextual effect was increasingly facilitative as one advanced in age.

General Discussion

Results of the current study support previous research as well as extend understanding of the interdependence of WM and auditory comprehension skills in the language impairment of individuals with aphasia. In addition, the current findings replicate and expand previous findings relative to the influence of linguistic context on auditory comprehension skills of PWA.

The present study demonstrated no age-related difference in WM capacity, aphasia severity, and auditory comprehension skills in a group of young and older adults with aphasia. Strong positive relationships were observed among WM capacity, aphasia severity, and auditory comprehension across all participants with age as a continuous variable. Thus, individuals with aphasia have reduced WM capacity, regardless of age. These results provide additional support for previous findings indicating that aphasia adversely affects WM functioning and most individuals with aphasia have decreased WM capacity (Francis et al., 2003; Friedmann & Gvion, 2003; Just & Carpenter, 1997). In Baddeley's (1992; 1998; 2003) multi-component model, working memory comprises the central executive, the phonological loop, and the visuospatial sketchpad. As mentioned, the phonological loop consists of a phonological store and an articulatory rehearsal process which are important to language comprehension. The language impairment in aphasia may disrupt memory traces, which are typically held in the phonological store for a few seconds before they fade; consequently, individuals with aphasia may not be able to retrieve these traces from the store for adequate comprehension. Thus, the current findings are consistent with previous speculation that aphasia yields interdependent impairments in working memory and comprehension.

In the current investigation and others (Fisk and Warr, 1996; Salthouse, 1994), WM span was not related to age in individuals with aphasia; however, WM was related to severity of aphasia. Participants with increasing aphasia severity tended to have more limited WM capacity, which in turn contributed to decreased accuracy and increased response time in auditory comprehension, especially with structurally complex constructs such as passive sentences. Slow and effortful processing in conjunction with aphasic language deficits result in poor comprehension skills. Thus, the current results support the notion that reduced WM capacity contributes to comprehension deficits in PWA (Caplan & Waters, 1997; Caspari et al, 1998; Davis, 2007; Hough et al., 1997). However, as indicated, the Listening Span task used to measure WM span in the current investigation was linguistically loaded, possibly taxing already compromised language systems. Thus, it is possible that WM capacity of the current participants may have been underestimated. Furthermore, the Listening Span task required comprehension skills at both the word and sentence level. This factor may contribute to the strong relationship between WM span and auditory comprehension. Therefore, this result should be interpreted cautiously.

The participants benefited more from non-predictive context than predictive context in the comprehension of active sentences. Active sentences are relatively easy for aphasic individuals to understand due to their simple sentence structure; thus, PWA might have been able to process active sentences without the aid of preceding context. Therefore, predictive context may have an adverse influence on comprehension of active sentences as it provides redundant as well semantically supportive information relative to the target sentences. Individuals with aphasia may "lose interest" as well as experience decreased attention when they hear the target sentences that contain "old" information that is consistent and possibly repetitious of preceding linguistic context. Unlike predictive contexts, non-predictive contexts only provide some redundancy relative to information that familiarizes PWA with the lexical referents, specifically agents and actions, and does not predictive the relationship between the subject and object of the target sentences (Germani & Pierce, 1992; Hough et al., 1989; Pierce, 1991). Thus, with non-predictive context, the individual with aphasia is presented with novel information that is not conveyed by the target sentences. The listener does have the opportunity to become familiar with the nouns and verb from the preceding context, but must focus their limited resources on determining the relationship in the target sentences. In the case of active sentences, this is a relatively simple process, particularly with the non-predictive preceding context already identifying the agents and action. As a result, non-predictive contexts have a more facilitative effect than predictive context in comprehending active sentences.

Relative to the comprehension of passive sentences, the results revealed that predictive contexts were more beneficial than non-predictive contexts. The syntactic structures of passive sentences are more complex than those of active sentences as the first noun cannot be assigned the thematic role in passive sentences. Moreover, the semantic reversibility of the passive sentences prevents most individuals with aphasia from inferring sentence meaning with the help of their world knowledge. Therefore, the PWA may choose between the two nouns in the sentence at random in the absence of linguistic context for comprehension of passive sentences (Davis, 2007; Berndt, Mitchum, & Haendiges, 1996). Predictive context appears to facilitate comprehension of passive sentences because it provides semantic constraints and makes one interpretation of the target sentence more plausible than the other; thus, the adult with aphasia does not need to solely rely on the syntactic cues to deduce the meaning of the target sentence (Gernani & Pierce, 1992; Pierce, 1991).

In contrast to predictive context, non-predictive context does not provide the semantic framework that makes the correct relationship in the passive sentences more plausible. Although the adults with aphasia in the current investigation did not need to divide processing resources between determining the meaning of the nouns and the relationship between the nouns in the passive sentences, they had difficulty understanding passive sentences because of their impaired grammatical judgments (Ansell & Flowers, 1982; Peach, Canter, & Gallaher, 1988; Pierce, 1979;

Pierce & Wagner, 1985), especially relative to the lower functioning participants. Consequently, predictive context enhanced comprehension of passive sentences more than non-predictive context.

Limitations of the Study

One limitation of the current study is the limited sample size. This is a consistent observation for many studies in aphasia. However, the current sample size does limit generalization of results to the overall population of PWA.

The method to measure WM capacity also may be considered a study limitation. As previously mentioned, the Listening Span task was linguistically loaded; thus, WM spans of the participants may have been underestimated due to their already existing language problems.

Implications for Future Research

Future research should involve replication of the current protocol with a different method to measure WM span, such as immediate serial recall (e.g., a set of digits, letters or unrelated words). Serial recall is not linguistically loaded and may yield unique findings relative to WM capacity and its influence on other explanatory variables in PWA.

Future research should explore performance of individuals with aphasia on Sentence Assembly as well as its relationship to performance on the linguistic context task, particularly the passive and active sentences in isolation. In Sentence Assembly, sentences are broken into their component parts. Participants are instructed to put the randomized component parts in the correct order according to pictures. Sentence Assembly examines the syntactic aspect of word order. Weigl and Bierwisch (1970) proposed that difficulty in sentence comprehension resulted from a disturbance of performance for the PWA, not a loss of competence. However, Caramazza and Zurif's (1976) pivotal findings suggested that individuals with aphasia experienced a loss of competence which they compensated for through the use of nonsyntactic strategies, such as relying on world knowledge for sentence interpretation. The ability of individuals with aphasia to use prior world knowledge allows them to interpret sentences with internal, semantic constraints including both active and passive nonreversible sentences. Examining findings on sentence assembly relative to performance on the linguistic context task, which examines the ability to utilize context to comprehend active and passive reversible sentences, may provide valuable information in regard to the relationship between loss-of-syntactic-competence relative to performance disturbance in PWA.

Future research also should explore performance of individuals with aphasia on the Production task (modified Reporter's test) and its relationship to WM capacity. In the Production Task, participants are instructed to describe actions performed by the examiner after the examiner points to or manipulates tokens differing in color, shape, and/or size. Individuals need to store and manipulate information, including action, color, shape, and/or size, in working memory in order to perform this task. It would be valuable to examine the hypothesis that reduced WM leads to decreased oral production skills because oral production of language requires processing of various sentence elements simultaneously.

