To my extraordinary husband, Don, my partner in this achievement
ACKNOWLEDGMENTS

First, I wish to thank my husband, Don, and Mom, without whose love and unwavering encouragement I would not have had the perseverance to fulfill my dream of completing this doctoral program.

In addition, I sincerely thank my mentor and committee chair, Jay Rosenbek, who inspired me to begin the program in the first place, and who provided intellectual guidance and moral support throughout the challenges of the program. It is because of him that I have become a scientist.

I also express the utmost gratitude to my committee, Lise Abrams, Lori Altmann, Leslie Gonzalez Rothi, and Michael Marsiske. It is not hyperbole to say that I would not have completed this program without the immense assistance and support I received from each and every one of these consummate professionals every step of the way. What they did to help me was well above and beyond the requirements of committee members, and I will always remember it.

I also thank my many wonderful friends and colleagues who encouraged and assisted me around every obstacle. In particular, I am forever indebted to Lisa LaGorio, with whom I experienced the many peaks and valleys over the years, and who not only served as my friend and confidant, but also as my independent judge for the scoring procedure. Furthermore, I am indebted to Nancy Schaeffer, librarian extraordinaire and friend, who guided me through the research process, from my very first day of school to the last. Additionally, I thank my friend Margaret Odom for her tireless smile and helping hand ensuring that I met every milestone.

For supporting the actual execution of my dissertation study, I would like to express my deepest appreciation to the many senior organizations and community
members throughout Northeast Florida who made it possible to recruit study participants, without whose help this project never would have been accomplished. Specifically, I wish to thank Mary Geer, Family Housing Management Company, Inc., and the residents at San Jose Manor, Linda and Bobby Rubens and the residents at Mount Carmel Gardens Apartments, Pam Melfi, St. Johns County Council on Aging, Inc., and the members of St. Augustine Coastal Community Center, Joanne Boatwright, Taylor Residences, and the residents at Taylor Apartments, Jeff Backfisch, Community and Senior Center Services, and the members of Mandarin Senior Center, and Vicki van Horn, St. Johns County Council on Aging, Inc., and all the members of The Ponte Vedra Players Community Senior Center. I would not have been able to conduct this study without their kindness, enthusiasm, and invaluable assistance.

Finally, I offer my heartfelt gratitude to my very special friends, Harvey Bradt, Moultrie Oaks, Tom and Maureen Humphrey, Humphrey Properties, Inc., Gary and Sue Brewster, and John Petherbridge, Larry Davis, and Bill Anderson, Petherbridge, Davis, and Company, P.A. If it had not been for their help, I would still be searching for subjects.
# TABLE OF CONTENTS

## ACKNOWLEDGMENTS

## LIST OF TABLES

## LIST OF FIGURES

## ABSTRACT

## CHAPTER

### 1 INTRODUCTION

#### Statement of Problem

#### Specific Aims

- Specific Aim 1: Note Fidelity
- Specific Aim 2: Recall and Recognition
- Specific Aim 3: Note Fidelity/Recall and Recognition
- Specific Aim 4: Cognitive Correlates

#### Research Hypotheses

- Hypothesis 1
- Hypothesis 2
- Hypothesis 3
- Hypothesis 4

### 2 LITERATURE REVIEW

#### Introduction

#### Cognitive Aging and Plasticity

- Cognition
- Language
- Cognitive Interventions

#### The Mechanism of Notetaking

#### Notetaking in Education

#### Notetaking in Adults

#### Notetaking in Older Adults

#### Note Fidelity

#### Notetaking Training

#### Cognitive Factors

#### Our Proposed Mechanism

- INPUT
- PROCESS
- OUTPUT

#### Summary

#### Notetaking Training Protocol
<table>
<thead>
<tr>
<th>Table</th>
<th>page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-1 Experimental procedure</td>
<td>80</td>
</tr>
<tr>
<td>4-1 Demographics for each group</td>
<td>96</td>
</tr>
<tr>
<td>4-2 Cognitive measures for each group</td>
<td>96</td>
</tr>
<tr>
<td>4-3 Outcome data for each group</td>
<td>97</td>
</tr>
</tbody>
</table>
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-1</td>
<td>Proposed mechanism for facilitating episodic memory improvement through systematic notetaking training.</td>
<td>67</td>
</tr>
<tr>
<td>3-1</td>
<td>CONSORT diagram for participant recruitment and group assignment.</td>
<td>79</td>
</tr>
<tr>
<td>4-1</td>
<td>Comparison of group means across sessions for note fidelity, with 95% confidence interval error bars.</td>
<td>98</td>
</tr>
<tr>
<td>4-2</td>
<td>Comparison of group means across sessions for recall, with 95% confidence interval error bars.</td>
<td>98</td>
</tr>
<tr>
<td>4-3</td>
<td>Comparison of group means across sessions for recognition, with 95% confidence interval error bars.</td>
<td>99</td>
</tr>
</tbody>
</table>
It is well documented that episodic memory declines with age, and in order to maintain functional independence, older adults must recall such critical information as medical advice. Notetaking is a strategy that has been shown to enhance episodic memory in school-age children and younger and older adults. Moreover, trained notetaking has been demonstrated to further augment recall. However, notetaking training has not been studied in older adults. In this study, we investigated the effects of a novel notetaking training protocol on note fidelity, free recall, and delayed recognition of spoken discourse in healthy adults aged 60 and older.

We alternately assigned participants to control and treatment groups of 24 subjects each. Each group was subdivided into smaller groups of one to four, and met for five 2-hour sessions over 3 weeks. All subjects took notes while listening to identical standardized audiotaped 4 ½ - minute narratives, but only treatment groups received notetaking lessons. Subjects subsequently produced free recall protocols without referring to their notes, and 10 minutes later completed standardized 24-item yes/no recognition tests. We compared groups on note fidelity, the number of accurate propositions written during the listening task, immediate free recall, the number of
accurate propositions written after the task, and recognition test scores. The treatment group produced significantly more accurate propositions in their notes and recall protocols and performed better on delayed recognition tests than controls. Treatment subjects showed significant positive correlations between change in note fidelity and change in recognition, and between change in recall and change in recognition, and the correlation between change in note fidelity and change in recall was positive, though it failed to reach significance. These results support positive effects of training.

We investigated cognitive correlates of subjects’ baseline and posttest performance, hypothesizing that working memory, processing speed, semantic and episodic memory, and executive control would predict outcomes. Correlational analyses confirmed that baseline performance was predicted by these measures. Episodic memory, vocabulary, and executive control predicted improvements from training.

These findings suggest that notetaking training may have value as a simple, cost-effective cognitive intervention for improving episodic memory in healthy older adults.
CHAPTER 1
INTRODUCTION

Statement of Problem

The population of individuals over the age of 65 is the fastest growing in the world. The World Health Organization (WHO, 2008, in Ballard, 2010) estimates that the number of older adults globally in 2025 will be 1.2 billion, growing to 2 billion by 2050. In the United States alone, individuals over 65 years of age currently comprise more than 13% of the population, and this percentage is expected to double within 30 years (U.S. Census Bureau, 2000, in Gazzaley & D’Esposito, 2007). With normal aging comes cognitive changes, some beneficial, some detrimental. Those that are detrimental, however, such as declines in episodic memory formation, e.g., recall of medical information, profoundly impact functional independence. Fortunately, numerous cognitive interventions for older individuals have proven to be effective for enhancement of the impaired processes targeted and, in a few cases, for the maintenance and transfer of skills, illustrating that learning and neuroplasticity with training are possible in older age (Baltes & Willis, 1982; Schaie & Zanjani, 2006; Willis et al., 2006), and even in very old age (Singer, Lindenberger, & Baltes, 2003). In this study, we sought to determine whether a novel cognitive intervention, systematic notetaking training, would enhance note fidelity (i.e., note quality), and whether that training would serve to improve recall and recognition of ecologically relevant spoken discourse material in healthy older individuals.

The normal aging process can be illustrated by a two-component model, a dynamic interaction between retained cognitive abilities and cognitive deficits. On the one hand, cognitive pragmatics, a culmination of semantic and procedural knowledge
accumulated through societal experiences, is relatively resistant to aging effects (Baltes & Schaie, 1976). On the other hand, cognitive mechanics, which encompasses basic cognitive elements such as working memory, processing speed, executive control, and acquisition of new episodic memories (Baltes, Staudinger, & Lindenberger, 1999; Horn & Cattell, 1967), is most vulnerable to degradation with advanced age, showing a relatively linear decline across the lifespan (Salthouse, 2004). The declines in cognitive mechanics, specifically learning and memory abilities, adversely affect functional abilities and the overall quality of life necessary for independent living (Rapp, Schnaider-Beeri, Sano, Silverman, & Haroutunian, 2005). Therefore, in order to maintain functional independence, healthy older adults must be able to learn and recall important information in everyday life, such as current events, financial information, and medical advice.

Several decades of cognitive aging research have resulted in the development of specific cognitive interventions that have proven effective in augmenting memory capabilities in healthy older adults (Ball et al., 2002; Rebok, Carlson, & Langbaum, 2007; Verhaeghen, Marcoen, & Goossens, 1992; Willis et al., 2006), demonstrating that neuroplasticity in older age is not only possible, it can be substantial. Programs usually target one process at a time, and often fail to result in transfer to untrained tasks. Many strategies that are taught are difficult to apply to daily life (Burack & Lachman, 1996), and the most effective programs that do promote maintenance and transfer frequently entail extensive training, requiring considerable financial and time investments. Thus, in order to effect greater availability of techniques that enhance functional independence in the aging population, it is imperative that we develop
practical, cost-effective, and easily taught and learned strategies that are equally effective, enabling these individuals to compensate for reduced mechanics abilities while optimizing those that are intact.

One strategy that has been shown to promote learning in a diverse assemblage of populations – systematic notetaking training – is relatively time- and cost-effective (Meyer, Young, & Bartlett, 1989) and, to our knowledge, has not been systematically applied to older individuals for purposes of augmenting memory of information that they hear and need to remember. Taking notes spontaneously is an activity that is informally practiced in nearly every aspect of daily life, and across the lifespan (Piolat, Olive, & Kellogg, 2005). The vast majority of students in school report taking lecture notes (Palmatier & Bennett, 1974), and adults frequently take notes to remember information such as appointment schedules (Piolat et al., 2005). Studies also specifically show that older adults write frequent reminder notes in order to aid their memory (Moscovitch, 1982; Perlmutter, 1978). Moreover, robust evidence shows that notetaking promotes learning, discussed below.

Notetaking has been categorized into two separate functions, process and product (Kiewra, 1985a). Both process, the encoding effect of transcribing notes, and product, the external reference function, have been demonstrated to be effective for facilitating higher academic achievement in educational applications (Bretzing, Kulhavy, & Caterino, 1987; Cohn, Cohn, & Bradley, 1995; DiVesta & Gray, 1972; Einstein, Morris, & Smith, 1985; Kiewra, Benton, & Lewis, 1987). Although many notetaking studies do not explicitly differentiate between these processes, we have chosen to do so because each has its own function. Because process alone, as an encoding strategy, has been
demonstrated to facilitate both immediate and delayed recall (Bentley & Blount, 1980; Berliner, 1969; Weiland & Kingsbury, 2001), and review of notes is not always possible, we chose to investigate process.

A large body of literature supporting notetaking as a learning strategy comes from the educational psychology field. Notetakers have been shown to exhibit significantly greater academic achievement in objective recall and recognition tests than those who do not take notes (Bretzing et al., 1987; Cohn et al., 1995; DiVesta & Gray, 1972; Einstein et al., 1985; Kiewra et al., 1987; Titsworth & Kiewra, 2004). Moreover, research supports its effect specifically as an encoding process (Bligh, 2000; Hartley & Davies, 1978; Kobayashi, 2006; Ladas, 1980; Weiland & Kingsbury, 2001).

