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AGE, ATTENTION, AND OTS IN A CONSTRAINED VS UNCONSTRAINED TASK

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THESIS

A thesis submitted in partial fulfillment of the
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By

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ABSTRACT OF THESIS

AGE, ATTENTION, AND OTS
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The discourse of older healthy adults is commonly described as lengthy and off-topic and thought to be associated with a general cognitive decline that occurs in healthy aging. This study investigated the overall decline in attention associated with healthy aging and its relationship to instances of off-topic speech (OTS) in a constrained and unconstrained language production task. Ninety cognitively healthy adults participated and comprised three age cohorts (40 – 75+). Participants completed cognitive measures of attention and two discourse tasks that included recounting personal events and describing a procedure. Older adults exhibited poorer scores on measures of selective and shifting attention, and elderly adults produced more OTS as compared to middle-aged (40s) and older (60s) adults in the unconstrained task only. Poorer scores of shifting attention were significantly correlated with more OTS in the older adults (60s) only. Overall, a marked increase in variability of language production was observed with advancing age. Results indicated the need for further research on the relationships between age, attention, OTS, and task type in healthy aging to determine an underlying cause for increasing variability of language production with age.

KEYWORDS: healthy aging, selective attention, shifting attention, off-topic speech, language production

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Chapter One: Introduction

Background

The discourse of older healthy adults is commonly described as lengthy and off-topic. Off-topic speech (OTS) or off-topic verbosity (Arbuckle & Gold, 1993) is operationally defined as speech that begins as relevant to a topic, but subsequently becomes more loosely related or entirely unrelated. The influence of age on the incidence of OTS has been studied across the life-span and results have consistently shown that the incidence of OTS significantly increases with age (Arbuckle & Gold, 1993; Arbuckle, Nohara-LeClair, & Pushkar, 2000; Beaudreau, Storandt, & Strube, 2006; Cooper, 1990; Glosser & Deser, 1992; Gold, Andres, Arbuckle, & Zieren, 1993; James, Burke, Austin, & Hulme, 1998; Juncos-Rabadan, Pereiro, & Rodriguez, 2005; Pushkar et al. 2000; Trunk & Abrams, 2009).

Changes in both inhibition and speed of processing during healthy aging are believed to influence the incidence of off-topic speech (OTS) observed in language samples of healthy older adults (Arbuckle & Gold, 1993; Arbuckle et al. 2000). The Inhibition-Deficit Hypothesis (Hasher & Zacks, 1988) posits that as we age it becomes increasingly difficult to ignore irrelevant stimuli and so the incidence of OTS increases. Hasher, Lustig, & Zacks (2007) reviewed their work on inhibition and healthy aging by proposing that inhibition consists of three individual processes: access, deletion, and restraint. In the case of language production, OTS would have to first be accessed, then the processes of deletion and restraint must fail for the off-topic utterance to be spoken. Furthermore, the ability to inhibit irrelevant information during a language production

task is thought to be mediated by *selective attention* (Drag & Bieliauskas, 2010), as well as *shifting attention* (Wager, Jonides, & Reading, 2004). Selective attention is defined as the "differential processing of simultaneous sources of information" (Johnston & Dark, 1986, p. 44). Wager, et al., defined shifting attention as a paradigm requiring participants to "resolve interference" from competing stimuli, such as irrelevant thoughts that may be manifested as OTS (p. 1687).

Age-related changes in inhibition have frequently been measured using the Stroop effect (Burke, 1997; Hartman & Hasher, 1991; Kwong & Ryan, 1995; McDowd, 1997; Persad, Abeles, Zacks, & Denburg, 2002). The Stroop effect refers to the interference experienced during a Stroop task, such as naming the color of ink in which a color word is printed, rather than the reading the printed word (e.g. the word "red" printed in blue ink) (MacLeod, 1991). There are many variations of the stroop task, and the most commonly used task is the Stroop Color and Word Test (STROOP; Golden, 2002). Smith and Jonides (1999), found that the same neural area (premotor cortex) is activated by visuospatial selective attention and task management. This means that by administering a visuospatial selective attention task such as the Stroop color-word test, one can cautiously draw conclusions about verbal rehearsal and task management for speech production (Hasher, Lustig, & Zacks, 2007).

Inhibition is also mediated by shifting attention (Wager, Jonides, & Reading, 2004). Wager and colleagues investigated neuroimaging and attention and found that, as with selective attention, the same areas of the brain are activated by both spatial and nonspatial shifting attention. Smith and Jonides, (1999) also concluded that neural activation for verbal storage and rehearsal is directly correlated to spatial tasks (Broca's

area and supplementary premotor areas for inner speech). One such spatial task that assesses shifting attention is the Comprehensive Trail-Making Test (CTMT; Reynolds, 2002). The CTMT requires participants to draw connected lines from alternating circled letters and numbers in order by shifting their attention between the two in the presence of distracter circles. The CTMT has not been previously used in the literature as a predictor of OTS, but it is appropriate given that preliminary research suggests that both selective and shifting attention may be involved in the mechanism of inhibition during speech production (Mar, 2004; Wager, Jonides, & Reading, 2004). The Stroop and CTMT tasks tax the attentional control system by providing opportunities for access, deletion, and restraint to either succeed or fail.

The relationship between age and OTS has been investigated in the context of a number of narrative tasks including structured interviews (Arbuckle & Gold, 1993; Glosser & Deser, 1992; Gold et al. 1993; Gold & Arbuckle, 1995; Pushkar, et al., 2000), conversations (Pushkar, et al., 2000), picture descriptions (James, et al. 1998; Juncos-Rabadan et al. 2005), personal narratives (Beaudreau, et al. 2006; James, et al.; Trunk & Abrams, 2009, Wills, Capilouto, & Wright, 2011), and procedural narratives (Trunk & Abrams, 2009). The type of task used for discourse elicitation has been shown to impact the incidence of OTS (James et al Year?.). Specifically, constrained tasks (e.g. picture descriptions) have been shown to be associated with less OTS (See Mortensen, Meyers, and Humphreys, 2006 for review) as compared to unconstrained tasks (e.g. personal narratives). One suggested reason for this phenomenon is that the presence and amount of OTS in elderly discourse is influenced by the increased cognitive requirements and degree of constraint the task places on speech production (Lavie, Hirst, Fockert, &

Viding, 2004; Arbuckle, et al., 2004). Lavie and colleagues (2004) proposed the Load Theory of Selective Attention, which suggests that as the cognitive load of a task increases, control over selective attention decreases. Consequently, researchers hypothesize that constrained tasks provide a scaffold for language production not available in unconstrained tasks. Without such a scaffold, unconstrained tasks place greater cognitive demands on the speaker and increase the likelihood of interference and inability to inhibit unwanted thoughts and ideas (Arbuckle, et al., 2004; James, et al. 1998).

In summary, this research shows that a general decline in attention with age, and an increase in OTS with age. Studies have also shown that OTS is dependent upon task type. However, we do not yet know how attention influences OTS across tasks, or when in the lifespan significant changes in attention and OTS emerge.

Therefore, the purpose of the current study is to investigate the influences of attention and age on the incidence of OTS in healthy adults from middle age to elderly, in the context of a constrained (e.g. procedural description) task and unconstrained (e.g. recount) task.

Research Questions and Hypotheses

The current study addresses several research questions.

1. How does age influence the incidence of OTS in language samples elicited from a constrained (e.g. procedural description) versus unconstrained (e.g. recount) task? It is hypothesized that the incidence of OTS will be significantly greatest for the eldest cohort (75+), as compared to other cohorts, regardless of task.

2. Is selective attention related to the incidence of OTS in healthy adults when examined in the context of a constrained and unconstrained language production task? Does age influence this relationship?

   It is hypothesized that poorer scores on a measure of selective attention will significantly correlate with higher instances of OTS in an unconstrained task only, regardless of age.

3. Is shifting attention related to the incidence of OTS in healthy adults when examined in the context of a constrained and unconstrained language production task? Does age influence this relationship?

   It is hypothesized that poorer scores on a measure of shifting attention will significantly correlate with higher instances of OTS for the unconstrained task only, regardless of age. Furthermore, it is hypothesized that with advancing age there will be an increase in OTS and a simultaneous decline on measures of attention.

Chapter Two: Review of Literature

To answer the questions of interest, a review of studies was conducted to examine previous research related to the relationships between age, attention, OTS, and task type, as well as existing evidence for the Inhibition-Deficit Hypothesis (Hasher & Zacks, 1988). These topics are discussed as they directly relate to the current study.

