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Time of day effects on language discourse in healthy aging and dementia

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TIME OF DAY EFFECTS ON LANGUAGE DISCOURSE IN
HEALTHY AGING AND DEMENTIA

A Dissertation
Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

In

The Department of Communication Sciences and Disorders

By
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ABSTRACT

This study's purpose was to investigate whether language discourse follows a diurnal pattern across one 10-hour day in normal healthy aging individuals (NHA) and individuals with mild to moderate Alzheimer's disease. Ten healthy older adults; and ten older adults clinically labeled with probable Alzheimer's disease were recruited for this study. Measurements of procedural language, narrative language, and cognition, the Benton Judgment of Line Orientation (BJLO), were collected across one day at 9:00am, 12:00pm, 3:00 pm, and 6:00pm. Language samples were evaluated for linguistic variables to evaluate the quantity and quality of the discourse samples. Results indicated that the two groups differed significantly on their cognitive performance across the day, but cognitive performance was not correlated with any of the linguistic measures. Measures of narrative quality were significantly different between the groups. Group differences in procedural quality and quantity were non-significant. Some linguistic variables were susceptible to changes in diurnal patterns, while others were not. Diurnal effects appeared most prevalent in those with a higher cognitive status, with individuals with Alzheimer's disease showing less variation in linguistic measures across the day. Clinically, these results could impact the timing and administration of cognitive exams and therapies, as to account for changes in arousal patterns. Future studies should include examinations of other linguistic variables to evaluate their susceptibility to diurnal patterns. Physiological measures should be included to provide a more objective measure of circadian rhythms.

CHAPTER ONE INTRODUCTION

Statement of the Problem

It often is noted that older adults complain of word-finding difficulty and mental fatigue at the end of the day. Research in the area of circadian rhythms (CRs) has provided evidence that certain areas of cognition are susceptible to changes in arousal (May, Hasher, & Stoltzfus, 1993; May, Hasher, & Foong, 2005), but it is not known if arousal patterns impact language discourse. The CR research has focused largely on diurnal changes in memory, attention, and inhibition as a function of age. Given that language discourse relies heavily on both memory and attention (Bayles and Tomoeda, 2007), it seems plausible that language may be at risk for the effects of diurnal rhythms. By discovering what cognitive abilities are susceptible to changes in arousal, it will be possible to quantify individual performances on tasks, which will lead to an enhanced picture of cognitive health. However, to date, researchers studying normal aging processes and disease have not studied individual changes in arousal and cognitive performance. Cognitive research has identified several potential sources of performance change in aging. Four prominently cited changes in aging include reductions in speed of processing, declines in working memory, failures of the inhibitory system, and changes in sensory function (Park, 2000).

Along with the cognitive changes associated with healthy aging, CRs have become an area of recent interest. This research has focused largely on how changes in arousal rhythms affect performance. Changes in CR have been reported as a common phenomenon in healthy older adults, and an even more common phenomenon in individuals with dementia, based on physiologic measures (Yoon, May, & Hasher, 1999).

Research using self-report behavioral questionnaires has demonstrated a significant shift toward improved performance in the morning as a function of aging. This shift begins to appear around the age of 50 (Ishihara, Miyake, Miyasita, & Miyata, 1991), resulting in most older adults having a preference for the morning. Only recently, investigators have begun to study the effect of arousal patterns on cognitive change in aging participants. Several investigators have reported time-of-day effects by measuring cognitive processes including attention, executive functioning, and memory in healthy aging participants (May, 1999; Yoon, et al., 1999; May, et al., 2005; Intons-Peterson, Rocchi, West, Mclellan, & Hackney, 1998). These studies suggest improved performance on complex tasks when tested during optimal peak arousal, as determined by self-reported preference and self-reported peak alertness (Hasher, Chung, & May; 2002; May, Hasher, & Foong; 2005; Wincour & Hasher, 1999). To date, the studies reported in the healthy aging literature have not controlled for the time-of-day effect. Failure to acknowledge the existence of the time-of-day effect in healthy aging may lead investigators to erroneous conclusions about cognitive and language performance. This is empirical work that must be done.

Discourse is defined as a series of connected sentences (Guendouzi & Muller, 2008). Discourse production is considered to be a more valid task to elicit higher level language and cognitive processes than elicitation of phonologic, semantic, or syntactic structures (Orange & Kertesz, 2000; Braun, Guillemin, Hosey, & Varga, 2001; Flemming & Harris, 2008). Researchers have found conversational discourse impairments in propositional content, grammatical complexity, syntactic complexity, naming, cohesion, coherence, and length in both healthy aging and in individuals with AD (Bayles and Tomoeda, 2007; Kemper, Thompson, & Marquis, 2001; Bowles & Poon, 1985; Drevenstedt & Bellezza, 1993). However, researchers

have failed to define the point at which an older adult's discourse is considered disordered. Research results have demonstrated that cognitive processes, such as attention and memory, contribute to discourse production ability in healthy aging (Bell, et al., 2003; Brookshire, Chapman, Song, & Levin, 2000; Kemper, Rash, Kynette, & Norman, 1990; Norman, Kemper, & Kynette, 1992; Snowden, et al., 1996). In addition to declines due to healthy aging processes, older individuals are at a higher risk for other neurodegenerative diseases that may affect cognition and language (Kemper, et al., 2001)

Alzheimer's disease is one of the many dementia types and results in generalized cognitive decline. Therefore, one may expect to find discourse disruption in individuals with AD. Researchers investigating discourse in individuals with AD and with mild cognitive impairment have reported deficits including vague and empty language content, disruptions in cohesion and coherence, difficulties with turn-taking, decreases in number of utterances and total words, increases in use of mazes (i.e., a series of words that do not contribute to the meaning of language), and verbosity (Flemming & Harris, 2008; Dijkstra, Bourgeois, Allen, & Burgio, 2004; Carlomagno, Santoro, Menditti, Pandolfi, & Marini, 2005; Cherney & Canter, 1990; Glosser & Deser, 1990; Nicholas, et al., 1985; Hier, Hagenlocker, & Schlindler, 1985).

Few researchers have acknowledged the effects of arousal or testing time-of-day in their studies. Researchers have studied diurnal patterns in pre-lexical access to syllables and sentences in children, word fluency in dementia, language memory, auditory perception, spelling, and voicing (Reinberg, Ugolini, Motohashi, Fravigny, Bickova-Rocher, 1988; Yaretsky, Arzi, & Ashkenazi, 1995, 1996; Oakhill, 1986a, 1986b; Folkard, 1975; Morton & Diubaldo, 1993, 1995). These studies have shown mixed results, indicating that some aspects of language are vulnerable to changes in circadian rhythms, while others are relatively stable. This seeming

lack of awareness of the important role that arousal and time-of-day preference play may have a significant impact upon the understanding of the investigative results, or it may confound the results all together. Again, this is empirical work that needs to be conducted.

The number of people diagnosed with AD is predicted to reach 7.7 million by 2030, a more than 60% increase from the 5.1 million currently affected (Alzheimer's Association, 2010). Therefore, identifying factors that contribute to cognitive and language change, including changes within CRs, is imperative to determine if they have an effect on the cognition and language discourse of healthy aging individuals with AD. This study's purpose is to investigate if language discourse follows a diurnal pattern across a single 10-hour day in healthy aging individuals and those with Alzheimer's disease.

Specific Aims

- Specific aim 1: Determine if a relationship exists between measures of cognition and discourse across four times in a single day.
- Specific aim 2: Determine if a statistically significant difference exists between individuals with AD and healthy aging participants at four times of day on quality of narrative discourse.
- Specific aim 3: Determine if a statistically significant difference exists between individuals with AD and healthy aging participants at four times of day on quality of procedural discourse.
- Specific aim 4: Determine if a statistically significant difference exists between individuals with AD and healthy aging participants at four times of day on quantity of narrative discourse.
- Specific aim 5: Determine if a statistically significant difference exists between individuals with AD and healthy aging participants at four times of day on quantity of procedural discourse.

Research Hypotheses

- Hypothesis 1: Changes in discourse elements will show a positive correlation with changes in the BJLO for both normal healthy aging participants and individuals with AD.
- Hypothesis 2: Measures of abandoned utterances and mazes in narrative discourse will increase across the day for both normal healthy aging participants and individuals with AD, with the individuals with AD participants showing a steeper decline than normal participants.

- Hypothesis 3: Measures of abandoned utterances and mazes in procedural discourse will increase across the day for both normal healthy aging participants and individuals with AD, with the individuals with AD participants showing a steeper decline than normal participants.
- Hypothesis 4: Measures of total utterances and words per minute will decline across the day in narrative discourse for both normal healthy aging participants' individuals with AD, with the individuals with AD participants showing a steeper decline than normal participants.
- Hypothesis 5: Measures of total utterances and words per minute will decline across the day in procedural discourse for both normal healthy aging participants' individuals with AD, with the individuals with AD participants showing a steeper decline than normal participants.

CHAPTER TWO LITERATURE REVIEW

To understand why it is necessary to determine if a diurnal pattern exists in the speech of normal individuals with healthy aging or individuals with dementia, the literature review is divided into five sections. These include: time of day effects, cognitive aging, language discourse and dementia, and discourse analysis.

Time of Day Effects

Research on CRs is an area of growing focus in the literature on aging. CRs are defined as a daily (24-hour) cycle of activity. CRs can be regular variations in the environment, such as the alternation of night and day. CRs include sleep-wake patterns and levels of arousal. These rhythms are often measured via self-reported preference or physiological measures. Preference for most activities shifts to morning with increased age. The research also has shown that areas of cognition such as memory, attention, and inhibition are susceptible to changes in arousal.

Changes in CRs are common in older adults, and variations in morning and evening preference and performance have been examined across the life span. May, Hasher, & Stoltzfus (1993) demonstrated that older adults held a strong preference for the morning, while younger adults tended to prefer later times. A study examining 1,500 college students (ages 18 to 23) and 600 older adults (ages 60 to 75) indicated that less than 3% of older adults identified themselves as evening types, where as nearly 75% self-identified as morning types (May & Hasher, 1998). These results contrast with younger adults, as roughly 40% indicated their preference for the evening and only 10% for the morning. All others were classified as neither type (May & Hasher, 1998). Using the Morningness Eveningness Questionnaire to establish preferences, these results confirmed the results of previous cross-sectional studies (Horne & Ostberg, 1977; May et al., 1993), that time-of-day preferences shift to morning with increased age. However,

these data are based upon cross-sectional data rather than observations made across the day. In addition, these preferences are similar regardless of education, occupation, and place of residence. The authors suggested that although changing neurological patterns contribute to this shifting preference, lifestyle adaptation, such as work schedules may play a role in the shift to morning preference (May & Hasher, 1998). In addition to studying preference, research on CRs also has examined how changing arousal patterns affect cognition both across the life span and across a single day. When task burden and preferred time result in improved performance, the result is “the synchrony effect” (May & Hasher, 1998). This effect has been demonstrated in memory, attention, and inhibition tasks. May and colleagues (1993) found that recognition performance was also significantly moderated by age and time-of-day preference.

Memory has been examined for diurnal patterns. May and colleagues (2005) assessed memory retrieval as a function of arousal and time of day. Arousal is the physiological or psychological state of being awake and reactive (May & Hasher, 1998). Younger and older adults were tested during self identified on- and off-peak arousal times (i.e., times at which a person is more or less alert) in implicit and explicit memory tasks. As expected, performance on the explicit tasks was superior during peak arousal times for both groups. In contrast, implicit recall performance was superior during off-peak times of day. These data suggest that time-of-day effects upon memory recall is related to type of task (May, et al., 2005). Verbal digit span (i.e., an indicator of short term memory) measured as the longest repetition of previously presented numbers forward and backward, also has been shown to improve across a day for younger adults, while it declines across the day for older adults (Yoon, et al., 1999). This research also shows that people make more false memory errors at off-peak times of day (Yoon, et al., 1999).

Attention has also been assessed across a day. May (1999) examined younger and older adults' ability to solve simple word problems with distracters at on- and off-peak times of day. These peak times were defined by their self-reported preferences for either morning or evening. Participants were given three cue words (e.g., rat, blue, cottage), which all referred to the same target (i.e., cheese). Distracters were placed next to the cue words, and participants were instructed to ignore these (e.g., rat [cat], blue [red], cottage [cabin]). As hypothesized, both younger and older adults showed a synchrony effect associated with testing at peak and off-peak times of day. Participants showed decreased performance in the presence of misleading distracters, and increased performance in the presence of leading distracters.

Intons-Peterson and colleagues (1998) tested attention at on- and off-peak times of day, and revealed that both older and younger adults displayed negative priming (i.e., a decreased acuteness to stimuli resulting from exposure to certain events) when tested at peak times and not at off-peak times. Priming in the experiment was measured by having participants ignore target stimuli and in later tasks measure if the participants still ignore them or show a delayed response from previous task layover. Older adults also performed slower and less accurately than younger adults in attentional tasks (Horne & Ostberg, 1977; May et al., 1993). May (1999) further demonstrated this effect by using distractions in an encoding task. Younger adults were bothered by a distraction in the afternoon, but were unaffected in the morning, while older adults demonstrated the opposite pattern, as they were more affected by smaller distraction efforts in the morning than the afternoon.

In addition to memory and attention, inhibition has been examined during on- and off-peak times of arousal. Inhibition is typically defined as the ability to eliminate distracting information and screen outgoing messages for their correctness. May and Hasher (1998)

investigated whether older and younger adults could demonstrate activation shifts away from information that was no longer relevant. On-peak priming for younger adults was so efficient that disconfirmed items were less accessible than items that were never presented in the task. When tested at off-peak times of day, older adults demonstrated positive priming for both the target and disconfirmed items, indicating that they have difficulty deleting non-relevant information from their working memory during off-peak times.

According to Bodenhausen (1990), less control over dominant responses and poorer self-monitoring occur at non-optimal times of day. As a result, more schema-driven behaviors, such as common rote greetings, and routines will be evident during non-optimal periods (Bodenhausen, 1990). It is hypothesized that because over-learned responses are preserved at non-optimal times of day, no time-of-day differences will be found if an over-learned response is correct. This suggests that independent of the synchrony effect, specialists in a topic may be able to continue to perform at high levels. However, if people are tested on areas in which they have little knowledge, it is reasonable to expect that the literature may be exaggerating actual age differences (Bodenhausen, 1990).