Notetaking research has also been extended to a limited number of adult and learning-compromised populations (Hartley, 2002). For example, researchers have investigated the effects of notetaking on memory in young and older adult jurors (Fitzgerald, 2000; ForsterLee, Kent, & Horowitz, 2005), corporate managers (Middendorf & Macan, 2002), and adults with learning and neurogenic disabilities (Dror, Makany, & Kemp, 2010; Evans, Pelham, & Grudberg, 1994; Groot, Wilson, Evans, & Watson, 2002). Furthermore, several research groups have specifically examined its effects in older adults’ recall of either written (Burack & Lachman, 1996) or spoken material (McGuire, Morian, Codding, & Smyer, 2000; Morrow, Leirer, Carver, Tanke, & McNally, 1999; Morrow et al., 2003; Hartley, 2002). These studies demonstrated evidence of significantly improved memory after notetaking.

The literature has further shown that systematic training of how to take notes enhances its learning effects for written prose and lecture material in younger
individuals (Kobayashi, 2006) as does training of how to use organizational strategies for written recall of text in older adults (Meyer et al., 1989; Meyer, Talbot, Stubblefield, & Poon, 1998; Meyer & Poon, 2001). Yet, no research group, to our knowledge, has implemented a program of systematic notetaking training with healthy older adults, nor investigated its effects on note fidelity and subsequent recall and recognition of naturalistic spoken discourse material. Moreover, only one study to our knowledge has assessed note quality in healthy older adults, showing a positive correlation with memory performance (Morrow et al., 1999), although notetaking effectiveness has frequently been measured by analyzing note quality in academic settings (Bretzing & Kulhavy, 1981; Kiewra, 1985b; Peverly et al., 2007; Titsworth & Kiewra, 2004).

In this innovative study, we collected and analyzed data in order to establish a mechanism of learning through systematic notetaking training in healthy older adults, utilizing note fidelity, immediate free recall, and delayed recognition as the primary measures of training effects. We postulated that a training program that incorporated use of an internal retrieval strategy would help mitigate cognitive deficits responsible for reductions in the acquisition and retrieval of new memories, including working memory, processing speed, and executive control, while capitalizing on preserved semantic and procedural abilities, as shown in previous studies (Meyer, Marsiske, & Willis, 1993). It was our contention that subjects trained in notetaking would exhibit superior gains in these three outcome measures, compared with subjects who took spontaneous notes without training.

**Specific Aims**

Our goal was to determine whether formal instruction of healthy older adults in a novel notetaking strategy would increase the amount of accurate information
transcribed in their notes and later retrieval, without review of the notes, of that information. We extended the training program design from previous research targeting structured training of organizational strategies to aid recall of written prose in this population (Meyer et al., 1989; Meyer et al., 1998; Meyer & Poon, 2001). However, our program additionally incorporated a concurrent notetaking component and targeted spoken material. The primary aims were to determine whether structured notetaking training would improve: 1) note fidelity, operationally defined as the number of accurate propositions transcribed, and 2) immediate free recall and delayed recognition. Secondary aims were to determine whether: 1) note fidelity predicted recall and recognition, and 2) pretest cognitive measures predicted note fidelity, recall, and recognition.

Specific Aim 1: Note Fidelity
Determine if structured notetaking training improves fidelity of notes in healthy older adults.

Specific Aim 2: Recall and Recognition
Determine if healthy older adult trained notetakers exhibit significantly greater recall and recognition relative to healthy older untrained notetakers.

Specific Aim 3: Note Fidelity/Recall and Recognition
Determine if changes in note fidelity predict changes in recall and recognition in healthy older adults.

Specific Aim 4: Cognitive Correlates
Determine if pretest cognitive measures—working memory, processing speed, semantic memory, episodic memory and executive control – in healthy older adults predict: a) baseline note fidelity and change from baseline to posttest, b) baseline free
recall and change from baseline to posttest, and c) baseline delayed recognition and change from baseline to posttest.

**Research Hypotheses**

**Hypothesis 1:**
Healthy older adults who are trained in a systematic notetaking strategy will produce notes with greater note fidelity, as measured by the number of accurate propositions transcribed, than healthy older adults who take notes but are not trained.

**Hypothesis 2:**
Healthy older adults who are trained in notetaking for five sessions over two to three weeks will exhibit significantly greater free recall and delayed recognition of material presented than healthy older adults who are not trained in notetaking.

**Hypothesis 3:**
Greater note fidelity, as measured by the change in number of accurate propositions transcribed from baseline to posttest, will positively correlate with greater changes in free recall and delayed recognition of the material presented.

**Hypothesis 4:**
Pretest cognitive measures—working memory, processing speed, semantic memory, episodic memory and executive control – will predict: a) baseline note fidelity and change from baseline to posttest, b) baseline free recall and change from baseline to posttest, and c) baseline delayed recognition and change from baseline to posttest.
CHAPTER 2
LITERATURE REVIEW

Introduction

In order to illustrate that instructed notetaking should enhance note fidelity, recall, and recognition of discourse material in healthy older adults, we have divided this chapter into three sections that portray the rationale for our hypotheses: “Cognitive Aging and Plasticity,” the “Mechanism of Notetaking,” and the “Notetaking Training Protocol.” Under “Cognitive Aging and Plasticity” we describe the normal aging process and how it affects memory and language, including review of the intervention studies that have been conducted that have sought to enhance cognitive functions in this population. In the “Mechanism of Notetaking” section, we present the notetaking literature and a novel model of the processes underlying this learning strategy. Finally, the “Notetaking Training Protocol” section describes the training program from the perspective of the research upon which it was founded.

Cognitive Aging and Plasticity

Historically, the aging process, whether normal or pathological, has been viewed as an invariant, inevitable decline, both physically and cognitively (Baltes & Schaie, 1976). However, we now know that aging without pathology is defined by variability, multidimensionality, and greater neuroplasticity than was once believed. Many decades of cognitive aging research, beginning in the 1940s with Hebb’s conceptual framework separating “intellectual power” from “intellectual products” (Hebb, 1949), have established that normal aging can be defined by a two-component model, a dichotomy of evolutionary-based neurophysiology, vulnerable to aging, and culture-based experience, processes that are preserved (Baltes, 1993). Horn and Cattell (1967) used
the term “fluid” to describe the vulnerable aspects of intelligence essential for complex cognition, prone to age-related deterioration, and “crystallized” to describe the knowledge and abilities acquired through life that remain relatively intact. In later years, Baltes and colleagues similarly demonstrated that normal aging processes change asymmetrically, and are influenced not only by genetics, “cognitive mechanics,” but also experiential factors, “cognitive pragmatics” (Baltes & Schaie, 1976). The two-component model of aging is supported by a history of large cross-sectional and longitudinal studies (Singer, Verhaeghen, Ghisletta, Lindenberger, & Baltes, 2003; Baltes & Willis, 1982; Schaie, 1994; Schaie & Zanjani, 2006). The cognitive changes identified in these studies impact language processing, learning, and remembering, in a significant but asymmetric way.

This model of cognitive aging is also supported by cognitive neuroscience. Studies have shown that volumetric, neurochemical, and metabolic changes occur selectively in the aging brain (Raz, 2000). The normal aging process results in selective dendritic changes and reduction of synapses (Burke & Barnes, 2006; DeCarli et al., 2005) that result in impaired memory and learning abilities. These neural changes, the bases of cognitive mechanics, limit but still allow neuroplasticity (Kliegl, Smith, & Baltes, 1990), making intellectual plasticity a dynamic process (Baltes & Schaie, 1976) mediated by experience (Lovden, Backman, Lindenberger, Schaefer, & Schmiedek, 2010; Nadeau & Wu, 2006).

Baltes and colleagues have hypothesized that it is the individual’s dynamic balancing of the gains and losses associated with these changes that determines whether aging is successful or unsuccessful. This interaction is illustrated in a model of
Selective Optimization with Compensation (SOC, Baltes, 1993), which predicts that successful aging relies on: 1) selecting appropriate goals, 2) optimizing performance of those goals, and 3) compensating with spared abilities in order to maximize strengths and minimize losses. Declines in cognitive mechanics abilities such as working memory, processing speed, executive control, and acquisition of episodic memories, are most detrimental to learning (Cabeza & Nyberg, 2000; Cabeza, McIntosh, Tulving, Nyberg, & Grady, 1997; Salthouse, 2004), because they diminish the ability to process and remember verbally presented material in daily life. For example, healthy older adults often complain about having difficulty remembering such information as current events, financial information, and physicians’ recommendations (Ballard, 2010; Morrow et al., 1999).

In contrast, with aging comes a significant increase in semantic and procedural knowledge (Verhaeghen, 2003), resulting from extensive experience. This balance of cognitive function remains qualitatively consistent across the lifespan (Salthouse, 2004: Salthouse & Davis, 2006), with relatively linear declines in processing speed, memory, and reasoning, beginning in early adulthood, offset by increases in vocabulary becoming evident from childhood to the mid-50’s, remaining stable or slightly reduced through the 60’s and 70’s, and still strong until very old age (Singer et al., 2003). Older adults generally compensate for deficits in daily life with intact pragmatic skills such as motivation, persistence (Salthouse, 2004), knowledge, and self-efficacy (Stine-Morrow, 2007). These abilities can help counteract the limits imposed by reduced mechanics by building on or reorganizing those processes (Baltes, 1993; Baltes et al., 1999; Baltes, Soworka, & Kliegl, 1989; Salthouse, 2004; Schooler, 2007; Stine-Morrow, 2007; Stine-
Morrow, Parisi, Morrow, Green, & Park, 2007). However, when the cognitive demands of a situation are taxing, such as listening to a physician’s medical advice, the difficulty of processing and retaining new information becomes problematic, negatively impacting functional independence.

Cognition

The learning process relies on working memory, speed of processing, executive control, and episodic memory formation (Bopp & Verhaeghen, 2005; Park et al., 2002). A large body of evidence suggests that processing speed and working memory capacity are responsible for most of the age variance between younger and older adults, and both are strongly related to long-term memory (Park et al., 2002; Salthouse & Davis, 2006). Researchers have found that processing speed, working memory, and long term memory diminish similarly, with short term memory declining less precipitously (Park et al., 2002; Salthouse & Davis, 2006).

First, working memory is crucial for complex processes such as learning, reasoning, calculation, perceptuomotor integration, and language comprehension, while short-term memory is responsible for temporary input storage (Baddeley, 2000; Baddeley & Logie, 1999). Baddeley and colleagues identified multiple components within the working memory system: the phonological loop, responsible for storing and processing auditory input, specifically language, the visuospatial sketchpad, which stores and processes visual and spatial information such as orthographic input, the multimodal limited-capacity episodic buffer, which allows synthesis of new input with long-term memory, and the central executive, which regulates them. The central executive processes incoming information, manipulating it during multiple-task processing, retrieving stored long-term memory for the task at hand, and transferring
new material to long-term memory during encoding for later retrieval. Thus, it controls encoding and retrieval strategies, attention-switching, and coordination of auditory and visuospatial information. Working memory has been demonstrated to be limited in capacity, but is supported by the use of strategies and prior knowledge (Baddeley & Logie, 1999; Brown & Craik, 2000).

Evidence suggests that working memory measured in dual-task paradigms is relatively age-invariant unless cognitive demands are high (Riby, Perfect, & Stollery, 2004). Semantic processing, such as that used for language comprehension, is somewhat resistant to working memory deficits in aging, while episodic processing is adversely affected by impaired executive controls necessary to monitor multiple tasks (Riby et al., 2004; Verhaeghen & Cerella, 2002). Age differences are most evident when older adults perform tasks requiring maintenance of more than one distinct mental set of information (Verhaeghen & Cerella, 2002). However, strategic training and practice help mitigate the difficulties of dual-task management (McDowd & Shaw, 2000; Meyer et al., 1993).