Age and Attention

Hartman and Hasher (1991) investigated an age-related decline of inhibitory mechanisms, specifically suppression, by having healthy adults read aloud sentences with predictable and unpredictable endings. The study included 44 younger adults (ages 17 to 28) and 24 older adults (ages 60 to 76). Participants were given sentences with both highly predictable endings, and an alternate target ending that was much less predictable or appropriate but still formed a meaningful sentence. They were told to read each sentence to themselves and try to remember the last word in each sentence. Participants were also given the Stroop test as part of a neuropsychological battery. Results indicated that older adults recalled both the predictable and unpredictable ending words equivalently, whereas the younger adults recalled significantly more predictable ending words. This supports the notion that inhibitory control declines with age, as older adults were not able to suppress, or delete the unpredictable ending words from their working memory. Moreover, older adults showed significantly poorer scores on the Stroop color-word test as compared to younger adults, and poorer scores on this subtest significantly correlated with greater recall of unpredictable, less appropriate ending words. These results indicate that selective attention is greatly involved in inhibition during a verbal performance task.

Carlson, Hasher, Connelly, and Zacks (1995) conducted a similar study that examined the influence of distracting text on reading comprehension in younger and older healthy adults. Participants were divided into two groups: 32 younger adults (ages 17 to 22) and 32 older adults (ages 62 to 75). Participants each read 12 consecutive stories, 6 without distracting text, and 6 with distracting text placed at random within the passages. Participants read the passages aloud then answered multiple-choice comprehension questions. Older adults read significantly slower than younger adults, and comprehension accuracy was significantly poorer for older adults as compared to younger adults. These results also support the Inhibition-Deficit Hypothesis (Hasher & Zacks, 1988), as older adults reading comprehension was negatively affected by decreased ability to inhibit distracting text within the passages.

Age and OTS

Glosser and Deser (1992) contributed to early research on aging and OTS by examining microlinguistic and macrolinguistic changes in healthy aging in a recount/interview task. Participants included 14 healthy middle-aged adults (ages 43 to 61) and 13 healthy elderly adults (ages 67 to 88). The macrolinguistic variable of interest was global coherence (similar to OTS), which the researchers operationally defined as "the relationship of the meaning or content of a verbalization with respect to the general topic of conversation" (pp. P268). Global coherence was measured on a scale from 1 to 5, where 5 was the most coherent and 1 was the least coherent. Language samples were segmented into C-unit verbalizations, which is one independent clause. From there, each verbalization was given a coherence rating from 1 to 5. Reliability for the global coherence scale was not reported. However, results indicated that elderly adults were

given significantly lower ratings of global coherence as compared to middle-aged adults. This was a rare study that suggests increased OTS emerges between the middle-age and elderly years.

Age, Attention and OTS

Arbuckle and Gold (1993) investigated the role of inhibition on the incidence of OTS in older, healthy adults using a life-history interview task. The study included 196 adults aged 61 to 90. The trail-making test from the Halstead-Reitan Battery (Reitan & Davison, 1974) was used to measure shifting attention, and the Wisconsin Card-Sorting Test (WCST; Milner, 1964) and Controlled Word Association Test (Benton & Hamsher, 1976), a measure of fluency, served as measures of inhibition; both tests were combined to form an inhibition factor score. A life history interview was employed and OTS was measured using a 9-point continuum. The scale estimated both item verbosity (i.e. number of answers to questions where the participant spoke off-topic) and extent verbosity (i.e. the degree to which the answer was off-topic). Inter-rater reliability for coding item verbosity and extent verbosity was reported to be 82% and 87% respectively. Correlation matrices and regression analyses revealed a statistically significant main effect for the impact of age on attention and OTS. The older group (ages 73-90) performed more poorly on both attention measures and had significantly poorer scores on the OTS measures compared to the younger group (ages 61-72). Interestingly, age was a better predictor of item verbosity as compared to extent verbosity. In addition, the most statistically significant predictor of both item and extent verbosity in the life-history interviews was the participants' scores on measures of inhibition. Results support the Inhibition-Deficit Hypothesis, and the authors concluded that the age-related increase in

OTS observed was the result of widespread cognitive decline rather than declines in language processing areas of the brain.

Gold & Arbuckle (1995) followed up their 1993 study by bringing back 175 of the original 205 participants and replicating the original procedures. The researchers investigated whether participants' OTS levels remained consistent approximately 15 months after the original study. Researchers again used a life-history interview. Participants ranged in age from 61 to 93 and were again given the trail-making test from the Halstead-Reitan Battery (Reitan & Davison, 1974) as a measure of shifting attention, and the Controlled Word Association Test (Benton & Hamsher, 1976) as a measure of inhibition. Participants' previous scores on the Wisconsin Card-Sorting Test (Milner, 1964) were used due to time constraints and combined with the trail-making test to form an inhibition factor score. Raters again scored each answer to an interview about how each participant's life has changed since the previous study for OTS for item and extant verbosity on the same 9-point continuum used in the original study. Inter-rater reliability for coding item verbosity and extent verbosity was reported to be 85% and 86% respectively. Results indicated that OTS scores remained stable across the 15 month period. However, in contrast with the original study, age was not a significant predictor of OTS during follow-up. Inhibition was again the most significant predictor of both item and extant verbosity.

Wills, Capilouto, and Wright (2011) conducted a pilot study investigating age, attention, and OTS in the context of an unconstrained (recount) task. Participants included 30 healthy adults from middle age to elderly across five age cohorts (40s, 50s, 60s, 70s, and 80s). Participants were administered two cognitive measures of attention:

the Comprehensive Trail Making Test (CTMT; Reynolds, 2002), which measures shifting attention and Stroop Color and Word Test (STROOP; Golden & Freshwater, 2002), which measures selective attention. Language samples were collected in the context of a recount task, "tell me about your last vacation," and OTS was analyzed using a three point scale developed by the authors, and inter-rater reliability was reported to be 93.7%. The two measures of attention were combined to form one standardized attention score, and then this attention score was analyzed for relationships with age and OTS across three age cohorts. Results indicated no significant relationship between attention and OTS, regardless of cohort. However, further analyses revealed a significant decline on the combined measures of attention with age, and this decline became apparent around age 60. Additional analyses evaluated the measures of attention separately, and revealed a more marked decline on the measure of selective attention, beginning around 60 years of age. Results confirmed the findings of previous research that attention declines with age, and thus indicated the need for further research on relationships between age, attention, and OTS.

Age, OTS and Task Type

James and colleagues (1998) investigated OTS and task type in two groups of healthy adults. Twenty young adults (M= 19.4 years, SD= 1.2) and twenty older adults (M=73.1 years, SD=4.2) were asked to recount three personal narratives and describe three pictures. The number of words scored as off-topic served as the measure of OTS. Each instance of OTS was deemed either "indirectly relevant" or "irrelevant," and inter-rater reliability was reported to be 89%. Results indicated that the incidence of OTS was significantly greater for the older group as compared to the younger group for the

personal narratives but not the picture descriptions. James et al. hypothesized that personal narratives allowed for more autobiographical information to invade the participants' thought processes. They further hypothesized that once irrelevant information was accessed it was not inhibited and manifested as OTS. The authors concluded that age-related differences in producing OTS are conditional. As such, these differences depend on the nature of the task, as well as the degree to which the task constrains language production.

Trunk and Abrams (2009) examined OTS in healthy, younger and older adults in the context of two autobiographical narratives: an episodic narrative (describe one specific memory) and a procedural narrative (describe an individual's daily routine). Twenty-four younger adults (age 18-21) and 24 older adults (age 75-87) participated in the study. OTS was measured as a single rating per narrative, and reliability for scoring OTS was not reported. Older adults exhibited significantly more OTS when computed as a percentage of total words spoken as compared to the younger group, but for procedural narratives only. Although no measure of attention was included in this study, the authors concluded that their results did not support the inhibition-deficit hypothesis due to lack of statistically significant differences in incidence of OTS between constrained and unconstrained tasks. However, these conclusions should be interpreted cautiously due to the fact that the "constrained" task in this study was not truly constrained because it was a procedural *narrative* (a re-telling of a person's individual routine, such as "describe how you get ready every morning") rather than a procedural *description* (e.g. "tell me how to make a peanut butter and jelly sandwich").

Collectively, these studies provide differing support for an overall increase in OTS with age, and general decline in attention with age based on the Inhibition-Deficit Hypothesis (Hasher & Zacks, 1988). These studies also provide some support for the Load Theory of Selective Attention (Lavie, et al., 2004) by showing that OTS is more likely to surface in the context of an unconstrained language production task as compared to a constrained language production task. However, findings regarding the specific influences of age and attention on the incidence of OTS remain unclear. Although changes in attention are frequently cited as a possible explanation for increased OTS with age, studies have inconsistently included a measure of attention and/or inhibition. In order to draw conclusions regarding the influence of attention on the incidence of OTS in healthy aging, it is necessary for studies to compare performance on measures of attention with OTS during language production. The following chapter outlines methods for the current study.

Chapter Three: Methods

Participants

Data for this study was part of a larger study investigating discourse processing in healthy aging. *An a priori* power analysis indicated that 90 participants were needed to have 72% power to detect a medium effect-size for 3 normally distributed covariates with a p =.05 criterion of statistical significance. Therefore ninety participants were recruited across three age cohorts: 40 year olds (MG), 60 year olds (OG) and 75+ (EG). There were thirty participants per cohort with equal number of males and females. Demographic variables of interest are summarized in Table 2.1.