Summary

In summary, findings indicated that age did not appear to influence WM, aphasia severity, or auditory comprehension performance in a group of adults with aphasia. However, decreased aphasia severity was strongly linked to both increased WM and auditory comprehension, and WM and auditory comprehension were highly related in both young and older groups. Non-predictive context was more facilitative than predictive context in comprehension of active sentences. However, predictive context was of more benefit than non-predictive context in the comprehension of passive sentences, particularly for more severely impaired participants. This robust finding is consistent with previous research and continues to require further exploration relative to its use in language treatment in aphasia.

Speech-language pathologists need to acknowledge the importance of WM relative to comprehension in aphasia and take into consideration the role of WM capacity in structuring treatment tasks. The strong relationship between WM capacity and auditory comprehension for the participants with aphasia in the current investigation suggests that auditory comprehension skills may be enhanced by compensating for reduced WM capacity. This may be addressed through providing repetitions, allowing longer response time, shortening length of speech, and providing contextual information. Specifically, treatment procedures need to incorporate non-predictive linguistic contexts to aid comprehension of active sentences whereas predictive linguistic contexts may be used to facilitate comprehension of passive sentences. Such strategies may be especially beneficial with more severely impaired individuals with aphasia. Implementation of these strategies in language treatment continues to require further investigation.

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Appendix A

Questionnaire

Name: ______________________ Birthdate: ____________________

Date of stroke: ________________ Gender: Male____ Female ____

Choose **one** in each category:

1. Original hand preference: Right Left Ambidextrous
2. Education completed:
   Grammar School Junior High High School College Graduate school
3. Native language: English Spanish Others_____________
4. Did you have any communication problems prior to the stroke?
   Yes (please specify) ____ No
5. Did you have learning disabilities prior to the stroke? Yes No
6. Di you have attention disorders prior to the stroke? Yes No
7. Did you have any of the following prior to the stroke? Please circle.
   Alcoholism Substance Abuse
   Dementia Mental illness
   Heart disease Cancer (please specify)_____________________
   Others (please specify) _____________________________________

Appendix B

IRB Approval

EAST CAROLINA UNIVERSITY

University and Medical Center Institutional Review Board
East Carolina University • Brody School of Medicine
600 Moye Boulevard • Old Health Sciences Library, Room 1L-09 • Greenville, NC 27834
Office **252-744-2914** • Fax **252-744-2284** • **www.ecu.edu/irb**
Chair and Director of Biomedical IRB: L. Wiley Nifong, MD
Chair and Director of Behavioral and Social Science IRB: Susan L. McCammon, PhD

TO: Monica Hough, PhD, Dept of CSDI, College of Allied Health Sciences, ECU—Mailstop 668

FROM: UMCIRB

DATE: November 10, 2009

RE: Expedited Category Research Study

TITLE: "Influence of linguistic context and working memory on auditory comprehension of young and older aphasic adults"

UMCIRB #09-0759

This research study has undergone review and approval using expedited review on 10.28.09. This research study is eligible for review under an expedited category because it is on collection of data from voice, video, digital, or image recordings made for research purposes. It is also a research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies. (NOTE: Some research in this category may be exempt from the HHS regulations for the protection of human subjects. 45 CFR 46.101(b)(2) and (b)(3). This listing refers only to research that is not exempt.). The Chairperson (or designee) deemed this **unfunded** study **no more than minimal risk** requiring a continuing review in **12 months**. Changes to this approved research may not be initiated without UMCIRB review except when necessary to eliminate an apparent immediate hazard to the participant. All unanticipated problems involving risks to participants and others must be promptly reported to the UMCIRB. The investigator must submit a continuing review/closure application to the UMCIRB prior to the date of study expiration. The investigator must adhere to all reporting requirements for this study.

The above referenced research study has been given approval for the period of **10.28.09** to **10.27.10**. The approval includes the following items:

- Internal Processing Form (received 10.19.09)
- Appendix A: Questionnaire
- Appendix B: Informed Consent Document (received 10.23.09):
- Appendix C: Working Memory Tasks
- Appendix D: Comprehensive Tasks
- Appendix E: Production Task
- Appendix F: Sentence Assembly Task
- Appendix G: Contextual Influence Task
- ECU Health Care Components

The Chairperson (or designee) does not have a potential for conflict of interest on this study.

The UMCIRB applies 45 CFR 46, Subparts A-D, to all research reviewed by the UMCIRB regardless of the funding source. 21 CFR 50 and 21 CFR 56 are applied to all research studies under the Food and Drug Administration regulation. The UMCIRB follows applicable International Conference on Harmonisation Good Clinical Practice guidelines.

IRB00000705 East Carolina U IRB #1 (Biomedical) IORG0000418
IRB00003781 East Carolina U IRB #2 (Behavioral/SS) IORG0000418
IRB00004973 East Carolina U IRB #4 (Behavioral/SS Summer) IORG0000418
Version 3-5-07

UMCIRB #09-0759
Page 1 of 1

UMCIRB HIPAA Authorization Checklist/Approval Form

UMCIRB #: 09-0759 PI: M. Hough

Title of study (full or abbreviated): Influence of linguistic context and working memory on auditory comprehension of young and older aphasic adults.

Check one of the boxes below:

- [ ] Use of ECU "Research Participant Authorization to Use and Disclose Information for Research"
- [x] Use of a sponsor/granting agency or other alternative HIPAA Patient Authorization
- [ ] Use of research informed consent document form with required elements of the HIPAA Patient Authorization

Designated UMCIRB reviewer has reviewed the substitute HIPAA Patient Authorization for Research or proposed research consent form and found that it is written in plain language and contains:

Yes	No	
☑	☐	A specific and meaningful description of the information to be used or disclosed
☑	☐	The name or identification of persons or class of persons authorized to make requested use/disclosure of PHI
☑	☐	The name or identification of persons or class or persons who will use PHI for research-related purposes
☑	☐	A description of each purpose of the use or disclosure
☑	☐	The individual's signature (or that of his/her authorized representative) and the date.
☑	☐	An expiration date or event, or a statement "end of research study" or "none" when appropriate
☑	☐	A statement that the individual may revoke the authorization in writing;
☑	☐	Any exceptions to the right to revoke (e.g. researcher may continue to use and disclose, for research integrity and reporting purposes any PHI collected from the individual pursuant to such Authorization before it was revoked).
☑	☐	A statement that information disclosed under the Authorization could potentially be re-disclosed by the recipient and would no longer be protected under HIPAA.
☑	☐	A statement of the ability or inability to condition treatment, payment, enrollment or eligibility for benefits on the authorization by stating either stating the applicable conditions or the consequences to the individual for refusal to sign the authorization.

- [x] **All the above elements are present, HIPAA AUTHORIZATION document is APPROVED**
- [ ] **All the above elements are not present; HIPPA AUTHORIZATION document is NOT APPROVED**

Susan McCammon 10-28-09

Designated UMCIRB Reviewer Date

Principal Investigator: Present this signed form at the time PHI is requested from custodians of records. ***By signing this document, I acknowledge and affirm that all enrolled subjects have signed a valid HIPAA Authorization Form.***

Principal Investigator Date

UMCIRB
APPROVED
FROM 10-28-09
TO no expiration

Version 08-04-03

Appendix C
Informed Consent form
CONSENT DOCUMENT

Title: A study of influence of working memory and linguistic context on auditory comprehension of aphasic adults.