Comprehension of auditory and written material by older adults is relatively well-preserved until working memory demands are excessive (Light, 1991; Stine-Morrow et al., 2007). For example, age-related working memory reductions may result in impaired comprehension of complex language (Kemper & Herman, 2006; Waters & Caplan, 2005). Evidence also supports that older adults exhibit deficits in the inhibition of irrelevant information (Hasher and Zacks, 1988), such that the attentional gating mechanism that prevents input irrelevant to the current goal from becoming stored in working memory becomes defective with age. This reduction in inhibition increases the
amount of active information in storage, effectively reducing short-term and working memory capacities (Bopp & Verhaeghen, 2005), and adversely affecting encoding and transfer to long-term memory (Gazzaley & D'Esposito, 2007). However, inhibition deficits may be mitigated by decreasing cognitive load, discussed in the next section.

Second, processing speed has been widely demonstrated to be reduced in the aging process, and it significantly impacts memory (Balota, Dolan, & Duchek, 2000; Salthouse & Coon, 1993). Reduced processing speed is evident in latency measures of language performance (Thornton & Light, 2006). Information to be remembered is postulated to either be encoded ineffectively due to a “limited time mechanism” (Salthouse, 1996), or to decay while in working memory storage before it can be processed due to a “simultaneity mechanism” (Salthouse, 1996). Indeed, when processing speed is controlled for, age-related deficits in working memory and short-term memory are reduced (Verhaeghen & Salthouse, 1997), though not eliminated. However, the effects can also be minimized by reducing cognitive load.

Third, executive function is also diminished with age. A review of executive function meta-analyses (Verhaeghen & Cerella, 2002) examined underlying age differences in selective attention, measured by Stroop and negative priming tasks, and divided attention, assessed by dual-task and task-switching paradigms. No age deficits were revealed in selective attention or local switching, indicators of executive control associated with task-switching. However, age differences were apparent in the dual-task studies, as well as in global switching, the cognitive set-up effort prior to switching tasks. Therefore, selective attention and changing focus of attention were comparable
between young and older adults (Verhaeghen & Cerella, 2002), whereas attending to multiple sets of information was more difficult for older individuals.

Finally, episodic memory acquisition and retrieval are reduced with age. The formation of episodic memories, memories for the specifics of events, occurs through three processes: 1) encoding, the transformation of external information into internal representations, 2) retention, and 3) retrieval, the accessing of stored memories (Old & Naveh-Benjamin, 2008). An advantage for older adults is that successful encoding involves intact cognitive pragmatics, such as motivation, prior knowledge, setting goals, recognizing stimulus distinctiveness, and utilizing expectations and expertise to organize material in a meaningful way. However, aging is posited to impair encoding effectiveness and efficiency (Balota et al., 2000; Brown & Craik, 2000), possibly because older adults no longer spontaneously utilize the learning strategies incorporated by younger adults (Old & Naveh-Benjamin, 2008; Dunlosky & Hertzog, 2001), because they use less elaborative, shallower, encoding processes, making retrieval more difficult, or because their strategies no longer work as well (Brown & Craik, 2000; Craik & Lockhart, 1972). External factors, such as task instructions and the materials themselves, are also crucial to encoding (Craik & Lockhart, 1972), but can be modified to reduce cognitive load.

The second process, retention, relies on short-term memory to provide temporary storage, and is only minimally affected with age (Old & Naveh-Benjamin, 2008). In contrast, retrieval, the final process, shows the greatest age-related deficits of the three (Balota et al., 2000). Retrieval necessitates the existence of appropriate cues to simulate the encoding condition, according to the encoding specificity theory (Tulving &
Thomson, 1973). Some theorists predict that declines in the distinctiveness of encoding abilities with age prevent strong cues from being formed to facilitate future retrieval (Balota et al., 2000; Craik & Byrd, 1982; Thornton & Light, 2006). Environmental supports that reduce attentional demands during retrieval have been shown to cue retrieval in older adults (Morrow & Rogers, 2008; Brown & Craik, 2000; Craik & Jennings, 1992; Old & Naveh-Benjamin, 2008), thereby buffering age-related deficits (Craik & Jennings, 1992). Furthermore, older adults can be taught to use specific strategies to overcome retrieval difficulties (Meyer et al., 1993).

While these cognitive deficits do affect overall function, it is possible to attenuate their effects through compensatory techniques. For instance, cognitive load theory offers a way to reduce working memory demands to optimize older adults’ performance (Van Gerven, Paas, Van Merrienboer, & Schmidt, 2000). The educational gerontology literature shows that cognitive load can be managed so that individuals can achieve optimal learning, as has been demonstrated in young adults. Working memory capacity is essential to construct and store schemata in long-term memory. Schemata, rule-based mental models (Mayer, 1989) are used to integrate and chunk new information, save working memory storage capacity and result in transfer to untrained situations (Kiewra, 1991). Once schemata are formed, they become automatic and reduce cognitive load. The limits on learning placed by reductions in working memory, speed of processing, and inhibition, therefore, can be offset by instructional designs incorporating cognitive load theory. For example, using solved problems to illustrate concepts taught and minimizing irrelevant information help reduce cognitive load (Van Gerven et al., 2000; Van Gerven, Paas, Van Merrienboer, Hendriks, Schmidt, 2003).
Older adults’ preserved abilities often provide compensatory support for cognitive deficits, as well. Semantic memory, procedural memory, and some executive functions such as selective and sustained attention, generally remain strong, and can be used, particularly with training, to overcome cognitive limitations (McDowd & Shaw, 2000; Meyer et al., 1993). This is especially true for language comprehension which, although somewhat constrained by deficits in working memory, processing speed, and executive control, is relatively well-maintained with age, as we discuss next.

Language

Language processing reflects the bidirectional interplay between bottom-up, data-driven processes and top-down, contextual influences. In the initial processing stages, speech signals are perceived, then mapped onto phonological or orthographic representations, depending on the input modality. Bottom-up priming, pre-threshold activation that facilitates word retrieval, allows these representations to achieve the next processing stage, lexical access, followed by processing at the conceptual level. Under ideal circumstances, this processing mechanism facilitates successful language comprehension along a trajectory from the level of word recognition, to parsing of syntactic structures, to sentence meaning, and ultimately, to discourse comprehension (Burke & Shafto, 2008).

Research has shown that older adults exhibit greater deficits at the lower levels of language processing than at the higher. For example, difficulties in accessing the phonological and orthographic level information are most evident in word-finding deficits, particularly tip-of-the-tongue phenomena (Abrams, Trunk, & Merrill, 2007), in which the concept is accessible but the phonological link to it is not. Higher level semantic connections, fortified by a lifetime of experience, are richer and less
vulnerable to cognitive aging than phonological or orthographic connections (Thornton & Light, 2006), allowing older adults to compensate for information lost at lower linguistic levels with top-down processes (Verhaeghen, 2003).

Older adults may also display difficulty at the lexical level of language processing. Word recognition has been found to be adversely affected by impaired auditory perception (Burke & Shafto, 2008; Thornton & Light, 2006), as well as lexical variables such as frequency and neighborhood density. With regard to connected speech, however, older individuals exhibit minimal difficulty with canonical sentences, the structures of which can be anticipated through linguistic procedural memory abilities. Difficulties arise when more complex syntax is used, reflecting reductions in processing speed (Burke & Mackay, 1997) and working memory (Kemper & Herman, 2006). Fortunately, the strengths of older adults in semantic and procedural knowledge (Salthouse & Davis, 2006) can provide support at the lexical and discourse levels (Burke & Shafto, 2008).

In fact, discourse processing is relatively well-buffered from age effects. Older adults exhibit difficulties recalling the surface and textbase levels of discourse, which requires verbatim, or nearly verbatim, recall (Zwaan & Rapp, 2006). However, they display invariant use of situation models, gist knowledge crucial for comprehension, which rely on top-down contextual use of schemata (van Dijk & Kintsch, 1983; Zwaan & Rapp, 2006). This applies to both written and spoken discourse. When making inferences, older adults perform as well as younger, unless working memory load is high (Thornton & Light, 2006). The relative resilience of discourse processing suggests that language expertise helps buffer the effects of reductions in working memory,
processing speed, and executive control (Burke & Mackay, 1997). Selective repetition, semantic elaboration, and syntactic simplification have been shown to facilitate comprehension (Kemper & Harden, 1999). Hence, older adults are able to compensate for diminishing cognitive mechanics by taking advantage of intact pragmatics, utilizing top-down processes, and exploiting language expertise (Thornton & Light, 2006), as suggested by the SOC model of successful aging (Baltes, 1993). This evidence supports the value of memory remediation through practice and enhanced familiarity, targeting strengthening of those connections (Burke & Mackay, 1997), while minimizing deficits. These principles have been incorporated into our notetaking training protocol.

Cognitive Interventions

Despite cognitive changes, healthy older adults evidence substantial performance plasticity resulting from targeted cognitive interventions. Significant treatment effects for the acquisition and maintenance of skills taught have been frequently demonstrated (Jobe et al., 2001; Schaie & Zanjani, 2006; Willis et al., 2006, Winocur et al., 2007). Treatments for age-related deficits have employed strategy-based training targeting the deficient processes of cognitive mechanics, and have proven effective in improving them in both cross-sectional and longitudinal studies. Such strategic interventions include exercises to improve attention, concentration, reasoning, and processing speed (Baltes & Willis, 1982; Hohous, 2006; Willis et al., 2006), mnemonic strategies (Valenzuela et al., 2003; Willis et al., 2006), computer-based memory techniques (Mahncke et al., 2006; Mahncke, Bronstone, & Merzenich, 2006; Gunther, Schafer, Holzner, & Kemmler, 2003), and self-generated memory strategies to improve language processing, including discourse recall (Cavellini, Pagnin, & Vecchi, 2003; Dunlosky, Kubat-Silman, & Hertzog, 2003; Valentijn et al., 2005). Training of
specific mnemonic strategies, such as Method of Loci and Pegword techniques, name-
face association, organization, and imagery, has proven to be significantly effective for
episodic memory tasks, as illustrated by a 33-study meta-analysis by Verhaeghen and
colleagues (Verhaeghen et al., 1992).

Increased neurological activation (Nyberg et al., 2003; Small et al., 2006) and
neurochemical changes (Valenzuela et al., 2003) have been directly associated with
several of these interventions. Both human and animal studies have demonstrated that
experience shapes the brain (Johanssen & Belichenko, 2002; Johanssen & Ohlsson,
1996; Kleim & Jones, 2008; Kolb, Forgie, Gibb, Gomez, & Rowntree, 1998; Nadeau &
Wu, 2006). Strategy-based memory interventions specifically have resulted in
neuroplasticity (Small & McEvoy, 2008; Jones et al., 2006). These results illustrate that
intellectual stimulation through systematic training results in enhanced performance,
and may lead to either restitutive or compensatory neuroplasticity (Jones et al., 2006;
Lovden et al., 2010; Nadeau & Wu, 2006; Valenzuela et al., 2003).