The protocol for the larger study required that all participants met the following inclusion criteria: (1) hearing within functional limits as measured by the CID List of Everyday Speech (Davis & Silverman, 1970); (2) Native English speakers as documented by self report; (3) negative history for cognitively deteriorating conditions such as Alzheimer's or Parkinson's per self report as well as measured by a scaled score of 29 or above on the *Mini-Mental Status Examination* (Folstein & Folstein, 2002); (4) aided or unaided visual acuity within normal limits, as indicated by passing a vision screening (Beukelman & Mirenda, 1998); (5) no depression at the time of the experiment as measured by a score of 0-4 on the Geriatric Depression Scale-Short Version (Yesavage, 1988); and (6) no previous neurological condition (i.e., stroke, head injury) per self report.

Experimental Procedures

Participants were tested individually in a quiet, well-lit setting. Testing took place across two sessions (referred to as cognitive and discourse sessions), each lasting

between one and two hours. During the initial session, participants gave consent and completed screening measures to determine their eligibility to participate. Demographic data and medical history were also obtained during this session. Participants who met the study's inclusion criteria then completed either the discourse session or the cognitive session. For the discourse session, participants completed eleven tasks; only the results of one recount and one procedural description are reported here. The order of sessions and tasks was randomized and counterbalanced across participants, and language samples were audio or video recorded for future transcription.

Cognitive Measures

The following measures of attention were administered to participants during the cognitive session: Comprehensive Trail Making Test (CTMT; Reynolds, 2002), and Stroop Color and Word Test (STROOP; Golden & Freshwater, 2002). For the CTMT, only time, in seconds, that was required to complete Trail 5 are reported and subjected to statistical analyses. Trail 5 is considered the most difficult trail, and requires the participant to connect alternating letters and numbers in order in the presence of empty distracters. For the Stroop, only scores from the third and most difficult task, the Color-Word portion, were subjected to statistical analyses. In this test, the participant labels colors that are printed in non-corresponding ink (e.g., the word RED printed in blue ink), while ignoring the printed word. This task is scored by number of colors labeled correctly in 45 seconds.

Discourse Tasks

For this study, two discourse tasks were analyzed: one constrained task (procedural description) and one unconstrained task (recount). Procedural descriptions

have rarely been utilized in the research of adult discourse production, and are defined as expository tasks that describe how to do something in a logical time sequence (Mar, 2004; Ulatowski, 1981). As previously mentioned, this type of task is considered to place more constraints on speech as compared to autobiographical tasks because it is a non-narrative task, and the structured order of the description is less likely to prompt irrelevant speech based on experience (Ulatowski, 1981). Recount tasks are personal, episodic narratives that require the participant to recall and retell a past experience (Trautman, Healey, & Norris, 2001).

Participants were given an example prior to the collection of each language sample. For the recount task "vacation," the examiner read the following script:

"I am going to tell you about a recent experience. Let me tell you about my Spring Break. My family and I took a trip to Daytona Beach, Florida. There were five of us. We drove and it took us 20 hours to get there. We spent the days lying on the beach getting a sun burn and at night we went out for dinner and then played Putt-Putt. We had a great time!" Demonstration of the task was followed by a prompt, "Now it is your turn. Tell me what you did on your last vacation."

For the procedural task "peanut butter and jelly," the examiner read the following script:

"I am going to tell you how to make a pot of coffee. First you fill the coffee pot with water and pour that in the coffee machine. Then I put the filter in the machine and add the coffee grounds—about 7 scoops. Then I put the coffee pot underneath the filter, and turn on the machine and wait."

If the participant stopped before 15 seconds the examiner encouraged them to continue by saying, "Is there anything else you can tell me?" Trained graduate research assistants in communication sciences and disorders obtained the language samples and were required to follow the same script to account for using different examiners across participants.

Language Transcription and Reliability

All language samples were orthographically transcribed from the audio or video recordings and segmented into C-units, or independent clauses according to rules described by Loban (1976). Total number of words for each task was also calculated using rules outlined by Nicholas and Brookshire (1993): Unintelligible words, made-up words, partial words, nonword fillers (e.g. um, er, uh), and commentary that started or ended the sample (e.g. here I go; that's all) were not counted as words. All remaining words were subjected to the following rules: whole words and acronyms were counted as one word, contractions such as "don't" and "can't" were counted as two words, and shortened versions of two words such as "shoulda" and "kinda" were counted as the two words representing, "should have" and "kind of."

Ten percent of the samples were randomly selected for a second transcription to determine intra-rater and inter-rater reliability for word-by-word agreement. Reliability was subjected to the following formula: (total agreements / [total agreements + total disagreements] X 100)Intra-rater and inter-rater agreement were both above 90 percent. Ten percent of the samples were also randomly selected for a second rating for OTS by trained graduate research assistants. Agreements and disagreements were calculated using the above method. Point-to-point intra- and inter-rater agreement for rating OTS was 97.7% and 89.4%, respectively.

Language Analysis

OTS has typically been scored holistically, which provides one single rating per transcript (Trunk & Abrams, 2009), or by determining total number of off-topic words in a transcript (Arbuckle & Gold, 1993; Beaudreau, et al., 2006; James, et al. 1998). When

reported, reliability for rating OTS in these studies, ranged from 78% to 98% (Arbuckle & Gold, 1993; Beaudreau, et al. 2006; Glosser & Deser, 1992; Gold & Arbuckle, 1995). Consequently, the present study took a different approach and used an OTS rating scale developed by Wills, Capilouto, and Wright (2011). This OTS scoring system combined aspects from previously reviewed studies (Arbuckle & Gold, 1993; James et al. 1998) and was closely fashioned after Glosser and Deser's (1992) global coherence rating scale. OTS was defined as the relationship of the content of each utterance to the overall conversational topic, similar to Glosser and Deser's (1992) definition of global coherence. Moreover, for this study, OTS was any utterance that veered from the initial topic, either the recount task "vacation" or the procedural description "peanut butter and jelly." Each C-unit received a score of 1, 2, or 3, where a score of 1 meant the utterance was completely irrelevant to the topic, a score of 2 meant the utterance was slightly off-topic, and a score of 3 meant the utterance was focused and relevant to the topic. The OTS rating scale is presented in Appendix A. Mar (2004) stated that personal narratives may manifest in expository tasks such as procedural descriptions in the forms of personal experiences or opinions. For the purposes of this study, anecdotal narratives within the procedural description were considered off-topic because each participant was provided with an example expository procedural description free from personal narratives. An OTS mean score was obtained for each participant by adding the scores for each task and dividing that total by the number of utterances, or C-Units, in each task. An example transcript rated for OTS is provided in Appendix B.

Statistical Analyses

The relationships among age, attention, OTS, and task type (constrained and unconstrained) were analyzed using Pearson's product-moment correlations, one-way analyses of variance (ANOVAS), and paired t-tests using PASW Statistics 18 (SPSS Inc., 2001). A significance level of alpha = .05 was used for all analyses.

Chapter Four: Results

Preliminary Analyses

Preliminary analyses were conducted to ensure demographic characteristics were not contributing factors to study results. Demographic variables of interest are summarized in table 2.1. Mean age was mid-range for all cohorts: 44.8 (MG), 66.1 (OG), and 80.2 (EG). Mean education level was 14.7 years for the MG, 15.9 years for the OG, and 14.6 years for the EG. One-way ANOVAs indicated no significant differences between cohorts with respect to years of education, $F(2, 87) = 2.24$, $p = .112$, therefore years of education was not considered in subsequent analyses.

Given that some previous studies measured OTS as a total number of words spoken off-topic, it was deemed necessary to investigate whether total number of words spoken influenced the amount of OTS. A one-way ANOVA indicated a significant difference between cohorts for total number of words spoken in the constrained task (procedural description) only, $F(2, 87) = 3.49$, $p = .035$. Post-hoc comparisons indicated a significant difference between the OG and EG, where the OG spoke more words than the EG for the constrained task. However, no subsequent statistical analyses for relationships between age, attention, and OTS were found to be significant within the constrained task, therefore total number of words spoken was not considered in further analyses. Mean OTS score (with standard deviations in parentheses) for the constrained task was generally consistent across age groups: 2.92 (0.2), 2.88 (0.28), and 2.89 (0.2) for the MG, OG, and EG respectively. However, a linear decline in mean OTS score for the unconstrained task was observed with advancing age: 2.88 (0.24), 2.76 (0.28), and 2.69 (0.36) for the MG, OG, and EG respectively; see Figure 7. Visual examination of

histograms for each variable of interest by cohort revealed no violations of normality assumptions. Upon completion of preliminary analyses, statistical analyses were conducted to answer the study's questions of interest.

Research Question 1a: Does age influence the incidence of OTS in language samples elicited from a constrained (e.g. procedural description) task?