Although no studies have investigated diurnal patterns of language discourse across the day, smaller parts of language have been examined for changes across the day. Reinberg and colleagues (1988) examined healthy and language impaired children for diurnal patterns in pre-lexical access to syllables and sentences. Results indicated that while language impaired children did not demonstrate any consistent diurnal pattern of performance, healthy children showed peak performance on sentence comprehension near 9:00am in the morning and peak on syllabic repetition at 7:30pm. Oakhill (1986a, 1986b, 1988) has shown a relationship between language memory and circadian rhythms over several studies. Results of these studies indicate

that as the day progresses a shift from more superficial text processing to more meaning based processing occurs. Participants were asked to remember stories as best they could and while their ability to remember exact wording was better in the morning, they performed better on text comprehension in the evening. Folkard (1975) reports results contrary to the previous studies reporting that semantic processing degrades in the afternoon, while being superior in the morning hours.

Morton and Diubaldo (1993) examined identification of speech sound voicing in a time of day paradigm in young adults. Participants were superior at detecting voicing in the afternoon between 1:30-4:00pm. In another time of day paradigm, they examined spelling ability and found that in the afternoon more phonetic errors occurred (Morton & Diubaldo, 1993). One potential flaw in their research is that they used two separate groups for morning and afternoon testing, potentially causing the appearance of a temporal trend caused by individual difference in the participants.

In a study examining word fluency, healthy aging participants were asked to name items in categories for two minutes twice daily at 7-9:00am and 5-6:00pm (Yaretsky et al., 1995). Participants named significantly more items in the categories in the afternoon, indicating greater cognitive efficiency at that time (Yaretsky et al., 1995). One potential flaw in this study is that the same questions were asked both in the morning and the evening, giving participants a chance to think of additional categorical items prior to the second testing sessions. In a follow-up study by Yaretsky and colleagues (1995), the same word fluency paradigm was used with participants possessing lower cognitive status. The population showed no time dependency compared to those with higher cognitive status (Yaretsky et al., 1995). This result may indicate that diurnal

variations in language are more likely in those without cognitive dysfunction. The lower the cognitive status, the less likely performance will be moderated by circadian rhythms.

These studies have shown mixed results, indicating that some aspects of language may be vulnerable to changes in circadian rhythms, while others may not. Other cognitive literature indicates that cognitive performance is better during self-reported peak arousal times. For those cognitive functions that are in part affected by CRs, younger adults will improve in their performance across the day, while older adults will show diminishing performance (May & Hasher, 1998). This finding is important in the scope of the current investigation, because if language is susceptible to CRs, then a predictable pattern of performance on language tasks may arise based on the time of day of testing; however, no research has investigated whether changes in CR have an impact on spoken language discourse.

Cognitive Aging

Four prominently-cited effects of aging have been noted to contribute to the decline of cognitive functioning: decreased processing speed, decreased working memory, decreased inhibition, and decreased sensation. Processing speed refers to the rate at which stimuli handled and applies to all cognitive functions. It affects the sequential execution of operations, and thus may have an effect on processes that do not seem to have a speed component. In general, the more complex the operation, the more it is likely that older adults will demonstrate cognitive slowing (Salthouse, 1996).

Working memory is the temporary storage and management of information. It is often tested by having participants store and process information simultaneously (Park, 2000). For example, by requiring participants to simultaneously respond to current stimuli but by using criteria issued steps before. Working memory abilities have been shown to decline in both cross-

sectional and longitudinal studies (Hedden & Gabrieli, 2004). Craik and Byrd (1982) suggested that limitations in working memory would be lessened by external supports.

Working memory declines occur in the abilities to bind information together during memory encoding and retrieve those associations at a later time (Mitchell, Johnson, Raye, & Mather, 2000; Naveh-Benjamin, 2000). In addition, even when both participants know a particular item or fact, older adults tend to be worse at remembering the source of their information than their younger counterparts (Johnson, Hashtroudi, & Lindsay, 1993). Binding and retrieval of related information are central to discourse processing.

A third proposed effect is the decline in inhibitory function. There are three proposed functions of inhibitory control that make it essential for effective cognition: 1) preventing irrelevant information from entering working memory; 2) deleting irrelevant information; and 3) delaying response until an assessment of its appropriateness and accuracy can be made (Hasher, Zacks, & Rahhal, 1999; Park, 2000). There are numerous consequences of diminished inhibitory control. Individuals with impaired inhibition may be more susceptible to distracting information from both external and internal sources. Poor inhibition also may lead to difficulty acquiring new information, comprehending questions, and retrieval of memories due to difficulty in clearing away irrelevant information from working memory (Park, 2000). As seen in older adults, these deficits may result in a heavier reliance on schemas (i.e., over-learned responses such as greetings) and stereotypes in place of analytical thinking. For example, older adults may be reluctant to go to new locations or restaurants because they may not fit previously learned patterns of behavior.

Finally, decreasing sensory function may also cause cognitive differences in older adults (Park, 2000). A study conducted by Lindenberger and Baltes (1994) provided persuasive

evidence that the age-related variance in measures of numerous cognitive abilities were strongly correlated with measures of visual and auditory acuity.

In summary, as people age, cognitive performance diminishes across various domains as a function of both advancing age and shifting CRs. Older adults demonstrate reduced performance as they age at off-peak times of day. In as much as language relies heavily on memory shown to be burdened by these shifts, it seems plausible to assume that language may be susceptible to the cognitive shifts across the day. As discussed in the next section, some aspects of language discourse have been shown to decline with age.

Language and Discourse in Aging

Cognition and Language

Age-related deficits occur in some fashion at nearly all levels of the language production and comprehension process, but not all deficits are related to language declines *per se*, but may be due to changes in other cognitive skills that mediate language, such as memory (Stine & Wingfield, 1990). Because cognitive skills such as attention, memory, and inhibition are important for discourse (Bell et al., 2003; Brookshire, et al., 2000), researchers have attempted to link changes in conversational output with age-related cognitive changes (Kemper, et al., 1990; Norman, et al., 1992; Snowdon, et al., 1996).

Kemper, Kynette, Rash, Sprott and O'Brien (1989) investigated the relationship between working memory and language. Younger (18 to 28) and older (60 to 92) groups' discourse was examined for syntactic complexity in three types of discourse samples (i.e., oral questionnaire, oral expository, and written narrative). The younger group demonstrated greater working memory capacity and produced more syntactically complex sentences. The mean number of clauses per utterance was highly correlated with backward digit span, the ability to recall

numbers in reverse (Kemper et al., 1989). The authors suggested that despite having ample time to plan output, working memory limitations may have prevented the older group from producing complex syntactic forms. Alternatively, it may be that older adults learned that these types of complex sentences were difficult to comprehend, and therefore refrained from using them in both written and expository discourse so to not burden other listeners.

Kauser and Hakami (1983) investigated encoding and recall in younger and older participants. All participants were given 12 topics to discuss and then were asked to recall and recognize the topics. Older adults performed poorer on the recall task, but performed equally on the recognition task. The authors suggested that older adults had not lost encoding ability, but were developing a difficulty with retrieval. Tun, Wingfield, and Stine (1991) also investigated passage recall, and reported that when working memory span was controlled for, younger and older participants performed similarly, further suggesting a strong correlation between working memory span and the recall of verbal information.

In addition to memory, the relationships among attention, inhibition and language have been studied. Older adults demonstrated more difficulty detecting semantically incorrect information, understanding the gist of a passage, and making inferences about it (Cohen, 1979) suggesting that older adults have reduced processing capacities, which are not sufficient for passage based processing. In addition, older adults demonstrated semantic satiation, failure of inhibition, and unnecessary resource allocation, resulting in extraneous material being encoded, stored, misinterpreted as being an important part of the message, and/or blocking proper encoding of relevant material (Hasher, Stoltzfus, Zacks, & Rypma, 1991).

To summarize, the cognitive demands of spoken discourse, coupled with decreases in cognition, negatively affect spoken discourse performance in older adults. Numerous studies

have linked changes in cognition to changes in discourse production. In addition, the discourse literature documents age-related decrements in spoken discourse production, as detailed in the following section. However, uncertainty lies in determining whether the declines are due to variations in language processing or cognitive deficits (Glosser & Deser, 1992). It is reported that declines in both sensory and cognitive functions do impact the discourse of older adults; however, unless these abilities are relatively taxed, older adults maintain a high degree of functionality in their discourse (Kemper, 1986, Bayles and Tomoeda, 2007; Togher, 2001). To further examine age-related changes in discourse and language, the following section details older adults' performance on language tasks.

Language and Discourse

Some aspects of language are impaired in normal aging, and in order to determine if the discourse varies across a single day, it is necessary to understand how aging affects language production. One of the most common complaints of aging adults is that they have difficulty retrieving the names of people, places, and objects (Kemper, 1994). This is coupled with increased incidence of the tip-of-the-tongue phenomenon (TOT), in which a known target word is not readily accessible. The TOT has been shown to increase with age, and researchers have demonstrated that older adults have less access to partial words than their younger counterparts (Maylor, 1990). Furthermore, age negatively affects confrontational naming (e.g., rapid naming of pictures) and generative naming (e.g., naming items in a category), with older adults often demonstrating a reduced ability to retrieve words and definitions (Bowles & Poon, 1985). Older adults also use a higher percentage of indefinite words, such as “thing,” as well as produce longer pauses. These deficits have been hypothesized to result from decreasing ability to access semantic memory rather than decreased semantic memory itself because adults continue to learn

new concepts throughout life and show increased knowledge of vocabulary as they age (Bayles & Tomoeda, 2007).

Older adults produce less cohesion in story retelling. Drevestedt and Bellezza (1993) asked younger and older adults to self-generate a story and then recall it. Results indicated that older individuals fell into three general groups. Those who: 1) could generate good stories but not recall them, 2) could both generate and recall as well as younger adults, or 3) could neither generate nor recall well. People in the third group also demonstrated memory deficits on standardized measures of cognition.

A study investigating narratives of older and younger healthy adults yielded significant differences in the amount of information and number of main events participants could provide. Older adults produced fewer main events in response to both single pictures and picture sequences (Harris-Wright, et al., 2005). The authors suggested that older adults may have performed more poorly because the task required a greater degree of inference making, and did not easily allow for participants to default to the compensatory strategies that they may use in more rehearsed story retellings (Harris-Wright et al., 2005). Older adults also use simpler forms of sentence construction than their younger counterparts (Kemper, et al., 1989; Kemper, et al., 2001). Kemper and colleagues (2001) studied the propositional density and developmental level in oral language samples of older adults. Their analysis indicated that the syntactic complexity of adult speech declines in late adulthood as does propositional content.

The aforementioned studies produced conflicting descriptions of older adults' discourse abilities. It is possible that varied performance is a result of differing methodologies (Obler et al., 1994). For example, some studies used picture stimuli, while others used interviews or self-generated responses. Additionally, the inconsistency could be due to individual differences in

participants' abilities. Ulatowska and colleagues. (1988) concluded that multiple factors, including study design, physiological, and/or cognitive decline might account for the variability in results across studies. The next section will discuss similar declines in language areas as they pertain to Alzheimer's disease.

Language and Discourse in Dementia

Dementia is defined by the American Psychiatric Association (1994) as an impairment in short and long-term memory with changes in judgment, abstract thinking, higher cognitive functions, or personality that affects a person socially or occupationally. Though numerous types of dementia exist, this paper primarily will focus on the literature surrounding AD, as it is the most commonly occurring type of dementia (Bayles & Tomoeda, 2007). AD encompasses deficits in multiple cognitive functions, and thus, language deficits are always present. The following sections describe both language and discourse impairments associated with AD.

Language

Language is defined as, "a purely human and non-instinctive method of communicating ideas, emotions, and desires by means of a system of voluntarily produced symbols" (Sapir, 1921). The complex nature of cognition makes it difficult to identify if the language impairments (e.g., semantics, lexicon, syntax, phonology) in AD interact with impairments in memory, or if they are due to direct damage to language centers. Language structures are used to arrange and order language (i.e., syntax), where usage refers to how and why the language is being used (i.e., discourse). People with AD have trouble producing linguistic information because language processing is a distributed process involving thinking, generating and ordering ideas, as well as declarative memory and working memory systems (Bayles & Tomoeda, 2007, Orange & Kertesz, 2000, Ulatowska et al., 1988). Individuals with AD demonstrate difficulties

comprehending language due to deficits in perception, recognition, attention, inference making, and memory, thought to be caused by damage to the hippocampus that occurs early in the disease process. This causes impairment in episodic memory, which in turn causes these people to forget what they just heard, read, or thought. As a result, they produce numerous sentence fragments, and listener comprehension suffers (Bayles & Tomoeda, 2007; Dijkstra, et al., 2002; Ripich, Carpenter, & Ziol, 2000).

Communication problems are often the first sign of the presence of dementia in an older adult (Bayles & Tomoeda, 1991). Family members tend to recognize changes in conversation and memory, but often times these changes are difficult to distinguish from typical age-related declines. In a survey conducted with AD patients, caregivers identified the most common language deficits associated with the disease: word-finding difficulties, difficulty naming objects, difficulty writing letters, impaired comprehension of instructions, and difficulty sustaining a conversation or completing a sentence (Bayles & Tomoeda, 1991). Overall, AD patients were described as less efficient communicators by their caregivers.

Syntax

Persons with AD demonstrate relatively intact syntactic processing. Kemper (1997) asked a group of elderly adults and individuals with AD to judge the acceptability of grammatical sentences. Though the individuals with AD were less confident about their responses, the results showed that both groups accurately identified simple sentences that were grammatically correct. When sentences were more complex, such as containing embedded clauses, both groups made more errors. These errors indicate a possible inability to parse out syntax when working memory abilities were taxed. Kempler and Zelinski (1994) suggested that syntactic ability is relatively spared, but performance constraints are applied in order to process

syntactic information and that deficits in working memory resources are the primary cause of syntactic errors of processing, not a deficit in the application of linguistic rules. Kempler and Curtiss (1983) also suggested that syntax remained relatively spared early on in dementia, and represented a separate neuropsychological ability from language productions and lexical functioning. Other studies have indicated that some aspects of syntactic production may be impaired in AD (Altman, Anderson, & Kempler, 1993; Altman, Kempler, & Anderson, 2001). In a study comparing morphosyntax and lexical aspects of speech, Altman, Kempler, and Anderson (2001) found that individuals with AD demonstrate similar declines as an aging group but also show declines in any area in which they must self generate speech. The authors suggest that this reflects a more related model of activation across semantic and grammatical features which are equally impaired in AD.