Researchers conducting several large longitudinal studies have demonstrated
significant treatment gains and maintenance of skills trained, as well as evidence of
transfer. The Adult Development and Enrichment Project (ADEPT, Baltes & Willis,
1982; Baltes, Kuhl, Gutzmann, & Sowarka, 1995), which targeted figural relations and
inductive reasoning, and the Seattle Longitudinal Study (SLS, Schaie, 1994; Schaie &
Zanjani, 2006), which targeted inductive reasoning and spatial orientation, both resulted
in significant proximal gains and transfer. More recently, researchers conducted a
longitudinal, multisite, randomized controlled trial, Advanced Cognitive Training for
Independent and Vital Elderly (ACTIVE, Jobe et al., 2001; Willis et al., 2006), to
investigate three types of intensive strategy-based training, speed of processing, reasoning, and mnemonics. The training was designed to facilitate the functional application of these skills to daily life activities, such as financial management and driving. Trained groups showed significant improvements within the domains for which they had been trained. In addition, after five years, one instance of cross-domain transfer from processing speed to reasoning, and one instance of generalization of reasoning training to daily living activities, were identified. Transfer to health-related quality of life was identified for the speed of processing training, as well (Wolinsky et al., 2006).

Recent years have brought about the emergence of a more domain-general category of cognitive interventions for older adults. These studies incorporate interventions that target not a single cognitive process, but rather engage multiple cognitive domains simultaneously, and are based on epidemiological research that has revealed associations between higher cognitive function and greater intellectual complexity across the lifespan (Bennett et al., 2003; Bosma et al., 2003; Schooler & Mulatu, 2001; Scarmeas & Stern, 2004; Stern, 2006; Wilson, Barnes, & Bennett, 2003). Interventions that incorporate progressively increasing challenges and acquisition of new skills have resulted in significantly improved cognitive performance (Fried et al., 2004; Stine-Morrow et al., 2007; Stine-Morrow, 2007).

An illustration of this can be seen in a study that employed individualized piano instruction to treatment subjects, enabling encoding of new skills that engaged multiple networks rather than targeting specific processes. A six-month course of lessons resulted in significant increases in speed of processing and executive control (Bugos,
Perlstein, McCrae, Brophy, & Benbaugh, 2007), although the gains were only maintained while learning and practice continued. Studies such as these have shown that engaging multiple processes such as working memory, processing speed, selective and dual-task attention, goal setting, short term memory, episodic and semantic memory, and synthesis and integration of information, facilitates cognitive improvement in older adults (Stine-Morrow, 2007). The integration of numerous cognitive processes combined with targeted strategy training is the foundation upon which our intervention protocol was based.

It was our contention that cognitive intervention should focus on maximizing older adults’ strengths and minimizing their deficits, based on the SOC model (Baltes, 1993; Stine-M Morrow et al., 2007). Evidence has shown that well-preserved cognitive pragmatics abilities in normal aging may be used to support those cognitive mechanics abilities that decline, resulting in enhanced episodic memory (Park, Gutchess, Meade, & Stine-Morrow, 2007; Verhaeghen et al., 1992). Thus, our treatment protocol has been designed to take advantage of the preserved abilities of semantic and procedural memory, selective and sustained attention, and language expertise to help attenuate the learning deficiencies imposed by reductions in working memory capacity, speed of processing, and executive control, to facilitate episodic memory formation.

**The Mechanism of Notetaking**

Notetaking is a relatively cost-effective and easily taught and learned activity (Meyer et al., 1989). Taking notes spontaneously is informally practiced in nearly every aspect of daily life across all age groups, whether for recording lecture material, taking minutes during a meeting, organizing personal finances, or arranging travel plans and appointments (Burack & Lachman, 1996; Piolat et al., 2005). Notetaking is
hypothesized to incorporate not only declarative memory, but also procedural memory due to the automaticity gained by practice (Piolat et al., 2005). Students of all ages report taking notes, as many as 99% (Palmatier & Bennett, 1974), to facilitate both reading comprehension and lecture material retention (Bonner & Holliday, 2006), and its study in educational applications has demonstrated that it is effective for both encoding and as an external aid, reflected in significantly higher academic achievement by notetakers than non-notetakers (Bretzing et al., 1987; Cohn et al., 1995; DiVesta & Gray, 1972; Einstein, et al., 1985; Kiewra et al., 1987; Titsworth & Kiewra, 2004).

It is postulated that two distinct components of notetaking exist—1) process, the actual transcription of orthographic representations from heard concepts, and 2) product, the external record used for later review. These processes have been studied extensively in the educational psychology literature for grade school, high school, and college students, and to a much lesser degree in adults, learning-compromised individuals, and older adults. The process of taking notes is purported to activate an encoding function (Kobayashi, 2006) whereby novel information is incorporated into existing mental models (Mayer, 1989) and instantiated into long-term memory through directed attention and cognitive organization (Einstein et al., 1985). Studies have shown that process, product, and the combination of both have positive effects on academic achievement (Kiewra, 1987; Kiewra & Frank, 1988; Kiewra, DuBois et al., 1991; Kiewra, Mayer, Christensen, Sung-II, & Risch, 1991). Review of notes after attending a lecture has been shown to further enhance recall of the material due to the ability to revise and reorganize the information (Bligh, 2000). However, product review is not always possible in everyday life.
Thus, each component of notetaking serves a unique and separate function. However, many studies examining notetaking do not distinguish between them. Therefore, because process alone has been demonstrated to facilitate recall (Weiland & Kingsbury, 2001), and because the encoding effect has not been systematically studied in older adults, we chose to investigate process only, as a potential cognitive intervention.

**Notetaking in Education**

The educational psychology literature suggests that students take notes to encode lecture material for several reasons, among them, to focus attention and concentration, facilitate memory during the lecture, increase comprehension of the topic and its structure, and determine what information is important, and the evidence overwhelmingly supports these functions (Bligh, 2000; Hartley & Davies, 1978; Ladas, 1980). Considerable empirical evidence, predominantly coming from studies of lecture learning by college students, supports the effectiveness of each notetaking component – process and product – separately and together, though a few studies have shown notetaking to have no effect or a detrimental effect on learning (Bligh, 2000; Ladas, 1980; Hartley & Davies, 1978). We review this literature here.

Much of the evidence supports the most optimal learning strategy through notetaking as the combination of encoding and review (Kiewra, 1989, 1991). For example, a 21-study meta-analysis of early research on notetaking in lectures revealed a modest effect for encoding (.34) compared to a large effect of notetaking and review (1.56) (Henk & Stahl, 1985). In addition, Crawford (Crawford, 1925a, 1925b) assessed the effects of spontaneous notetaking on immediate and long-term retrieval, and found that notetakers recalled more than non-notetakers in both conditions, supporting both
the encoding (immediate) and review (delayed) functions. Likewise, Di Vesta & Gray (1972, 1973) found that notetaking resulted in better recall, even without review, than no notetaking for free recall and recognition, but review increased the effects. Moreover, studies incorporating guided notes, in which students complete information from the lecture in a partial outline provided by the lecturer, have shown that notetakers who recorded more accurate information displayed significantly better recall, especially after review, than less accurate notetakers (Nye, Crooks, Powley, & Tripp 1984; Williams & Eggert, 2002).

In a comprehensive study, Fisher & Harris (1973) investigated the relative effects of 5 combinations of encoding and review, and measured recall and recognition immediately and after 3 weeks. The best outcomes resulted from students’ taking their own notes in lieu of using a provided handout, and reviewing them, and the least effective strategy was taking no notes while simply mentally reviewing the lecture material. Note quality correlated positively with both recognition and recall. These results support the combination of the process of notetaking and product review as a significant learning strategy.

Considerable evidence also supports the encoding function alone as an effective learning strategy, especially if note quality is high. Encoding effects without review have been demonstrated by Austin, Lee, and Carter (2004), who showed that undergraduates who completed guided notes, then set them aside, performed better on achievement tests than those who took no notes, but only when they transcribed a large number of main points, examples, and elaborations in those notes. Similarly, Baker and Lombardi (1985) found significant positive correlations between the number of
propositions in the notes and academic test scores when no review was allowed, with notetakers outperforming non-notetakers. Likewise, Barnett, DiVesta, and Rogozinski (1981) examined the effects of notetaking versus no notetaking, and review of self-generated notes versus review of handouts. Those who took their own notes without reviewing them achieved higher scores than those who took no notes but reviewed the handouts, suggesting that review of notes did not increase recall beyond that of the notetaking process. Immediate encoding effects have been revealed by a substantial number of researchers, including Hult (1984), who demonstrated that highly effective notes, defined as those containing more information transcribed in an organized manner, significantly improved recall independent of review, as well as others (Aiken et al., 1975; Di Vesta & Gray, 1973; Einstein et al., 1985).

Studies have also demonstrated that notetaking without review significantly increased both immediate and delayed recall (Bentley & Blount, 1980; Berliner, 1969; Crawford, 1925a, 1925b; Maqsud, 1980 in Bligh, 2000; Weiland & Kingsbury, 2001). These researchers showed that students exhibited augmented short- and long-term recall of lecture material without note review, supporting the encoding hypothesis. In addition, studies that have analyzed notetaking in younger students, or those that have utilized stimuli other than lecture material, have similarly found significant effects of notetaking on long-term academic achievement (Bretzing et al., 1987; Cohn et al., 1995; Einstein et al., 1985; Kiewra et al., 1987; Titsworth & Kiewra, 2004).

Some research has indicated that learning effects only occur after note review. For example, an early study demonstrated that the best immediate and delayed recall occurred when no notes were taken; however, once the notetakers reviewed and
revised their notes, they outperformed non-notetakers (Freyberg, 1956 in Sutherland, Badger, & White, 2002). Another group (Carter & Van Matre, 1975) similarly showed an increase in recall in the notetaking group, but only after they reviewed their notes. In a second study (Van Matre & Carter, 1975), they examined immediate and 1-week delayed recall and recognition and reported that the worst memory performance was by those who took no notes, and the second worst was by those who took notes but did not review them. Therefore, they concluded that notetaking effects were solely reliant on review.

Several notetaking studies have been criticized for having methodological deficiencies, such as low power, lack of randomization, no control group, or lack of procedural information (Ladas, 1980). Indeed, a number lack details about materials or procedures (Eisner & Rohde, 1959 in Hartley & Davies, 1978; DeWitt, 2007; Fisher & Harris, 1974; Ladas, 1980), and few test for cognitive measures, leaving unanswered questions about potentially crucial interactions between cognition and notetaking effects. Evaluating these studies is somewhat difficult particularly due to the lack of information reported about the stimuli used, such as level of difficulty, meaningfulness, density, rate, or length. However, in well-designed studies failing to find notetaking effects, or finding inferior performance after notetaking, the passages were informationally dense and presented at a rapid rate, resulting in increased cognitive load and interference with comprehension and memory (Cook & Mayer, 1988; Ladas, 1980).

For example, McClendon (1956 in Hartley & Davies, 1978) presented material at rates between 130 and 155 words per minute, and identified no significant difference in immediate or delayed recall between notetakers and non notetakers. Similarly, Peters
(1972) utilized a presentation rate of 146 words per minute, and concluded that not taking notes resulted in better performance than taking notes. In contrast, Howe (1970) presented the material at 90 words per minute and found significant positive results, a 7-times greater probability of recalling information with notetaking. Therefore, it is likely that some rates may be too fast to accommodate notetaking (Cook & Mayer, 1988; Ladas, 1980).

In conclusion, the vast majority of studies in educational psychology have favored notetaking as an encoding strategy, with or without review (Bligh, 2000; Ladas, 1980). The preponderance of evidence shows that the likelihood of remembering the propositions that are noted is significantly greater than those not noted (Aiken, et al., 1975; Crawford, 1925a, 1925b; Einstein et al., 1985; Fisher & Harris, 1973; Howe, 1970), as much as 40% versus 7% in one study (Einstein et al., 1985). Notetaking has even been shown to positively impact transfer to higher cognitive processes, such as critical thinking (Peper & Mayer, 1978, 1986; Shrager & Mayer, 1989).