To address the first research question, a one-way (ANOVA) was conducted to examine the differences in mean OTS and task type between all three cohorts (MG, OG, and EG). The between group factor was cohort, and the within group factor was OTS in the constrained task. Results indicated no significant differences in mean OTS for the constrained task between groups, $F(2, 87) = .353$, $p = .703$ (see Figure 1). Bonferroni adjustment was employed because multiple comparisons were made. Pearson correlation coefficients were also computed to examine the relationship between OTS in the constrained task and age across all cohorts. No significant relationships were indicated (see Figure 2).

Research Question 1b: Does age influence the incidence of OTS in language samples elicited from an unconstrained (e.g. recount) task?

One-way ANOVA was conducted to examine differences in mean OTS, where the between group factor was cohort, and the within group factor was OTS in the unconstrained task. Results indicated no significant differences between cohorts, $F(2, 87) = 2.76$, $p = .069$ (see Figure 1). Given the lack of group differences, Pearson correlation coefficients were computed to examine the relationship between age and OTS in the unconstrained task across all cohorts. As expected, age and OTS in the unconstrained task were found to be significantly correlated, $r = -.262$, $p = .013$. Additionally, visual

inspection of scatter plots confirmed the trend that lower mean OTS scores (more OTS) were observed with advancing age in the unconstrained task only, with markedly increased variability in the EG (see Figure 3).

OTS in Constrained vs. Unconstrained Task

Given that no significant differences were found between age groups for OTS for each task type, a paired t-test was conducted to analyze the difference between mean OTS in the constrained and unconstrained tasks regardless of age. Results indicated an overall difference in mean OTS for the two task types (constrained and unconstrained) $t(89) = -3.69$, $p = .000$ (two-tailed) where more OTS was observed in the unconstrained task as compared to the constrained task (see Figure 4).

Research Question 2a: Is selective attention related to the incidence of OTS in healthy adults when examined in the context of a constrained language production task? Does age influence this relationship?

To address the second research question, a Pearson correlation coefficient was computed for selective attention and OTS in the constrained task and was not significant, $r = .067$, $p = .532$. To determine if age influenced the relationship between selective attention and OTS in a constrained task regardless of cohort, Pearson correlation coefficients were computed within each cohort. No significant differences were observed, $r = .028$, $p = .884$ (MG); $r = .184$, $p = .330$ (OG); $r = -.037$, $p = .847$ (EG).

Research Question 2b: Is selective attention related to the incidence of OTS in healthy adults when examined in the context of an unconstrained language production task? Does age influence this relationship?

A Pearson correlation coefficient was computed for selective attention and OTS in the unconstrained task and was statistically significant across all groups, $r = .282$, $p = .007$ suggesting that poorer scores on a measure of selective attention correlate with higher instances of OTS in an unconstrained task (see Figure 5). However, when examined by cohort (MG, OG, and EG), correlations of selective attention and OTS in the unconstrained task were not significant, $r = .147$, $p = .440$ (MG); $r = .133$, $p = .483$ (OG); $r = .290$, $p = .120$ (EG). These results suggest that age does NOT influence the relationship between selective attention and OTS in an unconstrained task.

A one-way ANOVA was conducted to compare performance on the measure of selective attention by cohort, where the between group factor was cohort and the within group factor was Stroop score. Results indicated a significant difference in selective attention between cohorts, $F(2, 87)= 11.97$, $p = .000$, and post-hoc comparisons revealed significant differences between all three cohorts (MG from OG $p = .006$; MG from EG $p = .000$; OG from EG $p = .045$) where scores on the Stroop CW test were consistently poorer with advancing age. Mean selective attention scores, as measured by number of color-words labeled correctly in 45 seconds, declined with age: 43.3 (MG), 35.6 (OG), and 30.1 (EG) (see Figures 6 and 7).

Research Question 3a: Is shifting attention related to the incidence of OTS in healthy adults when examined in the context of a constrained language production task? Does age influence this relationship?

Pearson correlation coefficients were computed to investigate the relationship between shifting attention and OTS in the constrained task. The relationship was not significant, $r = .037$, $p = .726$. To determine if age influences this relationship, Pearson correlation coefficients were computed within each cohort, and no significant relationships were found, $r = -.085$, $p = .657$ (MG); $r = .121$, $p = .525$ (OG); $r = .135$, $p = .477$ (EG).

Research Question 3b: Is shifting attention related to the incidence of OTS in healthy adults when examined in the context of an unconstrained language production task? Does age influence this relationship?

Additional Pearson correlation coefficients were computed to examine the relationship between shifting attention and OTS in an unconstrained task, and were significantly related regardless of age, $r = -.309$, $p = .003$ where poorer scores of shifting attention correlated with more instances of OTS (see Figure 8). When examined by cohort, only the OG exhibited a significant relationship between shifting attention and OTS and the unconstrained task, $r = -.376$, $p = .041$ where poorer scores in shifting attention correlated with more OTS (see Figure 9). No other correlations were significant within cohorts, $r = -.219$, $p = .244$ (MG); $r = -.235$, $p = .211$ (EG).

A one-way ANOVA was conducted to compare mean performance on a measure of shifting attention between cohorts. Results indicated a significant difference between cohorts, $F(2, 87) = 18.34$, $p = .000$. Post-hoc comparisons revealed a significant

difference between mean scores for the MG and EG, $p = .000$ such that elderly participants had a significantly lower mean score as compared to middle-aged participants. No other significant differences were found. Scatter plots were constructed and indicated a trend of poorer scores on the CTMT Trail 5 task as age increased. Mean score of shifting attention, as measured by time taken to complete CTMT trail 5, declined with age: 60 seconds (MG), 66.2 seconds (OG), and 111.9 seconds (EG) (see Figures 5 and 6). All dependent variables of interest are summarized in table 3.1.

Chapter Five: Discussion

The purpose of the current study was to investigate the direct influences of attention and age on the incidence of OTS in healthy adults from middle age to elderly in the context of a constrained (e.g. procedural description) and unconstrained (e.g. recount) language production task. It was hypothesized that in general, participants in the EG (75+ year olds) would produce more OTS than the MG (40 year olds) and the OG (60 year olds) regardless of task. It was also hypothesized that poorer scores on measures of selective and shifting attention would significantly correlate with higher instances of OTS in the unconstrained task only, regardless of age. This chapter discusses results, limitations, future directions, and clinical implications.

Age, OTS, and Task Type

Results indicated that more OTS occurred in the context of an unconstrained task as compared to a constrained task, regardless of age. Moreover, findings showed a steady increase in OTS with advancing age in the unconstrained (recount) task, though this increase was not significant between cohorts (MG, OG, and EG). Although there was not a significant increase in OTS based on age between the three cohorts, the fact that these results approached significance should be noted. Post-hoc comparisons indicated a significant difference in mean OTS in the unconstrained task for the MG and EG, p = .023, where the EG exhibited more OTS in the unconstrained task as compared to the MG.

Given there were no group differences in OTS in the context of the constrained task, and group differences in OTS in the unconstrained task only approached significance, these results provide limited support for the hypothesis regarding age, OTS

and task type. Individual variability stands out as the main reason for these findings. Visual examination of scatter plots conveys a distinct increase in variability across age groups, with the most variability evident in the EG (75+ year olds). It is probable that individual speaking style and personality are substantial contributors to the incidence of OTS in any type of task; however individual variability was noticeably increased for the unconstrained task.

These results are consistent with previous findings that OTS increases with age in the context of an unconstrained language production task (Arbuckle & Gold, 1993; Glosser & Deser, 1992; Gold & Arbuckle, 1995; James et al., 1998). James and colleagues (1998) found a similar trend that older adults produced more OTS as compared to younger adults in the context of an unconstrained task, but not in a constrained task. Given that more OTS was observed overall in an unconstrained task as compared to a constrained task, results also provide limited support for the Inhibition-Deficit Hypothesis (Hasher & Zacks, 1988). These results provide additional evidence that weaker inhibitory processes are more likely to spawn OTS in a task where irrelevant information is more likely to be accessed (e.g. recount). Furthermore, because the current study examined participants from middle age to elderly as opposed to younger versus older adults, or elderly adults only, this particular result sheds some light on when in the lifespan a distinct increase in OTS begins. Based on results of the current study, it is plausible that an increase in OTS during healthy aging unconstrained language production tasks emerges between the middle age (40s) and elderly years (75+).

Age, Selective Attention, OTS, and Task Type

Preliminary findings of the current study replicated previous findings on declining scores on measures of selective attention with age (Carlson, Hasher, Connelly, & Zacks, 1995; Hartman & Hasher, 1991; Wills, et al., 2011). As hypothesized, poorer scores on selective attention correlated with higher incidence of OTS in the unconstrained task only, regardless of age. However, the linear relationship between selective attention and OTS was not dependent upon age for a number of possible reasons: 1) a measure of selective attention may not be sensitive enough to detect subtle inhibitory deficits between age groups in healthy aging; 2) selective attention, in isolation, may be a greater contributor to inhibitory processes during verbal, language production tasks than age. These findings make a positive contribution to the literature given that previous research on selective attention as an isolated process was not directly related to OTS. Previous studies on the relationship between attention and OTS have typically combined several measures of attention, including selective and shifting attention, into one attention "factor" or score. By separating the measures of selective and shifting attention, the current study was able to examine each type of attention's direct influence on OTS in healthy aging in each task type. Selective attention has been shown to be a significant player in multiple cognitive processes (Burke, 1997; Hartman & Hasher, 1991; Hasher, Lustig, & Zacks, 2007; Kwong & Ryan, 1995; McDowd, 1997; Persad, Abeles, Zacks, & Denburg, 2002). In addition, Balota and colleagues (2010) named the Stroop task the most well-studied measure of selective attention, and the most sensitive measure to early cognitive changes associated with Alzheimer's disease. However, results of the current

study poses that more research is needed to investigate its direct role in the production of OTS in healthy aging.