Principal Investigator: Monica S. Hough, PhD, CCC-SLP
Health Sciences Building, Suite 3310
Department of Communication Sciences & Disorders
East Carolina University

Secondary Investigator: Kun Yu
Second Year Master Student
Department of Communication Sciences & Disorders
Health Sciences Building, Suite 3310
East Carolina University

Institution: East Carolina University

Address: Department of Communication Sciences & Disorders (CSDI)
College of Allied Health Sciences
Health Sciences Bldg, Suite 3310
East Carolina University
Greenville, North Carolina 27858

Telephone #: 252-258-3851 (Yu)
252-744-6090 (Hough)

This consent document may contain words that you do not understand. You should ask the study coordinator to explain any words or information in this consent form that you do not understand.

INTRODUCTION

You have been asked to participate in a research study being conducted by Kun Yu, second year master student under the direction of Monica S. Hough, PhD, Professor, Department of CSDI. This research study is designed to investigate how working memory and linguistic context influence auditory comprehension of young and older adults with aphasia.

PLAN AND PROCEDURES

All data will be collected by Kun Yu. You will be asked to undergo pre-experimental testing and five experimental tests during the entire course of the study. The pre-experimental testing will include two subtests from the *Boston Diagnostic Aphasia Examination-III* (BDAE-III), Oral Commands and Complex Ideational Material to determine your auditory comprehension level. You will also be administered the *Western Aphasia Battery-R* (WAB-R) which tests the presence and extent of aphasia. For the experimental tests, You will be administered tests including listening span, comprehension task (the Token Test), production task (the Reporter's Test), sentence assembly, and the contextual influence task. In listening span, you will be presented with a series of sentences and a separate word immediately after the sentence. You then will be asked to recognize the target word and to answer questions about the sentences. In the comprehension task, you will be asked to point to or manipulate tokens after commands are presented auditorily. In the production task, you will be asked to describe actions performed by the examiner as she moves tokens. In sentence assembly, you will be asked to put words together according to pictures shown to you. For the contextual influence task, you will be asked to choose a picture that represents sentences and short paragraphs presented to you, auditorily. You understand that you can request break time if you would like to rest. You understand that the testing will take approximately 2-3 hours to complete and this includes breaks. You understand that you can ask for a drink during these rest periods.

You understand that the examiner will instruct you on how to perform the experimental tasks prior to the beginning of the testing and you will have a chance to practice these tasks. You may withdraw from the study if you deem necessary without any repercussions on the therapy services you receive at East Carolina University (ECU) Speech-Language and Hearing Clinic, Pitt County Memorial Hospital, and the Pitt Regional Rehabilitation Facility. You understand that participation in this study has nothing to do with the therapy services you receive at East Carolina University (ECU) Speech-Language and Hearing Clinic, Pitt County Memorial Hospital, and the Pitt Regional Rehabilitation Facility.

If you choose to participate, you will come to the Speech-Language and Hearing Clinic at the Department of Communication Sciences and Disorders at East Carolina University. Total testing time will be approximately 2 to 3 hours in total and will be scheduled at your convenience.

POTENTIAL RISKS AND DISCOMFORTS

Although it is not possible to predict all possible risks or discomforts that participants may experience in any research study, the present investigators anticipate that no major risks or discomforts will occur in the present project. While undergoing the testing, the participant may experience minimal nervousness with an unfamiliar exam and frustration with poor performance. The participant may discontinue the study with no penalty and at will.

POTENTIAL BENEFITS

The literature is scarce relative to specifically examining the effects of both age and working memory capacity on auditory comprehension abilities with aphasia. More information is needed to understand to what extent aging affects working memory capacity and to understand the effects of different severity level of aphasia on working memory capacity. The degree to which working memory capacity affects various language modalities is unknown. Moreover, the influence of different linguistic contexts on aphasic individuals' auditory comprehension and the effects of working memory capacity on aphasic individuals' ability to take advantage of different contextual conditions in auditory comprehension have yet to be examined. This investigation may provide more insight into aphasic patients' ability to process information in daily listening situations and help individuals with aphasia become better communicators.

SUBJECT PRIVACY AND CONFIDENTIALITY OF RECORDS

You understand that all records related to the study will remain confidential. Your name will not be used to identify information or results in scientific presentations or publications. Your data will be coded to conceal your identity. All computer data collected will be stored on the principal investigator's laptop computer or on digital video disks (DVD) stored in a locked storage cabinet, with access limited to the above listed persons.

TERMINATION OF PARTICIPATION

You may stop participating at any time you choose without penalty, loss of benefits, or without jeopardizing any continuing medical care at this institution. You understand that if you experience severe nervousness with an unfamiliar exam and severe frustration with poor performance, the examiners may terminate your participation in the study to ensure your comfort.

COSTS OF PARTICIPATION

There will be no costs to you for participating in this research study.

COMPENSATION AND TREATMENT FOR INJURY

The policy of East Carolina University and/or Pitt County Memorial Hospital does not provide for payment or medical care for research participants because of physical or other injury that result from this research study. Every effort will be made to make the facilities of the School of Medicine and Pitt County Memorial Hospital available for care in the event of injury.

A corporate sponsor may pay for some physical injuries caused by a research study; however, there is no corporate sponsor for this investigation. You should notify the study coordinator as soon as you believe you have experienced any study related illness, adverse event, or injury. The study coordinator will determine if the adverse event or injury was a result of your participation in this study. The study coordinator is not responsible for expenses that are due to pre-existing medical conditions, underlying disease, your negligence or willful misconduct, or the negligence or willful misconduct of other individuals involved in the research study. You do not give up any legal rights as a research participant by signing this consent form.

VOLUNTARY PARTICIPATION

Participation in this study is voluntary. If you decide not to be in this study after it has already started, you may stop at any time without losing benefits that you should normally receive. You may stop at any time you choose without penalty, loss of benefits, or without a causing a problem with your medical care at this institution.

PERSONS TO CONTACT WITH QUESTIONS

The investigators will be available to answer any questions concerning this research, now or in the future. You may contact the investigators, Kun Yu or Dr. Monica S. Hough at phone numbers 252-258-3851 (Yu) or 252-744-6090 (Hough). If you have questions about your rights as a research participant, you may call the Chair of the University and Medical Center Institutional Review Board at phone number 252-744-2914 (days). If you have a question about injury related to this research, you may call PCMH Risk Management Office at 252-847-5246.

CONSENT TO PARTICIPATE

Title: A study of influence of working memory and linguistic context on auditory comprehension of aphasic adults.

I have read all of the above information, asked questions and have received satisfactory answers in areas I did not understand. (A copy of this signed and dated consent form will be given to the person signing this form as the participant or as the participant authorized representative.)

____

Participant's Name **(PRINT)** **Signature** **Date** **Time**

____

Guardian's Name **(PRINT)** **Signature** **Date** **Time**

WITNESS: I confirm that the contents of this consent document were orally presented, the participant or guardian indicates all questions have been answered to his or her satisfaction, and the participant or guardian has signed the document.

____

Witness's Name **(PRINT)** **Signature** **Date**

PERSON ADMINISTERING CONSENT: I have conducted the consent process and orally reviewed the contents of the consent document. I believe the participant understands the research.

____

Person Obtaining consent **(PRINT)** **Signature** **Date**

____

Principal Investigator's **(PRINT)** **Signature** **Date**

Appendix D

Working Memory Task Instructions

Task Instructions

THIS TASK INVOLVES LISTENING TO SOME SENTENCES AND WORD FINALS AND REMEMBERING THE WORD FINALS. YOU WILL BE ASKED TO POINT TO THE PICTURES OF ALL THE WORD FINALS YOU REMEMBER. YOU WILL ALSO BE ASKED A QUESTION ABOUT THE SENTENCES YOU HEARD. THERE ARE THREE SETS OF SENTENCES PER TRIAL.