**Notetaking in Adults**

Although the act of notetaking as a learning strategy has been studied extensively in academic settings, it has been extended to adults in a relatively small number of studies. For example, studies have investigated the effect of taking notes on memory in adult jurors, corporate interviewers, learning-compromised adults, and individuals with traumatic brain injury, discussed below. In nearly all cases, it has been shown to result in significantly improved memory for the important information presented, even when not reviewed afterwards.

Both laboratory and naturalistic studies have been conducted to investigate the effects of notetaking on juror performance. For example, one research group
(Rosenhan, Eisner, & Robinson, 1994) showed young adults a videotaped courtroom simulation. The notetaking groups recalled significantly greater information than those who did not take notes, and a modest correlation between the number of notes taken and recall was found. In addition, notetaking subjects reported being better able to keep up with the pace of the proceedings. ForsterLee and colleagues (ForsterLee, Horowitz, & Bourgeois, 1993; ForsterLee & Horowitz, 1997; Horowitz & Forsterlee, 2001) also conducted several studies with adults simulating jury scenarios. For both audiotaped and videotaped stimuli, the notetakers recalled significantly more information, even without reviewing their notes, than those who did not take notes. Several additional studies (Fitzgerald, 2000; ForsterLee et al., 2005) compared the effects in younger and older jurors, and reported significant positive main effects in the notetaking conditions for recall of case-related information and decision-making in both age groups. Naturalistic studies in legal contexts have been less conclusive, however, likely due to the many confounding variables beyond experimental control (Hartley, 2002).

Several studies have investigated the effects of taking notes on memory and decision-making in corporate contexts. One investigator (Schuh, 1978) found that managers who took notes while watching a videotaped interview exhibited significantly greater recollection accuracy than those who did not, even without reviewing them. Another showed that notetaking and note review in a simulated employment interview increased accuracy of the employer’s recall of details (Middendorf & Macan, 2002). Moreover, in studies of impaired populations, adolescents with attention deficit hyperactivity disorder showed significantly improved note quality and lecture
comprehension measured by assignment scores after being trained in taking notes (Evans et al., 1994), both with and without note review. In addition, adults with traumatic brain injury and non-injured controls who chose to take notes demonstrated significantly enhanced prospective memory (Groot et al., 2002), and adult financial professionals with dyslexia using an organizational notetaking format performed comparably to controls using linear notes (Dror, Makany, & Kemp, 2010).

**Notetaking in Older Adults**

Despite evidence that notetaking facilitates recall in these diverse groups, its study as a learning technique in healthy older individuals has been limited. The few studies that have examined notetaking in older adults have shown that if subjects take notes, it improves their memory for the information presented. Beyond the studies comparing younger and older jurors previously discussed, only a limited number of research groups, to our knowledge, have examined the effects of notetaking on older adults’ memory for auditorily presented ecologically relevant information. All of these studies revealed evidence of significantly improved memory after the process and/or review of notetaking. Only one group addressed note fidelity (Morrow et al., 1999), and none provided notetaking training, though one taught a written organizational strategy while investigating memory for text (Meyer et al., 1989; Meyer et al., 1998; Meyer & Poon, 2001).

Morrow and colleagues (Morrow et al., 1999), for example, examined the effects of message organization, repetition, and notetaking, on memory for automated telephone appointment messages in young and older adults. Participants were given the option of taking notes, and were allowed to review their notes during memory testing. Although the lack of differentiation between process and review did not allow direct comparisons
specific to these two components, results indicated that both groups demonstrated significant and proportionate gains in the amount of information retained as a result of notetaking. In addition, note quality was assessed, and the authors showed that both young and older adults who had recorded more accurate information in their notes exhibited greater recall. Another study by this group (Morrow et al., 2003) demonstrated that notetaking and review by older airline pilots, combined with occupational expertise, mitigated age differences in pilot communication. An interesting aside is that pilots receive notetaking training as part of their air safety training program (Morrow et al., 2003).

McGuire and colleagues (McGuire et al., 2000) presented two groups of older adults, only one of which was instructed to take notes, with a videotaped simulation of a doctor’s office visit. Presentation was either normally paced at 169 words per minute, or modified by a slower rate of 136 words per minute and exaggerated intonation. In this study, individuals who took notes were not allowed to review them. Results showed that when notes were taken during the normally paced condition, subjects retained less information than did non-notetakers, presumably because of the greater demand on cognitive resources. However, the group who took notes in the slowed rate condition, which is relatively fast compared to other studies, retained significantly more information during immediate and delayed recall than those in all other conditions. This suggests that the notetaking process facilitated memory in a naturalistic setting, though only when working memory and slowed processing speed were accommodated.

A different practical application of notetaking, list-making for shopping, was implemented in a study by Burack and Lachman (1996). List-making is a self-cuing
strategy, but without the time and dual-task confines inherent in taking notes simultaneously with discourse. Because cognitive interventions often require much effort to learn and may not be easily transferred to daily life, they investigated the effects of list-making and the intention of referring back to them or not, on list recall by young and older adults. Subjects were either asked to make a list or not, and told that they would be able to review the list or not, while trying to remember written items to purchase at a store. Intention had no effect. However, not only did list-making significantly improve recall in older adults compared with subjects who made no notes, but both younger and older adults had even greater recall when they spontaneously organized the lists by chunking related items together. Thus, this type of notetaking in an organized format aided recall (Burack & Lachman, 1996).

In a study similarly targeting memory improvement through strategic writing but without concurrent notetaking, Meyer and colleagues systematically trained healthy older adults how to use a plan to organize prose as they read it, then write a recall protocol based on that organization (Meyer et al., 1989; Meyer et al., 1998; Meyer & Poon, 2001). They examined how using the organizational strategy affected text recall, and found significant effects, but only when it was systematically trained. The training strategy, “read and recall,” was hypothesized to be an encoding and retrieval strategy through which participants could learn to identify main ideas in an organized way, then use the strategy to search stored memory during retrieval. In all of these studies, significantly improved recall, maintenance, and transfer were demonstrated in the trained conditions, and in the most recent study, effects transferred to two ecologically relevant videotapes (Meyer & Poon, 2001). Because written prose and discourse are
comparably learned by healthy older adults, provided the time allotted for each is
equivalent (Sticht & James, 1984; Stine, Wingfield, & Poon, 1986), we have extended
the basic premise and principles of Meyer’s organizational strategy use protocol from
text to discourse passages.

To summarize, McGuire and colleagues limited their investigation to encoding
effects, but Morrow and colleagues allowed note review. Burack and colleagues (1996)
and Meyer and colleagues (1989), on the other hand, investigated notetaking strategies
absent the time constraints of notetaking concurrent with stimuli. However, all of these
results support the hypothesis that writing information in an organized manner facilitates
encoding in healthy older adults. A systematic review of non-academic applications of
notetaking, including those targeting older individuals, confirmed that evidence supports
taking notes to enhance memory in older adults, but few studies have implemented
formal training in adults, and even fewer have applied notetaking in naturalistic
environments, key to its usefulness as a generalizable cognitive intervention (Hartley,
2002).

**Note Fidelity**

The effectiveness of notetaking has frequently been assessed in educational
research by measures of note quality, shown to predict information recall in studies of
students (Bretzing et al., 1981; Kiewra, 1985; Peverly et al., 2007; Titsworth & Kiewra,
2004), but only in one study of older adults (Morrow et al., 1999). Furthermore, studies
have shown positive correlations between the number of lecture ideas transcribed and
overall academic achievement (Cohn, Hult, & Engle, 1990; Isaacs, 1994; Kiewra &
Fletcher, 1984; Fisher & Harris, 1973; Walbaum, 1989). A substantial number of
studies of notetaking training in students have used note quality as the primary outcome measure.

Note quality has been variously defined as the number of main ideas and details, quantity of words, amount of explanatory information, number of examples, and number of combined details and organizational points recorded. Several researchers have determined that “completeness” of notes was predictive of achievement in school-age children, and some have incorporated templates into their training programs (Baker & Lombardi, 1985; Einstein et al., 1985; Kiewra & Fletcher, 1984; Pollio, 1990). For example, Lee and colleagues (Lee, Lan, Hamman & Hendricks, 2008) taught third graders strategic notetaking methods over four sessions, using a template to record main ideas during videotaped lectures. The trained groups recorded a higher percentage of important information in their notes, than those who had received no training. In addition, the trained groups exhibited significantly superior long-term recall.

Other studies have targeted college students in the use of guided notes, as previously described, incomplete lecture notes in which they fill in the main points during the lecture, some with training (Austin et al., 2004), some without training (Williams & Eggert, 2002; Nye et al., 1984). In all cases, even without review (Austin et al., 2004), students demonstrated higher quality notes as measured by percentage of main points, examples, and elaborations, and scored higher on academic tests than those who took fewer notes. Older students in school have been shown to use their knowledge and experience, higher motivation, and ability to implement strategies, all preserved in older adults, to record lengthier notes with a greater number of important points (Wilding & Hayes, 1992). Thus, the predominating conclusion from academic applications is that
the better organized, clearer, and more numerous the ideas noted, the more helpful to memory are the notes (Bligh, 2000). In our study, we defined note fidelity as the number of accurate propositions transcribed.

**Notetaking Training**

While notetaking necessitates an enormous amount of cognitive effort, requiring integration of multiple networks (Piolat et al., 2005), once skill mastery is achieved, it appears to serve as a potent encoding strategy. It requires simultaneously processing phonological linguistic input and producing orthographic output, directing attention and working memory to a dual-task activity, central executive evaluation and sorting of the information (Piolat et al., 2005), and writing notes quickly and accurately.

The essential components of encoding proposed to be afforded by notetaking are not necessarily innate. In fact, studies have shown that most students show poor competence at identifying and selecting important information that should be noted (McDonald & Taylor, 1980; Hartley & Marshall, 1974). Students traditionally record very incomplete notes, usually fewer than 40% of the important ideas from lectures (Kiewra, 1985c, 1985d; Kiewra et al., 1987; O’Donnell & Dansereau, 1993). Selecting the material to record requires experience and judgment, and improves as a student progresses from grade school to college (Bligh, 2000). In order to select relevant and inhibit irrelevant information, it is necessary to know what signals to look for that demarcate topic changes, analyze the hierarchical structure of the material, including main and supporting ideas, and extract key concepts. For this to take place, instruction is often necessary (Bligh, 2000).

Formal notetaking instruction has been shown in the educational psychology literature to improve the amount of information noted and recalled over and above
simple spontaneous notetaking. Positive encoding effects of notetaking training in elementary (Lee et al., 2008), junior high, and high school students have been demonstrated, as evidenced by enhanced recall and academic performance. A 17-study meta-analysis by Kobayashi (2006) examined the effects of notetaking interventions on encoding. The analysis included studies of interventions targeting junior high and high school students, and examined effects of training on memory from lectures and written prose. Results indicated a positive effect of training on recall. Furthermore, young adults with learning disabilities (Boyle & Weishaar, 2001; Ruhl & Suritsky, 1995) and attention deficit hyperactivity disorder (Evans et al., 1994) have significantly benefited from structured notetaking training, as demonstrated by greater achievement after instruction.

Training the strategic use of a template upon which to transcribe notes has shown positive effects on recall, as well (Hartley & Davies, 1978). For example, Spires and colleagues (Spires, 1993; Spires & Stone, 1989) showed that for high school students with learning disabilities, combining instruction with self-questioning increased the quality of the notes and immediate comprehension and recall. They developed a structured program based on giving students completed outline models of notes and instructing them to divide the propositions into main ideas and details. Gradually, prompts are faded and students learn to take notes independently. This technique also incorporates self-questioning, which reinforces the generation effect. It has been used with high school students with attention deficit hyperactivity disorder, as well, and resulted in increases in the quantity of notes, as well as better comprehension of content in those who had the best organized notes (Evans et al., 1994). Several other
researchers have taught strategic notetaking methods, incorporating summarization of material to further enhance encoding, in high school and college students with learning disabilities or educable mental retardation (Boyle & Weishaar, 2001; King, 1992; Ruhl & Suritsky, 1995). Instructing fifth graders in a linear, hierarchical notetaking strategy, similar to the one used in our study, has proven significantly more valuable for enhancing immediate and delayed recall than training in other methods, or no training (Arslan, 2006). Moreover, instructing sixth graders (Peck & Hannafin, 1983) and ninth graders (Faber, Morris, & Lieberman, 2000) to take notes on a formatted template yielded significant positive effects on the amount of information recalled compared with no training.