Semantics and Naming

Persons with AD usually have fluent verbal expression, meaning they have little difficulty in their language production, early in the course of the disease. Semantics (including naming) deteriorates early in the disease process, (Bayles & Tomoeda, 2007; Nicholas et al. 1997). Naming deficits start with proper names and progress to include simple familiar objects (Bayles & Tomoeda, 2007; Nicholas et al. 1997; Bayles, Tomoeda, & Trosset, 1992). Individuals with Alzheimer's disease replace specific noun references with more non-specific terms such as "thing" or "her" and increase use of circumlocutions, and pauses for word finding, (Olga, Emery, & Oxman, 2003). Nicholas and colleagues (1997) suggested that unlike the word retrieval deficits present in individuals with normal healthy aging, individuals with AD have a disturbed semantic system that limits their ability to name things. Still, other researchers contend that deficits in word retrieval result from a problem with access, and that in at least the early

stages of the disease, the lexical-semantic system remains intact (Nebes & Brady, 1990). Word retrieval problems disrupt the flow of normal discourse and may be a contributor to early indications of dementia (Bayles & Tomoeda, 2007). These processes negatively affect the structure of the person's discourse.

Discourse

Discourse has many definitions depending on the theoretical and analytical model used in its study. Discourse at its simplest is defined as “language structure beyond the sentences level” (Guendouzi & Muller, 2008, pp. 5). While additional definitions of discourse are illustrated in the following section, Ulatowska and Chapman (1995) defined discourse in the study of dementia as follows:

Although discourse may be comprised as a single word, a phrase, a sentence, or a combination of all of the above, discourse typically consists of a sequence of connected sentences. The coherence of discourse is determined by how well this sequence of sentences is related...Precisely, discourse is defined linguistically (i.e., via words and sentences) and is defined communicatively (i.e., a unit of language that conveys a message). (p. 115)

At the conversational level, numerous discourse functions have been found to be impaired in dementia. Hamilton (1994a, 1994b) described four general stages of language deterioration in Alzheimer's. These stages arose from a four-and-a-half year sampling of a single participant with AD. Stage one was characterized by word-finding difficulties and memory lapses, but the participant was aware of her communication problems, and attempted to manage them with the use of humor and circumlocutions. In stage two, the participant remained active in the conversation, but her awareness of errors decreased, and the use of perseverations

and repetition began to appear. Stage three was characterized by reduced conversational participation and the use of perseverations and formulaic language. By stage four, the participant was no longer an active contributor in conversation. Additionally, stage four was characterized by the loss of most lexical language and replaced with a small set of nonverbal responses (e.g., “Uh-huh”) which were used to request clarification, take turns, and indicate interest.

Guendouzi and Muller (2008) suggested that as AD progresses, the burden of communicative success shifts to the communication partner. They also contend that as memory and cognitive processes become more impaired, there will be an emergence of strategies designed to compensate for the impairments such as heavier reliance of scripts. It has been shown that declines in language not only correlate highly with cases of early-onset AD, but are indicative of a rapid progression of the disease process (Faber-Langendoen et al., 1988).

Production

Many studies have investigated the production of discourse in individuals with AD. These deficits include decreased coherence and cohesion (Dijkstra et al., 2002; Dijkstra et al., 2004; Ripich, et al., 2000; Ripich & Terrell, 1988), poor topic maintenance (Ulatowska et al., 1988, Ulatowska & Chapman, 1995; Guendouzi & Muller, 2008), poor conversational repair (Orange, Lubinski, & Higginbotham, 1996), shorter sentences (Hier et al., 1985; Ripich et al., 2000), higher usage of indefinite pronouns (Santo Pietro & Berman, 1984; Ulatowska et al., 1988), ideational perseveration (Tomoeda et al., 1996; Guendouzi & Muller, 2008), and reduced informational content (Bayles et al., 1992; Giles, Patterson, & Hodges, 1996; Ripich et al., 2000).

Several studies demonstrate a simplification in sentence production in individuals with AD. Kemper, LaBarge, Ferraro, and Cheung (1993) showed that in sentence formation tasks,

individuals with AD produced shorter, simpler, and less informationally-dense sentences. In a separate study, Snowdon, et al. (1996) looked at the autobiographical statements from a group of Notre Dame nuns with confirmed AD, and found diminished propositional density in their autobiographies, even at a very young age, prior to diagnosis. Dijkstra and colleagues (2004) found that individuals with AD produced discourse that was vaguer, aborted, indefinite, repetitive, and contained more disruptive topic shifts and cohesion errors than an aging group during a 15-minute conversation conducted by nurses' aides within a long-term care facility.

Formulaic phrases, consisting of familiar phrases and stereotypical greeting, are a classic symptom of AD. Snowdon (2001) noted that though some of the research participants could barely articulate a sentence, they were often able to answer questions appropriately by employing familiar phrases. These phrases are noted to steadily increase throughout the duration of the disease process, and are seemingly correlated with a reduction in word recall (Bayles, Tomoeda, Kaszniak, Stern, & Eagans, 1985; Snowdon, Bathgate, & Varma, 2001; Wray, 2008). Formulaic phrases appear to be somewhat automatic and over-learned and researchers suggest for that reason formulaic phrases bypass the linguistic deficits associated with even severe AD (Wray, 2008).

Those with AD also have deficits in story retelling, wherein they most frequently describe setting information only. Typical older adults are able to supply story information regarding setting, complications, protagonist actions, and the resolution (Ulatowska & Chapman, 1995). Conversational partners of people with individuals with AD typically complain of difficulty understanding them during conversations. One reason for these troubles is that the discourse of individuals with AD often contains ambiguous units including non-referential items and the omission of essential information. These units are thought to be the results of cognitive,

discourse, and linguistic declines. These discourse features are mentioned often in the literature as problematic (Cherney & Canter, 1990; Mentis, Briggs-Whittaker, & Gramigna, 1995; Nicholas et al., 1985; Snowden, et al. 2001; Wray, 2008; Bayles and Tomoeda, 2007).

Coherence and Cohesion

Coherence and cohesion are frequently studied aspects of discourse in both NHA and AD. Cohesion is defined as the relationships within and between the sentences, while coherence has been defined as overall topic maintenance and how closely an utterance relates to the overall topic (Dijkstra et al., 2004; Ripich et al., 2000; Laine, Laakso, Vuorinen, & Rinne, 1998). A study conducted by Dijkstra and colleagues (2002) investigated stage-related changes to the discourse of AD patients. Sixty transcripts of nurses' aides conversing with AD patients were analyzed. Twenty people within the early, middle, and late stages of AD were in each group. The results of the study demonstrated that disturbances at the utterance level, namely local coherence and cohesion, were most impaired in the late stages of AD as compared to early stages. Discourse level impairments, such as global coherence, topic elaboration, and initiation were more impaired in middle to late stages (Dijkstra et al., 2002). Discourse level characteristics require the activation and maintenance of topics throughout a conversation, while utterance level characteristics only require activation that is relevant from utterance to utterance (Dijkstra et al., 2002).

Laine and colleagues (1998) examined the differences in the discourse of individuals with AD and vascular dementia patients (VAD). They analyzed 20-utterance language samples from interviews for local and global coherence, use of non-referential items, and informativeness. Results suggested that AD and VAD patients perform similarly on discourse tasks demonstrating impaired global, but not local coherence, increased use of non-referential words, and decreased

informativeness. Informativeness was highly correlated with scores on the *Boston Naming Test* (BNT; Goodglass & Kaplan, 1983), where global coherence was highly correlated with measures of semantic processing (Laine et al., 1998). It is unclear why the BNT would correlate with measures of discourse informativeness, but perhaps both measures represent comparable levels of difficulty in language production, thus are maintained together and decline together. Though the BNT was highly correlated with informativeness, the BNT was not been found to be correlated with other discourse markers important for an overall picture of performance such as global coherence, therefore would not be an accurate judge of all discourse performance markers.

Topic Management

Topic management has been an area examined in the discourse of older adults and individuals with AD. Topic management consists of introducing, maintaining, shifting and repairing a conversation. A study by Mentis and colleagues (1995) examined topic maintenance, which is related to global coherence, using a number of parameters. Multidimensional Topic Coherence Analysis, originally developed by Mentis and Prutting (1991), provides more detailed descriptions of discourse problems in individuals with AD using specific parameters such as: number of topics introduced or reintroduced, appropriate topic shifts and changes, problematic shifts, new information units, requests for novel information, requests for clarifications, repetitions of old information, nonlinguistic units, and unintelligible units (Mentis, et al., 1995). Results indicated that individuals with AD had a reduced ability to change topics, had difficulty contributing to the development of a topic, and failed to consistently maintain topics in a coherent manner. People with AD also had more problematic topic introduction, as well as tangential and non-coherent topic shifts. These declines place an increased responsibility on the

discourse partner to maintain the conversation (Mentis et al., 1995).

The numerous disturbances present in the discourse of people with AD lead to an increased need for conversational repair. Conversational repair is considered a collaborative venture that involves all members of a conversation (Mentis et al, 1995). Conversational repairs often consist of a formulaic response, and include the problematic utterance and a repair of the problem. This sequence of events typically is referred to as a trouble source repair, or TSR (Orange et al., 1996). The preferred method of TSR is self-correction by the individuals with AD, and facilitation by the conversational partner is the second preferred method. Researchers have found that in the early stages of AD, the TSR is often initiated by the individuals with AD, while in later stages, it is initiated by the conversational partner (Orange et al., 1996; Sabat, 1991). A study conducted by Orange and colleagues (1996) reported that nearly 25% of early-stage AD utterances and 33% of middle-stage AD utterances involved conversational repair.

In summary, research has investigated several aspects of language and discourse decline in dementia. Overall, individuals with AD are described as less efficient and effective communicators and have impairments in several areas of language and discourse processing and production. However, to date, no research has been done examining discourse changes and their relationships to CRs. It is necessary to determine if changes in CRs lead to further language deterioration in individuals with AD and normal aging individuals. The following section will discuss the conventions of studying discourse and methodological strategies. Several frequently used units of measure are discussed. In addition, different types of discourse re described, focusing on procedural and narrative discourse types.

Discourse Analysis

Three major views of discourse have arisen from the literature. Schiffrin, Tannen, and Hamilton (2001) defined these as: 1) anything beyond the sentence; 2) language use; and 3) social usage of language that include the nonlinguistic aspects of language use (i.e. turn-taking, gestures). The purpose of the research often guides which analysis is chosen and at which level of discourse the researcher's questions are active. Schiffrin and colleagues (2001) distinguished between two approaches to discourse: the first is the formalist approach, which looks at discourse as a product and is concerned with specific features within the discourse samples. The second approach, the functionalist approach, seeks to infer meaning from the patterns arising from language use and its social execution. Discourse studies in older populations often use a formalist approach, and examine changes in discourse structures arising from cognitive change.

When investigating the discourse of older adults, it is possible to measure discourse quality and quantity. One frequently used measure of quality is D-level, or developmental level. This measure scores sentences on the basis of grammatical complexity, and is sensitive to embedding within sentences (Kemper, et al., 2001). This method also is sensitive to the use of left- versus right-branching sentence constructions. Left-branching constructions place an embedded clause to the left of the main clause, and are considered a more difficult construction because information must be retained and anticipated to create the main clause. Research has shown that older adults produce fewer left-branching constructions, which is hypothesized to reflect limitations in working memory (Gibson, Schuetz, & Salomon, 1996; Kemper et al., 2001).

Propositional density, P-density, is another measure of adult discourse quality. Originally described by Kintsh and Keenan (1973), P-density measures of how much information is present

within a single sentence. P-density is correlated with levels of verbal fluency and vocabulary (Cheung & Kemper, 1992; Kemper & Sumner, 2001). This measure is likely a reflection of processing capabilities and efficiency. Both P-density and D-level have been used as measures in studies with older adults and adults with dementia (Cheung & Kemper, 1992; Kemper et al., 2001; Snowden et al., 1996).

Cohesion is another frequently used construct in discourse analysis. Cohesion refers to the relations of meaning that exist with the text. Lack of cohesion typically represents an increase in non-referential items, deictic expressions, filler words, and conjunctions (Cherney & Canter, 1990). Vague and empty speech may be attributed to cohesion deficits, and has been cited by numerous researchers as a primary deficit in individuals with AD (Ripich & Terrell, 1988; Santo Pietro & Berman, 1984; Tomoeda, Bayles, Trosset, Azuma, & McGeagh, 1996; Ripich, et al., 2000)

Another common disturbance in the discourse quality of individuals with AD is reduced conversational coherence. Though coherence is composed of many pieces, most importantly it requires a thematic structure and a logical propositional development. Problems in the area of coherence in dementia often are represented by reduced information content, irrelevant and redundant ideas, reduced capability to clarify and expand ideas, and the omission of relevant information (Dijkstra, et al., 2004; Laine, et al., 1998; Ripich & Terrell, 1988). Two kinds of coherence exist within discourse: 1) global coherence, how the utterances relate to the overall topic; and 2) local coherence, how each utterances relates to the preceding utterance. Both coherence and cohesion have been referred to as discourse-building features. Their presence helps to maintain message quality. This is the reverse of discourse-impairing features such as revisions, aborted phrases, indefinite words, and disruptive topic shifts (Dijkstra, et al., 2004).

Other units of measure have been used to evaluate discourse quality in both normal older adults and individuals with AD. These measures include: empty words (Ripich & Terrell, 1988; Santo Pietro & Berman, 1984), T-units (i.e., one dominant clause with its subordinate phrases) (Ulatowska et al., 1988), information units (Bayles et al., 1992; Giles, et al., 1996; Ripich, et al., 2000), and number of questions asked (Ripich et al., 2000; Ripich, Vertes, Whitehouse, Fulton, & Ekelman, 1991). Investigations into the use of mazes and fillers indicate individuals with AD produce more repetitions of phrases, words, and revisions than those without AD, as well as an increase in abandoned utterances (Guendouzi & Mueller, 2008; Ripich, et al., 2000).