LET'S PRACTICE

Place a card with a single sentence + word final exposed.

Say: LISTEN TO THE SENTENCE + WORD FINAL

Turn the card over and say:

NOW FIND THE PICTURE OF THE WORD FINAL

If the response is correct ask a question about the sentence and proceed to next practice card. Place a card with two sentences +word finals. Expose one sentence at a time. And say:

NOW THERE ARE TWO SENTENCES AND TWO WORD FINALS. LISTEN TO BOTH SENTNECES AND WORD FINALS

Turn the card over and say: FIND THE PICTURES OF BOTH WORD FINALS

Ask a question about one of the sentences.

If the response is incorrect, say:

LISTEN TO THE SENTENCE AGAIN

SEE, THIS IS THE FINAL WORD (point to it)

NOW FIND IT HERE (turn over card)

If response is accurate, proceed to practice card #2.

If response is still inaccurate, repeat explanation and demonstration

Abandon if subject fails to demonstrate understanding after two practice sessions

Example of a Working Memory Score Sheet

Name:_________________________Date:______________________Time:___________________

SCORE SHEET 1

SET	TRIAL 1	TRIAL 2	TRIAL 3
1A	Bread	train	fork
2B	vest coat	clock queen	stop dish
3C	glass man old	go saw leash	thump scarf bird
4D	pie rope log drink	kick gun face lips	arm hit roof hand
5E	bath drum ring dog tree	plug gate ball nose horse	fight cape splash knife blond
6F	play kiss kill pie box thief	smile dress boat bath nest read	hair sleep sick mouse toes wing

A1 Did the pilot fly a kite or a plane? 2 Did the chef ruin or save the meal? 3 Did the doorbell or the phone ring again?	D 1 Did she clean the shower or the bath? 2 Did they buy a house or a condo? 3 Did the girl eat some cake or some candy?
B1 Did Shelly eat an orange or a peach? 2 Did he arrive too late or too early? 3 Did he want more juice or didn't he?	E1 Did she brush her teeth or her hair? 2 Did the boys go skiing or hiking? 3 Did Tom stop smoking or drinking?
C1 Did Bill want chicken wings or chicken breast? 2 Did the man save the boy or the dog? 3 Did they fly to New Orleans or New York?	F1 Did he forget or remember the address? 2 Did the dentist or the doctor prescribe rest? 3 Did the vet treat the snake or the dog?

Working Memory Task

Set1
Trial 1 The pilot flew the plane. Bread
Trial 2 The chef ruined the meal. Train
Trial 3 The phone rang again. Fork

Set 2
Trial1 Shelly ate another peach. Vest
Bill wrote a letter. Coat

Trial 2 He ordered steak and fries. Clock
He arrived too late. Queen
Trial 3 The thiefescaped from prison. Stop
He didn't want any juice. Dish

Set 3
Trial1 Bill wanted chicken wings. Glass
Greg slid down the slide. Man
He asked for more milk. Old
Trial 2 The baby didn't stop crying. Go
The man saved the boy. Saw
He bit a hole-in-one. *Leash*
Trial 3 They flew to New York. Thumb
She tripped and fell. Scarf
Bob signed the check. Bird

Set 4
Trial1 The driver crashed the car. Pie
The cowboy rode the horse. Rope
The baby slept at last. Log
She cleaned the shower. Drink
Trial 2 The car was speeding. Kick
They bought a condo. Gun
He ran away quickly. Face
He was the guest of honor. Lips
Trial 3 The girl ate some candy. Arm
The wedding was over at last. Hit
She hated the hat. Roof
The pencil point broke. Hand

Set5
Trial1 The woman baked a cake. Bath
Harry closed the window. Drum
He arrived too late. Ring
She brushed her teeth. Stairs
The couple sailed last week. Tree
Trial2 The boys went hiking. Plug
He plays golf on Sundays. Gate
Their farm is in Montana. Ball
She bought an electric drill. Nose
She poured the coffee. Horse
Trial 3 He broke his leg. Fight
The band played a tune. Cape
The bedroom was untidy. Splash
Tom stopped smoking. Knife
The man cleaned the floor. Blond

Set 6
Trial1 He fixed the blender. Play
The nurse left the room. Kiss
The dog was panting. Kill
She ironed her clothes. Pie
Jerry waited for the bus. Box
He forgot the address. Thief
Trial 2 We ate at Wendy's. Smile
The lights went out. Dress
The two friends played golf. Boat
The dentist pulled the tooth. Bath
The mechanic changed the oil. Nest
The doctor prescribed rest. Read
Trial 3 They drank their beers. Hair
He ran away quickly. Sleep
Bill walked every day. Sick
The champ scored a goal. Mouse
They lit up the pool. Toes
The vet treated the snake. Wing

Appendix E

Comprehension Task Instructions

Pre-Task Instructions

Pre task instructions are provided only to those subjects who have demonstrated the ability to match shapes, colors and/or sizes.

1. Set up board appropriately for each subject
2. Ask: CAN YOU SEE ALL THESE TOKENS ON THE TABLE?
   I WILL ASK YOU TO DO SOME THINGS WITH THEM
3. Say: THESE TOKENS ARE ALL CIRCLES AND THESE TOKENS ARE ALL RECTANGLES
   THERE ARE RED ONES, BLUE ONES, WHITE ONES, YELLOW ONES AND BLACK ONES
   SOME ARE BIG AND SOME ARE LITTLE (if appropriate)

   LISTEN CAREFULLY AND DO EXACTLY WHAT I SAY.
   WAIT UNTIL I FINISH GIVING THE INSTRUCTION.
   ARE YOU READY?

   TOUCH A BLACK CIRCLE

   NOW I WILL GIVE YOU TWO INSTRUCTIONS

   TOUCH A BIG BLUE RECTANGLE AND A SMALL WHITE CIRCLE
4. If the patient fails to respond within thirty seconds, repeat the instruction. If necessary, provide training on identifying shapes, colors, and sizes.
5. Following training, re-administer pre task instructions.
6. On successful completion of training and compliance with pre task instruction, administer task.
7. If subject fails to identify tokens appropriately after three training sessions, abandon task.

Comprehension Task for Individuals with Very Low WM Spans

Name:________________________Date:_____________________Time:__________________

Task Instructions

USE FIVE TOKENS OF DIFFERENT COLORS AND DIFFERENT SHAPES

LISTEN CAREFULLY AND DO EXACTLY WHAT I SAY
REMEMBER TO WAIT UNTIL I FINISH
ARE YOU READY?

