INVESTIGATING COMPREHENSION DIFFERENCES BETWEEN ACTIVE AND PASSIVE SENTENCES IN A YOUNG AND OLDER ADULT POPULATION

by

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Communication Science and Disorders, University of Pittsburgh, 2008

Submitted to the Graduate Faculty of

The School of Health and Rehabilitation Sciences in partial fulfillment

of the requirements for the degree of
Bachelor of Philosophy in Communication Science and Disorders

University of Pittsburgh

2008

UNIVERSITY OF PITTSBURGH

THE SCHOOL OF HEALTH AND REHABILITATION SCIENCES

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The current investigation sought to determine whether normal, non-impaired young and older adults performed differentially on the active and passive sentences of the Computerized Revised Token Test – Active/Passive (CRTT-A/P). Twenty-five young adults (18 to 30 years old) and twenty-five older adults (50 to 80 years old) completed this study.

The first purpose of this study was to determine if the two groups (i.e., young and older) differed significantly in their performance (as measured by overall mean scores) on the two sentence types (i.e., active and passive sentences) across each of the four subtests. Significant differences between subtests were found; participants obtained significantly higher scores on Subtest VIII than on Subtest V and Subtest VI.

The second purpose of this study was to determine if the two groups differed significantly in their efficiency scores on the two sentence types across each of the four subtests. It was found that (1) participants obtained significantly higher efficiency scores on Subtest VII than on Subtests V and VI and that (2) participants obtained significantly higher efficiency scores on Subtest VIII than on Subtest VI.

The final purpose of this study was to determine if the two groups differed significantly in their response times on the two sentence types across each of the four subtests. It was found that: (1) participants responded more quickly to the passive sentence type than to the active sentence type across all four subtests; (2) the older group responded more quickly on Subtest V than on Subtests VI and VIII; and (3) the older group responded more quickly on Subtest VII than on Subtests VI and VIII.

When differences between the two groups were examined for all of the measures, only one significant difference was found (the older group performed significantly slower than the young group on Subtests VI and VIII). These findings demonstrate that language comprehension abilities remain relatively constant with age. While the CRTT-A/P did not detect any significant comprehension differences between active and passive sentences in young and older individuals, this test has yet to be administered to various pathological groups (e.g., persons with agrammatic comprehension). This study thus provides preliminary data for future comparisons with pathological populations. Such studies are equally important for advancing our understanding of the way we comprehend language and form grammatical meaning.

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PREFACE

I would like to thank the following individuals for making this thesis possible:

To Dr. Malcolm R. McNeil: None of this would have happened without your endless support, advice, and encouragement. Thank you for not allowing me to give up and for pushing me to accomplish more. Indeed, I am so fortunate to have you as my mentor and thesis advisor.

To Drs. Patrick J. Doyle, Sheila R. Pratt, Michael W. Dickey, and Donald A. Robin: Thank you for providing me with the feedback that I needed to improve this manuscript.

To Elaine Rubinstein: Thank you for helping me analyze my data and understand the results.

To the Faculty of the Communication Science and Disorders department: Thank you for all of your encouragement and support.

To all of the graduate students that I work with at the VA Hospital-Highland Drive: Thank you for sharing all of your knowledge and research experience with me. This entire process has been a lot easier because of you all.

To Neil Szuminsky: Thank you so much for helping me organize and rescore all of my data. Without you, I would have no data to work with!

To the SHRS Research Development Fund, School of Health and Rehabilitation Sciences, University of Pittsburgh: Thank you for providing me with the financial support that I needed to complete this study.

And last, but certainly not least, to my family: Thank you Dad, Mom, and Anita for always being there for me, for believing in me, and for supporting me in all of my endeavors. Without your love and encouragement, I would not be where I am today. Dad, even though you are not here to see me finish my thesis, I know that you would be so proud of me. I love you, Dad.

1.0 INTRODUCTION

Aphasia, one of the many devastating consequences of a stroke, is a neurologic disorder that negatively affects one's ability to produce and comprehend spoken or written language. One disorder that can appear in individuals with aphasia is agrammatism. Individuals with agrammatism are often characterized as having difficulty producing well-constructed simple sentences (i.e., subject-verb (SV) and subject-verb-object (SVO)) and complex non-canonical sentences (Thompson, 2001). They also tend to omit verbs, grammatical markers, and function words (i.e., prepositions, articles, auxiliaries, and pronouns) from their speech (Martin, Wetzel, Blossom-Stach, & Feher, 1989; Luzatti, Toraldo, Guasti, Ghirardi, Lorenzi, & Guarnaschelli, 2001; Thompson, 2001). In addition to these kinds of production deficits, comprehension deficits can also appear in individuals with agrammatism. Individuals with agrammatic comprehension often display behaviors characteristic of asyntactic comprehension – that is, they have difficulty understanding the syntactic structure of sentences and interpreting both the organization and roles of words in sentences.

Because the study reported here was motivated by much of the aphasia literature, specifically that on agrammatic comprehension, much of this literature review will focus on both normal and disordered language comprehension. Theories of agrammatic comprehension and methods of assessment will be discussed in the following literature review. Studies examining the relationship between age and language comprehension will also be explored because they have contributed to our current understanding of this comprehension deficit.

2.0 THEORIES OF AGRAMMATIC COMPREHENSION

Within the past three decades, several theories have emerged in an attempt to account for the performance patterns seen in individuals with agrammatic comprehension. An in-depth review of the most popular theories of agrammatic comprehension is provided below.

2.1 THE TRACE DELETION HYPOTHESIS

One of the first theories of agrammatic aphasia was the syntactic loss hypothesis (Grodzinsky, 1984; Grodzinsky, 1986). Grodzinsky, along with many others (Berndt & Caramazza, 1980; Bradley, Garrett, & Zurif, 1980), believed that the comprehension deficit was a result of some loss of syntactic knowledge or linguistic competence. Grodzinsky's syntactic loss hypothesis (more popularly known as the Trace Deletion Hypothesis (TDH)), suggests that agrammatic aphasics show a "deficit at the surface-structure (S-structure) level of syntactic representation" (Martin, Wetzel, Blossom-Stach, & Feher, 1989, p. 159). The "traces of elements that have been moved from their deep-structure [D-structure] position" are not maintained but deleted in S-structure (Martin, Wetzel, Blossom-Stach, & Feher, 1989, p. 159). Take, for example, the following:

D-structure (active sentence): The man kissed the woman.

S-structure (passive sentence): The woman was kissed by the man.

According to Grodzinsky's TDH, patients with agrammatic comprehension should have no difficulty comprehending the active sentence. Because there is no trace present, the noun phrases (i.e., "the man" and "the woman") can be assigned their correct thematic roles (i.e., "the man" as subject and "the woman" as object). However, patients should have difficulty comprehending the passive sentence because the trace linking the subject noun phrase "the woman" to its original thematic position (i.e., object position) in D-structure is deleted from S-Structure (Martin, Wetzel, Blossom-Stach, & Feher, 1989; Berndt, Mitchum, & Haendiges, 1996). With "two potential nouns filling the thematic role of agent…the patient is forced to choose at random between the two" (Berndt, Mitchum, & Haendiges, 1996). In sum, Grodzinsky (1990) states:

> "…on passives agrammatics perform at chance; that is, they are uncertain about the interpretation of these constructions and therefore guess. On actives, however, they perform above chance, virtually normally (see among others, Schwartz, Saffran, and Marin, 1980; Caplan and Futter, 1986; Grodzinsky et al., 1988)." (p. 79)

2.2 TIMING THEORIES

In contrast to the syntactic loss hypothesis, researchers (Linebarger, Schwartz, & Saffran, 1983; Berndt, Salasoo, Mitchum, & Blumstein, 1988; Lukatela, Crain, & Shankweiler, 1988; Shankweiler, Crain, Gorrell, & Tuller, 1989; Wulfeck & Bates, 1991; Lu, Bates, Li, Tzeng, Hung, Tsai, Lee, & Chung, 2000) began to develop alternative theories of agrammatic comprehension after finding that agrammatic patients were able to make fairly accurate grammatical judgments of correctly and incorrectly constructed sentences (e.g., a sentence such as "I hope you to go to the store now" would be judged as an incorrectly constructed sentence).

Furthermore, after testing several patients' abilities to comprehend various sentence types, researchers (Kolk & van Grunsven, 1985) found "variability in performance levels across different sentence types, and…across patients on a given sentence type," which could not be accounted for by the syntactic loss hypothesis (Martin, Wetzel, Blossom-Stach, & Feher, 1989, p. 160). Based on their results, these researchers argued that knowledge of complex sentence structures is preserved in these patients. Rejecting the previous claim that agrammatic comprehension was a result of some loss of syntactic competence, researchers started to attribute the deficit to other limitations in the language system.

Many researchers have attributed asyntactic comprehension to limitations in processing capacity or efficiency (Kolk & van Grunsven, 1985; Frazier & Friederici, 1991; Haarman & Kolk, 1991; Miyake, Carpenter, & Just, 1994). In Kolk and van Grunsven's (1985) working memory hypothesis, agrammatic comprehension arises from "a memory limitation in terms of either reduced storage capacity or accelerated decay rate" of information (Martin, Wetzel, Blossom-Stach, & Feher, 1989, p. 160). Different types of sentences place different demands on memory, and individuals differ from each other in their storage capacities and rates of decay. Thus, unlike the syntactic loss hypothesis, the working memory hypothesis can account for the variability in performance seen across patients on various sentence types.

2.3 MAPPING THEORIES

The surprising result that agrammatic patients can make accurate grammatical judgments even though their ability to comprehend sentences is impaired prompted researchers to devise a theory that could explain this phenomenon. One such hypothesis that emerged was the "mapping" hypothesis (Linebarger, Schwartz, & Saffran, 1983; Saffran & Schwartz, 1988; Linebarger, 1990). According to this hypothesis, patients are able to analyze the syntactic structure of sentences without any difficulty; however, breakdown in comprehension occurs when they are required to map "between grammatical roles (e.g., subject, object) and thematic roles (e.g., agent, theme)" (Martin, 2006, p.77).

Each of the theories discussed above make very strong predictions about the performance patterns of individuals with agrammatic comprehension. While these theories may account for some agrammatic behaviors, it would be incorrect to say that any one theory completely accounts for the source of the deficit. Subsequent studies have continually contradicted or disproved some aspect of these theories. For example, in a study evaluating Grodzinsky's TDH and Kolk and van Grunsven's working memory hypothesis, Martin and colleagues (1989) found results that argued "against any global theory of agrammatism that attempts to attribute all agrammatic speech and co-occurring syntactic comprehension deficits to the same source" (p. 157). In another study, Berndt and colleagues (1996) also recognized the difficulty of attributing agrammatic comprehension to a single causal factor (p.289).

However, while there is no unified theory, agrammatic comprehension is generally defined as a language disorder where affected individuals comprehend canonical sentences (i.e., active sentences) above chance level (Goodglass, 1968; Schwartz, Saffran, & Marin, 1980; Caplan, Baker, & Dehaut, 1985; Schwartz, Linebarger, & Saffran, 1985; Caplan & Futter, 1986; Grodzinsky, 1986; Berndt, 1987; Schwartz, Linebarger, Saffran, & Pate, 1987; Caplan & Hildebrandt, 1988; Grodzinsky, Finkelstein, Nicol, & Zurif, 1988; Saffran & Schwartz, 1988; Berndt, Mitchum, & Haendiges, 1996) and comprehend non-canonical sentences (i.e., passive sentences and other sentence types involving moved constituents), specifically those that are semantically reversible[1], at or below chance level.

[1] Semantically reversible sentences such as “The woman was kissed by the man” are not constrained by their lexical or pragmatic content because both nouns could serve as plausible agents of the sentence (Saffran & Schwartz, 1994;Carpenter et al., 1995).

3.0 AGE AND LANGUAGE COMPREHENSION

In addition to studying the disorder, researchers have looked at the relationship between age and language comprehension in hopes of gaining greater insight into the nature of agrammatic comprehension. According to Burke and MacKay (1997), language comprehension abilities remain relatively constant with age (p. 1848). For example, several studies have shown that elderly individuals rival younger individuals in their ability to process the meanings of words, the meanings of words in sentences, and simple sentences (Burke & Harrold, 1988; Laver & Burke, 1993). However, many studies have demonstrated that older individuals struggle more with syntactically complex sentences than younger individuals (Emery, 1985; Kemper, 1986; Kemper, 1988; Davis & Ball, 1989; Obler, Fein, Nicholas, & Albert, 1991; Kemper, 1992; Kemper & Anagnopoulos, 1993).

Several researchers have attributed this difficulty to limitations in working memory or a reduction in working memory capacity (Cohen, 1988; Carpenter, Miyake, & Just, 1995; Miyake, Carpenter, & Just, 1994). In fact, the working memory hypothesis described earlier is not only used to explain agrammatic comprehension, but also elderly performance on syntactically complex sentences. Miyake, Carpenter, and Just (1994) suggest that elderly individuals, like aphasic patients, “should be able to comprehend sentences without much difficulty as long as they have enough working memory resources available; however, the more resources that the comprehension of the sentence requires, the more their performance should deteriorate” (p. 676).

To provide evidence for their theory, Miyake and colleagues demonstrated that normal adults can perform like aphasic patients on sentence comprehension tasks that tax working memory (working memory demands were increased by varying the degree of syntactic complexity or the presentation rate of the experimental sentences).

In another study by Zurif, Swinney, Prather, Wingfield, and Brownell (1995), similar effects of age-related working memory limitations on on-line syntactic processing were observed. To determine the relationship between age, working memory, and sentence processing, Zurif and colleagues explain:

> "…we assess the presence or absence of priming between, on the one hand, a word (the prime) in an auditorily presented sentence and on the other hand, a visually presented target word (the probe). By presenting the probe at different times during the delivery of the sentence, we chart when the prime is active during the course of sentence comprehension…By choosing a probe related to the moved constituent…we can determine if elderly adults reactivate this constituent at the gap [i.e., the original position of the moved constituent now indexed by a trace]" (p. 169).