In addition, discourse analysis in older populations has included measures of the quantity of information being produced. Researchers have measured this by using number of words (Hier, et al., 1985; Lardy, Connelly, & Johnson, 1964; Nicholas, et al., 1985; Ripich & Terrell, 1988), syllables per minute (Santo Pietro & Berman, 1984; Smith, Chenery, & Murdoch, 1989), words per minute (Cherney & Canter, 1993; Hier et al., 1985; Ripich, et al., 2000), and total utterances (Ripich et al., 2000; Ripich et al., 1988). The results from these studies indicated that older adults and individuals with AD often produce fewer utterances and less information overall.

Numerous types of discourse analyses exist within the literature. Each of these approaches has advantages and disadvantages. One important factor to note is that different types of discourse tasks elicit different types of performances. This variability comes from the cognitive processes engaged on the sample type which for example, discourse tasks that require the recall of recent events may be more impaired due to memory declines, while discourse samples that do not require chronological information order, such a picture description, will often be easier, because they are less taxing on memory and attention.

Procedural Discourse

Procedural discourse requires an explanation of how a procedure is carried out. According to Schacter (1996), procedural discourse relies heavily on procedural memory. The speaker must provide instructions in a particular order to achieve an outcome by stating the setting, essential steps, and optional steps. Ulatowska et al. (1983) found that procedural discourse skills were correlated heavily with measures of cognition in healthy aging. In a later study, Ulatowska et al. (1988) found that when comparing 10 subjects with AD and 10 normal aging subjects in a cognitive and language protocol that included procedural discourse, the normal and AD participants performed similarly on linguistic measures (e.g., T-units, incorrect sentences, words per clause). Conversely, the AD subjects had more abandoned utterances, fewer *a priori* propositions, and more irrelevant statements.

A commonly used procedure is the construction of a peanut butter and jelly sandwich. Ripich and colleagues (1997) used procedural discourse tasks to investigate language changes in 60 people with AD and 50 normal aging elderly people. Subjects were asked to describe four common tasks: unlocking a door, getting dressed, mailing a letter, and making toast and jelly. Both linguistic elements (e.g., abandoned utterances, mazes, length of utterances) and procedural elements (e.g. counts of essential steps, optional steps, and repetitions) were measured. The results indicated that people with AD produced fewer statements, and omitted both essential and optional steps from procedural descriptions, asked more questions seeking clarification, and produced fewer intelligible utterances. When studying procedural discourse, Arkin and Mahendra (2001) used the question, “Tell me how you would go about planning a picnic for your family and friends?” The following section describes narrative discourse. Unlike

procedural discourse the event being considered is often specific to the individual telling it (i.e., wedding, vacation)

Narrative Discourse

Narrative discourse sampling involves the retelling of an event in chronological order. This can be achieved in a number of ways, such as having the person recount a specific personal experience, or a common story, such as *The Three Little Pigs*. This also can be elicited using action pictures or picture sequences. Narratives are an important aspect of communication, as they often are used for entertaining, and are essential for social communication. Arkin and Mahendra (2001) used the questions, “Tell me about your daily routine, the things you do nearly every day,” and, “What are some things you do once in a while?” to elicit a narrative sample.

Production of narrative discourse requires the complex interface of linguistic, cognitive, and social abilities (Coelho, 1995). Narratives frequently have been studied because they are considered a formulaic type of discourse due to their predictable structure. Such narratives follow a cognitively-based, measurable, structured set of rules called story grammar, which are not dictated by the specific content of the message conveyed (Coelho, 1998). Recent interest in age-related changes has led to an increase in the number of investigations on the interaction on aging, discourse, and cognition. Cannizzaro and Coelho (2003) investigated the relationship of discourse and executive function by using narrative samples. By using both story generation and story retelling, the results indicated that like previous studies, the elderly performed the poorest, and deficits were noted even in the highly educated. .

Furthermore, it was demonstrated that a relationship between story grammar and measure of executive function existed in aging (Cannizzaro & Coelho, 2003). The authors suggested that the investigation of narrative performance may provide a more suitable scale of elderly

performance to treat and assess those with cognitive-communication difficulties. Discourse analysis in older adults and individuals with AD is a growing area of investigation. This qualitative investigation into language change in these populations allows for insights into how this dynamic process changes due to both underlying cognitive declines and the effects of conversational partners. Studies previously investigating discourse in individuals with dementia have reported numerous deficits including vague and empty speech, disruptions in cohesion and coherence, difficulty turn-taking, and verbosity (Cherney & Canter, 1990; Glosser & Deser, 1990; Nicholas, et al.,1985). However, no discourse measures have been examined across time.

Previous research has examined circadian rhythms, cognitive aging, aging and language, AD and language, and discourse analysis. The preceding literature has illuminated how circadian rhythms can impact task performance, and how language and discourse change as a function of aging and Alzheimer's disease. However, no previous research has investigated if language discourse follows a diurnal pattern across the day.

CHAPTER THREE METHOD

The current study sought to examine how language discourse changes across a single day as for normal aging and AD individuals producing narrative and procedural discourse samples. The present study uses a quasi-experimental mixed methods design measuring both quality and quantity (i.e., mazes, abandoned utterances, total utterances, type token ratio, and words per minute) of language discourse. The purpose of descriptive studies is to explore potentially causal relationships between variables prior to, or as a substitute for, doing an experiment. It involves comparing population samples that different on a critical variable but otherwise comparable. It is aimed at the discovery of possible causes and effects of a behavior pattern or personal characteristic by comparing subjects in whom this pattern or characteristic is present with similar subjects in whom it is absent or present to a lesser degree. The researcher does not experimentally manipulate the independent variable but observes the effect of natural variations in populations (Borg & Gall, 1989).

Participants

A sample of 20 people in two groups was recruited for this study. A sample of volunteer participants was recruited from Baton Rouge, Louisiana and surrounding communities through: flyers and by word-of-mouth; Charlie's Place Adult Respite Center in Baton Rouge, Louisiana; and local independent-living facilities and retirement communities.

All participants received IRB approved informed consent prior to any data collection and had an opportunity to have all questions asked and answered. Identifying information was kept confidential, and data are referenced to each participant using a code number. Participants could have chosen to discontinue participation in the study at any point; however, none chose to do so. There were no risks or benefits associated with the procedure.

All participants met the following inclusionary criteria: (a) native English speaker; (b) no history of clinically diagnosed depression or major psychiatric disorders; (c) at least 8 years of formal education; (d) pure tone hearing screening of 45 dB; and (e) 80% accuracy on the speech discrimination subtest of the *Arizona Battery for Communication Disorders in Dementia* (ABCD; Bayles & Tomoeda, 1993).

Group 1 consisted of 10 normal aging adults aged 65–89. All participants in this group scored a 28 or higher on the *Mini Mental State Examination* (MMSE; Folstein, Folstein, & McHugh, 1975) to exclude the presence of cognitive dysfunction, and had no history of neurological disease or damage.

Group 2 consisted of 10 adults, ages 65–89, clinically labeled by their physicians as having probable Alzheimer’s disease. Participants in this group had to score an 11–25 on the MMSE. According to Bayles and Tomoeda (2007), early stage AD lasts from 2 to 4 years and is associated with average scores on the MMSE from 16–24. Middle stage AD is associated with MMSE scores from 8–15. Groups were not deliberately matched for age and gender because of recruitment difficulties; nevertheless, groups were similar in composition with average individuals with AD group age 2.1 years older and including one fewer male participant. From here forward dementia and individuals with AD will be used to represent the Alzheimer’s participants interchangeably.

As expected, the aging group achieved MMSE scores that were higher than those of the AD group ($t(18) = 10.182, p < 0.0001$). The average ages of the two groups were similar ($t(28) = 0.9762, p < 0.3419$), as were the gender compositions of the two groups ($\chi^2(1) = 0.6392, p < 0.6392$). All of the participants expressed a preference for morningness and passed the speech discrimination test.

Table 1

Participant Characteristics

Subject	Age	Gender	MEQ	MMSE	Speech Discrim.	Education
NHA 1	76	Male	Morning	29	Pass	12
NHA 2	73	Female	Morning	28	Pass	12
NHA 3	73	Female	Morning	30	Pass	14
NHA 4	75	Male	Morning	29	Pass	10
NHA 5	81	Male	Morning	30	Pass	16
NHA 6	88	Male	Morning	29	Pass	12
NHA 7	82	Female	Morning	29	Pass	8
NHA 8	79	Female	Morning	30	Pass	12
NHA 9	82	Female	Morning	30	Pass	10
NHA 10	84	Female	Morning	29	Pass	16
Mean	79.3			29.3		12.2
Std. Dev.	4.99			0.67		2.57
AD 1	79	Male	Morning	20	Pass	16
AD 2	87	Female	Morning	20	Pass	10
AD 3	80	Female	Morning	21	Pass	12
AD 4	88	Female	Morning	15	Pass	14
AD 5	80	Female	Morning	23	Pass	16
AD 6	82	Female	Morning	20	Pass	12
AD 7	72	Female	Morning	22	Pass	12
AD 8	79	Female	Morning	19	Pass	8
AD 9	82	Male	Morning	23	Pass	14
AD 10	85	Male	Morning	24	Pass	10
Mean	81.4			20.7		12.4
Std. Dev.	4.62			2.58		2.63

Note. MEQ=Morning-Eveningness Questionnaire (Horne & Ostberg, 1976); MMSE = Mini Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975)

Materials

The MMSE (Folstein et al., 1975) served as a screening test to determine the cognitive status of normal healthy aging participants and participants with dementia. The MMSE assesses cognitive status in the domains of orientation, registration, attention and calculation, recall, and language (naming, repetition, 3-stage command, reading, writing, and copy design), and has established validity and reliability for the study population.

The *Morningness-Eveningness Questionnaire* (MEQ) was used to determine sleep-wake habits across the day (Horne & Ostberg, 1976). This 19-item survey provides a subjective assessment of peak activity, appetite, and alertness. The scoring for the measure divides people into three general groups: morning types, evening types, and neither type. This measure has been validated using physiological measures, such as body temperature, heart rate, brain activity, and skin conductance, to separate morning and evening types, (Adan, 1991; Horne & Ostberg, 1976; Horne, Brass, & Pettitt, 1980). This measure has also been shown to be a valid measure of circadian rhythms (Smith, Reilly, & Midkiff, 1989).

The ABCD was used to assess the Alzheimer's patients (Bayles & Tomoeda, 1991). It includes 14 subtests that evaluate language expression, verbal episodic memory, language comprehension, visio-spatial construction, and mental status. The ABCD was standardized on patients who had Alzheimer's and Parkinson's disease, as well as younger and older nondisabled individuals (Bayles & Tomoeda, 1991). The test-retest reliability for the test was reported statistically significant for all of the subtests except word reading comprehension. The validity of each subtest on the ABCD was compared with common AD severity tools (MMSE, GDS, and Wais-R Block design) and was found to be statistically significant for all subtests, indicating the tool was comparable to current diagnostic and descriptive tools. The ABCD total score was found to be .75-.84 correlated with the same severity examinations.

The shortened version of the *Benton Judgment of Line Orientation Test* (BJLO; Benton, Varney, & Hamsher, 1978) was used to screen changes in cognition quickly throughout the day. Line judgment orientation has been shown to be a reliable tool to assess visual-spatial skills. The BJLO is considered one of the "purest" tests for visual perception because it requires minimal motor skills and verbal mediation (Lezak, Howieson, & Loring, 2004). The BJLO assesses

visual-spatial skills in line matching tasks, where a set of full or partial angled lines must be matched with two lines appearing on a stimulus card. Visual-spatial skills are sensitive to age-related changes in cognition and can become impaired (Salthouse, 1995). In addition, Meador and colleagues (1993) indicated that reduced attentional skills significantly impact the BJLO. Studies have demonstrated that persons with dementia perform poorer on the test than older controls do (Eslinger & Benton, 1983; Ska, Poissant, & Joannette, 1990). The reliability of the full form V (used in the odd-even short form) was .89 and was conducted on 124 older adults (Benton et al, 1978). The odd-even short form of the BJLO has been shown to be equivalent to the full version in both large mixed populations and geriatric populations (Woodard et al. 1998).

Procedure

Inclusionary Screening

All participants were assessed individually in their usual daily setting (i.e. house, care facility). During the first visit, consent was obtained and general identifying information, such as health status, education, and medication use, was collected using an intake questionnaire (See Appendices A and B). The MMSE was administered to assess relative cognitive status (Folstein et al., 1975).

All participants had to score 80% or better on the speech discrimination subtest of the ABCD. Normal aging participants received only this subtest of the exam, while individuals with AD received the entire exam. A hearing and vision screening was conducted at this time to ensure adequate sensory ability for the tasks.

Participants that passed the screenings were admitted to the study. All sessions were recorded using an audio digital recorder, which was placed on a surface between the participant and examiner. Those recordings were be used for test scoring and data analysis.

Testing

During the experimental procedure, language samples were taken at four points across the day: at approximately 9:00am, 12:00pm, 3:00pm, and 6:00pm. On average, each session lasted 20 minutes. Four procedural questions were asked in randomized order across time among participants. The procedural questions contained the following number of essential steps: unlocking a door (3), mailing a letter (5), making toast and jelly (5), and getting dressed (3). These four questions were standardized with normal aging participants (Ripich, et al., 1997). The examiner introduced the procedural task by saying, “If I didn’t know anything about it, tell me exactly how you would...” adapted from Ripich and colleagues (1997).

Using an interview format, narrative samples were also taken from each participant. Four questions were asked in randomized order across time and participants, and included, “tell me about 1) your day, 2) family, 3) last vacation, and 4) careers.” The examiner encouraged the participant to continue to talk for at least 2 minutes, and prompted them for more information using the phrase “Tell me more” if the participant stopped talking. This time frame was deemed appropriate based on norms for words per minute (wpm), conversational analysis, and total utterances (Guendouzi & Muller, 2007). This length was also utilized to control for the possibility that the examiner would prime for related linguistic information.