1. TOUCH THE **BLACK** TOKEN

2. TOUCH THE **YELLOW** TOKEN

3. TOUCH THE **BLUE** TOKEN

4. TOUCH THE **RED** TOKEN

5. TOUCH THE **YELLOW** TOKEN AND THE **RED** TOKEN

6. TOUCH THE **BLACK** TOKEN AND THE **BLUE** TOKEN

7. PLACE THE **RED** TOKEN **ON TOP** OF THE **WHITE** TOKEN

8. PLACE THE **BLACK** TOKEN **BELOW THE BLUE** TOKEN

9. PLACE THE **YELLOW** TOKEN TO THE **LEFT** OF THE **WHITE** TOKEN

10. PLACE THE **RED** TOKEN TO THE **RIGHT** OF THE **BLUE** TOKEN

Comprehension Task for Individuals with WM Spans of Two or Below

Name:_________________________Date:______________________Time:___________________

USE ONLY LARGE TOKENS

Task Instructions

LISTEN CAREFULLY AND DO EXACTLY WHAT I SAY

REMEMBER TO WAIT UNTIL I FINISH

ARE YOU READY

Commands can be repeated on request

1 TOUCH THE **YELLOW CIRCLE**

2 TOUCH THE **WHITE RECTANGLE**

3 TOUCH THE **RED RECTANGLE**

4 TOUCH THE **YELLOW RECTANGLE** AND THE **BLUE CIRCLE**

5 TOUCH THE **BLACK CIRCLE** AND THE **RED RECTANGLE**

6 TOUCH THE **WHITE RECTANGLE** AND THE **BLUE CIRCLE**

7 PLACE THE **RED CIRCLE ON TOP** OF THE **BLUE RECTANGLE**

8 PLACE THE **WHITE RECTANGLE BELOW** THE **YELLOW CIRCLE**

9 PLACE THE **BLUE CIRCLE** TO THE **LEFT** OF THE **BLACK CIRCLE**

10 PLACE THE **YELLOW RECTANGLE** TO THE **RIGHT** OF THE **BLACK CIRCLE**

Comprehension Task for Individuals with WM Spans of Four or Above

Name:________________________Date:_____________________Time:__________________

USE LARGE AND SMALL TOKENS

Task Instructions

LISTEN CAREFULLY AND DO EXACTLY WHAT I SAY.
REMEMBER TO WAIT UNTIL I FINISH.
ARE YOU READY?

1 TOUCH THE **BIG YELLOW CIRCLE**

2 TOUCH THE **LITILE WHITE RECTANGLE**

3 TOUCH THE **LITTLE RED RECTANGLE**

4 TOUCH THE **LITTLE YELLOW RECTANGLE AND THE BIG BLUE CIRCLE**

5 TOUCH THE **LIITLE BLACK CIRCLE** AND THE **BIG RED RECTANGLE**

6 TOUCH THE **BIG WHITE RECTANGLE** AND THE **LITTLE BLUE CIRCLE**

7 PUT THE **LI'ITLE RED CIRCLE ON TOP OF THE BIG BLUE RECTANGLE**

8 PUT THE **BIG WHITE RECTANGLE BELOW THE LITTLE YELLOW CIRCLE**

9 PUT THE **LIITLE BLUE CIRCLE** TO THE **LEFT** OF THE **BIG BLACK CIRCLE**

10 PUT THE **BIG YELLOW RECTANGLE** TO THE **RIGHT** OF THE **LITTLE BLACK CIRCLE**

Appendix F

Production Task (modified Reporter's Test) Stimuli and Instructions

Pre Task Instructions

Pre task instructions are provided only to those subjects who have demonstrated the ability to match shapes, colors and sizes.

1. Set up board appropriately for each subject.

2. Say: THIS TIME I WILL DO SOME THINGS WITH THE TOKENS. WATCH ME CAREFULLY.

Touch a big black circle and say:
SAY EXACTLY WHAT YOU SEE ME DO. DON'T LEAVE ANYTHING OUT. Repeat action if necessary.

4. NOW I WILL PERFORM TWO ACTIONS. WAIT FOR ME TO FINISH. SAY EXACTLY WHAT YOU SEE ME DO. DON'T LEAVE ANYTHING OUT.

Touch a small yellow rectangle and a big red circle

5. If subject fails to respond within 30 seconds, provide training on naming shapes, colors and sizes.

6. Following training, re-administer pre task instructions.

7. On successful completion of pre task instructions, administer task.

8. If subject fails to name tokens with more than 51% accuracy after three training sessions, abandon task.

Production Task for Individuals with Very Low WM Spans

Name:________________________Date:_____________________Time:__________________

Task Instructions

USE FIVE TOKENS OF DIFFERENT COLORS AND DIFFERENT SHAPES

WATCH ME AND SAY EXACTLY WHAT YOU SEE ME DO
REMEMBER TO WAIT UNTIL I FINISH
DON'T LEAVE ANYTHING OUT
ARE YOU READY?

Gestured commands can be repeated on request

1. TOUCHES THE **BLUE** TOKEN

2. TOUCHES THE **YELLOW** TOKEN

3. TOUCHES THE **BLACK** TOKEN

4. TOUCHES THE **RED** TOKEN

5. TOUCHES THE **WHITE** TOKEN AND THE **RED** TOKEN

6. TOUCHES THE **BLACK** TOKEN AND THE **BLUE** TOKEN

7. PLACES THE **YELLOW** TOKEN **ON TOP** OF THE **WHITE** TOKEN

8. PLACES THE **BLACK** TOKEN **BELOW THE BLUE** TOKEN

9. PLACES THE **YELLOW** TOKEN TO THE **LEFT** OF THE **WHITE** TOKEN

10. PLACES THE **RED** TOKEN TO THE **RIGHT** OF THE **BLUE** TOKEN

Production Task for Individuals with WM Spans of Two or Below

Name:________________________Date:_____________________Time:__________________

Task Instructions

USE ONLY LARGE TOKENS

WATCH ME AND SAY EXACTLY WHAT YOU SEE ME DO
REMEMBER TO WAIT UNTIL I FINISH
DON'T LEAVE ANYTHING OUT
ARE YOU READY?

Gestured commands can be repeated on request
1 TOUCH THE **YELLOW CIRCLE**

2 TOUCH THE **WHITE RECTANGLE**

3 TOUCH THE **RED RECTANGLE**

4 TOUCH THE **YELLOW RECTANGLE** AND THE **BLUE CIRCLE**

5 TOUCH THE **BLACK CIRCLE** AND THE **RED RECTANGLE**

6 TOUCH THE **WHITE RECTANGLE** AND THE **BLUE CIRCLE**

7 PLACE THE **RED CIRCLE ON TOP** OF THE **BLUE RECTANGLE**

8 PLACE THE **WHITE RECTANGLE BELOW** THE **YELLOW CIRCLE**

9 PLACE THE **BLUE CIRCLE** TO THE **LEFT** OF THE **BLACK CIRCLE**

10 PLACE THE **YELLOW RECTANGLE** TO THE **RIGHT** OF THE **BLACK CIRCLE**

Production Task For Individuals with WM Spans of Four or Above

Name:__________________________Date:_______________________Time:____________________

Task Instructions

Use large and small tokens

WATCH ME AND SAY EXACTLY YOU SEE ME DO AFTER I HAVE FINISHED.
DON'T LEAVE ANYTHING OUT. ARE YOU READY?