Age, Shifting Attention, OTS, and Task Type

Similar results were found regarding the relationships between shifting attention and OTS. Poorer scores on a measure of shifting attention declined with advancing age, as previous studies have shown (Arbuckle & Gold, 1993; Gold & Arbuckle, 1995; Wills, et al., 2011). As hypothesized, poorer scores on a measure of shifting attention were significantly correlated with higher incidence of OTS in the unconstrained task only, regardless of age. However, when analyzed by cohort, the only age group with a significant relationship between shifting attention and OTS was the OG (60 year olds). Within the OG, poorer scores of shifting attention significantly correlated with increased OTS in the unconstrained task only.

This significant finding provides new contributions to the aging, attention and OTS literature in several ways. First, this is the first study to suggest that shifting attention in isolation may be a more significant predictor of OTS than several inhibition measures combined. This may be due to the nature of shifting attention as a process that serves to "resolve interference" between competing stimuli (Wager, et al., 2004, p. 1687), as our cognitive processes are required to choose relevant thoughts over irrelevant thoughts to become accessed and transformed into spoken, coherent language. Additionally, this study suggests healthy adults may become more vulnerable to cognitive changes associated with shifting attention beginning at age 60.

Study Limitations and Future Directions

Based on this study's findings, follow-up studies are warranted to further investigate the influences of age and attention on OTS in a variety of tasks. One limitation to the current study is that participants were given only one task to measure selective attention, and one task to measure shifting attention, which may have limited the full scope of their true inhibitory skills. Future studies should include a battery of inhibitory tasks that challenge visual and auditory attention for a more accurate depiction of their performance on inhibitory tasks.

An additional limitation is that OTS was only examined in the context of one constrained task (procedural description) and one unconstrained task (recount). This may have provided a limited view of participants' natural language production by only giving them the opportunity to speak once in each type of task. Future studies should include at least two trials per task type for a more natural language sample and more carefully examine the role of individual variability. Furthermore, each task type (constrained and unconstrained) should be represented by several different sub-types. For example, constrained tasks should include not only procedural descriptions, but single and sequential picture descriptions as well. Unconstrained tasks should include a variety of sub-tasks such as personal narratives, life-history interviews, and recounts. Researchers noted that there was a broad range of variability in language production of participants throughout the healthy aging cohort. This variability is an inherently limiting factor. According to Balota and others (2010), samples of "healthy" adults may include participants who are beginning to or already displaying premature signs of Alzheimer's disease. Currently, without formal testing there is no way to know if an adult in middle

age or early elderly age is displaying signs of normal aging, or beginning signs of Alzheimer's disease. Therefore, the results of the current study raise an interesting question: Are the cognitive-linguistic changes occurring around age 60 "normal" changes or subtle, early predictors of Alzheimer's disease? Conducting more studies to investigate cognitive-linguistic changes in healthy aging with extensive inclusion criteria for "healthy" adults is one way to make progress in answering this question.

An additional way to answer the previously posed question is to conduct studies including healthy adults and adults who have been identified as having early stage Alzheimer's disease. These studies would examine subtle cognitive-linguistic changes in the areas of inhibition and OTS to see if there are differences in how the changes present. In these studies, the OTS rating scale would need to be expanded to prevent a "ceiling effect" from occurring and to provide a clearer picture of the off-topic utterances in each population. However, these studies would need to be interpreted with great caution because , healthy adults used as "controls" may present with early signs of Alzheimer's disease who have not yet been diagnosed.

Clinical Importance

Given the current study provides new information regarding relationships between age, attention, OTS, and task type, several clinical implications can be taken from the findings. Portions of neuropsychological tests are often administered by speech-language pathologists (SLPs) during the initial evaluation of patients with acquired neurogenic communication disorders such as right-hemisphere damage, aphasia, traumatic brain injury, dementia, or other neurologic conditions. Typically, parts of these tests target inhibitory skills, specifically selective and shifting attention; therefore the

current study provides further insight into the steady decline of these abilities that occurs with healthy aging, specifically how they interact with language production in certain tasks.

Discourse production is an area often assessed and treated by speech-language pathologists. During assessment, it is important for a clinician to obtain a natural language sample from a patient to know which direction to take in the course of treatment. Results of the current study provide evidence for which types of tasks to use while collecting a language sample. For instance, if a clinician feels that OTS may be a large part of a patient's discourse, they may move to a more constrained task to see if the OTS decreases in that context. Additionally, the relationship between inhibition and OTS can be observed in the assessment process by comparing a patient's performance on measures of selective and shifting attention to the amount of OTS present in their "unconstrained" and "constrained" language samples. This baseline relationship is a critical treatment implication.

Clinicians use a combination of theory and clinical judgment to implement treatment. Based on assessment results and the Load Theory of Selective Attention (Lavie et al., 2004), clinicians may be able to target deficits in selective attention, shifting attention, and/or OTS by manipulating the cognitive requirements, or "constraint" of language production tasks. This is a great way to target attention deficits discourse coherence simultaneously in the context of natural language production. Moreover, clinicians may target each process (selective attention, shifting attention, and OTS) individually, and track the patient's progress in each area to see which process is having a

greater impact on coherent language production. This will narrow the treatment scope and give the clinician a better idea of where to go with treatment.

Perhaps the most important clinical implication of the current study is the variable presentation of attention and OTS in healthy aging. Each person's speaking style and personality make significant contributions to their language production over the course of healthy aging *and* in the presence of a communication disorder. However, results of this study suggest that variability of OTS increases with age, especially in the context of an unconstrained task. Whether this variability is due to individual speaking style or the underlying presence of early dementia is still unknown. Clinicians need to be aware of individual variability in language production in order to treat each patient as an individual case. This allows clinicians to base treatment on individual style and preferences, as well as assessment results.

Conclusion

The overall results of this study are surprising based on simple logic. Previous research has shown that in general, OTS increases with age, and attention declines with age. Therefore, it would seem logical to assume that with advancing age, as attention decreased, OTS would increase. However, the results of this study indicated that task type and attention may have a greater influence on the amount of OTS spoken as compared to age. Additionally, individual variability due to age, attention, speaking style, the unknown presence of early dementia, or any combination of the above may be masking the relationships between age, attention, and OTS.

Table 2.1

Reported Means and (standard deviations) of Demographic Variables of Interest, by Cohort (N = 30 per cohort)

	MG[1]	OG[2]	EG[3]
M:F	15:15	15:15	15:15
Age	44.8 (3.2)	66.1 (2.5)	80.2 (4.1)
Educ	14.7 (2.5)	15.9 (3.1)	14.6 (2.3)
MMSE[4]	53.1 (5.2)	54.3 (7.0)	57.1 (12.2)
GDS[5]	1.0 (1.0)	0.8 (1.0)	1.4 (1.5)

[1] Middle Age Group (40 year olds); [2] Older Group (60 year olds); [3] Elderly Group (75+ year olds) [4] MMSE: Mini Mental State Exam Scaled Score; [5]Geriatric Depression Scale-Short Version

Table 3.1

Reported Means and (standard deviations) for Outcome Measures of Interest, by Cohort (N = 30 per cohort)

	MG[1]	OG[2]	EG[3]
CTMT Trail 5[4]	60(28)	66.2(17.5)	111.9(53.4)
STROOP C-W[5]	43.3(12.4)	35.6 (7.9)	30.1 (10.7)
Constrained TNW[6]	88.7 (50.3)	111.2 (66.4)	74.7 (42.1)
Unconstrained TNW[7]	143.1 (136.5)	235.4 (185.6)	225.8 (218.7)
Constrained OTS[8]	2.92 (0.2)	2.88 (0.18)	2.89 (0.20)
Unconstrained OTS[9]	2.88 (0.24)	2.76 (0.28)	2.69 (0.36)

[1] Middle Age Group (40 year olds); [2] Older Group (60 year olds); [3] Elderly Group (75+ year olds); [4]Comprehensive Trail Making Test Trail 5 time in seconds; [5]STROOP Color-Word Subtest Raw Score; [6]Total number of words for constrained task [7]Total number of words for unconstrained task; [8]OTS in constrained task; [9]OTS in unconstrained task

Figure 1.

Mean OTS by cohort for constrained task and unconstrained task.