In addition to the two language samples taken, participants were assessed for cognitive status. Since studies investigating normal aging and recent investigations into time of day changes have indicated that visual-spatial abilities are vulnerable, the shortened version of the BJLO (even-odd forms) was administered in alternating order during each of the four sampling sessions to measure cognitive status changes. The administration of these tasks was randomized

across each participant and each session. Randomization for all tasks was done using *Research Randomizer*, a random number generator (Social Psychology Network, 1997–2011).

In summary, the derived data for each participant includes demographic information (i.e., age, years of education, ethnicity, and gender), health status information (hearing screening, vision screening, health questionnaire), and scores for screening and inclusionary tests (i.e., MMSE, ABCD). In addition, the experimental data for each participant consists of the BJLO, procedural samples, and narrative samples at four time points in the day. Figure 1 explains the procedure visually.

VISUAL REPRESENTATION OF EXPERIMENTAL PROCEDURE

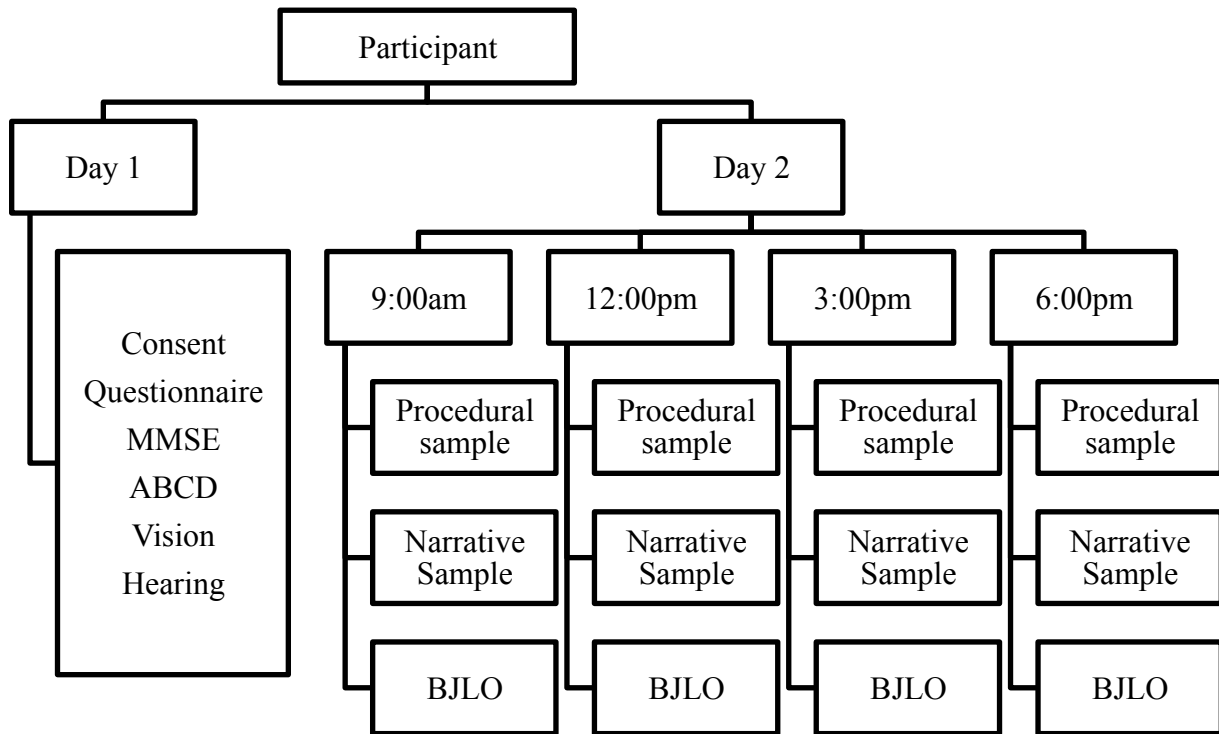


Figure 1. Visual representation of experimental procedure illustrating 2-day procedure and tasks associated with each day of testing. Narrative samples, procedural samples, and BJLO administration were given in a randomized fashion to eliminate order effects.

Language samples were typed and coded into *Systematic Analysis of Language Transcripts* (SALT; Miller & Chapman, 2000). SALT is computer analysis software that uses a standardized notation system to derive quantitative data and discourse variables. Samples were analyzed for linguistic variables. The linguistic elements analyzed in both procedural and narrative samples include total utterances, abandoned utterances, type token ratio, wpm, and use of mazes. These variables are defined as follows:

- Total Utterances: the total count of utterances produced during the structured task (i.e., an independent clause and its modifiers)
- Abandoned Utterances: utterances in which the speaker stopped mid-utterance resulting in a sentence fragment
- Type Token Ratio: Percent of different words to total words
- Words Per Minute: The number of wpm of sample
- Percent of Mazes used: Percent of maze words used as a percent of total words. Mazes include fillers (e.g., “uh”), repetitions, and revisions.

Inter- and intra-judge reliability for all discourse samples was derived in the following way. The examiner randomly chose and rescored 25% of the discourse samples. Ten percent of the discourse samples were also randomly chosen for rescoring by a second judge familiar with the scoring procedures, as is standard in discourse practice (Guendouzi & Muller, 2007, Flemming & Harris, 2008). The secondary judge had been trained in SALT transcription procedures via coursework, and by the examiner. This procedure was adapted from Flemming and Harris (2008). Intra-rate reliability was 96% for narrative discourse samples and 95% for procedural samples. Inter-rater reliability was assessed to be 98% for narrative samples and 97% for procedural samples.

Data Analysis

Means and standard deviations were calculated for all of the linguistic and procedural variables. Correlations were calculated between the cognitive and linguistic measures. The first aim of the study was to determine if there were relationships between cognitive function, discourse production, and time of day. The relationships between cognitive function and time of day were assessed via a two subject group by four time-of-day mixed model ANOVA calculated for BJLO scores. The probability of the F value for the main effect of subject group was expected to be less than $p = .05$, confirming the diagnoses of the experimental group as demonstrating decreased cognitive ability. The probability of the F value for the main effect of time-of-day was expected to be less than $p = .05$, indicating that there was a decline in cognitive function for all of the participants over time-of-day. A significant interaction between participant group and time-of-day was expected to reveal that the cognitive function of the AD group dropped off at a more rapid rate than that of the normal group. It was further hypothesized as part of the first aim of the study that measures of discourse would be affected by the declining cognitive function across the day. Correlation coefficients were calculated to assess the strength of the relationships between the difference in cognition from the first to last time of day and the differences from first to last time of day for each of the discourse measures.

The second and fourth aims of the study were to determine if the two participant groups differed in the manner in which the quality of their narrative and procedural discourse changed across the day. This possibility was assessed using MANOVA to compare the participant groups using the multiple dependent measures of change from 9:00 to 6:00 scores in abandoned utterances, percent utterances mazed, and type token ratio. If the MANOVA revealed a significant group difference at the $p < 0.05$ level, it was followed by ANOVAs comparing the

two groups for gains in each independent variable. The statistical significance of the MANOVA was judged using the F value. The third and fifth aims were to determine if the two participant groups differed in the manner in which the quantity of their narrative and procedural discourse changed across the day. This aim was evaluated using the same sequence of statistical procedures as the second and fourth aims applied to the quality measures derived from procedural samples.

CHAPTER FOUR RESULTS

The following section details the results of the current study. In summary, the BJLO was not found to be correlated with any linguistic variables, but did have a significant linear effect over time differentiating the two groups. A significant difference was found between the groups in narrative quality, specifically in the number of abandoned utterances across the day. No significant differences were found between the groups in narrative quantity, procedural quality, or procedural quantity. These results are described below for each specific aim.

Specific Aim 1

The first aim of the study was to determine if a relationship existed between measures of cognition and discourse across four times in a single day. It was hypothesized that changes in discourse elements would show a positive correlation with changes in the BJLO for both normal healthy aging participants and individuals with AD. This result was not found. The first step in answering this question was an analysis of change in BJLO across the day by the two groups. The second step involved calculating correlation coefficients between BJLO changes across the day with changes in the linguistic variables.

Figure 2 shows the average participant group scores as a function of time of day with associated standard error of estimates. The healthy aging group demonstrated an initial drop from 9AM to 12PM that flattened out for the rest of the day. The AD group showed a decline across the whole day that occurred more rapidly throughout the day.

DIURNAL PATTERN OF BJLO SCORES IN AGING AND ALZHEIMER'S DISEASE

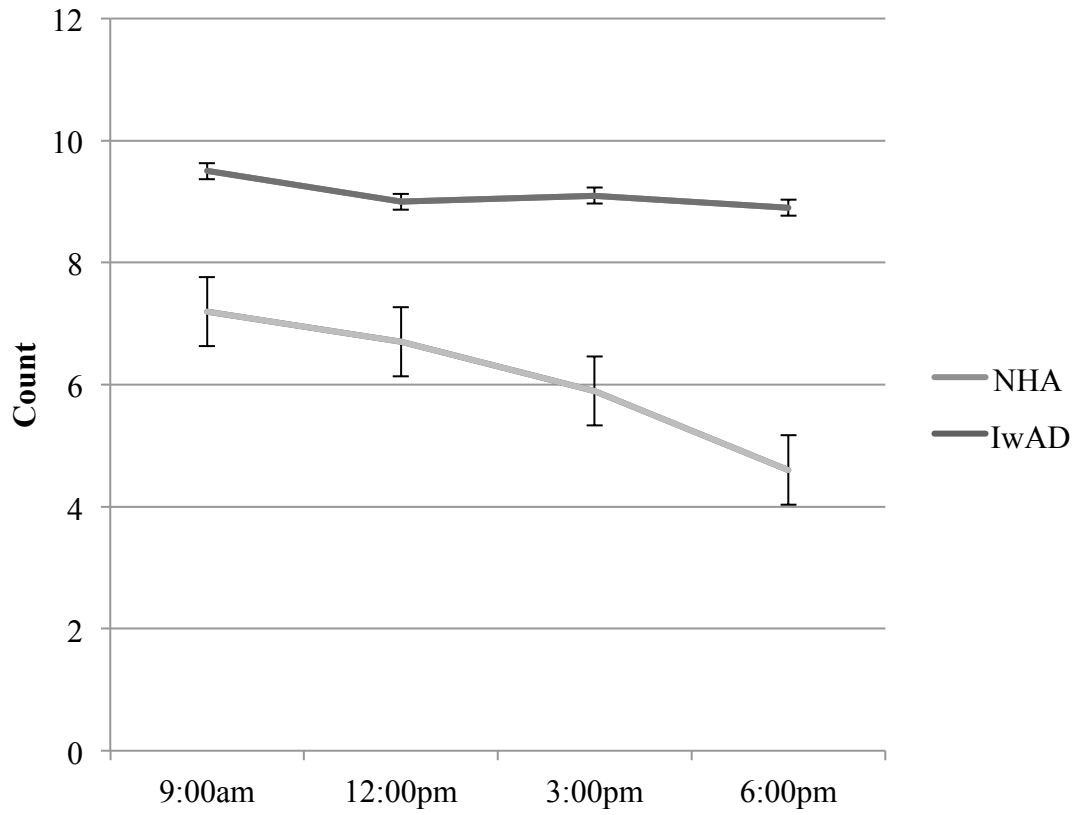


Figure 2. Results of BJLO performance across the day in NHA and individuals with AD with standard error bars. There was a significant group difference on performance and a significant linear effect. The BJLO did not correlate with any linguistic measure used within the study.

A 2 x 4 (Participant Group[Normal Healthy Aging, Alzheimer's Disease]) x Time of Day [9:00, 12:00, 3:00, 6:00]) mixed model analysis of variance showed that the apparent fall in BJLO as a function of time-of-day was significant, $F(3,16) = 3.564$, $p < .020$, $\eta^2 = .38$.

However, the Participant Group by Time of Day interaction failed to reach significance, $F(1,18) = 1.778$, $p < .162$, $\eta^2 = .37$, indicating that the BJLO scores of both groups were falling at approximately the same rate. As expected, the overall difference between participant groups was significant, $F(1,18) = 5.082$, $p < .037$, $\eta^2 = .21$.

Correlation coefficients were calculated between the difference in BJLO scores between 9 o'clock and 6 o'clock and the change that occurred over this time period in the linguistic measures. From highest to lowest these correlations were Abandoned Utterances ($r(18) = .303$, $p < .194$), Total Utterances ($r(18) = .206$, $p < .383$), Percent Mazed ($r(18) = .165$, $p < .487$), Type Token Ratio ($r(18) = .133$, $p < .577$), and Words per Minute ($r(18) = -.081$, $p < .733$). None of these correlations reached statistical significance.

These results indicate that BJLO scores drop as a function of time of day. This drop affected both groups equally. The drops in BJLO were not significantly correlated with the change across the day in any of the linguistic measures. This result indicates that the cognitive function necessary to perform on the BJLO, such as visual-spatial processing, decline across the day, and this does not include linguistic skills. This may indicate that linguistic skills and other cognitive functions remain relatively separate and have differentiating effects of circadian rhythms.

Specific Aim 2

The second aim of the study was to determine if a statistically significant difference existed between individuals with AD and aging participants on narrative discourse quality. It was hypothesized that measures of abandoned utterances, mazes, and TTR in narrative discourse would increase across the day for both normal healthy aging participants and individuals with AD, with the individuals with AD participants showing a steeper decline than normal participants. This prediction was partially upheld. Tables 2a and 2b show the means and standard deviations for the narrative variables across time in both groups. Two of the positive indicators of discourse structure, Total Utterances and Type Token Ratio both appear to decrease in frequency during the day. Total Utterances decline between 3:00 PM and 6:00 PM. Type Token Ratio declines between 9:00 am and 12:00 PM. Words per Minute vary up and down throughout the day. The two negative indicators of discourse production, Abandoned Utterances and Percent Mazing, appear to increase between 9:00 AM and 12:00 PM.