1 TOUCHES THE **BIG YELLOW CIRCLE**

2 TOUCHES THE **LITTLE WHITE RECTANGLE**

3 TOUCHES THE **LITTLE RED RECTANGLE**

4 TOUCHES THE **LITTLE YELLOW RECTANGLE** AND THE **BIG BLUE CIRCLE**

5 TOUCHES THE **LITTLE BLACK CIRCLE** AND THE **BIG RED RECTANGLE**

6 TOUCHES THE **BIG WHITE RECTANGLE** AND THE **LITTLE BLUE CIRCLE**

7 PLACES THE **LITTLE RED CIRCLE ON TOP OF** THE **BIG BLUE RECTANGLE**

8 PLACES THE **BIG WHITE RECTANGLE BELOW** THE **LITTLE YELLOW CIRCLE**

9 PLACES THE **LITTLE BLUE CIRCLE** TO THE **LEFT** OF THE **LITTLE BLACK CIRCLE**

10 PLACES THE **BIG YELLOW RECTANGLE** TO THE **RIGHT** OF THE **LITTLE BLACK CIRCLE**

Appendix G

Participant Production Task (modified Reporter's Test) Results

Participants	Production Task Scores
1	22.5
2	24
3	0
4	11
5	24
6	0
7	27
8	18.5
9	0
10	0
11	0.5
12	26
13	0.5
14	19.5
15	25.5
16	29

Appendix H

Sentence Assembly Task Instructions/Stimuli

Pre Task Instructions

HERE ARE SOME PICTURES

PLEASE POINT TO:

CARD 1	CARD 2	CARD 3
BOY	FATHER	CHILD
MAN	GIRL	FARMER
WOMAN	MOTHER	DOG
		BULL

If subject fails to identify the correct picture, the examiner will identify it.

The subject will be asked to try again. Train if necessary.

Discontinue testing if subject scores less than 70% after training.

SENTENCE ASSEMBLY TASK SCORE SHEET

Name:___________________________

Date:________________________Time:___________________

Task Instruction

Place picture in front of subject

Place word cards in pre-determined vertical order below picture and say:

PUT THESE CARDS IN ORDER SO THAT THEY MAKE A SENTENCE

- Repeat instructions if there is no response after 30 seconds
- Assist with reading
- Abandon task if subject fails to read words despite assistance

Score Sheet

Active sentences	Det/Subject	verb	Det/object
1. The girl chases the boy			
2. the mother yells at the boy			
3. the farmer scolds the boy			
4. the dog frightens the girl			
5. the dog follows the boy			

Passive sentences	Det/subj	Verb	prep	Det/obj
6. the man is kissed by the woman				
7. the girl is comforted by the mother				
8. the boy is hit by the farmer				
9. the dog is chased by the bull				
10. the child is pushed by the father				

Appendix I

Participant Sentence Assembly Task Results

Participants	Sentence Assembly Task Scores
1	5
2	10
3	4
4	5.5
5	9
6	10
7	7
8	12
9	7
10	0
11	0
12	9.5
13	8.5
14	13
15	9
16	16.5

Appendix J

Contextual Stimuli

Context Stimuli: Passive

Predictive: Both nurses and doctors work in a hospital. This hospital was overrun by patients. A nurse began checking on the condition of a patient whose heart monitor was buzzing. Suddenly, there was a frantic call through the ward. The doctor was called by the nurse.

Nonpredictive: Both nurses and doctors work in a hospital. This hospital was overrun by patients. A nurse began checking on the condition of a new patient. Suddenly, there was a frantic call through the ward. The nurse was called by the doctor.

Isolation: The doctor was called by the nurse.

Isolation: The nurse was called by the doctor.

Predictive: Many kings and queens were partying in a garden. This garden was filled with visiting royalty. Suddenly, a king saw someone he loved very much. Soon there was a polite kiss in the courtyard. The queen was kissed by the king.

Nonpredictive: Many kings and queens were partying in a garden. This garden was filled with visiting royalty. Suddenly, a king began walking toward an old friend among the royalty. Soon there was a polite kiss in the courtyard. The king was kissed by the queen.

Isolation: The queen was kissed by the king.

Isolation: The king was kissed by the queen.

Predictive: Both snakes and wolves can be found in caves. This cave was darkened in dusk. Suddenly, a hungry wolf saw something to eat. Then there was a fierce pouncing in the darkness. The snake was pounced upon by the wolf.

Nonpredictive: Both snakes and wolves can be found in caves. This cave was darkened in dusk. Suddenly, there was a rapid movement. Then there was a fierce pouncing in the darkness. The wolf was pounced upon by the snake.

Isolation: The snake was pounced upon by the wolf.

Isolation: The wolf was pounced upon by the snake.

Predictive: A pirate and a captain were searching for treasure. This treasure was hidden on a ship. Suddenly, the pirate was attacked from behind by the captain who had a knife. There was a deadly stab among the wreckage. The pirate was stabbed by the captain.

Nonpredictive: A pirate and a captain were searching for treasure. This treasure was hidden on a ship. Suddenly, there was a vicious fight with a knife. Then, there was a deadly stab among the wreckage. The captain was stabbed by the pirate.

Isolation: The pirate was stabbed by the captain.

Isolation: The captain was stabbed by the pirate.

Predictive: A dog and a cat were in the yard. The yard was shaded by a tree. The dog began to growl and show its teeth because he saw the frightened cat who was near the tree. Then there was a frantic chase across the grass. The cat was chased by the dog.

Nonpredictive: A dog and a cat were in the yard. The yard was shaded by a tree. The animals began making angry growling and hissing sounds. Then there was a frantic chase across the grass. The dog was chased by the cat.

Isolation: The cat was chased by the dog.

Isolation: The dog was chased by the cat.

Predictive: A girl and a boy were swimming in a lake. This lake was divided by a rope. Suddenly, the girl suffered a severe cramp and disappeared under the deep water. Then there was a daring rescue in the depths. The girl was rescued by the boy.

Nonpredictive: A girl and a boy were swimming in a lake. This lake was divided by a rope. Suddenly, it became very quiet and there was a disappearance under the deep water. Then there was a daring rescue in the depths. The boy was rescued by the girl.

Isolation: The girl was rescued by the boy.

Isolation: The boy was rescued by the girl.

Predictive: A woman and a man who were neighbors were watering their yards. Their yards were bordered by a fence. The man began walking toward the fence to play a joke on his neighbor. Then there was a wet spraying across the lawn. The woman was sprayed by the man.

Nonpredictive: A woman and a man who were neighbors were watering their yards. Their yards were bordered by a fence. Someone began walking toward the fence to play a joke. Then there was a wet spraying across the lawn. The man was sprayed by the woman.

Isolation: The woman was sprayed by the man.

Isolation: The man was sprayed by the woman.

Predictive: A secretary and a janitor were working in an office. This office was cluttered with files. Suddenly, the secretary tripped over some files that had been moved for cleaning. Then there was a loud scolding near the filing cabinet. The janitor was scolded by the secretary.

Nonpredictive: A secretary and a janitor were working in an office. This office was cluttered with files. Suddenly, a person fell over some files followed by a moaning sound. Then there was a loud scolding near the filing cabinet. The secretary was scolded by the janitor.

Isolation: The janitor was scolded by the secretary.

Isolation: The secretary was scolded by the janitor.

Predictive: A ghost and a witch were lurking in a dungeon. This dungeon was haunted by spirits. Suddenly, the ghost popped out of nowhere and shouted “BOO.” There was a terrible fright among the spooks. The witch was frightened by the ghost.

Nonpredictive: A ghost and a witch were lurking in a dungeon. This dungeon was haunted by spirits. Suddenly, there was shouting out of nowhere. There was a terrible fright among the spooks. The ghost was frightened by the witch.

Isolation: The witch was frightened by the ghost.

Isolation: The ghost was frightened by the witch.