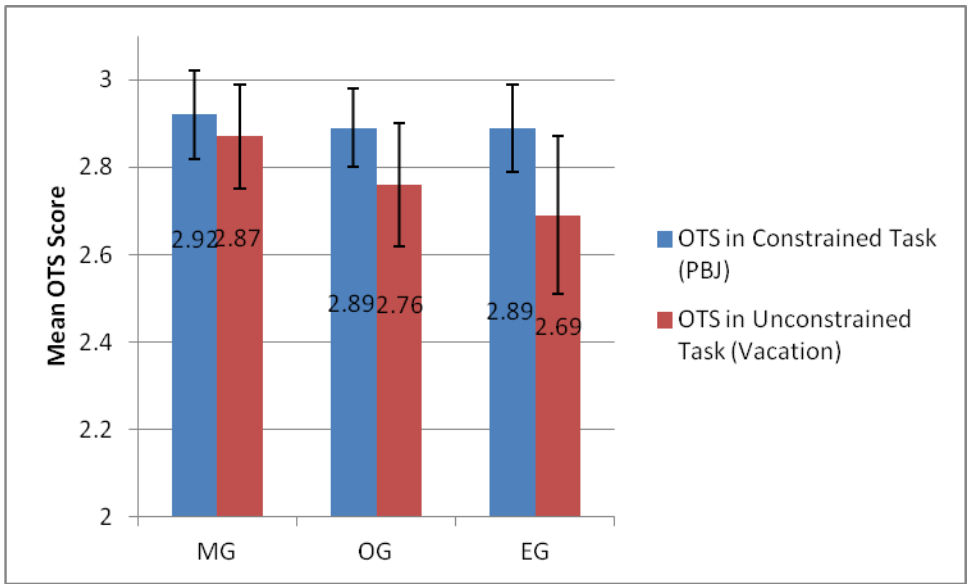


Figure 2.

OTS in constrained task, using age as a continuous variable.

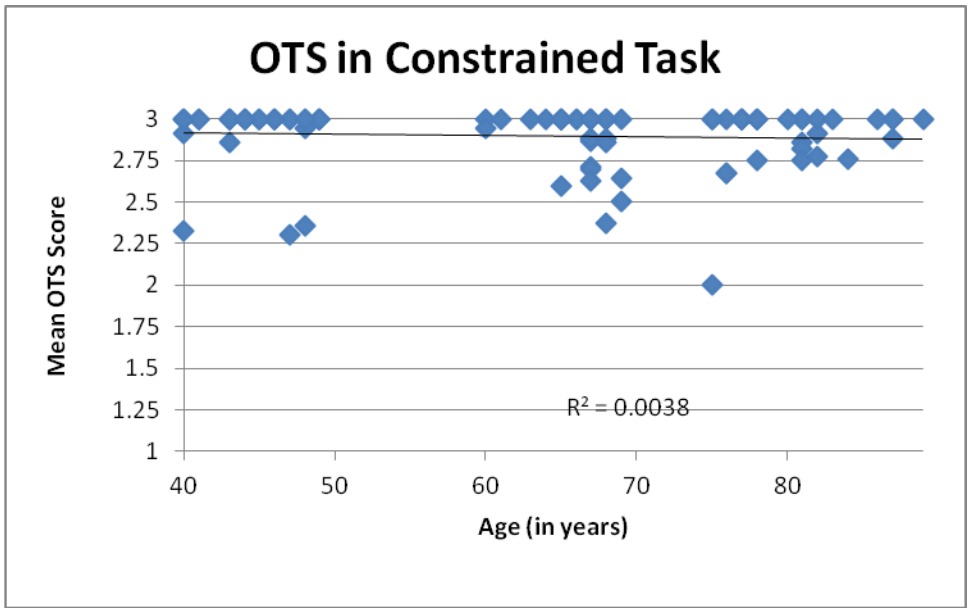


Figure 3.

OTS in unconstrained task, with age as a continuous variable.

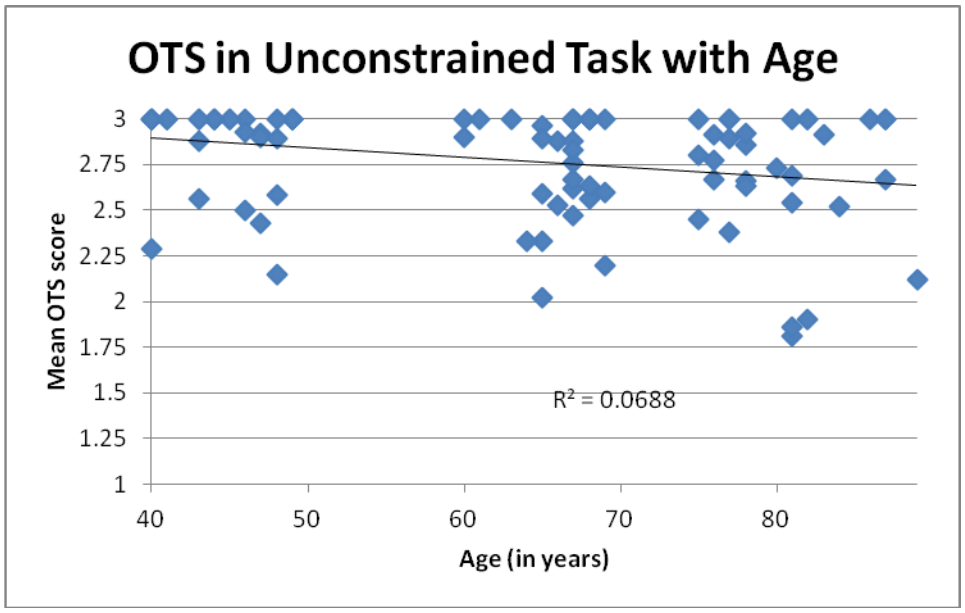


Figure 4.

Mean OTS in constrained and unconstrained tasks for all cohorts.

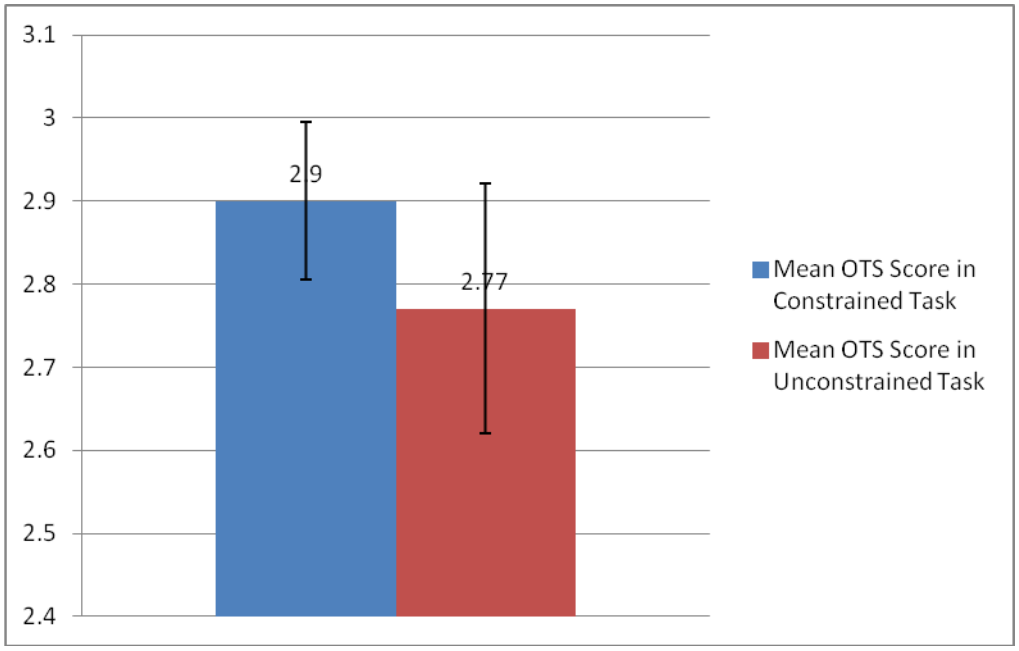


Figure 5.

Relationship between selective attention and OTS in unconstrained task (recount).