Table 2a

Descriptive Statistics of Linguistic Narrative Variables of the Aging group

Variable	Minimum	Maximum	Mean	Std. Dev.
Total Utterances				
9:00am	19	38	30	5.91
12:00pm	21	40	31	6.40
3:00pm	22	35	29	3.79
6:00pm	14	35	27	6.68
Type Token Ratio				
9:00am	0.50	0.67	0.56	0.05
12:00pm	0.41	0.61	0.51	0.06
3:00pm	0.45	0.59	0.52	0.05
6:00pm	0.43	0.61	0.52	0.05
Words Per Minute				
9:00am	76.50	164.00	121.68	26.06
12:00pm	111.07	182.00	146.58	23.23
3:00pm	83.44	181.94	132.68	33.83
6:00pm	96.29	200.34	129.70	34.16
Abandoned Utterances				
9:00am	0.00%	10.53%	5.04%	3.96%
12:00pm	3.03%	23.81%	9.51%	6.47%
3:00pm	3.45%	20.00%	12.32%	4.55%
6:00pm	6.06%	20.00%	13.15%	4.66%
Percent Mazed				
9:00am	17.65%	50.00%	29.51%	7.42%
12:00pm	22.92%	42.42%	31.90%	7.32%
3:00pm	17.24%	40.01%	30.24%	17.86%
6:00pm	17.24%	78.57%	35.5%	5.74%
BJLO				
9:00am	6	14	9.5	2.51
12:00pm	4	14	9	3.16
3:00pm	4	14	9.1	3.31
6:00pm	4	15	8.9	3.63

Table 2b

Descriptive Statistics of Linguistic Narrative Variables of the Alzheimer's disease group

Variable	Minimum	Maximum	Mean	Std. Dev.
Total Utterances				
9:00am	10	38	21	7.69
12:00pm	13	39	21	8.19
3:00pm	15	37	21	6.55
6:00pm	12	35	19	7.04
Type Token Ratio				
9:00am	0.47	0.77	0.59	0.08
12:00pm	0.46	0.71	0.57	0.08
3:00pm	0.45	0.80	0.57	0.11
6:00pm	0.39	0.74	0.57	0.03
Words Per Minute				
9:00am	47.70	188.43	102.98	41.38
12:00pm	55.00	214.00	111.01	46.39
3:00pm	36.69	171.00	104.62	40.33
6:00pm	49.76	167.00	112.31	34.42
Abandoned Utterances				
9:00am	0.00%	26.92%	8.91%	8.66%
12:00pm	0.00%	47.37%	11.10%	13.66%
3:00pm	0.00%	21.62%	10.10%	6.66%
6:00pm	0.00%	18.75%	8.71%	6.41%
Percent Mazed				
9:00am	18.42%	100.00%	52.50%	23.80%
12:00pm	13.33%	76.92%	40.01%	24.41%
3:00pm	14.29%	76.74%	41.30%	21.72%
6:00pm	11.54%	83.33%	46.43%	21.83%
BJLO				
9:00am	4	12	7.2	2.58
12:00pm	3	11	6.7	2.86
3:00pm	1	12	5.9	3.23
6:00pm	0	10	4.6	3.48

A one-way multivariate analysis of variance (MANOVA) was conducted to determine the effect of Participant Group [Normal Healthy Aging, Alzheimer's disease] on the change in measures of linguistic quality from the 9:00 test period to the 6:00 test period (i.e., abandoned utterances, type token ratio, and percent mazes used). Significant differences were found between the aging and individuals with AD group for the combined dependent measures $F(3,16) = 5.91, p = .007, \eta^2 = .52$.

Follow up ANOVAs for each gain score revealed a significant group difference for Abandoned Utterances, $F(1,18) = 8.777, p < .008, \eta^2 = .34$, but not Type Token Ratio, $F(3,16) = 2.30, p = .116, \eta^2 = .302$, or Percent Mazes, $F(1,18) = 1.529, p < .232, \eta^2 = .101$. Figure 3 shows the average scores of the two groups across time of day for abandoned utterances, percent of utterances mazed, and type token ratio. The normally aging group increased their production of abandoned utterances while decreasing their use of mazing and lowering of type token ratio. The individuals with AD lower their use of abandoned utterances, percent mazes, and type/token ratio.

DIURNAL PATTERN OF NARRATIVE QUALITY

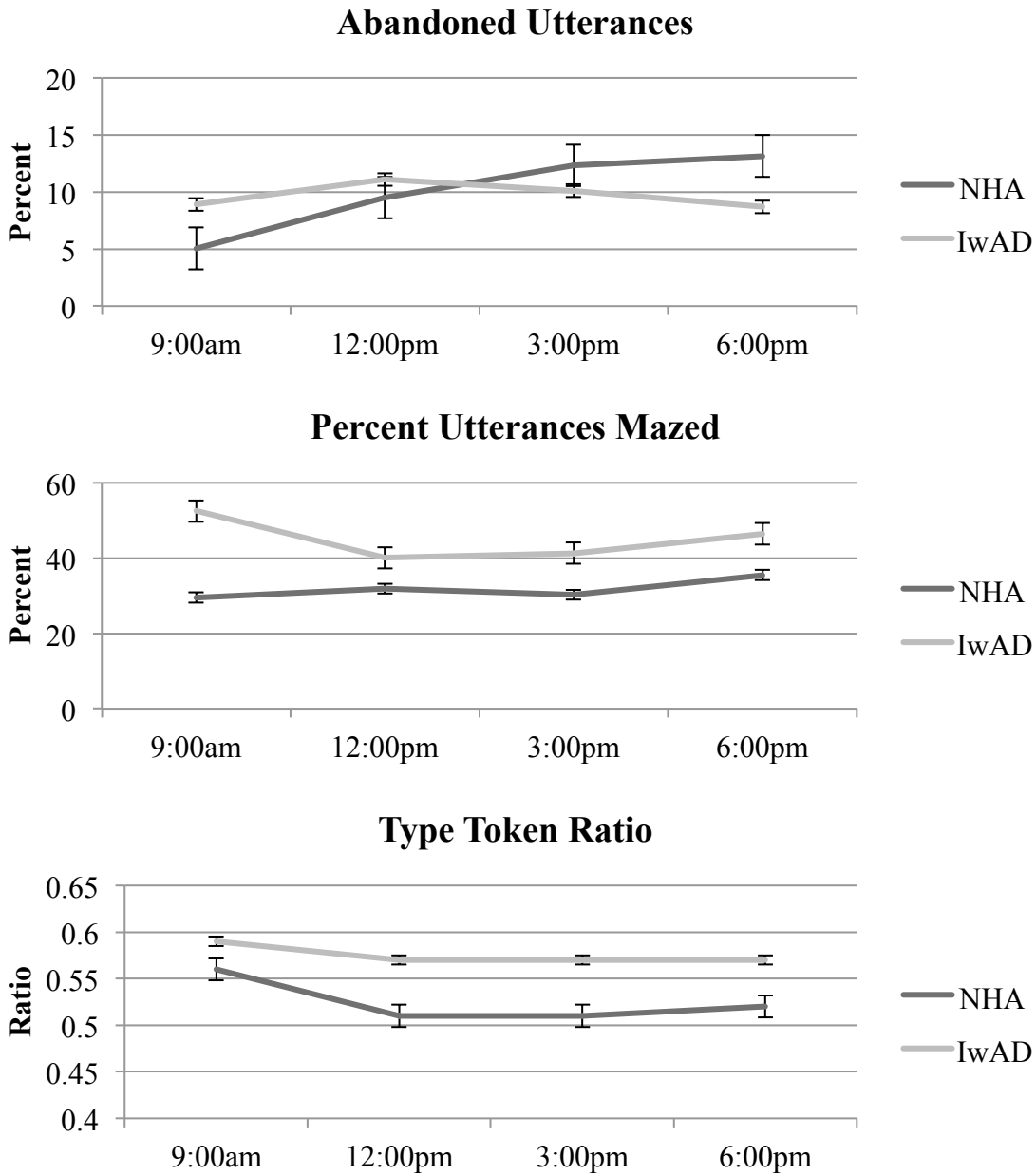


Figure 3. Average performance across the day on measures of narrative quality (abandoned utterances, percent of mazes, TTR) in NHA and individuals with AD with standard error bars. A significant difference was found between the two groups on measures of quality. Follow-up tests revealed that performance on abandoned utterances was significantly different across groups. Percent mazes used and TTR were not found to differ between the groups.

In summary, these results indicate that the groups differed in their trends in production of abandoned utterance but not the other variables. Normally aging individuals tended to abandon utterances at an increasing rate while the AD group abandoned utterances at a steady rate across the day. Though trends in the data were observed in narrative quality no other variables were significant either across group or across time.

Specific Aim 3

The third aim of the study was to determine if a statistically significant difference existed between individuals with AD and aging participants at four times of day on procedural discourse quality. It was hypothesized that measures of abandoned utterances and mazes in procedural discourse would increase across the day for both normal healthy aging participants and individuals with AD, with the individuals with AD participants showing a steeper decline than normal participants. This hypothesis was not supported by the data. Tables 3a and 3b show the means and standard deviations of the procedural linguistic variables for both groups. Total Utterances and Words per Minute increased from 9:00AM to 12:00PM while Type Token Ratio decreased during this time period. Abandoned Utterances and Percent Mazed varied up and down.

Table 3a

Descriptive Statistics of Linguistic Procedural Variables of the Aging Group

Variable	Minimum	Maximum	Mean	Std. Dev.
Total Utterances				
9:00am	0.67	4.33	1.90	1.33
12:00pm	0.80	6.00	2.07	1.66
3:00pm	1.00	2.67	1.92	0.65
6:00pm	0.67	6.33	2.31	1.54
Type Token Ratio				
9:00am	0.10	0.33	0.20	0.09
12:00pm	0.10	0.33	0.18	0.07
3:00pm	0.10	0.27	0.17	0.06
6:00pm	0.12	0.30	0.19	0.06
Words Per Minute				
9:00am	13.94	26.40	21.68	4.20
12:00pm	8.42	39.47	25.42	9.19
3:00pm	11.56	56.00	25.35	12.62
6:00pm	9.17	67.89	36.72	23.14
Abandoned Utterances				
9:00am	0.00%	2.56%	0.26%	0.81%
12:00pm	0.00%	6.67%	1.04%	2.29%
3:00pm	0.00%	3.64%	0.36%	1.15%
6:00pm	0.00%	4.76%	0.76%	1.67%
Percent Mazed				
9:00am	0.00%	16.67%	4.28%	5.38%
12:00pm	0.00%	13.33%	5.56%	4.20%
3:00pm	0.00%	22.00%	6.97%	6.59%
6:00pm	0.00%	13.33%	4.56%	5.45%

A MANOVA was conducted to determine the effect of group membership on measures of linguistic quality across the day. No significant differences were found between the NHA and individuals with AD group on the dependent measures, $F(3,16) = .849, p = .487, \eta^2 = .137$.

Table 3b

Descriptive Statistics of Linguistic Procedural Variables of the Alzheimer's disease Group

Variable	Minimum	Maximum	Mean	Std. Dev.
Total Utterances				
9:00am	0.40	3.33	1.82	1.11
12:00pm	1.33	7.33	2.55	1.78
3:00pm	0.80	6.33	3.01	1.66
6:00pm	0.80	4.33	2.03	1.06
Type Token Ratio				
9:00am	0.10	0.29	0.16	0.05
12:00pm	0.11	0.23	0.17	0.04
3:00pm	0.10	0.24	0.17	0.05
6:00pm	0.11	0.23	0.16	0.05
Words Per Minute				
9:00am	8.25	42.44	19.95	9.58
12:00pm	10.33	57.32	28.89	15.25
3:00pm	16.47	51.54	28.96	11.53
6:00pm	12.41	37.86	37.86	6.96
Abandoned Utterances				
9:00am	0.00%	4.29%	0.43%	1.36%
12:00pm	0.00%	6.67%	1.19%	2.22%
3:00pm	0.00%	6.67%	1.43%	2.52%
6:00pm	0.00%	11.11%	1.97%	3.68%
Percent Mazed				
9:00am	0.00%	27.78%	9.88%	8.59%
12:00pm	0.00%	27.27%	6.82%	8.23%
3:00pm	0.00%	26.67%	9.63%	7.76%
6:00pm	0.00%	16.67%	6.97%	5.33%

Measures of TTR, mazes and abandoned utterances remained relatively flat across the day. Both groups produced relatively few abandoned utterances during the procedural samples, and produced a very low percentage of mazes across the day. TTR also did not change substantially across the day. In summary, these measures of procedural quality are not as susceptible to changes in diurnal patterns. This is in contrast to measure of narrative quality.

Specific Aim 4

The fourth aim of the study was to determine if a statistically significant difference existed between individuals with AD and aging participants on narrative discourse quantity

(wpm and total utterances). It was hypothesized that measures of total utterances and words per minute would decline across the day in narrative discourse for both normal healthy aging participants' individuals with AD, with the individuals with AD participants showing a steeper decline than normal participants. This was not found. A MANOVA was conducted to determine the effect of group membership on measures of linguistic quantity across the day. No significant differences were found between the NHA and individuals with AD group on the dependent measures $F(2,17) = .516, p = .074, \eta^2 = .264$. Since the MANOVA was non-significant for these measures of quantity, no follow-up tests were conducted.

Normal aging participants produced more total utterances and words per minute as expected, but there was no significant trend across the day. Variables remained relatively flat across the day for both groups (see Figure 4). This indicates that though NHA participants perform better on measure of narrative quantity, these variables are not susceptible to changes in diurnal rhythms.