Words were added between a moved constituent and its gap in order to augment the distance between the two elements and increase working memory demands (p. 169). Zurif and colleagues found that sentence processing remains largely unaffected as long as the distance between the two elements falls within the limits of working memory capacity. Only when the distance between the two elements falls outside the limits of working memory capacity does sentence processing begin to breakdown. Thus, Zurif and colleagues concluded that sentence processing is not an automatic process immune to outside effects but is in fact a process that is susceptible to such effects like age-related memory constraints (p. 179).

In contrast to Miyake and colleagues and Zurif and colleagues, Waters and Caplan (2001, 2005) have argued against a relationship between age, working memory, and sentence comprehension. In a series of studies, Waters and Caplan (2005) utilized an auditory moving windows paradigm to test whether or not elderly participants differed from younger participants in their ability to syntactically parse sentences. In this type of task, different types of sentences are presented auditorily to participants one phrase at a time, and the "listening times to words or phrases presented one at a time reflect the time it takes to integrate lexical items into an accruing syntactic and semantic structure, and they are therefore longer when this integration is more difficult" (Waters & Caplan, 2004, p. 133). Waters and Caplan found that on-line measures of syntactic processing were unaffected by age and working memory capacity. Even though elderly participants had lower working memory capacities than younger participants, the two groups did not differ from each other in their listening times at the most capacity-demanding parts of complex sentences (p. 411).

To examine the effects of age and working memory capacity on sentence comprehension, Waters and Caplan also included an end-of-sentence plausibility judgment task to serve as an off-line measure of sentence comprehension. In this task, participants are asked to judge the semantic plausibility of the sentences presented to them via the auditory moving windows paradigm. Waters and Caplan found that elderly participants performed more poorly than younger participants on the plausibility judgment task, especially when sentences were syntactically complex. Based on these results, they concluded that age-related limitations in working memory, while separate from on-line syntactic processing, did play a role in off-line processes (Waters and Caplan refer to these off-line processes as "review processes") (p. 406). Thus, Waters and Caplan assert that working memory capacity is "not related to the on-line construction of syntactic form and meaning but is related to processes that occur after the meaning of sentences has been extracted" (p. 412).

As evidenced from above, researchers have conducted these types of studies in order to develop more complete theories of language comprehension. The studies discussed in this section all suggest models of language comprehension that involve working memory (determining which process – on-line or off-line – is exactly affected still remains subject to debate); others, however, propose different theories. Through a series of three experiments, Ferreira (2003) demonstrated that young unimpaired adults, not just elderly unimpaired adults, had more difficulty comprehending non-canonical sentence constructions than canonical ones. In the first experiment, participants were auditorily presented with a series of active and passive sentences; for each sentence, they were instructed to identify either the agent (i.e., the doer of the action) or the patient (i.e., the recipient of the action) of that sentence. The two arguments in the active and passive sentences were manipulated according to one of the following three conditions: (1) the items were semantically reversible; however, one arrangement was more plausible; (2) the items were nonreversible, meaning that one arrangement was implausible and semantically anomalous, and (3) the items were symmetrical, meaning that both arrangements were equally plausible (p. 172). Results showed that young participants frequently miscomprehended passive sentences as opposed to active sentences across all three conditions. Furthermore, Ferreira found that participants performed more poorly on the implausible, reversible passive sentences and the symmetrical passive sentences than on the implausible, reversible active sentences and the symmetrical active sentences. Based on these findings, she concluded that "it is more difficult to maintain algorithmically based thematic role assignments[2] in the passive when the resulting interpretation is inconsistent with schematic knowledge (Rumelhart, 1980)" (p. 179).

[2] That is, one assumes that the subject of a sentence is the agent and the object of the sentence is the patient.

The second and third experiments sought to determine if young unimpaired adults had difficulty comprehending subject-cleft sentences and object-cleft sentences (two infrequently used sentence constructions). The results from these two experiments showed that participants processed subject-cleft sentences similarly to active sentences and object-cleft sentences similarly to passive sentences. Ferreira thereby concluded that “the surface frequency of a syntactic form does not determine ease of processing” (p. 164).

From the following experiments, Ferreira states that current theories of language comprehension are insufficient; models of language comprehension, she argues, must consider the role of simple heuristics – that is, in addition to syntactic parsing, individuals rely on their knowledge of the world to derive sentence meaning. Because this strategy is much easier than syntactic parsing and requires minimal effort, individuals will forgo further syntactic analysis on sentences that are syntactically complex (i.e., passive sentences), and using their schematic knowledge, they will change the “true” meaning of the sentence to that which is most plausible and semantically acceptable. Thus, “language processing is often based on shallow processing, yielding a merely ‘good enough’ rather than a detailed linguistic representation of an utterance’s meaning” (p. 164).

4.0 METHODS OF ASSESSMENT

Many studies have demonstrated that persons with aphasia experience difficulty comprehending spoken language; however, there remain few standardized tests or specific performance criterion for the detection of this important communication disorder. As Thompson (2001) points out, "Available tests for comprehension…do not address all types of sentence-level problems that need to be tested" with an agrammatic patient population; such a limitation then, can make a definitive diagnosis of the comprehension deficit difficult or impossible (p. 612). Thus, in order to gain greater insight into agrammatic comprehension, researchers have developed their own tests to assess asyntactic comprehension. A review of some of these tests will now be discussed.

4.1 THE PCBA AND NSCT

The most popular methods of assessing agrammatic comprehension are lexical-to-picture or sentence-to-picture matching tasks. In these types of tasks, participants are given either a single lexical item (noun or verb) or a sentence; then, from a set of two to four pictures, participants must choose which picture best represents that word or sentence.

In the *Philadelphia Comprehension Battery for Aphasia* (PCBA) (Saffran, Schwartz, Linebarger, Martin, & Bochetto, unpublished) and the *Northwestern Sentence Comprehension Test* (NSCT) (Thompson et al., unpublished), the picture-pointing method is used to assess agrammatic comprehension. Both of these tests include lexical and sentence comprehension tasks (the types of sentences that are examined in these two unpublished tests are reversible actives, passives, object-relatives, and subject relatives). After participants are auditorily presented with a word or sentence, they must choose which of two pictures (i.e., the target picture or its semantically reversed counterpart) best reflects the meaning of the word or sentence (Thompson, 2001, p. 613). After administering the NSCT to several agrammatic patients, Thompson and colleagues reported that patients performed better on the lexical comprehension task than on the sentence comprehension task. In addition, they found that patients were better at comprehending simple canonical sentences (i.e., actives and passives) than they were at comprehending complex non-canonical sentences (i.e., passives and object relatives) (Thompson, 2001, p. 613).

4.2 THE NUVPB

According to Schwartz, Fink, and Saffran (1995), the following three processes must occur in order for us to successfully comprehend and produce sentences: "(1) recognising or retrieving the verb with all the information regarding meaning, associated grammatical roles, and argument structure; (2) forming a grammatical structure; (3) mapping the grammatical roles onto the semantic roles" (Bastiaanse, Edwards, Maas, & Rispens, 2003, p. 51). Because verbs play such a critical in sentence production and comprehension, researchers have begun to develop tests that assess agrammatic patients' ability to comprehend verbs and their arguments within recent years. For example, in the *Northwestern University Verb Production Battery* (NUVPB) (Thompson, Lange, Schneider, & Shapiro, 1997; Kim & Thompson, 2000), one of the three tasks assesses verb comprehension skills by asking patients "to point to the verb named (out of four pictures)" (Thompson, 2001, p. 613).

Like the NSCT, the NUVPB was also administered to a group of agrammatic patients. Thompson and colleagues found that patients were able to accurately comprehend verbs of various types.

4.3 THE PALPA

One published test for aphasia, *The Psycholinguistic Assessments of Language Processing in Aphasia* (PALPA) (Kay, Lesser, & Coltheart, 1992) attempts to identify the linguistic level at which a breakdown occurs in a particular deficit (Bastiaanse, Edwards, Maas, & Rispens, 2003). This test primarily consists of tasks that examine nouns and their phonological and semantic characteristics; only one sentence comprehension task using the picture-pointing paradigm is included (Bastiaanse, Edwards, Maas, & Rispens, 2003). Like most sentence-to-picture matching tasks, patients are presented auditorily with either an active or a passive sentence; then they are asked to choose one of three pictures (i.e., the target picture, its semantically reversed counterpart, and an unrelated picture) which best reflects the meaning of the stimulus. In addition to having a poorly developed sentence comprehension task, the PALPA continues to present other limitations that make it a weak tool for detecting agrammatic comprehension. First, the PALPA utilizes an insensitive scoring system that records patient responses as either correct or incorrect. Also, patients with good lexical vocabularies can easily eliminate the unrelated picture from the set of three pictures presented to them. In doing this, they are able to improve their chances of choosing the correct picture (i.e., from 33% to 50%); thus, the certainty of detecting a truly accurate response is diminished. For those patients with poor lexical vocabularies, however, the lexical items used in the PALPA can add an additional processing load to the assessment of grammatical structure, decreasing the specificity with which this test assesses grammatical performance. Finally, no reference data, both normal and pathological, has yet to be established for this test.

4.4 CAPLAN, BAKER, AND DEHAUT (1985)

Contrary to most tests, Caplan, Baker, and Dehaut (1985) used a performance task (instead of the traditional sentence-to-picture matching paradigm) to assess asyntactic comprehension. In their task, they asked patients to reflect the meanings of different sentence types (e.g., "The elephant hit the monkey" (active); "It was the elephant that hit the monkey" (subject cleft)) by manipulating toy animals. While their task was extremely thorough, Caplan and colleagues recognized that their study possessed several major limitations. First, the manner in which the toy animals were linearly placed in front of the patients may have influenced the way they assigned thematic roles in sentences. Second, the use of toy animals increased the complexity of the task, and some of the patients had difficulty identifying them due to phonological similarities between a few of the animal names. Finally, Caplan and colleagues acknowledged that they used an insensitive scoring system for their task. In addition to the pragmatic effects which could have influenced the scoring of responses, some patient responses were unclear and difficult for the scorer to interpret. Although Caplan and colleagues tried to establish a consistent method of scoring, the subjective interpretation of the scorer must still be taken into consideration.

4.5 THE VAST

The *Verb and Sentence Test* (VAST) (Bastiaanse, Edwards, Maas, & Rispens, 2003) consists of ten tasks, all of which are designed to help researchers and clinicians "investigate disorders affecting the production and comprehension of verbs and sentences" (p. 49). Of those ten tasks, three focus on language comprehension, more specifically: (1) verb comprehension, (2) sentence comprehension, and (3) grammaticality judgment. Like the NUVPB, the VAST uses a word-to-picture matching paradigm to examine verb comprehension. After participants are auditorily presented with a verb, they must choose among four pictures (i.e., the target, a closely related noun distractor, a related action distractor, and a noun distractor related to the action distractor) the one which best matches the meaning of the verb (p. 55). For example, the following would serve as distractors for the target verb "biting":

> Closely related noun distractor: "teeth"
> Related action distractor: "scratching"
> Noun distractor related to the action distractor: "nails" (p. 55)

Similarly to the PCBA and the NSCT, the VAST implements a sentence-to-picture matching paradigm to test comprehension on active, passive, subject-cleft, and object-cleft sentences. After participants are auditorily presented with a sentence, they must choose among four pictures (i.e., the target, its semantically reversed counterpart, a lexical distractor, and the semantically reversed counterpart of the lexical distractor) the one which best captures the meaning of the sentence (p. 56). For example, the following would serve as distractors for the target sentence "The cow kicks the horse":

> Semantically reversed counterpart: "The horse kicks the cow."
> Lexical distractor: "The cow bites the horse."
> Semantically reversed counterpart of the lexical distractor: "The horse bites the cow." (p. 56)

Finally, the grammaticality judgment task tests participants' ability to analyze and parse the syntactic structure of sentences (p. 56). Bastiaanse and colleagues used only irreversible sentences for this task because irreversible sentences "can be judged correctly without having to map thematic roles onto the arguments if one has access to the grammatical structure" (p. 56). They also used a variety of sentence types (i.e., actives, passives, object-clefts, and subject-clefts) to eliminate any potential effects of thematic role assignment on participants' ability to judge sentences (p.57). Sentences like "The woman is baked by the cake" are presented auditorily to participants, who must then decide whether the sentence is "good" or "bad" ("The woman is baked by the cake" should be judged as a bad sentence because an animate noun ("woman") cannot be baked by an inanimate noun ("cake")).

The VAST is a very thorough and well-developed test, which "contributes to the assessment of language disorders, because linguistic concepts are addressed that do not appear in other tests" (p. 62). Normative data have been established for both normal and aphasic populations. While the tasks in the VAST have high reliability and internal consistency, their validity still warrants further investigation. Bastiaanse and colleagues acknowledged that the validity of the tasks was difficult to determine because "there are no English tests that evaluate linguistic processing abilities in a comparable way" (p. 64). Nevertheless, the VAST is a very sensitive measure that provides a first step towards understanding the underlying nature of various deficits of aphasia.

4.6 THE SOAP

The *Subject-relative, Object-relative, Active, and Passive* (SOAP) syntactic battery (Love & Oster, 2002) uses a sentence-to-picture matching paradigm to assess language comprehension across four sentence types (i.e., actives, passives, subject-relatives, and object-relatives). Sentences were controlled for length and matched with pictures depicting two characters and an action (p. 507). After being auditorily presented with a sentence, participants must choose from a set of three pictures (i.e., the target, its semantically reversed counterpart, and a distractor showing two unrelated characters and an unrelated action) the one which best captures the meaning of the sentence.

The SOAP was administered to four populations: (1) brain-injured individuals with aphasia, (2) brain-injured individuals without aphasia, (3) young unimpaired individuals (18 to 22 years old), and (4) older unimpaired individuals (47 to 74 years old). As expected, Love and Oster found that non-aphasic individuals performed better than chance (chance level was set at 50% for the same reasons discussed above in the PALPA) on all sentence types (p.521).