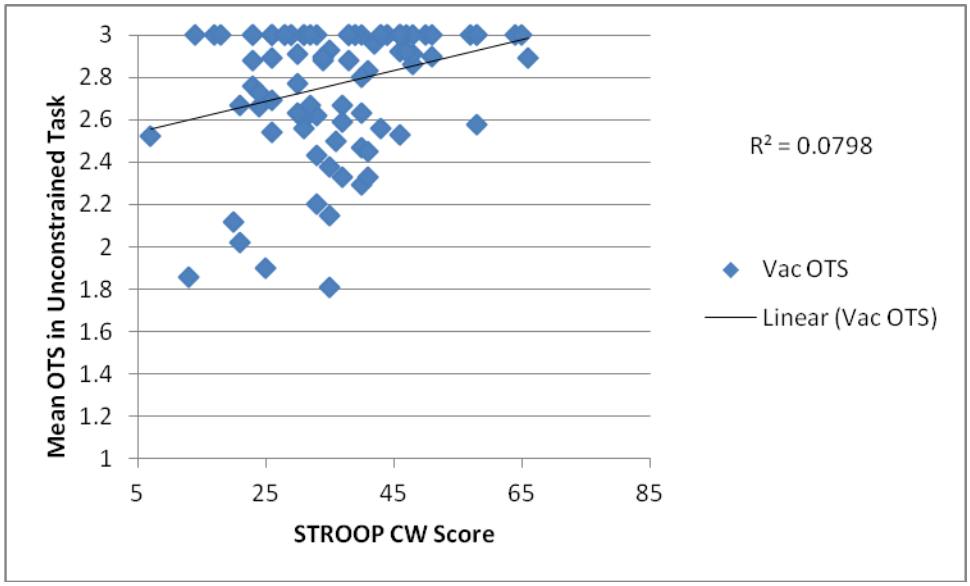
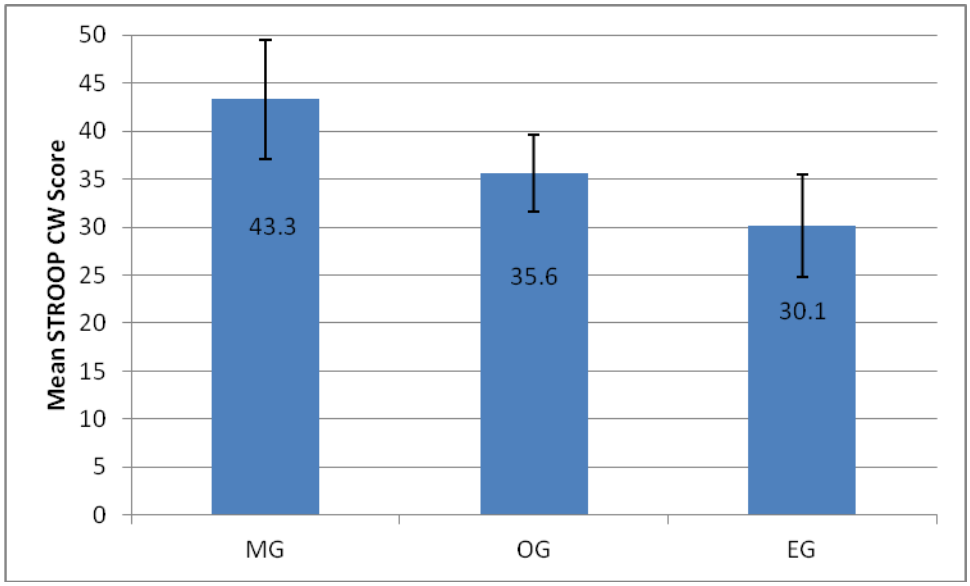


Figure 6.

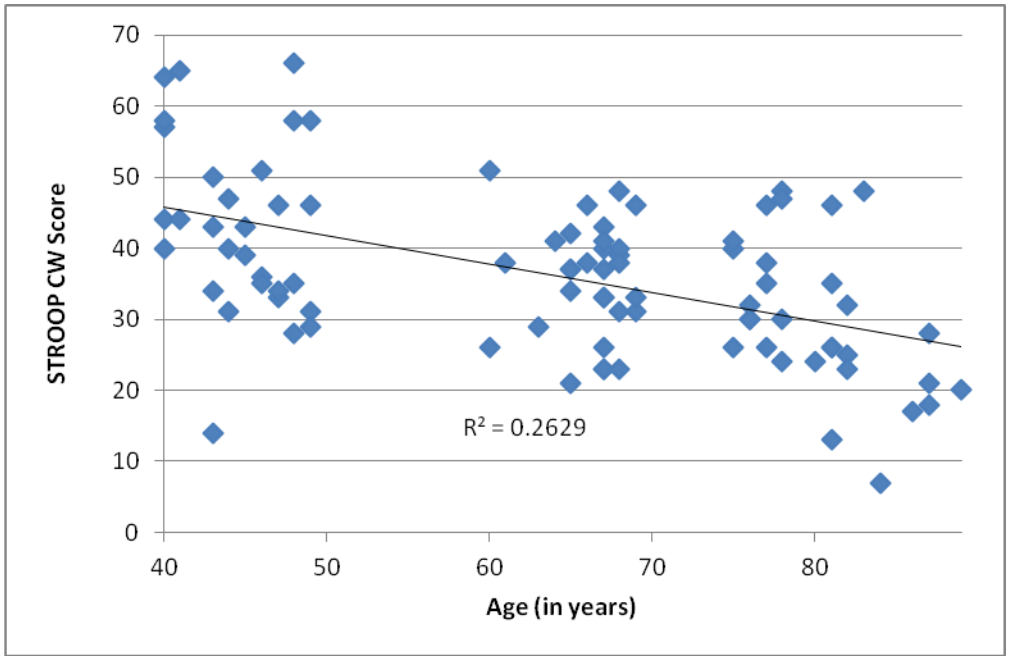
Mean scores of selective attention, by cohort.



Note: High scores = better scores.

Figure 7.

Mean scores of selective attention, using age as a continuous variable.



Note: High scores = better scores.

Figure 8.

Relationship between shifting attention and OTS in unconstrained task.

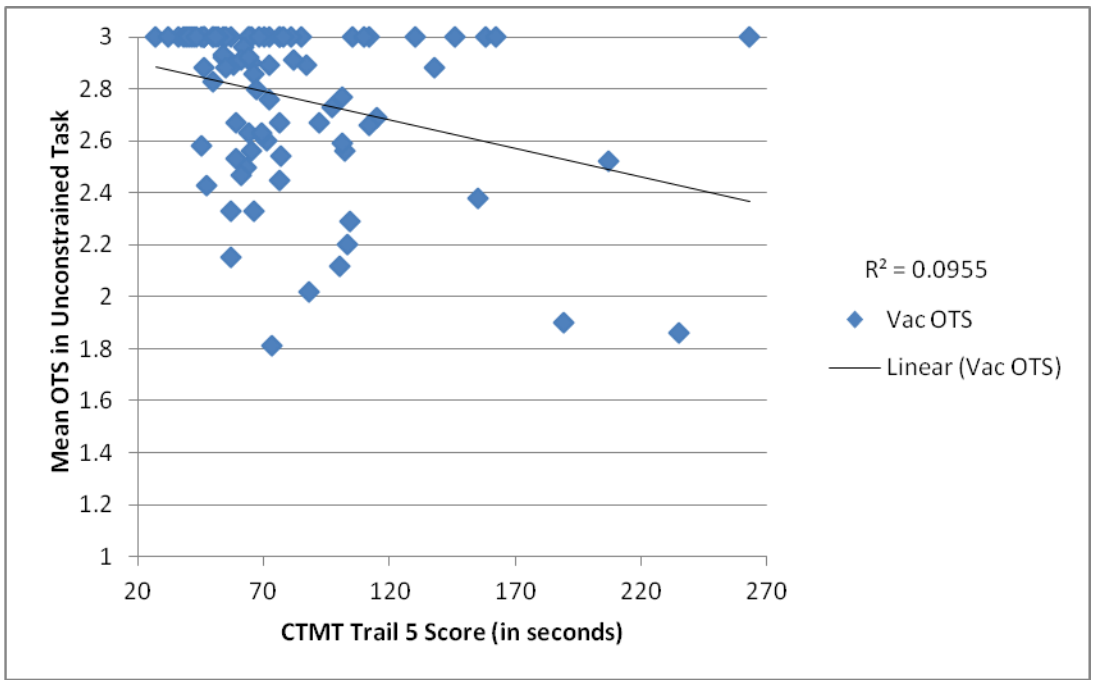


Figure 9.

Relationship between shifting attention and OTS in unconstrained task within the OG (60s).