Although a number of studies have incorporated training over extended durations, such as semesters (King & Stahl, 1985), others have limited their programs to a course of five or six classes lasting 1 to 2 hours (Jacobsen, 1989, in Gall, Gall, Jacobsen, & Bullock, 1990; Meyer et al., 1989; Meyer & Poon, 2001), and have shown significant training effects. Some of these programs have shown increased academic achievement with students who are at-risk (Jacobsen, 1989, in Gall et al., 1990) or have learning disabilities (Boyle & Weishaar, 2001). The most effective programs combine the use of a structured notetaking template to facilitate note organization, such as the Cornell format (Jacobsen, 1989, in Gall et al., 1990) or strategic cued format (Boyle & Weishaar, 2001), both of which promote the chunking of related ideas in an outline-type structure, with explicit training sequences of teacher modeling, practice, evaluation, and feedback (King & Stahl, 1985; Meyer et al., 1989). These studies, confirmed by a meta-analysis by Kobayashi (2006), have shown that the provision of a notetaking framework
incorporated with interactive instruction result in significant improvements in the ability to take more complete and accurate notes (Nye et al., 1984), and demonstration of superior recall (Boyle & Weishaar, 2001; Jacobsen, 1989, in Gall et al., 1990; Pollio, 1990; Spires, 1993).

Formal instruction such as that just described can be implemented to decrease cognitive load for adults, as well. Strategy use in older individuals has proven effective in reducing demands on working memory, processing speed, and inhibitory mechanisms by reallocating resources to the task at hand (Meyer et al., 1993). In addition, writing to dictation has been shown to activate the prefrontal cortex, including Broca’s area and the motor cortex, instrumental for intention and cognitive control (Balas, Netser, Giladi, & Karni, 2007; Omura, Tsukamoto, Kotani, Ohgami, & Yoshikawa, 2004). The act of writing has also been shown to facilitate spoken language in several cases of Broca’s aphasia, presumably by stimulating the link between orthography and phonology (Beeson & Egnor, 2006; Beeson, Rising, & Volk, 2003; Pinhasi-Vittorio, 2007).

Overall, evidence supports trained notetaking as a successful learning strategy in children and young adults. However, only one research group, to our knowledge, has examined the effects of structured written strategy training in older individuals, and they applied the strategy to the recall of written prose (Meyer et al., 1989; Meyer et al., 1998; Meyer & Poon, 2001). Meyer and colleagues demonstrated that healthy older adults can learn to use a structured outline strategy to effectively identify and transcribe the most critical ideas and the relationships among them, in order to increase the amount of information remembered from text. They showed that training individuals to identify the
signaling words that cue the organizational structure increased recall further (Meyer et al., 1989; Meyer et al., 1998; Meyer & Poon, 2001). This group's work has shown that trained readers, both younger and older, who incorporated the strategy and use of verbal signals, remembered twice the information than those who were not trained (Meyer et al., 1989).

In their study in 1989, Meyer and colleagues (1989) examined the effects of structured strategy training on recall for expository prose in younger and older adults. After five 2-hour sessions, significant improvements in learning and memory were revealed only for those who were trained to first identify the passage’s structure out of five choices, then use that structure to aid retrieval, but not for those who participated in practice alone, nor for controls. Both younger and older treatment groups learned the strategy, and the older groups performed even slightly better than younger controls who received no training. These results were evident in immediate recall and were maintained for 2 weeks. In addition, near transfer to everyday reading comprehension was found.

Meyer’s earlier work investigated how the top-level structure of text impacts reading comprehension and recall in high school and college students, and resulted in the following conclusions. First, ideas at the logical top-levels of text structure, i.e., main ideas and subordinate ideas, are better understood and remembered. Second, the relationships among the top-level major ideas affect recall significantly, while lower level detail relationships do not. Third, structure type affects memory. Fourth, students who use the structure to aid recall show superior recall than those who do not. Finally,
students can be taught to identify and use structures in order to facilitate memory, even as young as the ninth grade (Meyer et al., 1989).

Meyer and colleagues also investigated the effects of prose structure on recall of auditorily presented prose passages in younger adults, analyzing ideas recalled after one, two, or three passage repetitions, but without training (Meyer & McConkie, 1973). The results indicated that the subjects recalled the propositions in the same hierarchical manner as the subjects had done when reading the passages. Moreover, the 2001 study (Meyer & Poon, 2001) demonstrated transfer of training effects to ecologically relevant videotapes of approximately 12 minutes at 149 words per minute, showing that this strategic structure training proven for text recall can be extrapolated to auditory material. Therefore, we hypothesized that this type of technique should result in similar effects for memory of spoken discourse in healthy older adults.

For older adults, a potential obstacle to notetaking concurrently with auditory stimuli is that they generally demonstrate slower handwriting speed (Rodriguez-Aranda, 2003). Transcription fluency, i.e., legible handwriting speed, has been demonstrated to be a significant predictor of note quality and memory (Peverly et al., 2007). However, several studies have been conducted with high school and college students with learning disabilities, who demonstrated significantly slower writing than age-matched individuals without disability (Hughes & Suritsky, 1994), and they showed dramatic improvements after notetaking training (Boyle & Weishaar, 2001; King, 1992; Ruhl & Suritsky, 1995). Therefore, in our study, in addition to expecting our training to offset slower writing, we incorporated a pre-screening assessment of writing fluency as an
exclusionary tool for participants unable to write as quickly as their peers (Rodriguez-Aranda, 2003).

**Cognitive Factors**

Individual variables, such as motivation, prior knowledge, and cognitive abilities are instrumental in facilitating encoding (Brown & Craik, 2000). The mechanism of learning and remembering text (Mayer, 1984) and lecture content (Kiewra, 1991) through notetaking is hypothesized to engage multiple cognitive networks in order to instantiate new knowledge into long-term memory (Piolat et al., 2005), including selective attention, working memory, controlled processing, and semantic organization to create episodic memories (Kellogg, 2001). A number of cognitive skills have been examined as predictors of learning, some with notetaking, but somewhat inconsistent results have been demonstrated.

Educational achievement has been linked to several cognitive abilities, including working memory capacity, verbal ability, and prior knowledge. Working memory is most commonly found to be a primary predictor of learning ability (Gathercole & Pickering, 2000; Grimley & Banner, 2008). Greater memory gains from notetaking have been shown for students with higher working memory (Berliner, 1969), as well as those with higher verbal abilities (Van Matre & Carter, 1975). Prior knowledge also influences notetaking effects, as demonstrated by Peper and colleagues (Peper & Mayer, 1978, 1986). They found that individuals who took no notes evidenced better recall of factual information, while notetakers, especially if they took their own notes rather than receiving handouts, showed better transfer to new tasks. In addition, students with less prior knowledge performed better when they did not take notes.
In contrast, other researchers who hypothesized that working memory, verbal skills, and prior topic knowledge would predict lecture note quality and recall failed to do so. In one case, it was demonstrated that increased working memory benefitted college students more when they listened but did not take notes (Hadwin, Kirby, & Woodhouse, 1999), suggesting that notetaking interfered with learning. Similarly, it has been shown that students with higher cognitive abilities overall who took good quality notes prior to training failed to benefit from further instruction (Peper & Mayer, 1978). Moreover, students with less prior knowledge of the topic, or who demonstrate poorer learning skills, have shown greater gains from training than those with higher prior knowledge and superior study skills (Shrager & Mayer, 1989).

In older adults, cognitive predictors of learning new information have been studied, but few have involved notetaking. For example, Neils-Strunjas and colleagues examined the relationships between learning style, cognitive ability, and face-name learning (Neils-Strunjas, Krikorian, Shidler, & Likoy, 2001). They found that semantic fluency, visual memory, and episodic memory were associated with learning, but the best predictor was episodic memory. However, vocabulary comprehension was not significant. In a similar study, Bryan and colleagues investigated the effects of encoding strategy type and cognitive measures on word-list learning in younger and older adults (Bryan, Luszcz, & Pointer, 1999). Age differences were evident only when subjects used the complex encoding strategies, and associations with executive function and working memory were identified. However, processing speed predicted recall independent of the strategy used by the older adults. Finally, cognitive predictors of delayed medicine instruction recall in younger and older adults have been examined
(Neupert & McDonald-Miszcak, 2004). Results showed that vocabulary predicted recall in both age groups, but working memory was more predictive in the older subjects.

Researchers have demonstrated that individuals, both younger and older, with greater working memory capacity, semantic abilities, and executive function are better notetakers, as judged by number of words recorded, number of ideas noted, especially subordinate, and also perform better on measures of recall (Kiewra, 1988; Kiewra & Benton, 1988; Meyer et al., 1989; Meyer et al., 1998; Meyer & Poon, 2001; Morrow et al., 1999; Rice & Meyer, 1986). However, some of these same researchers have also demonstrated that older adults with average semantic abilities are able to perform as well as those with higher verbal skills when given strategy instruction (Meyer et al., 1989), and that training notetaking reduces the role of working memory, processing speed, and spatial abilities in accurate recall of heard information (Morrow et al., 2003). Accuracy of notes taken is also highly influenced by expertise in the field (Morrow et al., 2003).

Therefore, we investigated cognitive measures to determine their predictive value, and applied the SOC model of optimizing strengths while minimizing limitations to our intervention protocol.

**Our Proposed Mechanism**

We synthesized the literature and incorporated principles of learning and cognitive load reduction to create a proposed mechanism by which encoding and retrieval in healthy older adults is facilitated by our notetaking strategy. We outline this three-component mechanism – INPUT – PROCESS – OUTPUT – below.
First, we manipulated the INPUT of our training program to reduce cognitive load. The literature informs us that cognitive effort can be modified not only by skilled strategy use, but also by the nature of the source material, the notetaking technique employed, the source medium, the amount of information to be remembered (Piolat et al., 2005), and expectations (Van Matre, Yokoi, & Pressley, 1994). Cognitive load is reduced if the linguistic structure and content of the passage are familiar, and this is especially true for older adults, whose comprehension is maximized by discourse with canonical syntactic structures and recognizable topics (Burke & Shafto, 2008; Kemper & Herman, 2006). Therefore, we used as our stimuli the short narratives, incorporating older adults as the main characters, standardized by Dixon and colleagues (Dixon, Hertzog, & Hultsch, 1989) in order to maximize familiarity. In addition, studies have shown that pre-planned notetaking frameworks reduce cognitive demands (Kiewra, DuBois, Christian, & McShane, 1988; Kiewra & Frank, 1988), and the most commonly used format is the hierarchical outline, which reflects the same linear representation as our stimuli and is considered the best format for information retention (Bligh, 2000). Furthermore, if the discourse material is presented using only auditory input, this frees up working memory capacity for formation of new schemata (Van Gerven et al., 2000). Moreover, the amount of information contained in the discourse passage was limited to the optimal attention span of our subjects, 12 minutes or less for healthy older adults (Meyer et al., 1989), and presented at a rate conducive to comprehension in older individuals (Kemper, 1994; Wingfield & Stine-Morrow, 2000), and reported to show positive encoding effects during notetaking with presentation rates from 90 to 120 words per minute (Ladas, 1980). Finally, we directed the participants’ expectations with explicit
verbal instructions, shown to focus attention to critical information (Oakhill & Davies, 1991).