To determine the SOAP's sensitivity in "distinguishing among aphasia populations that would otherwise be grouped together," Love and Oster divided the aphasia population into three subgroups (i.e., those with receptive aphasia, those with severe expressive aphasia, and those with mild expressive aphasia) and correlated overall auditory comprehension scores on the Boston Diagnostic Aphasia Examination (BDAE) (Goodglass & Kaplan, 1972) with the SOAP for each subgroup. Based on their results, Love and Oster made several conclusions. First, individuals in the receptive aphasia group performed better than chance on canonical constructions but worse than chance on non-canonical constructions (p. 523). Second, individuals in the severe expressive aphasia group "demonstrated intact comprehension for canonical constructions but not for the noncanonical examplars" (performance on non-canonical sentences dropped to chance level), a finding that continues to confirm the literature (p. 523). Third, individuals in the mild expressive aphasia group, who show relatively preserved language abilities, yield a similar pattern of performance on the SOAP to those in the severe expressive aphasia group. Weak correlations between the BDAE and the SOAP for this subgroup demonstrates that the SOAP is sensitive (and even more so than the BDAE) to detect this group's subtle comprehension deficits (p. 525).

The SOAP is a well-developed, valid and sensitive measure that can help both researchers and clinicians alike "in teasing apart subtle auditory language deficits that more generalized tests [like the BDAE] do not detect" (p. 525). Using the SOAP as an assessment tool in conjunction with other aphasia batteries can thus provide "a more complete picture as to the processing abilities participants have for varying types of complex syntactic forms" (p. 526).

There are only a few published tests for aphasia that include tasks designed to assess various aspects of grammatical comprehension. Of those tests, the majority of them use a sentence-to-picture matching paradigm to examine sentence comprehension. As discussed earlier, this paradigm uses an insensitive scoring system; individuals with good lexical vocabularies can improve their chances of answering a question correctly by eliminating the unrelated picture(s). Even if results show chance performance, this type of scoring system does not capture critical information about comprehension processes. Furthermore, many of these tests possess substantial limitations in their design and/or psychometric development. Therefore, no standardized test for identifying individuals with agrammatic comprehension has yet emerged to meet the needs of both clinical and research communities.

5.0 THE CURRENT STUDY

5.1 BACKGROUND

In the current study, a version of the Computerized Revised Token Test (CRTT) called the Computerized Revised Token Test – Active/Passive Version (CRTT-A/P) was developed in an attempt to fill this important assessment void (a complete description of the CRTT-A/P will be discussed later in the 'Methods' section of this manuscript). The CRTT, which is the computerized version of the Revised Token Test (McNeil & Prescott, 1978), requires participants to manipulate test objects or tokens based on a variety of auditory commands. Using the CRTT to create a test for agrammatical comprehension has several advantages. First, test objects consist of a finite, high frequency, culturally neutral set of lexical items; they consist of two shapes (circles and squares) of two sizes (big and little) that vary by five colors (red, green, black, white, and blue). Using these common objects decreases the inter-item variability across targets and allows a more direct attribution of differences between the two sentence types to the grammatical form rather than to other linguistic and memorial factors. Second, four of the ten CRTT subtests require participants to move tokens to other tokens based on locative, prepositional commands (e.g., "Put the little blue circle before/above/to the left of/to the right of/etc. the big green square"). More importantly, because this test is computerized, its reliability is greatly enhanced relative to clinician administration, and its 15-point multidimensional scoring is capable of capturing reliably and with considerably greater sensitivity the processing demands of active versus passive sentences than all other test evaluative systems. Finally, the CRTT automatically measures variables such as response time, efficiency, and accuracy (i.e., the correct color and size of the token as well as the correct token position for locative commands).

5.2 EXPERIMENTAL QUESTIONS AND HYPOTHESES

The current investigation sought to determine whether normal, non-impaired young and older adults performed differentially on the active and passive sentences of the CRTT-A/P. The experimental questions and the hypotheses associated with each are as follows:

1. Are there significant differences between the two groups (i.e., young and older) in their performance (as measured by overall mean scores) on the two sentence types (i.e., active and passive sentences) across each of the four subtests[3]? It is hypothesized that:
   a. There will be no significant differences in overall mean scores between the two sentence types across any of the subtests for the young group.
   b. The older group will obtain significantly lower overall mean scores on the passive sentences than on the active sentences, especially for Subtests VI and VIII.
   c. The two groups will not differ significantly in their overall mean scores on the active sentences across the four subtests. However, the older group will differ significantly from the young group in their scores on the passive sentences.

[3] Subtest differences were also analyzed because the length of the sentence stimuli differed across each subtest.

2. Are there significant differences between the two groups in their efficiency scores on the two sentence types across each of the four subtests? It is hypothesized that:
   a. There will be no significant differences in efficiency scores between the two sentence types across any of the subtests for the young group.
   b. The older group will obtain significantly lower efficiency scores on the passive sentences than on the active sentences, especially for Subtests VI and VIII.
   c. The older group will differ significantly from the young group in their efficiency scores on the two sentence types across all four subtests.
3. Are there significant differences between the two groups in their response times on the two sentence types across each of the four subtests? It is hypothesized that:
   a. There will be no significant differences in response times between the two sentence types across any of the subtests for the young group.
   b. The older group will have significantly longer response times on the passive sentences than on the active sentences, especially for Subtests VI and VIII.
   c. The older group will have significantly longer response times than the young group on the two sentence types across all four subtests.

6.0 METHODS

6.1 SELECTION CRITERIA

Twenty-five adults between the ages of 18 and 30 years and twenty-five adults between the ages of 50 and 80 years completed this study. Participants from both groups met the following selection criteria: a minimum of an eighth-grade education; native speaker of English; a self-reported negative history of neurological, limb motor, psychiatric, speech, language, and reading impairments; performance that yielded a ratio (delayed recall/immediate recall x 100) equal to or greater than .70 on the Story Retell Test of the *Arizona Battery for Communication Disorders in Dementia* (ABCD) (Bayles & Tomoeda, 1993); and performance at or above 14.00 on the Computerized Revised Token Test (CRTT).

In addition to these selection criteria, all participants completed the following descriptive measures: an audiological exam (pure tone air conduction thresholds were obtained at 500, 1000, 2000, 4000, and 8000 Hz); a visual acuity exam using the *Reduced Snellen Chart*; and an oral word span task to assess memory span size (Waters, Rochon, & Caplan, 1992).

6.2 PARTICIPANTS

The fifty participants who completed this study were divided into two populations: (1) a young population (18 to 30 years old) and (2) an older population (50 to 80 years old).

For the young population, 12 males and 13 females met the selection criteria outlined above. These twenty-five participants had a mean age of 21.2 years and ranged from 19 to 29 years old (SD=2 years). Their overall mean CRTT score was 14.56 and ranged from 14.04 to 14.93 (SD=.25). The mean ABCD immediate and delayed story retell ratio score was .99 and ranged from .78 to 1.23 (SD=.08). The mean memory span size was 5.6 items and ranged from 5 to 7 items (SD=.76). Descriptive information for each participant in this population is summarized in Table 1.

Thirteen males and 12 females met the selection criteria for the older participant group. These twenty-five participants had a mean age of 67.1 years and ranged from 51 to 79 years old (SD=8.9 years). The mean CRTT score was 14.62 and ranged from 14.30 to 14.87 (SD=.15). The mean ABCD immediate and delayed story retell ratio score was .97 and ranged from .8 to 1.06 (SD=.06). The mean memory span size was 4.2 items and ranged from 3 to 5 items (SD=.5). Descriptive information for each participant in this population is summarized in Table 2.

Table 1: Young participant (18 to 30) biographical data and descriptive performance measures

Participant	***Gender***	***Age (Yrs.)***	***Score***	***Ratio***	***Span Size***
1	F	19	14.65	.78	5
2	F	20	14.29	1.00	5
3	M	21	14.64	1.00	7
4	F	21	14.81	.91	6
5	F	21	14.04	1.00	6
6	F	19	14.26	.91	5
7	M	22	14.73	1.00	5
8	F	22	14.45	1.04	5
9	F	22	14.72	1.04	6
10	M	23	14.44	.95	5
11	M	21	14.77	1.00	7
12	M	21	14.64	1.00	5
13	M	24	14.45	1.04	6
14	M	20	14.57	.96	5
15	F	19	14.93	1.23	5
16	M	20	14.74	1.00	5
17	F	29	14.12	.94	5
18	F	20	14.37	.90	6
19	F	20	14.82	1.00	6
20	M	21	14.85	1.00	5
21	M	21	14.35	.95	7
22	F	21	14.71	1.00	7
23	M	21	14.21	.95	5
24	F	21	14.75	1.05	5
25	M	21	14.73	1.00	6
Mean	(13F; 12M)	21.20	14.56	.99	5.60
SD		2.00	.25	.08	.76

= Computerized Revised Token Test; = *Arizona Battery for Communication Disorders of Dementia* (Bayles & Tomoeda, 1993), determined by number of delayed recall items/number of immediate recall items x 100.

Table 2: Older participant (50 to 80) biographical data and descriptive performance measures

Participant	***Gender***	***Age (Yrs.)***	***CRTT Score***	***ABCD Ratio***	***Span Size***
1	M	72	14.67	1.00	5
2	M	77	14.61	.80	4
3	F	70	14.48	.94	4
4	M	79	14.58	.91	5
5	F	77	14.75	1.00	4
6	F	66	14.46	1.05	5
7	F	72	14.39	1.00	4
8	M	72	14.75	1.06	4
9	M	51	14.64	.96	5
10	F	55	14.68	.86	5
11	F	76	14.64	1.00	4
12	F	77	14.54	1.05	4
13	M	71	14.34	1.00	4
14	M	53	14.75	.92	4
15	M	71	14.68	1.00	4
16	F	55	14.82	.96	4
17	M	51	14.42	1.00	4
18	M	66	14.73	1.00	4
19	M	65	14.73	1.05	4
20	F	74	14.30	.96	4
21	M	76	14.67	1.00	4
22	F	69	14.75	1.00	4
23	M	61	14.52	.96	3
24	F	57	14.70	.92	4
25	F	65	14.87	.95	5
Mean	(12F; 13M)	67.12	14.62	.97	4.20
SD		8.94	.15	.06	.50

= Computerized Revised Token Test; = *Arizona Battery for Communication Disorders of Dementia* (Bayles & Tomoeda, 1993), determined by number of delayed recall items/number of immediate recall items x 100.

6.3 STIMULI AND MATERIALS

The Computerized Revised Token Test – Active/Passive (CRTT-A/P) is a performance task that is designed to detect differences in auditory comprehension between active and passive sentences. It is comprised of four subtests modeled after Subtests V, VI, VII, and VIII of the Computerized Revised Token Test (CRTT). Similarly to Subtests V to VIII of the CRTT, test-takers must also move tokens to other tokens in the CRTT-A/P; however, instead of using locative, prepositional commands (e.g., "Put the little blue circle before/above/to the left of/to the right of/etc. the big green square"), the CRTT-A/P uses active and passive sentences constructed from the CRTT imperative commands (e.g., "The little blue circle touched before/above/to the left of/to the right of/etc. the big green square" and "Before/above/to the left of/to the right of/etc. the big green square was touched by the little blue circle."). Test-takers are then instructed to show what happened in each sentence by manipulating tokens on a computer touch screen (stimuli can be found in Appendix A). Responses are given scores based on the 15-point multidimensional CRTT scoring system (scoring categories and their descriptions can be found in Appendix C).

The active and passive sentence stimuli for the CRTT-A/P were produced by a male speaker in a sound-treated booth and digitally recorded onto a 1GB CF+ Type II PC card using a Shure SM93 microphone attached to a Marantz PMD-670 digital recorder. Each speech production was monitored for rate[4], intensity, and vocal quality.

[4] According to the literature, the preferred listening range for American English is 150 to 180 words per minute (wpm) (Sutton, King, Hux, Beukelman, 1995). Thus, a target-range of 3.0 to 3.5 syllables per second (syll./sec.) was established as a guideline for speaking rate.

The recorded speech stimuli were transferred to a desktop computer and edited with Adobe Audition version 1.0. Utterances were separated into individual soundfiles, and each soundfile was edited according to the following guidelines:

1. Add 50 msec. of silence to the beginning and end of each utterance, or spoken portion of the sound file.
2. Reduce or enhance any unusual intensity peaks so that they are equated within and between utterances.
3. Maintain silent inter-word intervals except when doing so distorts co-articulation.
4. Edit the spoken portion of each soundfile to an average root mean square (RMS) value of -28 dB.
5. Use the time compression/expansion feature of Adobe Audition version 1.0 to adjust the soundfiles whose speaking rates do not meet the target-range of 3.0 to 3.5 syll./sec. Average speaking rates of about 3.0 and 3.2 syll./sec. were achieved.

To ensure that all of the soundfiles met these criteria, two experienced listeners evaluated each of the soundfiles. Soundfiles that were deemed insufficient on any one of the above parameters were re-edited.

6.4 RANDOMIZATION

The CRTT-A/P consists of four subtests, and each subtest contains twenty test items (ten active sentences and ten passive sentences). All twenty test items for each subtest were randomized across participants under the following constraints:

1. No more than three active sentences or three passive sentences occurred consecutively in a given subtest.
2. An active sentence could not be followed by its corresponding passive sentence and vice versa.

Subtest order was randomized across participants.

6.5 PROCEDURE

Participants were administered the CRTT-A/P in a sound-treated booth using a desktop computer. They were seated at a comfortable distance in front of a touch screen monitor that displayed the test objects or tokens. The active and passive statements were presented auditorily to participants through two speakers at a loudness level of 75 dB SPL, and participants were instructed to show what happened in each sentence by manipulating the tokens on the touch screen.

6.6 PRETEST

A pretest was administered to participants in order to ensure that they could perform the experimental task. Similarly to the CRTT-A/P, participants were presented auditorily with active and passive sentences; then they were asked to show what happened in each sentence by manipulating tokens on a computer touch screen. The pretest consisted of three parts: (1) a block of five active statements, (2) a block of five passive statements, and (3) a block of ten statements (where the previous five active and five passive sentences were presented to participants in random order; this was done in order to determine if participants could “switch” from understanding an active sentence to a passive sentence and vice versa). Participants passed the pretest if they could demonstrate that they understood the demands of the task for three consecutive items in each block (i.e., they had to move a token to another token). Prepositions different from those used in the CRTT-A/P (*beneath, alongside, to the back of, to the side of,* and *on top of*) were used in the pretest (practice stimuli can be found in Appendix B).