DIURNAL PATTERN OF NARRATIVE QUANTITY

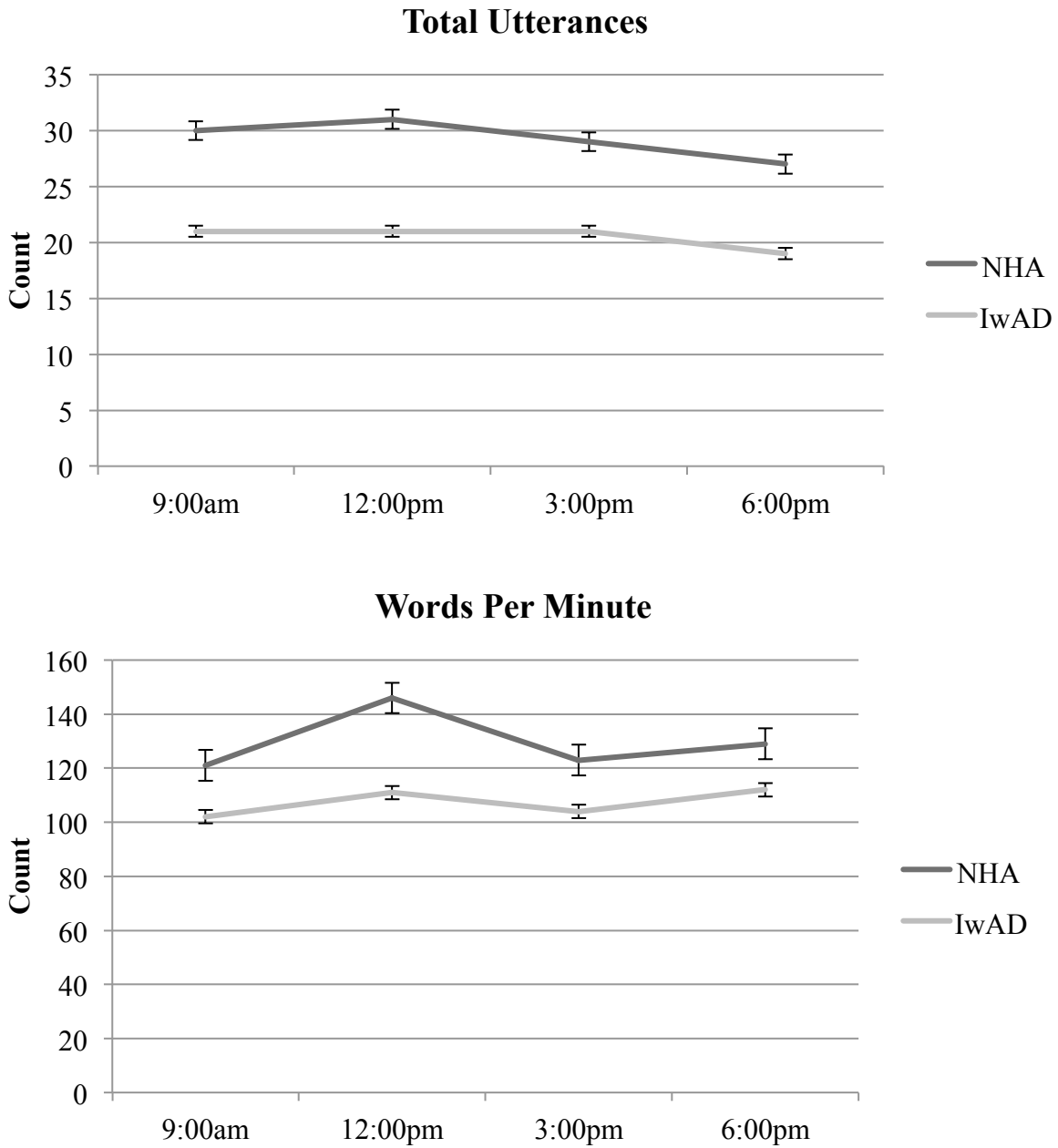


Figure 4. Average performance across the day on measures of narrative quantity (total utterances, wpm) in aging and individuals with AD with standard error bars. No statistical differences were found.

Specific Aim 5

The final goal of the study was to determine if a statistically significant difference existed between individuals with AD and aging participants at four times of day on quantity of procedural discourse. It was hypothesized that measures of total utterances and words per minute would decline across the day in procedural discourse for both normal healthy aging participants' individuals with AD, with the individuals with AD participants showing a steeper decline than normal participants. This result was not found. A MANOVA was conducted to determine the effect of group membership on measures of linguistic quality across the day. No significant differences were found between the NHA and individuals with AD group on the dependent measures, $F(2,17) = 1.24, p = .315, \eta^2 = .127$.

Total utterances increased approximately ten utterances from 9 o'clock to 6 o'clock. Words per minute increased as the day progressed in NHA participants (see figure 5), but remained relatively flat for individuals with AD; however, no significant difference was found over time for wpm. Like narrative discourse, measures of procedural quantity are not susceptible to changes in diurnal rhythms.

DIURNAL PATTERN OF WORDS PER MINUTE ON PROCEDURAL TASK

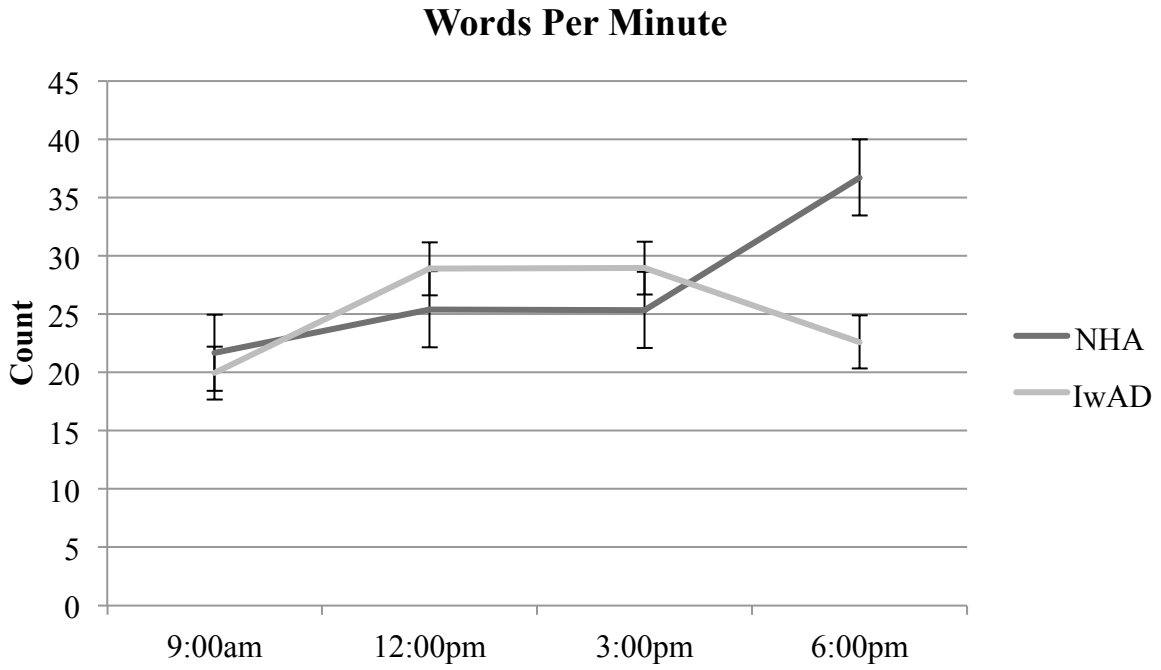


Figure 5. The diurnal pattern of wpm across the day in NHA and individuals with AD with standard error bars. There was no significant difference between the two groups.

CHAPTER FIVE DISCUSSION

The purpose of this descriptive study was to investigate if language discourse followed a diurnal pattern across a single 10-hour day in aging individuals and individuals with AD. It was expected that some linguistic elements would be susceptible to changes in diurnal patterns, and that individuals with AD would show a steeper decline across the day than NHA. Five aims guided the study:

- Specific Aim 1: Determine if a relationship exists between measures of cognition and discourse across four times in a single day.
- Specific Aim 2: Determine if a statistically significant difference exists between individuals with AD and healthy aging participants at four times a day on quality of narrative discourse.
- Specific Aim 3: Determine if a statistically significant difference exists between individuals with AD and healthy aging participants at four times a day on quality of procedural discourse.
- Specific Aim 4: Determine if a statistically significant difference exists between individuals with AD and healthy aging participants at four times a day on quantity of narrative discourse.
- Specific Aim 5: Determine if a statistically significant difference exists between individuals with AD and healthy aging participants at four times a day on quantity of procedural discourse.

The discussion section is divided into four major sections. In the first section, results are discussed as they relate to the major findings of the study. In the second section, limitations and future directions are discussed. In the third section, the clinical implications of the study are discussed, and in the final section, conclusions from the study are made.

Findings of the Current Study

This section will include the current findings of the study as they relate to the cognitive correlation results, narrative discourse results, and procedural discourse results.

Cognitive Correlations

Correlations were computed among the measure of change in the BJLO and the measures of change in the linguistic measures (i. e., wpm, total utterances, TTR, percent mazes, abandoned utterances). The BJLO, the measure of relative cognitive status, was highly correlated with group membership but not with other linguistic measures. The aging group produced little change in BJLO across the day, while demonstrating changes in several linguistic measures. The individuals with AD group showed the opposite pattern, with declining BJLO scores with little change in performance on linguistic measures.

There was a significant difference in BJLO scores across the day. The aging group averaged 9.5 out of 15 at 9:00am and declined to only 8.9 by 6:00pm. The individuals with AD group showed a steeper decline, with an average score of 7.2 at 9:00am that declined to 4.6 by 6:00pm (see Figure 2). In addition, there was also a significant linear trend for the BJLO across the day. This trend suggests that cognitive performance decreases at a relatively stable rate across the day. These results are consistent with a literature documenting cognitive decline in both aging and individuals with AD groups (e.g., Bayles & Tomoeda, 2007; Kemper et al., 2001).

It was hypothesized that the BJLO scores would decline across the day for both groups; however, it was not expected that BJLO scores would not correlate with any of the linguistic variables. Literature indicates that people with AD maintain relatively functional communication skills until later stages of the disease process (Bayles & Tomoeda, 2007;

Hamilton 1994a, 1994b). As the cognition of the individuals with AD declined, they were able to maintain relatively functional discourse. One possible reason for this is that the measures used in this study were not sensitive enough to detect changes across the day. Another possible explanation is that language and cognition are separate capacities that can function relatively independently of one another during this stage of decline. Language may also have been maintained because it is relatively robust and relies heavily on previously learned scripts and schemas.

Narrative Data

It was hypothesized that measures of narrative discourse quantity would decline across the day for both normal aging participants and individuals with AD, with the individuals with AD participants showing a steeper decline than normal participants showed. The data did not support this hypothesis. No significant differences were found between the groups. This included measures of total utterances and wpm.

Both groups showed a decline in the number of total utterances produced across the day, with the aging group demonstrating a steeper decline. On average, the NHA group produced 30 utterances at 9:00am and 27 at 6:00pm. Six of the ten participants in this group produced fewer utterances as the day progressed, with two participants producing nearly 10 fewer utterances at the end of the day. Four participants showed an increase in utterances across a day. Individuals with AD showed less decline across the day, with an average of 21 utterances at 9:00am and 19 at 6:00pm. Eight of the ten participants in this group showed a pattern of decline, while two showed an increase in total utterances. These data conflict with Ripich and colleagues (1998), who found that individuals with AD demonstrated fewer overall utterances than aging participants.

Words per minute (wpm) showed a relatively flat pattern of performance across the day for both groups. On average, the NHA group produced 130 wpm while individuals with AD produced only 108 wpm. NHA participants produced more wpm on average than individuals with AD did, and this was consistent across the day. These preliminary results indicate that the quantity of discourse produced does not change significantly across the day in the two groups.

In addition to changes in quantity, it was hypothesized that measures of narrative quality (i.e., abandoned utterances, mazes, and type token ratio) would decrease across the day for both normal healthy aging participants and individuals with AD, with the individuals with AD participants showing a steeper decline than normal participants. This hypothesis was supported by a significant difference between the groups in terms of measures of quality. Follow-up ANOVAs revealed that abandoned utterances were significantly different across the day by group. The NHA group went from 5% abandoned utterances at 9:00am to 13% by 6:00pm. The individuals with AD group, on the other hand, stayed relatively flat, at nearly 9% across the day. It was hypothesized that individuals with AD would show a steeper rate of decline than the NHA group; however, as in previous linguistic measures, the individuals with AD group remained relatively flat in performance in abandoned utterances. Conversely, the NHA showed a steady increase in abandoned utterances. An increase in abandoned utterances contributes to the diminished quality of discourse. In addition, this increase may be an indication that NHA subjects have difficulty finding words at the end of the day, a commonly cited concern.

No significant differences were found between the groups in the measure of mazes across the day. Nearly 30% of the NHA group's utterances contained mazes at 9:00am, while the individuals with AD groups contained 52% mazed utterances. Across the day, the NHA group

increased slightly, while the individuals with AD group declined slightly, decreasing the gap of their difference to only 10%.

Measures of TTR were also non-significant across the day. However, contrary to the hypothesis, NHA participants demonstrated a lower TTR across the day than the individuals with AD group. At 9:00am, the NHA group had a TTR of .56 versus the individuals with AD group at .59. These scores declined to .52 and .57, respectively by 6:00pm. This result is not consistent with Bucks, Singh, Cuerden, & Wilcock (2000), who suggested that NHA participants produce richer speech, based on higher TTR in NHA participants. On the other hand, it is possible that individuals with AD produced more linguistically diverse narratives because they skipped from topic to topic in previous studies (Bayles & Tomoeda, 2007; Garcia & Orange, 1996).

In summary, the results of the narrative measures across the day indicate that the percent of abandoned utterances variable was susceptible to changes in circadian rhythms. Additionally, though other variables did not demonstrate significant differences, group differences were found. Abandoned utterances may represent a stronger link to inhibitory and memory processes, leaving it more susceptible to effects of changing rhythms.

Procedural Data

In addition to tracking linguistic variables across the day in narrative discourse, the same variables were also examined in procedural discourse. It was hypothesized that measures of quantity and quality would decrease across the day for both normal healthy aging participants and individuals with AD, with the individuals with AD participants showing a steeper decline than normal participants. No significant differences were found in any of the linguistic variables between groups across time. Nearly all variables, with the exception of WPM remained

relatively flat across the day. WPM increased across the day for NHA participants rising from 21 wpm at 9:00am to 36 wpm at 6:00pm.