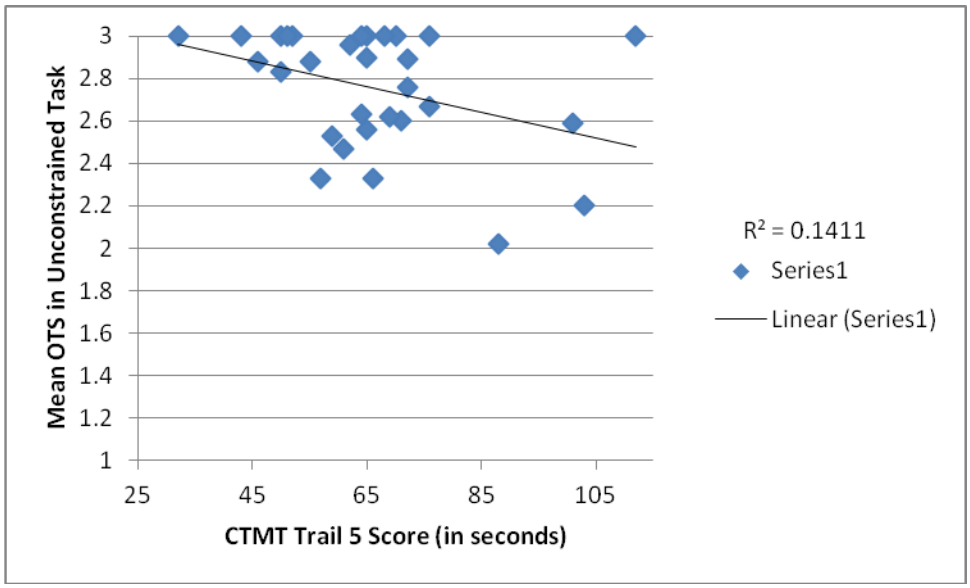
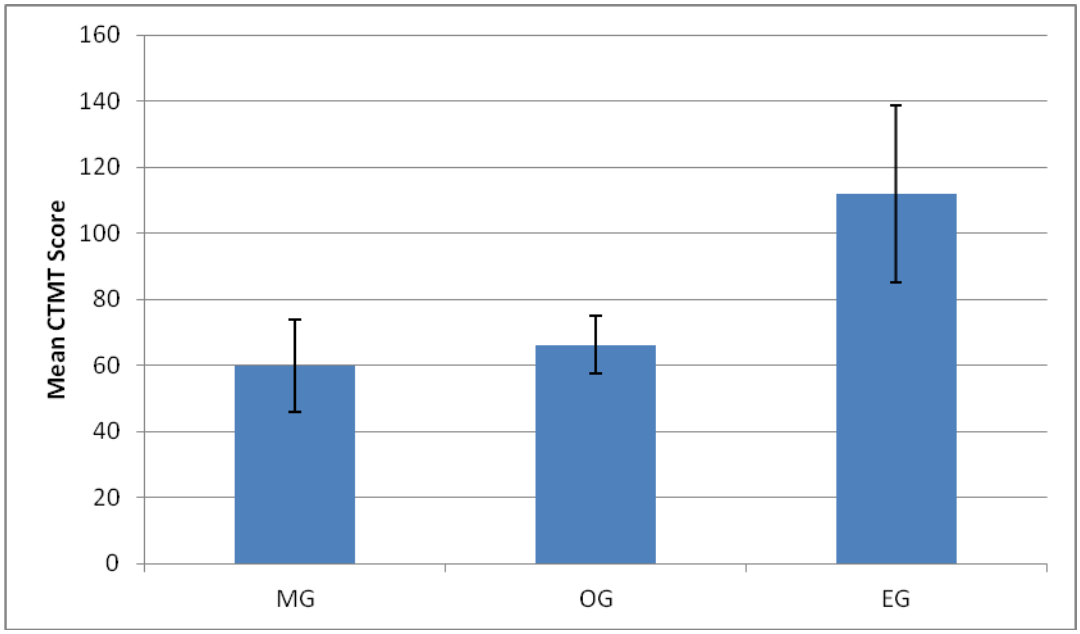


Figure 10.

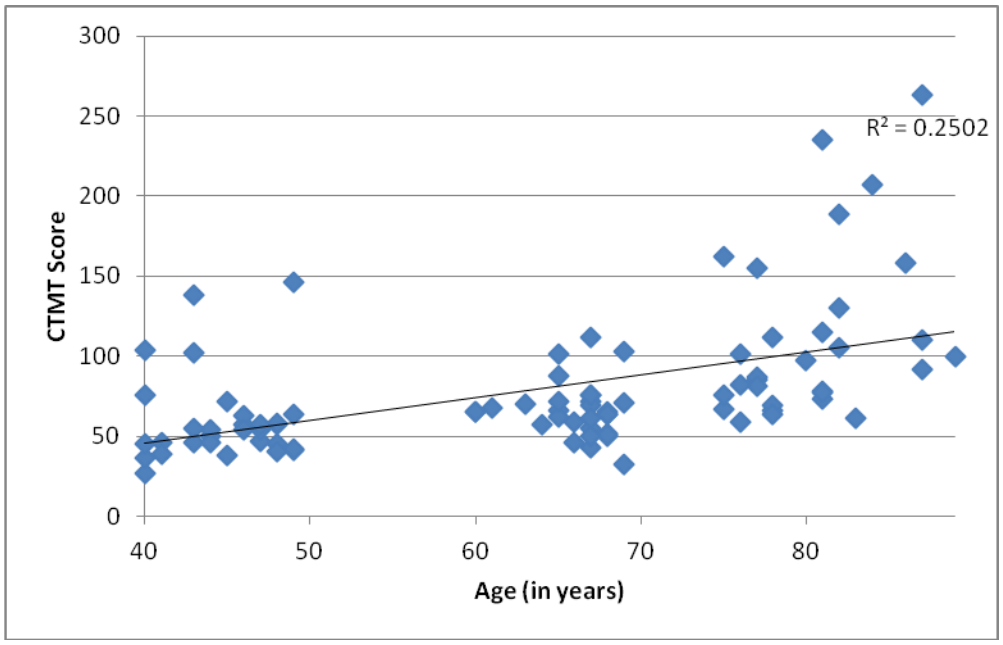
Mean score of shifting attention, by cohort.



Note: Lower scores = better scores

Figure 11.

Shifting Attention scores using age as a continuous variable.



Note: Lower scores = better scores

Appendix A.

OTS Rating Scale.

3 = The utterance (C-unit) is **obviously and directly related** to the stimulus/topic and provides main details about the topic. No inference is required by the listener.

2 = The utterance (C-unit) is **indirectly relevant** to the stimulus/topic. The information provided in the utterance is **not essential** but is still loosely related the main topic. A small amount of inference is required by the listener to figure out what the subject is trying to convey.

1 = The utterance (C-unit) is **unrelated** to the stimulus/topic. A significant amount of inference is required by the listener to try to figure out how the utterance could be related to the overall stimulus/topic.

Appendix B.

Sample Transcripts and OTS Ratings for each task type.

Constrained Task: “Tell me how to make a peanut butter and jelly sandwich.”

Utterance	OTS Score
1. *SUB: well first I would go to the cupboard and pull out the peanut butter.	3 because the utterance explains the first step in making a peanut butter and jelly sandwich
2. *SUB: and then I’d go to the fridge.	3
3. *SUB: and I’d get the strawberry jam.	3
4. *SUB: and then I would go to the counter where I have a loaf of bread.	3
5. *SUB: and then I would ask my husband do you want it toasted or plain?	1 because asking her husband this is a personal anecdote and is irrelevant to actually making a peanut butter and jelly sandwich.
6. *SUB: and he would probably say toasted.	1
7. *SUB: so I’d pop two [bread slices] in the toaster.	3
8. *SUB: and I’d get a dish or usually a salad plate	3
9. *SUB: and I’d toast the bread	3 (while toasting the bread is not necessary, it’s still directly a part of making the sandwich)
10. *SUB: and then I’d get a knife out of the drawer.	3
11. *SUB: and then I’d put peanut butter on both sides of toast.	3
12. *SUB: and then I would put jelly on both the strawberry jelly on both pieces of bread.	3
13. *SUB: and then I would pretend it was a sandwich.	1 because “pretending” is irrelevant to making the sandwich.
14. *SUB: and I’d cut it in half because at our house we don’t put the two pieces of bread together.	2 because an explanation of why you are cutting the sandwich in half is not directly related to making the sandwich.
Total # of Utterances: 14 SUM of OTS scores: 35	Mean OTS Score for Constrained Task: 35/14 = 2.5

Appendix B (continued).

Unconstrained task: “Tell me about your last vacation.”

Utterance	OTS Score
1. *SUB: uh Thanksgiving I went to Florida to see my children.	3 because this begins to directly answer the question about the participant’s last vacation.
2. *SUB: I have two uh well my son and his wife and two grandsons.	2 because not directly related to the prompt “tell me about your last vacation.”
3. *SUB: and it was my grandson older grandson’s birthday.	2 because it is unclear how this is directly related to “vacation.”
4. *SUB: he was uh six years old.	1 because irrelevant to “last vacation.”
5. *SUB: And so uh his father and I went and got balloons and fixed the house up with all balloons we and uh when he got home from school.	3 because referring to an activity in which participant engaged while on “vacation.”
6. *SUB: and um we celebrated his birthday on the patio.	3
7. *SUB: and um I had a fun time in Florida for a few days.	3
8. *SUB: I like to walk on the beach a couple of times.	3
9. *SUB: and um this is what I told you.	1 because entirely unrelated to speaking about last vacation.
10. *SUB: it’s gonna be very short.	1
11. *SUB: but we just uh we didn’t do much else.	3
12. *SUB: um I stayed a couple of about fourteen days.	3
13. *SUB: um we just um hung out.	3
14. *SUB: and um my son was off work.	2 because unclear how directly related to “last vacation;” information is not necessary.
15. *SUB: so we were together more than usual okay.	2
Total # of Utterances: 15 SUM of OTS scores: 35	Mean OTS Score for Constrained Task: 35/15 = 2.33

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