7.0 RESULTS

CRTT-A/P overall mean scores, efficiency scores, and response time (final time – initial time[5]) data were analyzed for the young and older normal participant groups. Both within-group comparisons and between-group comparisons were made using repeated measures analysis of variance, computed through the SPSS statistical software.

7.1 GROUP X SENTENCE TYPE X SUBTEST

7.1.1 Overall Mean

To determine the effects of group (i.e., young and older), sentence type (i.e., active and passive sentences), and subtest (i.e., Subtests V-VIII) on performance (as measured by overall mean scores), a three-way repeated measures ANOVA was performed with "sentence type" and "subtest" as within-subject factors and "group" as a between-subject factor. There was no significant main effect for sentence type (*df*=1; *F*-ratio=1.474; p=0.231). There was, however, a significant main effect for subtest (*df*=3; *F*-ratio=5.059; p=0.002) (Table A2). Post-hoc analyses (paired t-tests) were performed in order to examine this effect (Table A3). Significant differences between subtests were found (*df*=3; *F*-ratio=5.080; p=0.002). Further analyses

[5] The initial time of response is recorded when participants first touch a token after the sound file has ended; the final time of response is recorded when participants make their last touch on token.

revealed that participants obtained significantly higher scores on Subtest VIII (m=14.473) than on Subtest V (m=14.333; p=0.039) and Subtest VI (m=14.285; p=0.020); Subtest V did not differ significantly from Subtest VII (m=14.444; p=1.000) (Table A4). This is also shown in Figure 1 and Table A7. Additionally, no significant interactions were found between sentence type and group (*df*=1; *F*-ratio=3.180; p=0.081), subtest and group (*df*=3; *F*-ratio=0.796; p=0.498), between sentence type and subtest (*df*=3; *F*-ratio=0.623; p=0.601), and between sentence type, subtest, and group (*df*=3; *F*-ratio=1.313; p=0.272) (Table A2). Interestingly, the interaction between sentence type and group, though not significant, yielded a value that approached significance. A closer examination of the estimated marginal means for the sentence type X group interaction revealed that the older participant group performed better on the active sentences than on the passive sentences whereas the young participant group performed better on the passive sentences than on the active sentences (Table A8).

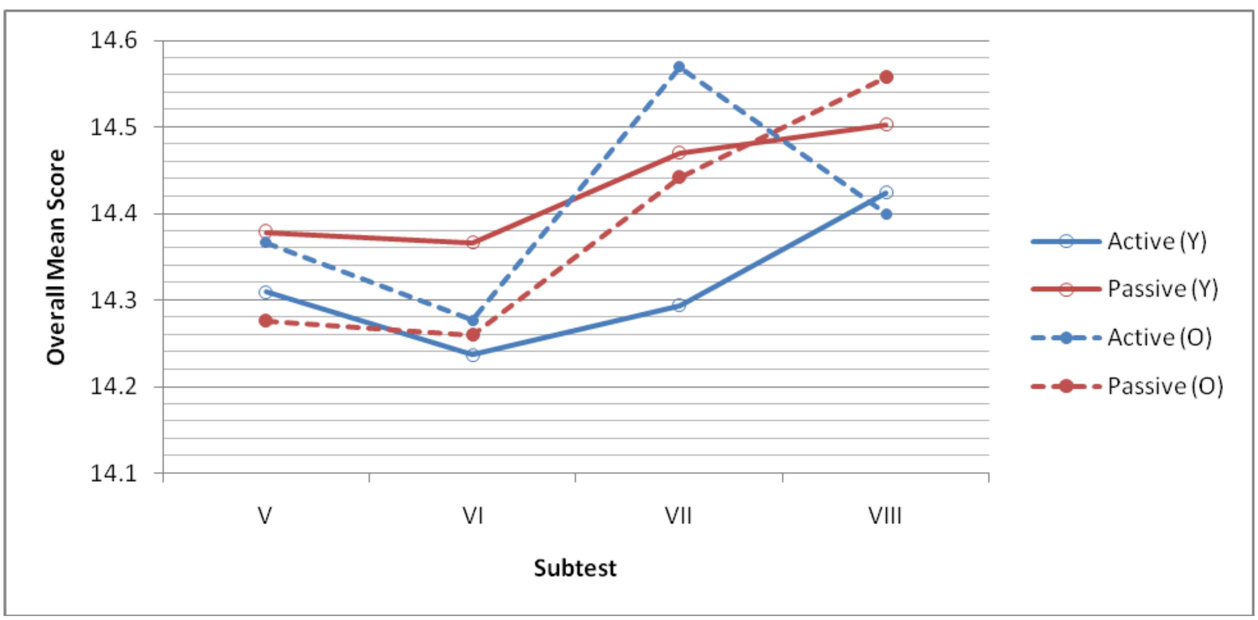

Figure 1: CRTT-A/P overall mean scores for the young and older participant groups

Power analyses were performed for the following non-significant effects: (1) sentence type, (2) sentence type X group, (3) subtest X group, (4) sentence type X subtest, and (5) sentence type X subtest X group (Table A2). For sentence type, the effect size was small[6] (partial eta squared=0.030; Cohen's f=0.18) and the observed power value was low (0.221). Given this observed effect size, a sample size of n=127 would be needed to achieve the ideal power value of 0.8. The sentence type X group interaction yielded a moderate effect size (partial eta squared=0.062; Cohen's f=0.26) and a low observed power value of 0.416; an estimated sample size of n=59 would be needed to achieve a power of 0.8. The subtest X group interaction yielded a small effect size (partial eta squared=0.016; Cohen's f=0.13) and a low observed power value of 0.218; a sample size of n=113 would be needed to achieve a power of 0.8. The sentence type X subtest interaction yielded a small effect size (partial eta squared=0.013; Cohen's f=0.11) and a low observed power value of 0.178; a sample size of n=139 would be needed to achieve a power of 0.8. Finally, the sentence type X subtest X group interaction yielded a small effect size (partial eta squared=0.027; Cohen's f=0.17) and a low observed power value of 0.345; a sample size of n=62 would be needed to achieve a power of 0.8.

7.1.2 Efficiency

To determine the effects of group, sentence type, and subtest using the efficiency index, another three-way repeated measures ANOVA was performed with "sentence type" and "subtest" as within-subject factors and "group" as a between-subject factor. There was no significant main effect for sentence type (*df*=1; *F*-ratio=0.946; p=0.336). There was, however, a significant main

[6] An effect size is considered to be small if it has a partial eta squared value of 0.0099, moderate if it has a partial eta squared value of 0.0588, and large if it has a partial eta squared value of 0.1379 (Cohen, 1988).

effect for subtest (*df*=3; *F*-ratio=9.122; p=0.000) (Table A12). Paired t-tests were performed in order to examine this effect (Table A13). Significant differences between subtests were found (*df*=3; *F*-ratio=8.984; p=0.000). Further analyses revealed that participants obtained significantly higher efficiency scores on Subtest VII (m=12.743) than on Subtest V (m=12.541; p=0.045) and Subtest VI (m=12.379; p=0.000) (Table A14). Participants also obtained significantly higher efficiency scores on Subtest VIII (m=12.640) than on Subtest VI (m=12.379; p=0.007) (Table A14). These differences are shown in Figure 2, and the estimated marginal means for each subtest are displayed in Table A17. Additionally, no other significant interactions were found between sentence type and group (*df*=1; *F*-ratio=1.914; p=0.173), between subtest and group (*df*=3; *F*-ratio=1.750; p=0.160), between sentence type and subtest (*df*=3; *F*-ratio=2.183; p=0.093), and between sentence type, subtest, and group (*df*=3; *F*-ratio=0.737; p=0.532). Interestingly, the interaction between sentence type and subtest, though not significant, yielded a value that approached significance. A closer examination of the estimated marginal means for the sentence type X subtest interaction revealed that participants obtained very similar efficiency scores across the two sentence types on Subtests V, VI, and VII; however, participants obtained higher efficiency scores on the passive sentences than on the active sentences for Subtest VIII (Table A17).

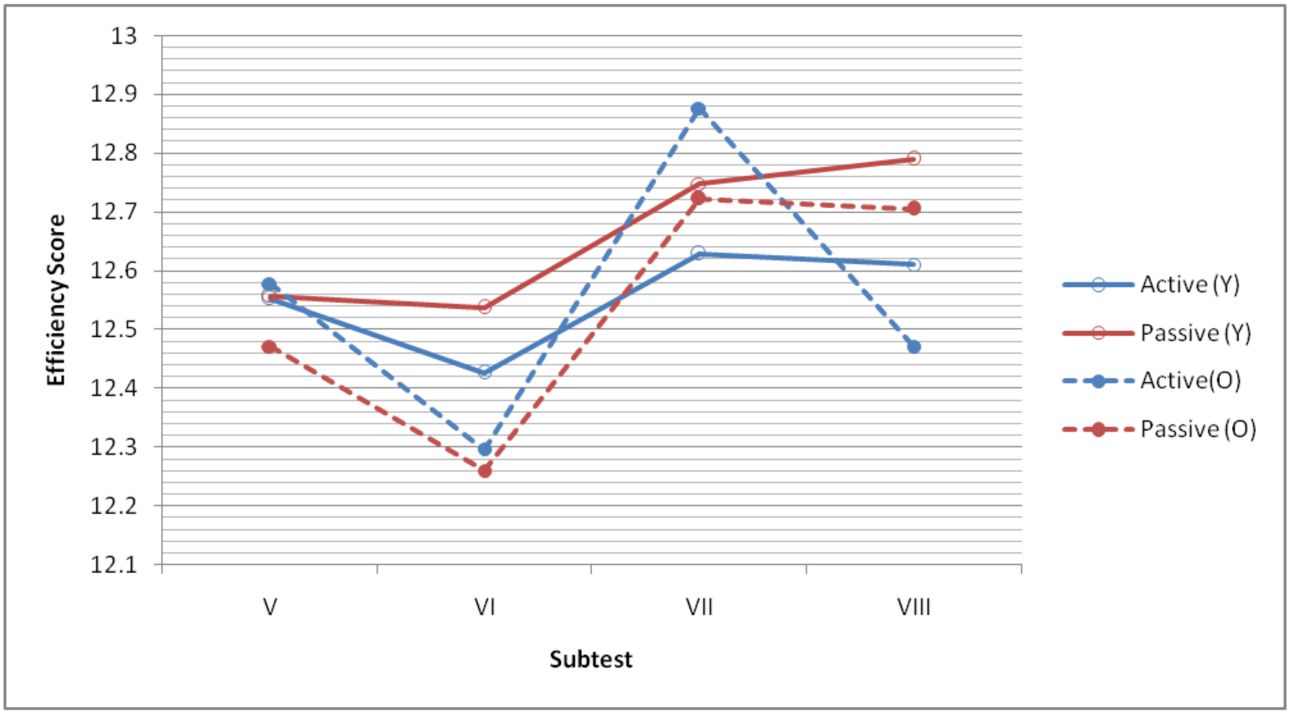

Figure 2: CRTT-A/P efficiency scores for the young and older participant groups

Power analyses were performed for the following non-significant effects: (1) sentence type (2) sentence type X group, (3) subtest X group, (4) sentence type X subtest, and (5) sentence type X subtest X group (Table A12). For sentence type, the effect size was small (partial eta squared=0.019; Cohen's f=0.14) and the observed power value was low (0.159); a sample size of n=203 would be needed to achieve a power of 0.8. The sentence type X group interaction yielded a small effect size (partial eta squared=0.038; Cohen's f=0.20) and a low observed power value of 0.273; a sample size of n=99 would be needed to achieve a power of 0.8. The subtest X group interaction yielded a small effect size (partial eta squared=0.035; Cohen's f=0.19) and a low observed power value of 0.449; a sample size of n=51 would be needed to achieve a power of 0.8. The sentence type X subtest interaction yielded a small effect size (partial eta squared=0.043; Cohen's f=0.21) and a fairly high observed power value of 0.546; a sample size of n=41 would be needed to achieve a power of 0.8. Finally, the sentence type X subtest X group interaction yielded a small effect size (partial eta squared=0.015; Cohen's f=0.12) and a low observed power value of 0.204; a sample size of n=120 would be needed to achieve a power of 0.8.

7.1.3 Response Time

To determine the effects of group, sentence type, and subtest on response time, a three-way repeated measures ANOVA was once again performed with "sentence type" and "subtest" as within-subject factors and "group" as a between-subject factor. There was a significant main effect for sentence type (*df*=1; *F*-ratio=22.714; p=0.000) and for subtest (*df*=3; *F*-ratio=8.879; p=0.000) (Table A22). Participants responded more quickly to the passive sentence type than to the active sentence type across all four subtests (Table A26).

Additionally, there was a significant interaction between subtest and group (*df*=3; *F*-ratio=5.470; p=0.001) (Table A22). Paired t-tests were performed in order to examine this significant interaction (Table A23). No significant differences between subtests were found for the young group (*df*=3; *F*-ratio=0.565; p=0.640), indicating that the young group had similar response times across the four subtests; however, significant differences between subtests were found for the older group (*df*=3; *F*-ratio=16.649; p=0.000). Further analyses revealed that the older group responded more quickly on Subtest V (m=2626.384) than on Subtests VI (m=3063.357; p=0.000) and VIII (m=2924.706; p=0.004) (Table A24). The older group also responded more quickly on Subtest VII (m=2558.937) than on Subtests VI (m=3063.357; p=0.000) and VIII (m=2924.706; p=0.001). These differences can be seen in Figure 3, and the estimated marginal means for each group across the four subtests are presented in Table A29. No other significant interactions were found between sentence type and group (*df*=1; *F*-ratio=0.534; p=0.469), between sentence type and subtest (*df*=3; *F*-ratio=1.207; p=0.309), and between sentence type, subtest, and group (*df*=3; *F*-ratio=01.222; p=0.304)[7].