These results are similar to a study conducted by Ulatowska and colleagues (1988) that compared 10 subjects with AD and 10 without on linguistic measures in procedural discourse. Results of the study found no differences on numerous linguistic measures, including T-units; words per t-unit; clauses per t-unit; word dependant clauses; wpm; and incorrect sentences. AD subjects did produce more abandoned utterances than persons without AD did, and AD subjects provided fewer a priori propositions than those without. The study also showed that AD subjects produced more irrelevant or incorrect propositions. In the current study, individuals with AD produced more mazes and abandoned utterances, as well as lower TTR. This result supports Ulatowska and colleagues (1988) findings indicating that individuals with AD do not perform as well on procedural discourse as typical aging people do. Examples of procedural samples from both groups follow:

Individuals with AD Subject Response:

- “Well, ya need to, what you got (uh) wrote in there. And then put your stamp on it and put it in the mailbox or (the a) the post office, whichever one you got.”
- “Gotta find the right key, for one thing, the main thing, and put it in there and unlock it. If you don’t have the right key you can’t do it, you gotta be sure (you) you have the right key

NHA Subject Response:

- “Well, you first have to have a key that you know that fits. (laughs) If you use a key or a (um) you might have a deadlock, might do that first, and then you use a key, and open the door!”

- “Well, if you’re gonna do it in the oven you turn the oven on. And you butter the toast. And (broil?) it, and then put your jelly on it. And if it’s a toaster you put it in the toaster, and push the little lever down, and bring it out and butter it and put your jelly on it.”

The examiner’s impression was that individuals with AD had a more difficult time than NHA subjects in producing the steps in procedural discourse. The procedural data have not been evaluated for the correctness of the steps given, and perhaps further group differences would arise from such a content analysis. Studies evaluating the content of procedural samples in AD populations have shown that AD subjects produce fewer steps overall, and fewer correct steps in a procedure. They also ask more clarification questions, indicating that they have difficulty interpreting directions or remembering previously used steps.

As discussed in the literature review, procedural discourse requires a myriad of cognitive skills, including memory, sequencing, organization, and linguistic skills. The findings of the current study are consistent with previous studies that showed procedural discourse is linked with cognitive abilities (Ripich et al., 1998; Ulatowska et al., 1997). As cognitive skills deteriorate, the ability to produce quality discourse also deteriorates (Ripich et al., 1995; Tomoeda & Bayles, 1993). In the current study, individuals with AD produced fewer utterances, and these utterances were not as diverse, more aborted, and less fluent. However, it appears as though people with mild to moderate deficits still have enough preserved ability to complete the task.

The mounting evidence that cognitive functions are affected by circadian rhythms (Schmidt et al., 2007) motivated this study. Since language processing entails a multitude of cognitive processes to function adequately, it seemed likely that circadian rhythms would also

affect the language system. Few studies have attempted to examine language processing or production for diurnal patterns. Reinberg and colleagues (1988) found diurnal patterns of pre-lexical access to syllables and sentences in children. Oakhill (1986a, 1986b, 1988) showed a relationship between language memory and circadian rhythms. Auditory perception, spelling, and voicing have also been examined diurnally (Folkard, 1975; Morton & Diubaldo, 1993, 1995). These studies showed mixed results, indicating that some aspects of language are vulnerable to circadian rhythms, and others are relatively stable. This is consistent with the results found in the current study.

Yaretsky and colleagues (1995, 1996) examined word fluency in dementia subjects. Their results indicated that word fluency measures are tied to a diurnal pattern, but only for those subjects not severely cognitively deficient. The results of the current study corroborate these results by suggesting that a floor effect may exist in some language measures and that more sensitive measures may be needed to eliminate a floor effect. In addition, circadian rhythms exert a larger effect on individuals with higher cognitive status.

Limitations and Future Directions

Limitations

Several limitations exist in the current study. Because of the small sample size, results cannot be generalized to the larger aging and AD population. Another limitation of the current study is the possible influence of external variables on the measures. Several possible confounds have been suggested in the measurement of data across a day. Meals have been shown to effect cognitive performance across the day, as well as shift work, exercise, and napping (Folkard, 2008). Since the current study did not control for these extraneous variables, it is possible that events, such as mealtime could have played a significant role in task performance. Furthermore,

when group size is small, it is more essential to control for subject variability to maximize group differences. One possible solution to these confounds is to use a constant routine design, which controls for participant differences by enacting or choosing participants of a similar daily routine. It may also be beneficial to assess levels of fatigue at the end of the day or motivation to determine if they affect performance.

The MEQ was chosen in this study to provide information about participants' self-reported circadian rhythms. Every patient in the current study was scored as a "morning type," and while it is likely the majority of participants would be scored as such because of age related shifts, it is unlikely that all participants would have been the same type. This may indicate that the tool is not sensitive enough to detect subtle differences in perceived rhythms or is biased towards age-related changes. The Munich Chronotype Questionnaire (Roenneberg et al., 2003; MCQ) is a tool developed more recently that has shown good reliability and validity in adult populations. This tool was not originally chosen because of its lack of use in the circadian literature. The MCQ has been shown to be highly correlated with physiologic measures of circadian rhythms and the MEQ. In a comparison study of the MEQ and the Munich Chronotype Questionnaire, the test subjects performed similarly, but the Munich questionnaire provided additional information about health and behavior that the MEQ did not, thus leading to a better picture of perceived rhythms (Zavada, Gordijn, Beersma, Daan, & Roenneberg 2005). Additionally, the Preferences Scale (Smith et al., 2002) has shown good validity in younger adults measuring circadian rhythms. A comparison of morning and evening preference tools may be warranted prior to further investigations.

Future Directions

Several future directions could be taken with this current line of research. The first would be to analyze additional variables already present within the data, such as pauses, essential steps, and content analysis. Ripich and colleagues (1997) analyzed essential and non-essential steps within procedural questions. Since the procedural questions were adapted from that same study, it seems necessary to investigate if similar results of Ripich and colleagues (1997) are replicated within the current data set, as well as if the steps had a diurnal pattern. Several studies have indicated that the speech of people with AD is vaguer and less definite than people without. An investigation into the content of the samples could provide further important information into the quality of AD discourse. Furthermore, the TTR discrepancies between the aging group and the individuals with AD group could indicate whether individuals with AD stay less on topic or use fewer scripts. The inclusion of a listener rater scale of cohesion and coherence could determine if the average listener could tell the difference between the NHA and the individuals with AD group. Another follow-up investigation could include the testing of subjects over two or more days to investigate the test-retest reliability of the measures.

Further investigating the nature of the abandoned utterances may yield some interesting results. The nature of the revision could be different for different groups. Some revisions may be for content, while some may be for syntax. Also following these abilities over time may provide some evidence to when these abilities deteriorate over time and in which order. Since the data revealed that the cognitive measure, the BJLO, deteriorated first, and then other linguistic measures changed at a slower rate, tracking these changes over time could provide information on cognitive persistence. This may also be achieved by incorporating a more severe AD group in a cross sectional design.

Follow-up studies should include more rigorous control of external variables, by recruiting more homogenous groups. This includes controlling for possible meal effects, work patterns, and exercise. Future studies could also include the correlation of physiological measures to linguistic ones. Measures of blood pressure, temperature, and heart rate have been used to indicate subtle changes in circadian rhythm; this could provide a clearer picture on individual variations in rhythms. The inclusion of additional cognitive measure to track cognition could provide further information about the overall status of cognition. The MMSE has been shown not to be sensitive enough to track daily changes and for this reason the BJLO was chosen. Other cognitive measure, such as clock drawing, blocks, and mazes may provide cognitive correlates with linguistic changes. Finally, the investigation into other types of discourse, such as conversation, could provide valuable information to the real-life performance of NHA and individuals with AD across the day.

Clinical Implications

The results of this study have clinical implications for both the NHA population and those with Alzheimer's disease. These results support previous evidence that discourse is sensitive to cognitive decline. It has been suggested that discourse could be used as an effective intervention tool in communicatively impaired people (Erber, 1994; Ripich et al., 1998). It is also important to identify at what point discourse becomes disordered, possibly to contribute to diagnostic assessment. The results of this study indicate that discourse remains relatively constant across the day at this level of AD severity and in NHA. This means that discourse is reliably measured at any time of day indicating the discourse therapy and intervention can be executed at any time during these levels of cognition.

Conclusions

The results of this study add preliminary findings in the areas of language change in NHA and AD and diurnal patterns of language. The results of this study add to a long line of evidence showing cognitive decline in Alzheimer's disease. On most linguistic variables, AD subjects performed poorer than their aging counterparts did (Total utterances, words per minute, percent mazes, percent abandoned utterances). This study also suggests that the performance on the BJLO and narrative discourse quality are susceptible to changes in diurnal rhythms. Evidence from this study could contribute to the small but growing body of literature documenting changes in language across a day. To our knowledge, this is the first study to investigate language discourse across a single day for diurnal patterns. Perhaps most importantly, this study provides further evidence that the effects of diurnal variation on language diminish as cognition declines. Further research is needed in these areas to identify factors that contribute to cognitive and language change, which is imperative to understanding cognitive health and better serving aging populations.

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APPENDIX A: CONSENT FOR PARTICIPATION

Study: Time of Day effects on Language Discourse in Healthy Aging and Dementia

Location: Baton Rouge Community

Investigators: Amanda Stead, the primary investigator, is available for questions at 225-328-7844 (astead1@gmail.com). Additionally, this study is being conducted under the direction of the Dr. Paul Hoffman 225-578-3937 (cdhoff@lsu.edu). Investigators may be contacted at anytime, if they are not available, you may leave a message and they will return your call.

Purpose of the Study: To investigate time of effects on language discourse

Procedures:

A. First, you will complete several tests to see if you qualify for the study. They will include hearing screening, vision screening, a cognitive screener, a language test, a language sample, and some questionnaires. The questionnaires are about personal history and sleep patterns and preferences. If you are able to pass these tests, you will be enrolled in the study. If you cannot pass these tests or you do not have a full day to commit to the study, you are finished with the study.

B. If you pass the tests taken in Part A you will be enrolled in a study that will include 15 people who are normal healthy aging or have mild dementia. You will be asked to provide language samples 4 times across a day and take two short tests at each sample. Each session will take approximately 30 minutes, and will occur at or near 9:00am, 12:00pm, 3:00pm, and 6:00pm. During each visit you will be asked to talk about a personally relevant event, such as your work history or family, as well as asked to describe the steps of a common task (ex. Making a peanut butter and jelly sandwich). You will also be asked to identify several lists of colors or words, and you will take a short test where you must identify specific lines coresponding to a lined template.

Potential benefits/Risks to the participant: There is no monetary benefit for participating in this research. This study will benefit mankind by expanding our knowledge about aging and dementia. There are no risks associated with this study

You can stop participating in the study at any time you want. We will not hold it against you. We will be glad to include you in future studies even if you decide to stop participating in this one.

(Consent form is continued on next page)

Initials of participant/caregiver

Consent Form, Page 2

Everything about you being in this study will be kept secret. Only the people that work on this study will be able to see your records. All information about your participation will be coded and your name and all other information about you will be removed. We keep all of your records in locked file cabinets or in password-protected computer files that other people cannot see on our computers. If the results of this research are published in a professional journal or meeting, you will not be identified in any way.

If you have any questions or concerns following the participation in this research, you may contact the primary investigator Amanda Stead at 225-329-7844 or by email at astead1@gmail.com or the co-investigator Dr. Paul Hoffman 225-578-3937 (cdhoff@lsu.edu). If you wish to contact the LSU-Institutional Review Board member for Communication Disorders, please call 225-578-3938.

If you have any questions about the study, you may ask the examiner at any time.

Thank you for your participation

To be completed by participant:

This study has been discussed with me and all of my questions have been answered. I may direct additional questions regarding study specifics to the investigators. If I have any questions about subjects' rights or other concerns, I can contact Robert C. Mathews, Chairman, LSU Institutional Review Board, 225-578-8692. I agree to participate in the study described above and acknowledged the researchers' obligation to provide me with a copy of this consent form signed by me.

Signature of Participant/Caregiver*	Date
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Signature of Examiner	Date
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To be completed by participants who cannot read:

The study subject has indicated to me that he/she is unable to read. I certify that I have read this consent for to the subject and explained that by completing the signature line above, the subject had agreed to participate.

Signature of Participant*

Date

Signature of Examiner

Date

APPENDIX B: BACKGROUND INFORMATION QUESTIONNAIRE

Thank you for participating in this research. You should have already read and signed the Consent Form. Please ask the examiner if you have any questions about your participation in this study, or if you have questions about any part of this questionnaire. Please do not write your name on this form. Participation is completely voluntary.

Sex (circle one) male female

Date of Birth (mm/dd/yy) _____

Highest level of education completed (circle one)

Elementary school High school Some college Technical School
College Graduate Post graduate studies Graduate degree

Where do you currently live? City _____ State _____

If you have lived at this location for less than 5 years, where did you previously reside?

City _____ State _____

Is English your primary language? Yes No

If NO, what is your primary language? _____

What is your occupation? _____

Do you have normal vision? (circle one) Yes No

If NOT, is it corrected by contact lenses or glasses? _____

Have you ever had a stroke or other neurological problems? (circle one) Yes No

If YES, when _____

If yes, please describe (include date) _____

Have you been diagnosed with "dementia" Yes No

If YES, how long ago, and by whom _____

Are you currently taking any medications? Yes No If YES, please list name and dose _____

Do you have any history of the following (circle either Yes or No for each)

Learning Disability	Yes	No	Seizure Disorder	Yes	No
Language Disorder	Yes	No	Psychiatric Illness	Yes	No
Drug or Alcohol Abuse	Yes	No	Depression	Yes	No

If yes to any of the above, please explain _____

Your responses to this questionnaire will only be identifiable by Subject ID and will be kept completely confidential.

Thank you again for your participation.

VITA

Amanda L. Stead, born April 1983 in Whitefish, Montana, spent the early years of her life in both Montana and Michigan. At the age of four, she moved to Wisconsin and graduated high school in 2001, and later from the University of Wisconsin-Madison in 2005. After college graduation, she moved to Louisiana and pursued both her Master of Arts and Doctor of Philosophy at Louisiana State University. Amanda's focus is on neurogenic speech-language disorders. Her research examines language and discourse within people who are healthy aging and in those with dementia and Alzheimer's disease across time. It is her goal to understand cognitive aging and turn research knowledge into evidence-based treatments that clinicians can use with adults who have communication disorders.