**PROCESS**

Second, we proposed that the PROCESS component would be supported by our training protocol. Our program targeted the two skills essential for taking effective notes based on the notetaking training literature: active listening and selective notetaking (Bligh, 2000; Gall et al., 1990). Teaching students (Engraffia, Graff, Jezuit, & Schull, 1999 in Gall et al., 1990) and adults (Lundgren & Shavelson, 1974; Wolvin et al., 1979, in Gall et al., 1990) how to actively listen for notetaking purposes has been shown to increase their attention skills, self-confidence, and overall achievement. Systematic listening training for teachers has been shown to increase their attentional skills (Lundgren & Shavelson, 1974). Likewise, listening training with school-age children has led to significantly increased academic achievement (Wolvin & Coakley, 1979, in Gall et al., 1990).

Selective notetaking is supported by studies that have shown that verbatim notes are the least effective for facilitating recall (Bretzing & Kulhavy, 1979). Rather, the most effective notes for later recall have been shown to be concise paraphrased transcriptions of main and related points (Fisher & Harris, 1973; Locke, 1977; Bretzing & Kulhavy, 1979; Kiewra, 1984). Recording only key content words and phrases, and judicious use of abbreviations and symbols, facilitate thorough and efficient notetaking (Wolvin et al., in Gall, et al., 1990). In summary, training with explicit instruction in active listening for verbal and nonverbal signals of important ideas, and selective notetaking, has consistently resulted in higher test scores in young students (Gall et al., 1990). These strategies, therefore, have been incorporated into the protocol.
We integrated a novel notetaking template to facilitate efficient note organization into the protocol. The framework that has proven to be the most common and effective way to take notes to recall the most important information, especially when listening to well-organized discourse, is the sequential outline format (Bligh, 2000). The outline notetaking method has been shown to increase the number of ideas written in a logical and organized manner (Kiewra, DuBois, Christensen, & Kim, 1989) and enhance test performance compared with other formats (Kiewra, Benton, Kim, Risch, & Christensen, 1995). Providing individuals with this type of template provides a guiding structure in which relationships among main and supporting ideas can be clearly noted. This allows for chunking information into manageable schemata, shown to compensate for reductions in working memory (Kiewra, 1988) and facilitate retrieval (Craik & Lockhart, 1972). Notetaking in this way enables the creation of connections between new information and prior knowledge, and when these external connections are built, incorporating chunking strategies, elaborative rehearsal, and generation effects (Kiewra, 1988, 1989; King, 1992; Peper & Mayer, 1978, 1986; Rickards & McCormick, 1988; Shrager & Mayer, 1989), new mental models of organized information, schemata, crucial for encoding (Brown & Craik, 2000), are created (Kiewra, 2002). Notetaking has been demonstrated to facilitate both internal and external connections (Bligh, 2000; Faber et al.; Kiewra, 1985a; Piolat et al., 2005; Slotte & Lonke, 1999; Weiland & Kingsbury, 2001), and training can lead to transfer to novel situations (Peper & Mayer, 1978, 1986). For these reasons, notetaking is thought to facilitate encoding information for long-term storage (Bligh, 2000).
OUTPUT

Last, we statistically analyzed the OUTPUT, the three primary outcome measures, note fidelity, immediate free recall, and delayed recognition, to determine any treatment effects of the protocol. We also conducted correlational analyses to account for influences of participant cognitive abilities. We have illustrated our proposed mechanism in Figure 2-1.

Summary

In conclusion, through synthesis of the literature, we developed a proposed mechanism for facilitating encoding through our systematic notetaking training program. We hypothesized that our training protocol would compensate for reduced cognitive mechanics, while supporting intact cognitive pragmatics, resulting in enhanced episodic memory. As Figure 2-1 illustrates, we controlled INPUT to reduce cognitive load while simulating naturalistic stimuli, targeted PROCESS with training, and analyzed OUTPUT, the primary outcome measures reflecting the effects of our training program.

Notetaking Training Protocol

We have seen that strategic training in healthy older adults reduces cognitive load and reallocates resources to task demands (Meyer et al., 1993). Our systematic notetaking training protocol is based on the principle of reduced cognitive load to facilitate learning and recall in healthy older adults, as illustrated in our proposed mechanism. Encoding new material is reliant on several factors, specifically, attention, selection, organization, and meaningfulness (Brown & Craik, 2000), and evidence supports that taking notes: 1) focuses and maintains attention (Peper & Mayer, 1986), 2) compels selection of important points (Piolat et al., 2005), 3) promotes identification of the underlying organizational structure of text or discourse (Einstein et al., 1985; Van
Meter, Yokoi, & Pressley, 1994), 4) generates conceptual links by promoting the search for meaning in what is heard (Peper & Mayer, 1986), and 5) facilitates encoding material into long-term memory for later retrieval (Meyer et al., 1989; Meyer et al., 1998; Meyer & Poon, 2001). Thus, we derived a notetaking training program for encoding discourse material engaging these five processes.

First, we focused and sustained attention utilizing naturalistic auditory stimuli, short narratives standardized specifically for older adults, not only for structural and semantic features (Dixon et al., 1989), but also for high interest level, demonstrated to facilitate learning (Schiefele, 1991, 1999). Young and older adults exhibit equivalence in sustained attention, especially for discourse (McDowd & Shaw, 2000). In addition, we expected the directed training and practice opportunities to compensate for the difficulty inhibiting irrelevant information (Hasher & Zacks, 1988), as has been demonstrated in previous research (McDowd & Shaw, 2000; Meyer et al., 1993).

Second, we taught experimental subjects to select key points by demonstrating differentiation of information that was relevant, e.g., main points, or irrelevant, e.g., minor details, guided by the notetaking template that provided an outline for top-level main and supporting propositions only. The template was used during training sessions and homework assignments only, designed to instantiate a structured mental representation to cue retrieval during the in-person recall and recognition assessments, when it was not available. Selection and organization require executive control, somewhat reduced in older adults (Verhaeghen & Cerella, 2002), but formal training and guided practice were expected to facilitate transformation of the discourse material into meaningful chunks of information, through use of the organizational template. In
addition, the time constraints inherent in the notetaking process we predicted would help participants disregard extraneous material while forcing them to choose only the crucial main and supporting propositions.

Third, we trained participants to take organized notes using the notetaking template, formatted with the same hierarchical structure, a familiar outline style, as the discourse passages. We then taught them to use the visual image of the organizational structure of chunked ideas as an internal retrieval cue for later recall. Thus, this environmental support was designed to reduce cognitive load on working memory, processing speed, and executive control, as well as provide a self-cuing strategy. The template was designed to allow for orthographic transcription of information chunks in part by promoting use of the procedural component of notetaking, followed by information encoding into conceptual representations, more easily stored for later recall.

The stimuli were densely structured. The higher the propositional density and the faster the presentation rate, the more difficult it is for individuals of all ages to understand discourse (Kintsch & Keenan, 1973), notably for students taking notes during lectures (Cook & Mayer, 1988). Therefore, we pre-recorded each story combining a speech rate of 100 words per minute with 3-second pauses inserted between sentences, shown to enhance comprehension and allow ample time to select and record notes (Gray & Madson, 2007). The rate was chosen to accommodate the slowed processing speed of older adults. It falls within the range of educational notetaking studies, from 90 (Howe, 1970) to 150 (Peck & Hannafin, 1983) words per minute during lectures, and is able to be processed adequately by older individuals,
ideally from 100 to 120 words per minute (Kemper, 1994; Wingfield & Stine-Morrow, 2000).

Fourth, we took advantage of the subjects’ rich semantic knowledge by choosing stimuli with meaningful content and organizational structure, discourse passages standardized for older adults (Dixon et al., 1989). These passages relayed personalized experiences, such as traveling or retiring, with older individuals as the protagonists. We chose to target discourse recall, as it is somewhat buffered from age effects because of language expertise (Burke & Mackay, 1997; Thornton & Light, 2006; Wingfield & Stine-Morrow, 2000) and preserved top-down contextual use of schemata (Zwaan & Rapp, 2006). Moreover, we expected the passages’ familiarity and predictability would facilitate encoding by compensating for limitations in cognitive mechanics (Burke & Mackay, 1997; Van Gerven et al., 2000; Wingfield & Stine-Morrow, 2000).

Finally, we posited that teaching participants to use the template to hierarchically chunk meaningful information, then visualize that organization to self-cue retrieval, would model the encoding specificity hypothesis (Tulving & Thomson, 1973). The structure would later serve as an internal mental schema to cue recall. We reinforced this learning strategy by providing identically-recorded passages for homework during which participants could practice taking structured notes using the template. In addition, we designed the training program to incorporate distributed practice, which facilitates learning (Shuell, 1981) and the intensity and duration that has resulted in positive learning effects in other studies (Meyer et al., 1989). Thus, participants were taught to use and practice the strategy of top-down retrieval search utilizing the hierarchical
structure with chunks of key content as a self-cue, in a program designed to also support encoding.

In summary, we predicted that instruction, environmental support, practice, and feedback provided across a multi-session course of training, 5 sessions over 2 to 3 weeks, would support the executive control necessary to select, manipulate, and transfer short-term input into long-term episodic memory, while compensating for working memory and processing speed demands through cognitive load reduction. We postulated that episodic memory of ecologically valid material would be enhanced by compensating for those processes impaired with age, by directing attention to and selection of pertinent content, promoting organization and encoding of new information into existing schemata, and formulating retrieval cues for later recall. Thus, we expected note fidelity, recall, and recognition to significantly improve in the treatment group, compared to controls, from pre-training to post-training.

We now discuss how our training protocol addresses each Specific Aim.

**Specific Aim 1: Note Fidelity**

Determine if structured notetaking training improves fidelity of notes in healthy older adults.

**Hypothesis 1:**

Healthy older adults who are trained in a systematic notetaking strategy will produce notes with greater note fidelity, as measured by the number of accurate propositions transcribed, than healthy older adults who take notes but are not trained.

The literature informs us that high note fidelity requires selection and organization of critical information (Piolat et al., 2005). We incorporated active listening into our protocol, such that subjects could identify key information by learning to use verbal
signals, attention-getting words, such as “therefore,” and nonverbal signals, changes in prosody to signify emphasis, within the discourse passage, effective for text recall in young and older adults (Meyer & Poon, 2001). To facilitate note organization, we taught subjects to take notes on a novel two-column outline-structured template. We also provided completed templates as models, known to decrease cognitive load (Van Gerven et al., 2000).

The template provided the environmental support for recording notes in an organized manner, differentiating main ideas and graphically representing their relationships with supporting ideas in hierarchical fashion to support top-down processing. Templates in which individuals must insert the important ideas helps to offload working memory and processing speed demands by allowing them to concentrate on main concepts (Katayama & Robinson, 2000), and training with templates has been demonstrated to increase the number of propositions noted (Austin et al., 2004; Baker & Lombardi, 1985; Einstein et al., 1985; Kiewra & Fletcher, 1984; Lee et al.; Pollio, 1990).

**Specific Aim 2: Recall and Recognition**

Determine if healthy older adult trained notetakers exhibit significantly greater recall and recognition relative to healthy older untrained notetakers.

**Hypothesis 2:**

Healthy older adults who are trained in notetaking will exhibit significantly greater recall and recognition of material presented than healthy older adults who are not trained in notetaking.