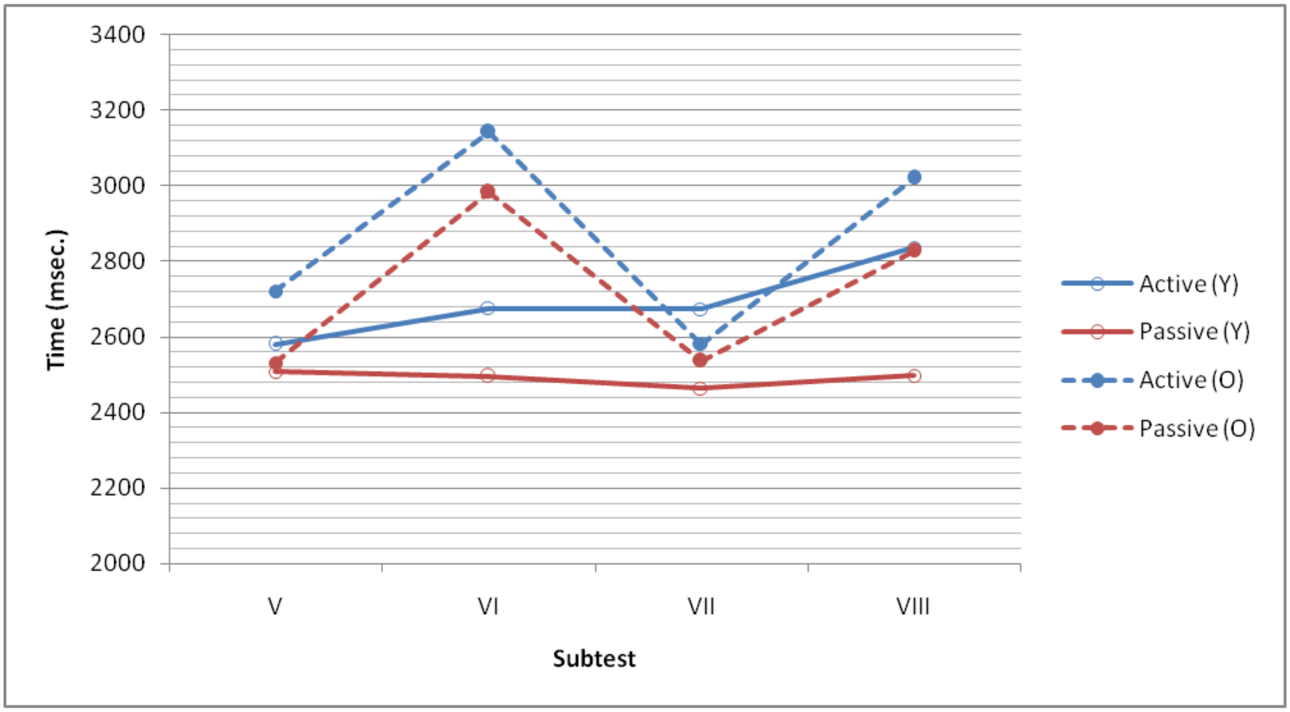

Figure 3: CRTT-A/P response times for the young and older participant groups

Power analyses were performed for the following non-significant effects: (1) sentence type X group, (2) sentence type X subtest, and (3) sentence type X subtest X group (Table A22). For the sentence type X group interaction, the effect size was small (partial eta squared=0.011; Cohen's f=0.11) and the observed power value was low (0.110); a sample size of n=353 would

[7] As shown in Table A31, the form of this non-significant interaction is similar across the two sentence types despite some differences.

be needed to achieve a power of 0.8. The sentence type X subtest interaction yielded a small effect size (partial eta squared=0.025; Cohen's f=0.16) and a low observed power value of 0.319; a sample size of n=72 would be needed to achieve a power of 0.8. Finally, the sentence type X subtest X group interaction yielded a small effect size (partial eta squared=0.025; Cohen's f=0.16) and a low observed power value of 0.322; a sample size of n=72 would be needed to achieve a power of 0.8.

8.0 DISCUSSION

The first purpose of this study was to determine if young and older normal unimpaired individuals differed significantly in their performance (as measured by overall mean scores) on active and passive sentence types across each of the four CRTT-A/P subtests. It was hypothesized that (1) there would be no significant differences in overall mean scores between the two sentence types across any of the subtests for the young group and that (2) the older group would obtain significantly lower overall mean scores on the passive sentences than on the active sentences, especially for Subtests VI and VIII (the longer compound sentences). The results of this study, however, are not completely consistent with these hypotheses. While significant differences were not found between the two sentence types for the overall subtest score, significant differences were found between the four subtests. Participants performed significantly worse on Subtests V and VI than on Subtest VIII. Given that the sentence stimuli in Subtest VIII involve only two locations (i.e., left and right) and the sentence stimuli in Subtests V and VI involve multiple locations (i.e., above, next to, etc.), participants may have found the items in Subtest VIII easier than those in Subtests V and VI.

It was also hypothesized that the two groups would not differ significantly in their overall mean subtest scores on the active sentences across the four subtests but that the older group would perform significantly more poorly than the young group on the passive sentences. The results, however, showed that the young and older participants did not differ on overall subtest score across the two sentence types. It is interesting to note that even though the two groups did not differ significantly in their performance on the two sentence types, the sentence type by group interaction did approach significance. As shown in Table A8, the young participant group performed better on the passive sentences than on the active sentences whereas the opposite effect was seen for the older participants group. Finally, there was no sentence type by subtest by group interaction, indicating that the two groups did not show a different pattern of performance across the two sentence types and across the four subtests for overall score. Because most of the comparisons were non-significant, statistical power was calculated for all non-significant results. Based on this analysis, a sample size of about 139 participants was estimated to be required in order to provide the most rigorous test of the differences between the group, sentence type, and subtest comparisons.

The second purpose of this study was to determine if the two groups differed significantly in their efficiency scores on the two sentence types across each of the four subtests[8]. As with the overall scores, it was hypothesized that (1) there would be no significant differences in efficiency scores between the two sentence types across any of the subtests for the young group and that (2) the older group would obtain significantly lower efficiency scores on the passive sentences than on the active sentences, especially for Subtests VI and VIII. The results of this study, however, are not completely consistent with these hypotheses. While significant differences were not found between the two sentence types for efficiency, significant differences were found between the four subtests. Participants obtained significantly lower efficiency scores on Subtests V and VI than on Subtest VII and significantly lower efficiency scores on Subtest VI than on Subtest

[8] The efficiency scores are derived from the same set of data as the overall mean scores; however, they are conditioned by a specified time.

VIII. While participants did not perform differently on the two sentence types across the four subtests, the sentence type by subtest interaction did approach significance. As shown in Table A20, participant groups obtained relatively similar scores on Subtests V, VI, and VII; however, participants obtained their lowest efficiency scores on the active sentences than on the passive sentences.

It was also hypothesized that the older group would differ significantly from the young group in their efficiency scores on the two sentence types across all four subtests. Similarly to the results for overall mean, non-significant results were found for the young and older participants in their efficiency scores across the two sentence types. While the sentence type by group interaction was not significant for efficiency, higher efficiency scores were seen on the passive sentence type for the young group, and higher scores were seen on the active sentence type for the older group (Table A18). The subtest by group interaction was not significant. Likewise, the sentence type by subtest by age interaction was also non-significant, indicating that the two groups did not show a different pattern of performance (as measured by efficiency scores) across the two sentence types for any of the four subtests. As indicated by the power analyses, the power values of these non-significant effects were fairly low. Thus, as previously mentioned, a larger sample size would be needed in order to provide a more robust test of these hypotheses.

The final purpose of this study was to determine if the two groups differed significantly in their response times across the two sentence types across each of the four subtests. As with the other two dependent measures, it was hypothesized that (1) there would be no significant differences in response times between the two sentence types across any of the subtests for the young group and that (2) the older group would have significantly longer response times on the passive sentences than on the active sentences, especially for Subtests VI and VIII. The results from the current study, however, did not support these hypotheses. Significant differences were found between the two sentence types for response time. That is, participants were faster to respond to the passive sentence type than to the active sentence type. Additionally, participants did not perform differently on the two sentence types across the four subtests.

It was also hypothesized that the older group would have significantly longer response times than the young group on the two sentence types across all four subtests. However, it was found that neither the young nor older participants differed significantly in their response times across the two sentence types. While the sentence type by group interaction was not significant for response time, the older participants did perform more slowly than the young participants on both sentence types. Furthermore, both groups had their fastest response times on the passive sentence type (Table A28). These differences, however, were relatively small (on average, the two groups differed by about 201.49 msec. for each sentence type) and non-significant. Interestingly, the two groups differed significantly in their response times across the four subtests (Table A29). While response times did not differ significantly across the four subtests for the young participant group, the older participant group was faster to respond to the passive sentences in Subtests V and VII than in Subtests VI and VIII. This finding may suggest that for the older group, an increased task demand was placed on these syntactically more difficult sentences when they were longer in length; thus, a greater demand was also placed on the "span" component of working memory. Finally, the three-way interaction of sentence type, subtest, and age for response time was non-significant, indicating that the two groups did not differ significantly in their response times across the two sentence types and across the four subtests. This non-significant interaction indicates that the form of the interaction is similar across the two sentence types despite some differences (Table A31). Again, the study proved to be substantively underpowered and a larger sample size would be needed in order to confidently fail to reject the null hypothesis.

In sum, when differences between the two groups were examined, only one significant difference was found. Other than the subtest by group interaction seen for response time, no other significant differences were found for any of the measures. The young and older participant groups did not differ significantly in their performance on active and passive sentences. These findings are consistent with many reports that language comprehension abilities remain relatively constant throughout the age range assessed in this investigation (Burke & Harrold, 1988; Laver & Burke, 1993; Burke & MacKay, 1997). However, as discussed previously, studies have consistently shown that unimpaired individuals (not just impaired individuals) have more difficulty comprehending passive than active sentences (Emery, 1985; Kemper, 1986; Kemper, 1988; Davis & Ball, 1989; Obler, Fein, Nicholas, & Albert, 1991; Kemper, 1992; Kemper & Anagnopoulos, 1993; Miyake, Carpenter, & Just, 1994; Zurif, Swinney, Prather, Wingfield, & Brownell, 1995; Ferreira, 2003). Perhaps then, an investigation into the nature of the CRTT-A/P sentence constructions themselves would help to explain the results from this study. Do individuals process the CRTT-A/P active and passive sentences the same way as they would process "typical" active and passive sentence constructions, or do they use a different processing strategy? As no other sentences with these constructions were used in this investigation, the answer to this question will have to await additional comparisons. It is possible, however, that participants may have found the CRTT-A/P passive sentence type easier to comprehend than the CRTT-A/P active sentence type because the preposition (i.e., the target location) is always provided first in the passive sentences. This can be particularly advantageous to participants, for they have only to remember which token needs to be moved to the target location. In other words, the CRTT-A/P passive sentence construction may not tax working memory as much as the CRTT-A/P active sentence construction; this is also suggested by the data in Table A26, which shows that both participant groups were significantly faster to respond to the passive sentences than to the active sentences across the four subtests. Thus, of the three hypotheses discussed above (i.e., the TDH, the working memory hypothesis, and the mapping theory), the results from this study are most consistent with a working memory hypothesis of language comprehension (Kolk & van Grunsven, 1985; Frazier & Friederici, 1991; Haarman & Kolk, 1991; Miyake, Carpenter, & Just, 1994). The results for response time may also provide further evidence for the working memory hypothesis. These data revealed that (1) the older participants were generally slower to respond to the sentence stimuli across the four subtests than the young participants and that (2) the older participants took a significantly longer time to respond to the longer subtests (i.e., Subtests VI and VIII) than to the shorter subtests (i.e., Subtests V and VII). These results suggest that there may have been some subtle processing differences between the young and older participant groups captured by the response time measure. Additional research will be required to investigate these possibilities.

If the CRTT-A/P passive sentences were found to function as other more traditional passive sentences, then the findings from this study would need to be interpreted as somewhat inconsistent with Waters and Caplan's (2005) claim that age-related limitations in working memory play a role in off-line[9] or "review processes" for older normal individuals. The Waters and Caplan hypothesis would suggest that the older participant group would have more difficulty

[9] While the CRTT-A/P quantifies performance using only off-line measures, this test involves both on-line and off-line processing.

comprehending the complex sentences (i.e., the passive sentences in the CRTT-A/P) than the simple sentences (i.e., the active sentences in the CRTT-A/P) whereas the young participant group would have no difficulty understanding either sentence type. However, older participants did not have more difficulty interpreting sentence meaning from the passive constructions used in this study than the young participants. This finding does not necessarily disprove Waters and Caplan's claim; in fact, an investigation more thorough than the current study (i.e., one that obtains a finer measure of on-line sentence processing on the CRTT and the CRTT-A/P) would be necessary in order to determine the exact relationship between age, working memory, sentence processing, and sentence comprehension. For example, incorporating eye-tracking into the current study might shed additional light on this relationship as eye-tracking paradigms have proven to be valid tools for measuring on-line cognitive processes, including those involved in auditory sentence processing (Liversedge & Findlay, 2000). Using eye-tracking methods to monitor saccadic eye movements in an auditory sentence comprehension task has the potential to "provide immediate information about how each word is interpreted as the sentence unfolds" in a natural manner (Eberhard, Spivey-Knowlton, Sedivy, & Tanenhaus, 1995, p. 410). Researchers have demonstrated this in a series of studies and have shown that participants' eye movements to objects in a visual array were closely time-locked to the words that referred to those objects (Eberhard, Spivey-Knowlton, Sedivy, & Tanenhaus, 1995; Liversedge & Findlay, 2000). Thus, in order to fully understand how sentences are comprehended, it is essential to also understand how sentences are processed.