Predictive: Once a salesgirl and a manager were working in a shop. This shop was lacking in help. The salesgirl felt tired and decided to take a break. Then there was a stern and determined pulling toward the register. The salesgirl was pulled by the manager.

Nonpredictive: Once a salesgirl and a manager were working in a shop. This shop was lacking in help. There was no one to assist a customer at the register. Then there was a stern and determined pulling toward the register. The manager was pulled by the salesgirl.

Isolation: The salesgirl was pulled by the manager.

Isolation: The manager was pulled by the salesgirl.

Predictive: A girl and a boy were sitting on their steps. These steps were in front of each other's houses. The friendly girl wanted to meet her new neighbor. There was a cheerful greeting between the yards. The boy was greeted by the girl.

Nonpredictive: A girl and a boy were sitting on their steps. These steps were in front of each other's houses. At first, there was silence between the new neighbors. Then, there was a cheerful greeting between the yards. The girl was greeted by the boy.

Isolation: The boy was greeted by the girl.

Isolation: The girl was greeted by the boy.

Predictive: Both a man and a lady were standing near a corner. This corner was brightened by a streetlight. In hopes of a date, the man desired to start a conversation. Soon there was a cheerful wink of an eye. The lady was winked at by the man.

Nonpredictive: Both a man and a lady were standing near a corner. This corner was brightened by a streetlight. A conversation was started in hopes of a date. Soon there was a cheerful wink of an eye. The man was winked at by the lady.

Isolation: The lady was winked at by the man.

Isolation: The man was winked at by the lady.

Predictive: Once a policeman was hiding behind a doorway, looking for a robber. This doorway was darkened by shadows. Suddenly, the policeman felt a blow to his head and a barrel at his back. Then there was a loud shot in the dark. The policeman was shot by a robber.

Nonpredictive: Once a policeman was hiding behind a doorway, looking for a robber. This doorway was darkened by shadows. Suddenly, there was a scuffle and a gun appeared. Then there was a loud shot in the dark. The robber was shot by the policeman.

Isolation: The policeman was shot by a robber.

Isolation: The robber was shot by the policeman.

Predictive: A girl and a boy were playing near a swing. This swing was crowded with children. Suddenly, the girl began screaming at a selfish boy on the swing. The girl was surprised by the boy's violent behavior. There was an angry kicking on the playground. The girl was kicked by the boy.

Nonpredictive: A girl and a boy were playing near a swing. This swing was crowded with children. Suddenly, there was a lot of screaming among the children near the swing. There was an angry kicking on the playground. The boy was kicked by the girl.

Isolation: The girl was kicked by the boy.

Isolation: The boy was kicked by the girl.

Predictive: A knight and a giant were wandering through a castle. This castle was built of stones. The knight knew he was in trouble and began to run away. Then there was a furious attack in the courtyard. The knight was attacked by the giant.

Nonpredictive: A knight and a giant were wandering through a castle. This castle was built of stones. Suddenly, the sound of someone running on the stones could be heard. Then there was a furious attack in the courtyard. The giant was attacked by the knight.

Isolation: The knight was attacked by the giant.

Isolation: The giant was attacked by the knight.

Context Stimuli: Active

Predictive: Both nurses and doctors work in a hospital. This hospital was overrun by patients. A nurse began checking on the condition of a patient whose heart monitor was buzzing. Suddenly, there was a frantic call through the ward. The nurse called the doctor.

Nonpredictive: Both nurses and doctors work in a hospital. This hospital was overrun by patients. A nurse began checking on the condition of a new patient. Suddenly, there was a frantic call through the ward. The doctor called the nurse.

Isolation: The nurse called the doctor.

Isolation: The doctor called the nurse.

Predictive: Many kings and queens were partying in a garden. This garden was filled with visiting royalty. Suddenly, a king saw someone he loved very much. Soon there was a polite kiss in the courtyard. The king kissed the queen.

Nonpredictive: Many kings and queens were partying in a garden. This garden was filled with visiting royalty. Suddenly, a king began walking toward an old friend among the royalty. Soon there was a polite kiss in the courtyard. The queen kissed the king.

Isolation: The king kissed the queen.

Isolation: The queen kissed the king.

Predictive: Both snakes and wolves can be found in caves. This cave was darkened in dusk. Suddenly, a hungry wolf saw something to eat. Then there was a fierce pouncing in the darkness. The wolf pounced upon the snake.

Nonpredictive: Both snakes and wolves can be found in caves. This cave was darkened in dusk. Suddenly, there was a rapid movement. Then there was a fierce pouncing in the darkness. The snake pounced upon the wolf.

Isolation: The wolf pounced upon the snake.

Isolation: The snake pounced upon the wolf.

Predictive: A pirate and a captain were searching for treasure. This treasure was hidden on a ship. Suddenly, the pirate was attacked from behind by the captain who had a knife. There was a deadly stab among the wreckage. The captain stabbed the pirate.

Nonpredictive: A pirate and a captain were searching for treasure. This treasure was hidden on a ship. Suddenly, there was a vicious fight with a knife. Then, there was a deadly stab among the wreckage. The pirate stabbed the captain.

Isolation: The captain stabbed the pirate.

Isolation: The pirate stabbed the captain.

Predictive: A dog and a cat were in the yard. The yard was shaded by a tree. The dog began to growl and show its teeth because he saw the frightened cat who was near the tree. Then there was a frantic chase across the grass. The dog chased the cat.

Nonpredictive: A dog and a cat were in the yard. The yard was shaded by a tree. The animals began making angry growling and hissing sounds. Then there was a frantic chase across the grass. The cat chased the dog.

Isolation: The dog chased the cat.

Isolation: The cat chased the dog.

Predictive: A girl and a boy were swimming in a lake. This lake was divided by a rope. Suddenly, the girl suffered a severe cramp and disappeared under the deep water. Then there was a daring rescue in the depths. The boy rescued the girl.

Nonpredictive: A girl and a boy were swimming in a lake. This lake was divided by a rope. Suddenly, it became very quiet and there was a disappearance under the deep water. Then there was a daring rescue in the depths. The girl rescued the boy.

Isolation: The boy rescued the girl.

Isolation: The girl rescued the boy.

Predictive: A woman and a man who were neighbors were watering their yards. Their yards were bordered by a fence. The man began walking toward the fence to play a joke on his neighbor. Then there was a wet spraying across the lawn. The man sprayed the woman.

Nonpredictive: A woman and a man who were neighbors were watering their yards. Their yards were bordered by a fence. Someone began walking toward the fence to play a joke. Then there was a wet spraying across the lawn. The woman sprayed the man.

Isolation: The man sprayed the woman.

Isolation: The woman sprayed the man.

Predictive: A secretary and a janitor were working in an office. This office was cluttered with files. Suddenly, the secretary tripped over some files that had been moved for cleaning. Then there was a loud scolding near the filing cabinet. The secretary scolded the janitor.

Nonpredictive: A secretary and a janitor were working in an office. This office was cluttered with files. Suddenly, a person fell over some files followed by a moaning sound. Then there was a loud scolding near the filing cabinet. The janitor scolded the secretary.

Isolation: The secretary scolded the janitor.

Isolation: The janitor scolded the secretary.

Predictive: A ghost and a witch were lurking in a dungeon. This dungeon was haunted by spirits. Suddenly, the ghost popped out of nowhere and shouted "BOO." There was a terrible fright among the spooks. The ghost frightened the witch.