As discussed earlier in this manuscript, there are few published tests available for the assessment of agrammatic comprehension. The current study was designed to provide a first step towards filling this assessment void and motivates a series of additional studies. Although this version of the CRTT-A/P did not detect comprehension differences between active and passive sentences for the young and older non-impaired participants, another version of the CRTT-A/P which omits the prepositions[10] or modifies the preposition in the sentence initial position might yield different results. In addition, the CRTT-A/P has yet to be administered to pathological populations, specifically persons with aphasia and agrammatic comprehension. Such studies are critical for advancing understanding of the way grammatical meaning is formed and language is comprehended and for assessing the value of the CRTT-A/P for detecting deficits in processing and comprehension. For example, can the CRTT-A/P detect comprehension differences between active and passive sentences in individuals with agrammatic comprehension? If so, then we would expect these individuals to perform reliably more poorly on the passive sentences compared to the active sentences. If not, then perhaps an investigation into the nature of the CRTT-A/P sentence constructions themselves would be necessary (as suggested above). Investigating whether or not the active and passive sentence constructions of the CRTT-A/P are inherently different from "typical" active and passive sentence constructions may reveal important information about the way that persons with agrammatic comprehension extract meaning from sentences and provide a means for assessing the concurrent validity of the experimental tasks. Such clinically relevant information may, as a result, lead to new and better rehabilitative treatments for individuals with agrammatic comprehension. Furthermore, it is important to determine if the CRTT-A/P performance of these individuals compares to that of the young and older participants tested this study. In other words, it will be important to determine

[10] For example, an active sentence would be constructed as follows: "The blue square touched the black circle." Its corresponding passive sentence would be constructed as follows: "The black circle was touched by the blue square."

if they show significant differences between the two sentence types across the four subtests for the overall mean, efficiency, and response time data.

The results from this study not only provide a broader understanding of how individuals comprehend grammatical meaning but also provide preliminary data for comparison with pathological populations for the ultimate goal of creating a standardized test that can validly and reliably identify individuals with agrammatic comprehension.

APPENDIX A

CRTT-A/P

Patient instructions (large tokens used only) I am going to say many different sentences about these. (Tokens flash.) I want you to listen carefully and show me exactly what happened in each sentence. Are you ready?

Subtest V items: Active sentences (large tokens used only)

1. The black square touched near the red circle.
2. The black circle touched above the white square.
3. The blue square touched before the black circle.
4. The red circle touched on the blue circle.
5. The blue circle touched behind the green square.
6. The green square touched under the black square.
7. The white circle touched below the blue square.
8. The white square touched next to the green circle.
9. The red square touched in front of the white circle.
10. The green circle touched beside the red square.

Subtest V items: Passive sentences (large tokens used only)

1. Near the red circle was touched by the black square.
2. Above the white square was touched by the black circle.
3. Before the black circle was touched by the blue square.
4. On the blue circle was touched by the red circle.
5. Behind the green square was touched by the blue circle.
6. Under the black square was touched by the green square.
7. Below the blue square was touched by the white circle.
8. Next to the green circle was touched by the white square.
9. In front of the white circle was touched by the red square.
10. Beside the red square was touched by the green circle.

Subtest VI items: Active sentences (all tokens used)

1. The big red square touched in front of the big white circle.
2. The big blue circle touched before the little green square.
3. The little green circle touched under the big red square.
4. The big black square touched above the little red circle.
5. The little black circle touched below the little white square.
6. The little blue square touched behind the big black circle.
7. The big green square touched near the little black square.
8. The big white circle touched next to the little blue square.
9. The little red circle touched beside the big blue circle.
10. The little white square touched on the big green circle.

Subtest VI items: Passive sentences (all tokens used)

1. In front of the big white circle was touched by the big red square.

2. Before the little green square was touched by the big blue circle.
3. Under the big red square was touched by the little green circle.
4. Above the little red circle was touched by the big black square.
5. Below the little white square was touched by the little black circle.
6. Behind the big black circle was touched by the little blue square.
7. Near the little black square was touched by the big green square.
8. Next to the little blue square was touched by the big white circle.
9. Beside the big blue circle was touched by the little red circle.
10. On the big green circle was touched by the little white square.

Subtest VII items: Active sentences (large tokens used only)

1. The black circle touched to the left of the white square.
2. The red square touched to the left of the white circle.
3. The black square touched to the right of the red circle.
4. The blue circle touched to the left of the green square.
5. The green circle touched to the left of the red square.
6. The white square touched to the right of the green circle.
7. The red circle touched to the right of the blue circle.
8. The white circle touched to the right of the blue square.
9. The blue square touched to the left of the black circle.
10. The green square touched to the right of the black square.

Subtest VII items: Passive sentences (large tokens used only)

1. To the left of the white square was touched by the black circle.
2. To the left of the white circle was touched by the red square.

3. To the right of the red circle was touched by the black square.
4. To the left of the green square was touched by the blue circle.
5. To the left of the red square was touched by the green circle.
6. To the right of the green circle was touched by the white square.
7. To the right of the blue circle was touched by the red circle.
8. To the right of the blue square was touched by the white circle.
9. To the left of the black circle was touched by the blue square.
10. To the right of the black square was touched by the green square.

Subtest VIII items: Active sentences (all tokens used)

1. The little green circle touched to the left of the big red square.
2. The big white circle touched to the left of the little blue square.
3. The big green square touched to the right of the little black square.
4. The little white square touched to the right of the big green circle.
5. The big red square touched to the left of the big white circle.
6. The little black circle touched to the left of the little white square.
7. The little red circle touched to the right of the big blue square.
8. The big black square touched to the right of the little red circle.
9. The big blue circle touched to the left of the little green square.
10. The little blue square touched to the left of the big black circle.

Subtest VIII items: Passive sentences (all tokens used)

1. To the left of the big red square was touched by the little green circle.
2. To the left of the little blue square was touched by the big white circle.
3. To the right of the little black square was touched by the big green square.

4. To the right of the big green circle was touched by the little white square.
5. To the left of the big white circle was touched by the big red square.
6. To the left of the little white square was touched by the little black circle.
7. To the right of the big blue square was touched by the little red circle.
8. To the right of the little red circle was touched by the big black square.
9. To the left of the little green square was touched by the big blue circle.
10. To the left of the big black circle was touched by the little blue square.

APPENDIX B

CRTT-A/P: PRACTICE ITEMS

Active sentences (large tokens used only)

1. The white circle touched beneath the black circle.
2. The red square touched alongside the green circle.
3. The blue square touched to the back of the black square.
4. The white square touched to the side of the green circle.
5. The blue circle touched on top of the red square.

Passive sentences (large tokens used only)

1. To the back of the black square was touched by the blue square.
2. To the side of the green circle was touched by the white square.
3. On top of the red square was touched by the blue circle.
4. Alongside the green circle was touched by the red square.
5. Beneath the black circle was touched by the white circle.

Active and passive sentences (large tokens used only)

1. The white circle touched beneath the black circle.
2. To the back of the black square was touched by the blue square.

3. The blue circle touched on top of the red square.
4. The red square touched alongside the green circle.
5. On top of the red square was touched by the blue circle.
6. The white square touched to the side of the green circle.
7. Beneath the black circle was touched by the white circle.
8. To the side of the green circle was touched by the white square.
9. The blue square touched to the back of the black square.
10. Alongside the green circle was touched by the red square.

APPENDIX C

CRTT AND CRTT-A/P SCORING SYSTEM

Table A1: Scoring categories and their descriptions

SCORE	DESCRIPTION OF RESPONSE
15	Correct
14	Vocal – Subvocal Rehearsal
13	Delay
12	Immediacy
11	Self-Correction
10	Reversal
9	Repeat
8	Cue
7	Error
6	Perseveration
5	Intelligible/Rejection
4	Unintelligible (differentiated)
3	Unintelligible (perseveration)
2	Omission
1	No Response

APPENDIX D

RAW DATA

Table A2: Tests of Between-Subjects and Within-Subjects Effects (Overall Mean)

Source	df	F-ratio	p-value	Partial Eta Squared	Observed Power
stype	1	1.474	0.231	0.030	0.221
stype X group	1	3.180	0.081	0.062	0.416
subtest	3	5.059	0.002	0.095	0.913
subtest X group	3	0.796	0.498	0.016	0.218
stype X subtest	3	0.623	0.601	0.013	0.178
stype X subtest X group	3	1.313	0.272	0.027	0.345

Table A3: Post-hoc Analyses for the Main Effect of Subtest (Overall Mean)

Source	df	F-ratio	p-value
Subtest	3	5.080	0.002

Table A4: Pairwise Comparisons for the Main Effect of Subtest (Overall Mean)

Subtest	Subtest	Mean Difference	p-value
5	**6**	0.048	1.000
	7	-0.111	0.313
	8	-0.140	0.039
6	**5**	-0.048	1.000
	7	-0.159	0.114
	8	-0.188	0.020
7	**5**	0.111	0.313
	6	0.159	0.114
	8	-0.029	1.000
8	**5**	0.140	0.039
	6	0.188	0.020
	7	0.029	1.000

Table A5: Estimated Marginal Means for Group (Overall Mean)

Group	Mean
Y	14.373
O	14.394

Table A6: Estimated Marginal Means for Sentence Type (Overall Mean)

Stype	Mean
A	14.360
P	14.407

Table A7: Estimated Marginal Means for Subtest (Overall Mean)

Subtest	Mean
5	14.333
6	14.285
7	14.444
8	14.473

Table A8: Estimated Marginal Means for the Sentence Type X Group Interaction (Overall Mean)

Group	Stype	Mean
Y	**A**	14.315
	P	14.430
O	**A**	14.405
	P	14.383

Table A9: Estimated Marginal Means for the Subtest X Group Interaction (Overall Mean)

Group	Subtest	Mean
Y	**5**	14.342
	6	14.302
	7	14.382
	8	14.465
O	**5**	14.323
	6	14.268
	7	14.505
	8	14.480

Table A10: Estimated Marginal Means for the Sentence Type X Subtest Interaction (Overall Mean)

Stype	Subtest	Mean
A	5	14.337
	6	14.258
	7	14.431
	8	14.415
P	5	14.328
	6	14.312
	7	14.456
	8	14.530

Table A11: Estimated Marginal Means for the Sentence Type X Subtest X Group Interaction (Overall Mean)

Group	Stype	Subtest	Mean
Y	A	5	14.306
		6	14.237
		7	14.294
		8	14.424
	P	5	14.379
		6	14.367
		7	14.470
		8	14.505
O	A	5	14.369
		6	14.279
		7	14.568
		8	14.405
	P	5	14.278
		6	14.258
		7	14.442
		8	14.556

Table A12: Tests of Between-Subjects and Within-Subjects Effects (Efficiency)

Source	df	F-ratio	p-value	Partial Eta Squared	Observed Power
stype	1	0.946	0.336	0.019	0.159
stype X group	1	1.914	0.173	0.038	0.273
subtest	3	9.122	0.000	0.160	0.996
subtest X group	3	1.750	0.160	0.035	0.449
stype X subtest	3	2.183	0.093	0.043	0.546
stype X subtest X group	3	0.737	0.532	0.015	0.204

Table A13: Post-hoc Analyses for the Main Effect of Subtest (Efficiency)

Source	df	F-ratio	p-value
Subtest	3	8.984	0.000

Table A14: Pairwise Comparisons for the Main Effect of Subtest (Efficiency)

Subtest	Subtest	Mean Difference	p-value
5	**6**	0.161	0.201
	7	-0.203	0.045
	8	-0.099	1.000
6	**5**	-0.161	0.201
	7	-0.364	0.000
	8	-0.261	0.007
7	**5**	0.203	0.045
	6	0.364	0.000
	8	0.103	0.630
8	**5**	0.099	1.000
	6	0.261	0.007
	7	-0.103	0.630

Table A15: Estimated Marginal Means for Group (Efficiency)

Group	Mean
Y	12.606
O	12.546

Table A16: Estimated Marginal Means for Sentence Type (Efficiency)

Stype	Mean
A	12.554
P	12.598

Table A17: Estimated Marginal Means for Subtest (Efficiency)

Subtest	Mean
5	12.541
6	12.379
7	12.743
8	12.640

Table A18: Estimated Marginal Means for the Sentence Type X Group Interaction (Efficiency)

Group	Stype	Mean
Y	**A**	12.553
	P	12.659
O	**A**	12.555
	P	12.536

Table A19: Estimated Marginal Means for the Subtest X Group Interaction (Efficiency)

Group	Subtest	Mean
Y	**5**	12.553
	6	12.482
	7	12.688
	8	12.701
O	**5**	12.529
	6	12.276
	7	12.799
	8	12.579

Table A20: Estimated Marginal Means for the Sentence Type X Subtest Interaction (Efficiency)

Stype	Subtest	Mean
A	**5**	12.564
	6	12.362
	7	12.752
	8	12.538
P	**5**	12.517
	6	12.396
	7	12.735
	8	12.742

Table A21: Estimated Marginal Means for the Sentence Type X Subtest X Group Interaction (Efficiency)

Group	Stype	Subtest	Mean
Y	A	5	12.548
		6	12.426
		7	12.629
		8	12.610
	P	5	12.557
		6	12.538
		7	12.748
		8	12.792
O	A	5	12.580
		6	12.298
		7	12.875
		8	12.466
	P	5	12.477
		6	12.254
		7	12.722
		8	12.692

Table A22: Tests of Between-Subjects and Within-Subjects Effects (Response Time)

Source	df	F-ratio	p-value	Partial Eta Squared	Observed Power
stype	1	22.714	0.000	0.321	0.997
stype X group	1	0.534	0.469	0.011	0.110
subtest	3	8.879	0.000	0.156	0.995
subtest X group	3	5.470	0.001	0.102	0.934
stype X subtest	3	1.207	0.309	0.025	0.319
stype X subtest X group	3	1.222	0.304	0.025	0.322

Table A23: Post-hoc Analyses for the Subtest X Group Interaction (Response Time)

Group	Source	df	F-ratio	p-value
Y	Subtest	3	0.565	0.640
O	Subtest	3	16.649	0.000

Table A24: Pairwise Comparisons for the Subtest X Group Interaction (Response Time)

Group	Subtest	Subtest	Mean Difference	p-value
Y	5	6	-42.247	1.000
		7	-25.425	1.000
		8	-122.591	1.000
	6	5	42.427	1.000
		7	16.822	1.000
		8	-80.343	1.000
	7	5	25.425	1.000
		6	-16.822	1.000
		8	-97.165	1.000
	8	5	122.591	1.000
		6	80.343	1.000
		7	97.165	1.000
O	5	6	-436.974	0.000
		7	67.446	1.000
		8	-298.323	0.004
	6	5	436.974	0.000
		7	504.420	0.000
		8	138.651	0.807
	7	5	-67.446	1.000
		6	-504.420	0.000
		8	-365.769	0.001
	8	5	298.323	0.004
		6	-138.651	0.807
		7	365.769	0.001

Table A25: Estimated Marginal Means for Group (Response Time)

Group	Mean
Y	2591.861
O	2793.346

Table A26: Estimated Marginal Means for Sentence Type (Response Time)

Stype	Mean
A	2779.335
P	2605.872

Table A27: Estimated Marginal Means for Subtest (Response Time)

Subtest	Mean
5	2585.339
6	2824.950
7	2564.329
8	2795.796

Table A28: Estimated Marginal Means for the Sentence Type X Group Interaction (Response Time)

Group	Stype	Mean
Y	**A**	2691.885
	P	2491.836
O	**A**	2866.784
	P	2719.908

Table A29: Estimated Marginal Means for the Subtest X Group Interaction (Response Time)

Group	Subtest	Mean
Y	**5**	2544.295
	6	2586.542
	7	2569.720
	8	2666.885
O	**5**	2626.384
	6	3063.357
	7	2558.937
	8	2924.706

Table A30: Estimated Marginal Means for the Sentence Type X Subtest Interaction (Response Time)

Stype	Subtest	Mean
A	**5**	2650.814
	6	2909.841
	7	2628.051
	8	2928.632
P	**5**	2519.864
	6	2740.058
	7	2500.606
	8	2662.959

Table A31: Estimated Marginal Means for the Sentence Type X Subtest X Group Interaction (Response Time)

Group	Stype	Subtest	Mean
Y	A	5	2580.726
		6	2676.524
		7	2674.424
		8	2835.865
	P	5	2507.864
		6	2496.560
		7	2465.016
		8	2497.905
O	A	5	2720.903
		6	3143.157
		7	2581.679
		8	3021.399
	P	5	2531.864
		6	2983.557
		7	2536.196
		8	2828.013

APPENDIX E

GROUP DATA

Table A32: Descriptive Statistics for Each Participant Group (Overall Mean)

Group	Stype	Subtest	Overall Mean	Std. Deviation	N
Y	A	5	14.306	0.495	25
		6	14.237	0.529	25
		7	14.294	0.532	25
		8	14.424	0.412	25
	P	5	14.379	0.459	25
		6	14.367	0.668	25
		7	14.470	0.403	25
		8	14.505	0.401	25
O	A	5	14.369	0.399	25
		6	14.279	0.425	25
		7	14.568	0.507	25
		8	14.405	0.527	25
	P	5	14.278	0.483	25
		6	14.258	0.601	25
		7	14.442	0.426	25
		8	14.556	0.316	25

Table A33: Descriptive Statistics for Both Participant Groups (Overall Mean)

Stype	Subtest	Overall Mean	Std. Deviation	N
A	5	14.337	0.446	50
	6	14.258	0.475	50
	7	14.431	0.533	50
	8	14.415	0.469	50
P	5	14.328	0.469	50
	6	14.312	0.632	50
	7	14.442	0.426	25
	8	14.530	0.358	50

Table A34: Descriptive Statistics for Each Participant Group (Efficiency)

Group	Stype	Subtest	Overall Mean	Std. Deviation	N
Y	A	5	12.548	0.767	25
		6	12.426	0.684	25
		7	12.629	0.751	25
		8	12.610	0.698	25
	P	5	12.557	0.924	25
		6	12.538	0.953	25
		7	12.748	0.719	25
		8	12.792	0.602	25
O	A	5	12.580	0.613	25
		6	12.298	0.685	25
		7	12.875	0.690	25
		8	12.466	0.620	25
	P	5	12.477	0.780	25
		6	12.254	0.866	25
		7	12.722	0.661	25
		8	12.692	0.609	25

Table A35: Descriptive Statistics for Both Participant Groups (Efficiency)

Stype	Subtest	Overall Mean	Std. Deviation	N
A	**5**	12.564	0.687	50
	6	12.362	0.680	50
	7	12.752	0.724	50
	8	12.538	0.658	50
P	**5**	12.517	0.847	50
	6	12.396	0.913	50
	7	12.735	0.684	50
	8	12.742	0.602	50

Table A36: Descriptive Statistics for Each Participant Group (Response Time)

Group	Stype	Subtest	Overall Mean	Std. Deviation	N
Y	**A**	**5**	2580.726	612.236	25
		6	2676.524	630.400	25
		7	2674.424	811.257	25
		8	2835.865	757.383	25
	P	**5**	2507.864	777.853	25
		6	2496.560	635.201	25
		7	2465.016	665.533	25
		8	2497.905	632.570	25
O	**A**	**5**	2720.903	618.721	25
		6	3143.157	735.021	25
		7	2581.679	602.712	25
		8	3021.399	573.278	25
	P	**5**	2531.864	553.350	25
		6	2983.557	792.396	25
		7	2536.196	532.444	25
		8	2828.013	780.442	25

Table A37: Descriptive Statistics for Both Participant Groups (Response Time)

Stype	Subtest	Overall Mean	Std. Deviation	N
A	**5**	2650.814	613.274	50
	6	2909.841	717.502	50
	7	2628.051	708.852	50
	8	2928.632	671.351	50
P	**5**	2519.864	668.187	50
	6	2740.058	752.106	50
	7	2500.606	597.575	50
	8	2662.959	722.577	50

APPENDIX F

INDIVIDUAL PARTICIPANT DATA

Table A38: CRTT-A/P Overall Mean Scores for Individual Young Participants

101	5	6	7	8
ACTIVE	14.209	14.050	14.800	14.400
PASSIVE	14.167	14.700	15.000	14.300

102	5	6	7	8
ACTIVE	13.667	14.100	13.767	14.200
PASSIVE	13.467	13.475	13.834	14.800

103	5	6	7	8
ACTIVE	13.701	14.400	13.300	14.325
PASSIVE	14.800	14.500	14.167	14.575

104	5	6	7	8
ACTIVE	14.600	14.500	14.600	14.800
PASSIVE	14.367	14.800	13.967	15.000

105	5	6	7	8
ACTIVE	14.667	14.900	14.567	14.800
PASSIVE	15.000	14.900	14.800	14.575

106	5	6	7	8
ACTIVE	14.067	14.625	14.667	14.050
PASSIVE	14.034	13.975	13.950	13.950

107	5	6	7	8
ACTIVE	15.000	14.500	14.600	14.300
PASSIVE	14.800	14.175	14.600	14.475

Table A38 (continued)

108	5	6	7	8
ACTIVE	14.101	13.500	14.367	14.083
PASSIVE	13.934	12.627	14.500	14.389

109	5	6	7	8
ACTIVE	14.367	14.525	14.500	14.600
PASSIVE	14.734	14.100	14.800	14.500

110	5	6	7	8
ACTIVE	14.500	14.700	14.300	14.800
PASSIVE	14.234	14.600	15.000	14.725

111	5	6	7	8
ACTIVE	14.667	14.275	14.567	15.000
PASSIVE	15.000	15.000	15.000	14.800

112	5	6	7	8
ACTIVE	14.334	14.200	13.700	14.600
PASSIVE	13.567	14.800	15.000	14.400

113	5	6	7	8
ACTIVE	14.600	14.100	14.367	14.075
PASSIVE	14.400	14.500	14.434	13.650

114	5	6	7	8
ACTIVE	13.900	14.100	14.633	14.500
PASSIVE	14.400	14.475	13.600	14.575

115	5	6	7	8
ACTIVE	15.000	14.700	14.600	14.750
PASSIVE	14.500	14.900	14.800	15.000

116	5	6	7	8
ACTIVE	14.634	14.700	14.100	15.000
PASSIVE	14.767	14.700	14.500	14.667

117	5	6	7	8
ACTIVE	13.967	13.475	13.368	13.675
PASSIVE	14.367	12.475	13.934	13.800

Table A38 (continued)

118	5	6	7	8
ACTIVE	13.630	14.175	14.700	14.300
PASSIVE	14.034	13.975	14.400	14.225

119	5	6	7	8
ACTIVE	14.567	15.000	15.000	14.550
PASSIVE	14.667	14.500	14.600	15.000

120	5	6	7	8
ACTIVE	15.000	14.500	14.500	14.900
PASSIVE	14.800	14.900	14.534	14.675

121	5	6	7	8
ACTIVE	13.767	12.800	13.200	13.925
PASSIVE	14.134	14.600	14.167	15.000

122	5	6	7	8
ACTIVE	14.367	14.775	14.833	15.000
PASSIVE	15.000	15.000	14.833	15.000

123	5	6	7	8
ACTIVE	13.067	13.300	14.333	13.475
PASSIVE	13.467	13.988	14.167	13.775

124	5	6	7	8
ACTIVE	14.400	13.900	14.667	14.200
PASSIVE	14.200	14.600	14.600	14.600

125	5	6	7	8
ACTIVE	14.867	14.125	13.317	14.300
PASSIVE	14.633	14.900	14.567	14.175

Table A39: CRTT-A/P Overall Mean Scores for Individual Older Participants

201	5	6	7	8
ACTIVE	14.519	14.575	15.000	14.800
PASSIVE	14.700	14.550	14.800	14.475

Table A39 (continued)

202	5	6	7	8
ACTIVE	14.556	14.300	14.600	14.350
PASSIVE	14.267	14.500	14.667	13.925

203	5	6	7	8
ACTIVE	13.867	13.925	14.267	13.925
PASSIVE	14.434	13.038	14.800	14.800

204	5	6	7	8
ACTIVE	14.630	14.025	14.667	14.600
PASSIVE	14.667	14.425	14.317	14.900

205	5	6	7	8
ACTIVE	14.867	14.800	14.833	15.000
PASSIVE	14.567	14.900	14.833	14.900

206	5	6	7	8
ACTIVE	14.167	13.975	15.000	14.889
PASSIVE	14.367	14.775	15.000	14.700

207	5	6	7	8
ACTIVE	13.867	14.275	14.400	14.425
PASSIVE	13.267	13.528	14.167	14.800

208	5	6	7	8
ACTIVE	14.134	14.725	15.000	14.900
PASSIVE	14.867	14.350	14.434	14.700

209	5	6	7	8
ACTIVE	14.867	14.500	14.600	14.675
PASSIVE	14.300	14.600	14.400	14.800

210	5	6	7	8
ACTIVE	14.867	14.900	14.800	14.800
PASSIVE	14.852	14.900	14.800	14.800

211	5	6	7	8
ACTIVE	14.067	14.425	14.867	13.250
PASSIVE	14.234	14.688	13.800	14.550

Table A39 (continued)

212	5	6	7	8
ACTIVE	14.350	14.425	14.367	13.525
PASSIVE	13.517	13.763	13.368	14.025

213	5	6	7	8
ACTIVE	14.100	13.350	14.400	14.714
PASSIVE	13.350	12.863	14.400	14.417

214	5	6	7	8
ACTIVE	14.800	14.350	14.800	14.200
PASSIVE	14.567	14.800	14.300	14.525

215	5	6	7	8
ACTIVE	14.300	13.725	14.667	14.300
PASSIVE	14.451	14.050	14.667	14.700

216	5	6	7	8
ACTIVE	14.667	14.700	15.000	14.800
PASSIVE	14.667	15.000	14.500	14.600

217	5	6	7	8
ACTIVE	14.467	13.700	14.734	14.400
PASSIVE	14.534	14.476	14.567	14.425

218	5	6	7	8
ACTIVE	14.600	14.200	14.600	15.000
PASSIVE	14.600	14.800	14.600	14.800

219	5	6	7	8
ACTIVE	14.433	15.000	15.000	14.875
PASSIVE	14.567	14.875	15.000	14.750

220	5	6	7	8
ACTIVE	13.800	13.850	12.967	12.938
PASSIVE	13.801	14.444	13.734	14.150

221	5	6	7	8
ACTIVE	14.100	14.600	14.600	14.300
PASSIVE	13.567	14.250	14.800	14.200

Table A39 (continued)

222	5	6	7	8
ACTIVE	14.600	13.700	14.600	14.333
PASSIVE	14.667	13.813	14.600	14.900

223	5	6	7	8
ACTIVE	13.267	14.125	13.201	14.300
PASSIVE	14.567	13.775	13.600	13.775

224	5	6	7	8
ACTIVE	14.667	14.667	15.000	14.500
PASSIVE	13.900	13.775	14.467	14.600

225	5	6	7	8
ACTIVE	14.667	14.150	14.222	14.325
PASSIVE	13.667	13.500	14.433	14.675

Table A40: CRTT-A/P Efficiency Scores for Individual Young Participants

101	5	6	7	8
ACTIVE	12.491	12.558	13.433	12.726
PASSIVE	12.195	12.878	13.698	12.692

102	5	6	7	8
ACTIVE	10.984	11.369	10.935	11.726
PASSIVE	10.244	11.003	11.430	12.723

103	5	6	7	8
ACTIVE	11.849	12.619	11.323	12.475
PASSIVE	13.301	12.44	12.202	13.295

104	5	6	7	8
ACTIVE	12.754	12.498	13.079	13.192
PASSIVE	12.983	13.075	12.534	13.649

105	5	6	7	8
ACTIVE	13.559	13.438	13.140	13.264
PASSIVE	13.749	13.512	13.441	13.068

Table A40 (continued)