Nonpredictive: A ghost and a witch were lurking in a dungeon. This dungeon was haunted by spirits. Suddenly, there was shouting out of nowhere. There was a terrible fright among the spooks. The witch frightened the ghost.

Isolation: The ghost frightened the witch.

Isolation: The witch frightened the ghost.

Predictive: Once a salesgirl and a manager were working in a shop. This shop was lacking in help. The salesgirl felt tired and decided to take a break. Then there was a stern and determined pulling toward the register. The manager pulled the salesgirl.

Nonpredictive: Once a salesgirl and a manager were working in a shop. This shop was lacking in help. There was no one to assist a customer at the register. Then there was a stern and determined pulling toward the register. The salesgirl pulled the manager.

Isolation: The manager pulled the salesgirl.

Isolation: The salesgirl pulled the manager.

Predictive: A girl and a boy were sitting on their steps. These steps were in front of each other's houses. The friendly girl wanted to meet her new neighbor. There was a cheerful greeting between the yards. The girl greeted the boy.

Nonpredictive: A girl and a boy were sitting on their steps. These steps were in front of each other's houses. At first, there was silence between the new neighbors. Then, there was a cheerful greeting between the yards. The boy greeted the girl.

Isolation: The girl greeted the boy.

Isolation: The boy greeted the girl.

Predictive: Both a man and a lady were standing near a corner. This corner was brightened by a streetlight. In hopes of a date, the man desired to start a conversation. Soon there was a cheerful wink of an eye. The man winked at the lady.

Nonpredictive: Both a man and a lady were standing near a corner. This corner was brightened by a streetlight. A conversation was started in hopes of a date. Soon there was a cheerful wink of an eye. The lady winked at the man.

Isolation: The man winked at the lady.

Isolation: The lady winked at the man.

Predictive: Once a policeman was hiding behind a doorway, looking for a robber. This doorway was darkened by shadows. Suddenly, the policeman felt a blow to his head and a barrel at his back. Then there was a loud shot in the dark. The robber shot the policeman.

Nonpredictive: Once a policeman was hiding behind a doorway, looking for a robber. This doorway was darkened by shadows. Suddenly, there was a scuffle and a gun appeared. Then there was a loud shot in the dark. The policeman shot a robber.

Isolation: The robber shot the policeman.

Isolation: The policeman shot a robber.

Predictive: A girl and a boy were playing near a swing. This swing was crowded with children. Suddenly, the girl began screaming at a selfish boy on the swing. The girl was surprised by the boy's violent behavior. There was an angry kicking on the playground. The boy kicked the girl.

Nonpredictive: A girl and a boy were playing near a swing. This swing was crowded with children. Suddenly, there was a lot of screaming among the children near the swing. There was an angry kicking on the playground. The girl kicked the boy.

Isolation: The boy kicked the girl.

Isolation: The girl kicked the boy.

Predictive: A knight and a giant were wandering through a castle. This castle was built of stones. The knight knew he was in trouble and began to run away. Then there was a furious attack in the courtyard. The giant attacked the knight.

Nonpredictive: A knight and a giant were wandering through a castle. This castle was built of stones. Suddenly, the sound of someone running on the stones could be heard. Then there was a furious attack in the courtyard. The knight attacked the giant.

Isolation: The giant attacked the knight.

Isolation: The knight attacked the giant.

Appendix K

Contextual Influences Task Instructions

<u>Pre Task Instructions</u>

HERE ARE SOME PICTURES

PLEASE POINT TO:

NURSE	KING	SNAKE	PIRATE	DOG
GIRL	WOMAN	SECRETARY	GHOST	SALESGIRL
LADY	POLICEMAN	KNIGHT	DOCTOR	QUEEN
WOLF	CAPTAIN	CAT	BOY	MAN
JANITOR	WITCH	MANAGER	ROBBER	GIANT

If participant fails to identify the correct picture, the examiner will identify it.

The participant will be asked to try again.

Discontinue testing if participant scores less than 80% after training.

Contextual Influence Task Instructions

Task Instructions

IN THIS TASK, YOU WILL LISTEN TO SOME SENTENCES AND I WILL SHOW YOU SOME PICTURES. YOU WILL BE ASKED TO POINT TO THE PICTURE THAT SHOWS WHAT HAPPENED.

LET'S PRACTICE.

LISTEN TO THE SENTENCE(S).

Present practice item one via the computer. Then show four pictures, say: NOW SHOW ME WHAT HAPPENED.

If the response is correct, go to practice item two.

If the response is incorrect or the participant fails to respond after 30 seconds, say: LISTEN TO THE SENTENCE(S) AGAIN.

Present the stimulus item again, say: SHOW ME WHAT HAPPENED.

If the response is still incorrect or the participant does not respond after 30 seconds, point to the correct picture and say: THIS PICTURE GOES WITH "THE DOCTOR WAS CALLED BY THE NURSE".

Go to practice item two, say: LET'S TRY ANOTHER ONE.

Discontinue the task if the participant fails to respond to the two practice items.

For the experimental items, instructions and/or stimuli may be repeated; however, oral feedback will not be provided if the participant fails to respond or chooses the incorrect picture.

LET'S TRY SOME MORE.

Appendix L

Participant Data for Working Memory Task (Listening Span)

Participants	Working Memory Scores
1	1
2	1
3	0.5
4	1
5	1
6	1
7	3.5
8	1.5
9	1
10	0
11	0.5
12	1
13	1
14	1.5
15	1
16	1

Appendix M

Participant Data for Comprehension Task (Modified Token Test)

Participants	Comprehension Task Scores
1	15
2	19
3	0
4	21.5
5	20
6	16.5
7	26.5
8	20
9	0
10	0
11	5
12	10
13	21
14	26
15	28
16	27

Appendix N

Participant Results for WAB-R Aphasia Quotient

Participants	WAB-R AQ
1	72.6
2	88.6
3	13.3
4	71
5	68.3
6	31
7	80.8
8	73
9	20.3
10	3
11	38.7
12	76.3
13	44.4
14	71.1
15	89.3
16	89.2

Appendix O

Participant Data for Contextual Influence Task

Part[1]	Contextual influence task	Active			Passive		
		Isolated	Predictive	Non-predictive	Isolated	Predictive	Non-predictive
1	85/120	20/30	24/30	28/30	16/30	26/30	20/30
2	77/120	18/30	22/30	30/30	14/30	22/30	16/30
3	56/120	14/30	18/30	16/30	14/30	10/30	12/30
4	63/120	15/30	12/30	24/30	13/30	16/30	18/30
5	56/120	17/30	20/30	20/30	10/30	10/30	8/30
6	50/120	12/30	8/30	14/30	10/30	12/30	22/30
7	111/120	28/30	26/30	30/30	27/30	28/30	28/30
8	93/120	24/30	26/30	28/30	20/30	22/30	22/30
9	60/120	12/30	18/30	16/30	15/30	18/30	14/30
10	33/120	9/30	6/30	8/30	7/30	12/30	8/30
11	54/120	10/30	14/30	14/30	14/30	16/30	16/30
12	88/120	24/30	20/30	24/30	18/30	26/30	22/30
13	62/120	16/30	14/30	18/30	14/30	16/30	16/30
14	69/120	19/30	26/30	20/30	13/30	18/30	10/30
15	52/120	14/30	12/30	18/30	12/30	4/30	18/30
16	45/120	12/30	8/30	12/30	12/30	12/30	10/30

[1] Participants.