106	5	6	7	8
ACTIVE	11.394	12.223	11.915	10.944
PASSIVE	11.519	11.236	11.095	11.553

107	5	6	7	8
ACTIVE	13.650	12.463	12.807	12.642
PASSIVE	13.816	12.059	13.050	12.724

108	5	6	7	8
ACTIVE	12.370	11.180	12.748	12.059
PASSIVE	11.414	10.398	12.196	12.672

109	5	6	7	8
ACTIVE	12.690	12.538	12.768	12.397
PASSIVE	13.018	11.844	12.897	12.286

110	5	6	7	8
ACTIVE	12.933	13.286	13.194	13.302
PASSIVE	12.409	13.163	13.852	12.773

111	5	6	7	8
ACTIVE	13.203	12.436	13.372	13.491
PASSIVE	13.743	13.334	13.78	13.399

112	5	6	7	8
ACTIVE	12.402	11.958	11.711	12.002
PASSIVE	11.522	12.729	13.154	12.198

113	5	6	7	8
ACTIVE	12.551	12.465	12.389	12.220
PASSIVE	12.531	12.914	12.139	11.598

114	5	6	7	8
ACTIVE	12.310	12.890	13.505	13.512
PASSIVE	12.605	13.111	12.596	13.437

115	5	6	7	8
ACTIVE	13.273	12.986	12.879	12.912
PASSIVE	12.777	13.12	13.191	13.201

Table A40 (continued)

116	5	6	7	8
ACTIVE	13.289	13.167	12.935	13.221
PASSIVE	13.291	13.438	13.007	12.871

117	5	6	7	8
ACTIVE	12.056	10.993	11.547	11.774
PASSIVE	12.373	10.348	12.178	12.003

118	5	6	7	8
ACTIVE	11.653	12.322	12.804	12.260
PASSIVE	11.733	11.634	11.897	12.491

119	5	6	7	8
ACTIVE	12.872	13.067	13.378	12.908
PASSIVE	13.051	12.679	12.992	13.231

120	5	6	7	8
ACTIVE	13.288	12.760	13.071	13.272
PASSIVE	13.244	13.236	13.028	12.820

121	5	6	7	8
ACTIVE	11.760	11.538	11.481	12.049
PASSIVE	12.214	13.012	12.347	13.481

122	5	6	7	8
ACTIVE	13.222	13.622	13.617	13.795
PASSIVE	13.968	13.711	13.734	13.860

123	5	6	7	8
ACTIVE	11.158	11.776	12.454	11.897
PASSIVE	11.180	12.545	12.321	12.153

124	5	6	7	8
ACTIVE	12.419	12.056	12.996	12.177
PASSIVE	12.242	12.685	12.744	12.538

125	5	6	7	8
ACTIVE	13.578	12.448	12.239	13.021
PASSIVE	12.798	13.348	13.193	13.077

Table A41: CRTT-A/P Efficiency Scores for Individual Older Participants

201	5	6	7	8
ACTIVE	13.206	13.095	13.551	13.281
PASSIVE	13.313	13.053	13.129	13.114

202	5	6	7	8
ACTIVE	12.321	11.917	12.374	12.010
PASSIVE	12.226	12.214	12.466	11.701

203	5	6	7	8
ACTIVE	11.654	11.580	12.238	11.869
PASSIVE	12.504	10.816	12.952	12.872

204	5	6	7	8
ACTIVE	12.733	11.552	12.766	12.255
PASSIVE	12.764	12.283	12.574	12.531

205	5	6	7	8
ACTIVE	13.720	13.092	13.664	13.109
PASSIVE	13.224	13.182	13.808	13.212

206	5	6	7	8
ACTIVE	12.278	12.272	13.669	12.797
PASSIVE	12.643	12.937	13.711	12.909

207	5	6	7	8
ACTIVE	11.727	12.109	12.626	12.253
PASSIVE	11.106	11.151	12.154	13.025

208	5	6	7	8
ACTIVE	12.578	12.895	13.449	13.136
PASSIVE	13.294	12.296	12.914	13.033

209	5	6	7	8
ACTIVE	13.217	12.847	12.987	12.730
PASSIVE	12.431	12.633	13.093	13.288

210	5	6	7	8
ACTIVE	13.693	13.642	13.889	13.496
PASSIVE	13.838	13.557	13.701	13.745

Table A41 (continued)

211	5	6	7	8
ACTIVE	12.809	12.593	13.579	11.536
PASSIVE	12.606	13.019	11.912	12.933

212	5	6	7	8
ACTIVE	12.314	12.227	12.546	11.160
PASSIVE	11.189	11.395	11.330	11.286

213	5	6	7	8
ACTIVE	11.832	10.630	12.237	12.161
PASSIVE	10.623	10.238	12.278	11.917

214	5	6	7	8
ACTIVE	12.972	12.212	12.971	11.951
PASSIVE	12.721	12.750	12.530	12.732

215	5	6	7	8
ACTIVE	12.265	11.517	12.797	12.390
PASSIVE	12.705	11.900	12.728	12.925

216	5	6	7	8
ACTIVE	13.138	13.050	13.300	13.220
PASSIVE	13.208	13.409	12.736	13.076

217	5	6	7	8
ACTIVE	13.034	12.439	13.519	12.782
PASSIVE	13.318	13.091	13.538	12.887

218	5	6	7	8
ACTIVE	12.412	11.857	12.638	12.803
PASSIVE	12.584	12.714	12.561	12.717

219	5	6	7	8
ACTIVE	12.581	13.325	13.546	13.344
PASSIVE	12.842	13.046	13.606	13.319

220	5	6	7	8
ACTIVE	12.005	12.274	11.518	11.678
PASSIVE	12.277	12.596	11.717	12.206

Table A41 (continued)

221	5	6	7	8
ACTIVE	11.958	12.155	12.416	12.252
PASSIVE	11.262	11.571	12.824	11.620

222	5	6	7	8
ACTIVE	12.598	11.552	12.575	11.837
PASSIVE	12.676	11.913	12.609	12.621

223	5	6	7	8
ACTIVE	11.441	11.807	11.132	12.169
PASSIVE	12.664	11.432	11.628	11.772

224	5	6	7	8
ACTIVE	12.852	12.641	13.327	12.876
PASSIVE	11.979	11.655	12.882	12.767

225	5	6	7	8
ACTIVE	13.170	12.170	12.553	12.561
PASSIVE	11.922	11.510	12.677	13.098

Table A42: CRTT-A/P Response Times (msec.) for Individual Young Participants

101	5	6	7	8
ACTIVE	2878.375	2405.200	2039.400	2926.100
PASSIVE	2421.500	2690.700	1923.000	2660.400

102	5	6	7	8
ACTIVE	4269.200	4121.400	4365.300	3790.000
PASSIVE	5212.400	4157.300	3815.900	2958.200

103	5	6	7	8
ACTIVE	2662.300	2639.900	4054.700	2956.800
PASSIVE	2140.000	2680.100	2795.300	1581.200

104	5	6	7	8
ACTIVE	2478.000	2763.500	2196.200	2295.100
PASSIVE	2316.700	2691.100	2265.300	1869.100

Table A42 (continued)

105	5	6	7	8
ACTIVE	1903.500	2187.100	2394.300	2598.200
PASSIVE	2061.500	2016.100	2059.300	2395.800

106	5	6	7	8
ACTIVE	3214.000	2890.700	3860.000	4337.600
PASSIVE	3042.500	3068.600	3950.500	3475.200

107	5	6	7	8
ACTIVE	1534.400	2488.100	2767.200	2267.000
PASSIVE	1580.800	2214.300	2109.100	2240.200

108	5	6	7	8
ACTIVE	1677.300	2305.100	1804.000	1966.778
PASSIVE	1336.300	1775.000	1926.400	1610.111

109	5	6	7	8
ACTIVE	2985.200	3258.900	3117.200	3599.600
PASSIVE	2890.000	3545.200	2896.500	3568.300

110	5	6	7	8
ACTIVE	2652.000	2408.500	1812.000	2680.400
PASSIVE	2386.400	1669.100	1454.200	2884.400

111	5	6	7	8
ACTIVE	2191.800	2661.400	1941.100	2469.100
PASSIVE	1789.300	2205.700	1762.700	2147.700

112	5	6	7	8
ACTIVE	2670.400	3221.100	3739.400	4338.900
PASSIVE	3575.200	2778.900	3015.400	3727.000

113	5	6	7	8
ACTIVE	2960.200	2533.900	3027.000	3029.800
PASSIVE	2599.300	2559.100	3386.500	3161.200

114	5	6	7	8
ACTIVE	2611.000	2045.700	1819.700	1564.200
PASSIVE	2688.900	2040.900	2053.800	1704.900

Table A42 (continued)

115	5	6	7	8
ACTIVE	2372.800	2640.100	2800.900	2835.556
PASSIVE	2554.200	2579.400	2392.000	2615.333

116	5	6	7	8
ACTIVE	1844.100	1668.400	1862.200	2098.200
PASSIVE	2063.900	1664.400	1947.500	2146.889

117	5	6	7	8
ACTIVE	3181.300	4543.900	3566.700	3603.500
PASSIVE	2215.800	3819.400	2987.200	3091.500

118	5	6	7	8
ACTIVE	2436.667	2530.200	2188.300	3374.900
PASSIVE	2183.200	2462.500	2511.300	2410.500

119	5	6	7	8
ACTIVE	2370.900	2645.000	2009.000	2371.200
PASSIVE	2264.600	2018.000	2262.700	2244.700

120	5	6	7	8
ACTIVE	2441.600	2418.500	1951.300	2310.100
PASSIVE	2169.600	2374.300	2074.800	2471.200

121	5	6	7	8
ACTIVE	3343.200	2249.300	3610.800	3753.700
PASSIVE	2876.200	2371.000	2823.100	2333.700

122	5	6	7	8
ACTIVE	1957.600	1832.700	1748.700	1697.400
PASSIVE	1565.100	1786.800	1662.500	1682.100

123	5	6	7	8
ACTIVE	3156.500	3209.300	3091.400	2680.700
PASSIVE	3176.200	2665.200	3102.400	2595.300

124	5	6	7	8
ACTIVE	2792.400	2574.400	2731.500	3103.100
PASSIVE	3150.600	2582.300	2732.200	3157.700

Table A42 (continued)

125	5	6	7	8
ACTIVE	1933.400	2670.800	2362.300	2248.700
PASSIVE	2436.400	1998.600	1715.800	1715.000

Table A43: CRTT-A/P Response Times (msec.) for Individual Older Participants

201	5	6	7	8
ACTIVE	2058.000	2369.300	2291.000	2562.800
PASSIVE	2056.600	2141.800	2604.400	2271.500

202	5	6	7	8
ACTIVE	3638.778	3611.600	3424.400	3515.500
PASSIVE	3254.900	3226.800	3374.300	3429.400

203	5	6	7	8
ACTIVE	3575.556	3969.400	3060.700	3300.200
PASSIVE	2452.800	3616.800	2832.100	2950.200

204	5	6	7	8
ACTIVE	2984.778	4684.600	2658.600	3826.300
PASSIVE	3143.800	3485.800	2666.900	3696.800

205	5	6	7	8
ACTIVE	1618.100	2559.200	1760.300	2756.700
PASSIVE	1734.500	2483.200	1554.900	2284.000

206	5	6	7	8
ACTIVE	2961.100	3095.600	2164.600	3457.222
PASSIVE	3117.700	2988.700	2110.100	3019.100

207	5	6	7	8
ACTIVE	3441.000	3238.700	2567.100	3055.900
PASSIVE	2961.800	3603.000	2579.400	2567.100

208	5	6	7	8
ACTIVE	2467.800	2912.800	2416.700	2525.000
PASSIVE	2183.000	2841.900	2243.500	2449.400

Table A43 (continued)

209	5	6	7	8
ACTIVE	2131.200	2117.200	2198.600	2345.800
PASSIVE	1852.400	2344.600	2312.300	2209.600

210	5	6	7	8
ACTIVE	1613.200	1818.700	1410.300	2069.900
PASSIVE	1366.889	1613.200	1645.000	1529.400

211	5	6	7	8
ACTIVE	1953.400	2675.222	1910.700	2923.800
PASSIVE	2001.600	1823.667	2807.700	2219.600

212	5	6	7	8
ACTIVE	3103.100	3557.100	2793.800	3622.800
PASSIVE	3274.700	3748.900	2981.000	4760.000

213	5	6	7	8
ACTIVE	3055.300	3815.000	2479.500	3223.429
PASSIVE	2816.444	5045.900	2934.200	3092.833

214	5	6	7	8
ACTIVE	2776.800	3103.100	2768.100	3731.100
PASSIVE	2730.400	2990.100	2923.000	2799.800

215	5	6	7	8
ACTIVE	3260.300	4084.300	2685.600	3555.500
PASSIVE	2322.900	3712.400	2678.700	2779.900

216	5	6	7	8
ACTIVE	2442.500	2525.900	2136.100	2271.300
PASSIVE	2263.500	2122.800	2193.400	2332.100

217	5	6	7	8
ACTIVE	1910.600	2043.300	1755.000	2575.800
PASSIVE	1975.100	2037.000	1602.800	2369.300

218	5	6	7	8
ACTIVE	3400.700	4121.500	2995.400	3109.600
PASSIVE	3043.600	2963.000	3219.700	3051.900

Table A43 (continued)

219	5	6	7	8
ACTIVE	2119.900	2199.000	1792.200	1781.600
PASSIVE	2002.900	2378.800	1708.300	1814.900

220	5	6	7	8
ACTIVE	3077.400	2815.900	3540.200	2920.700
PASSIVE	2277.700	2352.778	2013.200	2334.900

221	5	6	7	8
ACTIVE	3228.300	3536.900	3577.700	3181.800
PASSIVE	3141.778	3977.556	3006.200	4768.000

222	5	6	7	8
ACTIVE	3284.556	3617.600	3443.700	4129.222
PASSIVE	2807.500	3100.600	3265.800	3505.200

223	5	6	7	8
ACTIVE	2426.600	3544.500	3096.800	3216.700
PASSIVE	2432.900	3095.600	2855.100	3095.000

224	5	6	7	8
ACTIVE	3051.500	3176.111	2658.200	2849.000
PASSIVE	3318.300	3718.800	2542.000	3058.100

225	5	6	7	8
ACTIVE	2442.100	3386.400	2956.667	3027.300
PASSIVE	2762.900	3175.222	2750.900	2312.300

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