We have seen that training notetaking strategically teaches individuals to plan, select main and supporting ideas, inhibit irrelevant material, and transcribe the targeted
information in an organized format which provides a mental schema to cue later retrieval (Meyer et al., 1989; Meyer et al., 1998; Meyer & Poon, 2001). Positive encoding effects of formal notetaking training have been demonstrated in academic settings, as evidenced by higher recall and recognition scores (Faber et al., 2000; Kobayashi, 2006; Lee et al., 2008), especially when a template has been incorporated (Arslan, 2006; Hartley & Davies, 1978; Peck & Hannafin, 1983; Spires, 1993). Similar results have been shown in young and even older adults (Meyer et al., 1989; Meyer et al., 1998; Meyer & Poon, 2001). Thus, we predicted that our protocol would significantly improve immediate recall and delayed recognition for those trained, compared with controls.

**Specific Aim 3: Note Fidelity/Recall and Recognition**

Determine if changes in note fidelity predict changes in recall and recognition in healthy older adults.

**Hypothesis 3:**

Greater note fidelity, as measured by the change in number of accurate propositions transcribed from baseline to posttest, will positively correlate with greater changes in free recall and delayed recognition of the material presented.

The effectiveness of notetaking has been measured by correlating note quality with memory performance, and note quality has been shown to predict recall and recognition, both immediate and delayed, in academic settings (Bretzing & Kulhavy, 1981; Kiewra, 1985a; Peverly et al., 2007; Titsworth & Kiewra, 2004). Moreover, studies have shown positive correlations between the number of lecture details transcribed and overall academic achievement when compared at baseline and posttest (Cohn et al., 1990; Kiewra & Fletcher, 1984; Fisher & Harris, 1973; Walbaum, 1989).
Large individual differences in note quality exist, such as use of abbreviations and symbols. However, the predominating conclusion is that the better organized, clearer, and more numerous the ideas noted, the more helpful to memory are the notes (Bligh, 2000). Peverly and colleagues (Peverly et al., 2007) tested several factors to determine which were most predictive of lecture notetaking competence, and found that note quality was the best predictor of memory recall performance. Thus, evidence suggests that greater note quality in school-age individuals results in increased recall. In addition, in the only study of older adults that has examined the relationship between notes and recall, the results showed a significant positive correlation between the number of words recorded and recall (Morrow et al., 1999). Thus, we hypothesized that changes in note fidelity over time would predict changes in recall and recognition of the discourse material heard.

**Specific Aim 4: Cognitive Correlates**

Determine if pretest cognitive measures—working memory, processing speed, semantic memory, episodic memory and executive control – in healthy older adults predict: a) baseline note fidelity and change from baseline to posttest, b) baseline free recall and change from baseline to posttest, and c) baseline delayed recognition and change from baseline to posttest.

**Hypothesis 4:**

Pretest cognitive measures—working memory, processing speed, semantic memory, episodic memory and executive control – will predict: a) baseline note fidelity and change from baseline to posttest, b) baseline free recall and change from baseline to posttest, and c) baseline delayed recognition and change from baseline to posttest.
As previously discussed, results from notetaking studies are often confounded by lack of data regarding characteristics of the stimuli, methodological information describing variables such as instructions given, and cognitive measures of participants. Learning studies of older adults, such as the face-name study by Neils-Strunjas and colleagues (2001), have shown that episodic memory was the best predictor of recall (Neils-Strunjas et al., 2001). Working memory, processing speed, and executive function have predicted strategy use (Bryan et al., 1999), and vocabulary and working memory have predicted delayed recall (Neupert & McDonald-Miszcak, 2004).

In studies specific to notetaking, the literature has demonstrated that individuals with higher working memory, verbal abilities, and executive control benefit more from taking notes to facilitate encoding (Kiewra, 1988; Kiewra & Benton, 1988; Meyer et al., 1989; Meyer et al., 1998; Meyer & Poon, 2001; Morrow et al., 1999; Rice & Meyer, 1986), especially working memory (Grimley & Banner, 2008; Gathercole & Pickering, 2000). However, systematic training often compensates for cognitive deficits (Meyer et al., 1993; Morrow et al., 2003), unless the learner is already a skilled notetaker (Peper & Mayer et al., 1978).

On the other hand, it has also been shown that notetaking may be detrimental to individuals with high working memory (Hadwin et al., 1999). Thus, because of the inconclusive nature of these results, we chose to examine the cognitive measures most likely to influence performance in our participants.
Figure 2-1. Proposed mechanism for facilitating episodic memory improvement through systematic notetaking training.
CHAPTER 3
DESIGN AND METHODS

Design

A pretest-posttest alternately assigned 2-group design with repeated measures was employed, with two groups of healthy older adults screened for age, primary language, education, neurological history, and global cognitive function. The independent variable was notetaking training (trained, untrained), and dependent variables were note fidelity (number of accurate propositions transcribed during the listening task), free recall (number of accurate propositions recalled and written following the task), and delayed recognition (number correct on 24-item 2-choice test after 10-minute delay).

Participants

We recruited 48 healthy older adults aged 60 and over, screened for primary language (English), education (high school degree or greater), history negative for neurological pathology or dyslexia, and global cognition (Mini-Mental State Examination, MMSE, Folstein, Folstein, & McHugh, 1975, of 27 or higher). To determine the sample size, we conducted a power analysis, Greenhouse-Geiger corrected due to lack of sphericity in the data. We chose to use a more rigorous criterion of alpha = .01. With 5 occasions, power = .80, alpha = .01, we achieved 80% power with two groups of 24 subjects each, for a total sample size of 48.

Group determination was accomplished through alternate assignment. The total number of individuals that contacted us was 93. This number was the result of potential candidates’ either hearing a presentation at a retirement community or senior organization activity or seeing a study flyer posted in their community. Upon first
contact, we conducted a preliminary telephone screen for basic demographic and general health information, as described below, to determine initial eligibility. Those deemed ineligible (n = 30) were thanked for their time and informed that they might be interested in research opportunities different from the current study. Once candidates met the preliminary inclusion criteria, they were screened with the in-person screen, which included the MMSE and writing fluency screening assessment (Rodriguez-Aranda, 2003). Those individuals who satisfied both screening processes (n = 50) were alternately assigned to treatment or control group. A number of candidates who had met initial (n = 10) or final (n = 1) eligibility criteria chose not to participate in the study, either because of illness, busy schedules, or lack of interest, and thus were eliminated from the subject pool. Two additional subjects dropped out due to illness after attending 3 sessions, thereby failing to meet the 80% attendance criterion. Four controls and one treatment participant also attended only 80% of the sessions, making it necessary to interpolate the missing data as described in the next chapter. See Figure 3-1 for a CONSORT diagram summarizing recruiting and group assignment procedures (Schultz, Altman, & Moher, 2010).

**Recruitment**

Subjects were recruited from retirement communities, senior organizations, and local small businesses in Northeast Florida, in order to attain a relatively representative sample of the general population of healthy older adults in this geographical locale.

**Inclusion Criteria** included: 1) English as the primary language, 2) high school education or greater, 3) global cognition level measured by the MMSE as 27 or higher, based on norms in Iverson (1998), 4) corrected hearing and visual acuity within normal limits based on preliminary screenings, and 5) writing speed within normal limits for age.
group (maximum of 120 seconds to copy 157 characters in a list of 18 common words, based on results of 60-79 year olds given a handwriting speed test developed by Rodriguez-Aranda, 2003).

**Exclusion Criteria** included: 1) MMSE below 27, 2) less than a high school degree, and 3) neurological, visual, hearing, or writing disability that would impair the ability to listen to and understand a pre-recorded audiotaped narrative and take written notes, assessed by screening.

Participants were paid a total of $10, $5 of which was provided on the first day, and the remainder on the last day. We posted recruitment advertisements and conducted short presentations in Northeast Florida retirement and senior centers, and local businesses, as permitted by management.

**Informed Consent**

At recruitment, we informed potential participants as to what to expect in the study and how long it would take. We explained that their participation was entirely voluntary, and they could withdraw at any time without penalty. Those participating in the experiment were asked to read a copy of the Informed Consent and we explained it to them and asked them to sign it if they agreed with its content. We allowed 24 hours for their consideration to participate. We obtained signed Informed Consents for all 48 participants using Protocol #2008-U-1015, approved by the Institutional Review Board-02, University of Florida, and renewed in 2009, and provided each participant with a copy of the Informed Consent form for their records.
Screening Measures

In order to obtain relative homogeneity in the sample and fulfill inclusion/exclusion criteria, the following screenings were administered prior to enrollment in the experiment:

1. Initial Telephone Screen for Inclusion/Exclusion:
   - Vision, hearing, reading, writing: Interview (Jobe et al., 2001; Lachs et al., 1990; Wallhagen, Strawbridge, Shema, Kurata & Kaplan, 2001); within functional limits for study
   - General demographic information: Age, gender, marital status, education, ethnicity (Jobe et al., 2001)
   - General health information: “Has a doctor ever told you that you have…” – Alzheimer’s disease, stroke, transient ischemic attack (TIA), Parkinson’s disease, head injury, memory problems (Jobe et al., 2001)
   - Previous notetaking habits: Interview for any training and frequency of notetaking

2. In-person Screen (if candidate satisfied telephone screen criteria):
   - Writing speed and fluency: Read and copy 18 written words legibly with 157 characters in 120 seconds or less (Rodriguez-Aranda, 2003)
   - Global cognition: MMSE (Folstein, Folstein, & McHugh, 1975); cutoff = 27

Cognitive Battery

The following tests were administered in written format during the first experimental session:

- Forward and Backward Digit Span: (Wechsler Adult Intelligence Scale, WAIS-R, Wechsler, 1981) Forward span tests verbal working memory span by requiring participants to verbally repeat lists of numbers of increasing length in the order in which they are presented; Backward span tests verbal working memory span by requiring participants to verbally repeat lists of numbers of increasing length in the opposite order of how they are presented

- Trail Making Test Part B: (Reitan, 1992) tests cognitive flexibility, working memory, and speed; participants were asked to draw lines between numbers and letters without lifting their pencils from the paper and while working as quickly as possible. For Part B they drew a line from 1 to A, A to 2, 2 to B and so on for 60
seconds. Results were compared to norms for age group (Knight, McMahon, Green, & Skeaff, 2006)

- Hopkins Verbal Learning Test: (Brandt & Benedict, 2001) tests episodic memory through learning word lists over 3 trials, scored for total recall, delayed recall, and retention; this was alternated with other tests in between written trials to allow for delayed testing

- Digit Symbol Substitution Test: (Wechsler Adult Intelligence Scale, WAIS-R; Wechsler, 1981) tests speed of processing by participants’ substituting a symbol for a random succession of numbers given a visual pattern, and the score is number of boxes filled within 90 seconds

- Shipley Vocabulary Test: (Shipley, 1940) tests semantic memory through multiple choice vocabulary questions

- Phonemic and Semantic Fluency: (Thurstone Word Fluency Test, in Rodriguez-Aranda, 2003) tests written controlled processing and working memory; subjects write as many words as possible beginning with S and K, in 4 minutes per letter, and as many exemplars in a given category over three 1-minute trials, respectively

We provided all test forms to each participant in a stapled, serially-organized packet prior to the beginning of the first session, and gave directions for each test orally. The entire Cognitive Battery took less than 60 minutes.

**Experimental Stimuli**

During each session, we presented all participants with an audiotaped narrative of approximately 4 ½-minutes, previously developed for older adults and standardized for interest level, semantic and organizational difficulty, and number and level of importance of propositions (Dixon et al., 1989), as defined by Kintsch (1974). We chose spoken discourse not only to simulate naturalistic learning, such as that which takes place while listening to physicians’ recommendations, but also because the expected age trajectory for prose recall is often less steep than that for list recall (Thornton & Light, 2006), somewhat buffered against aging effects due to well preserved top-down contextual processing.
Based on the literature, we pre-recorded the standardized passages by Dixon and colleagues (1989), using a female voice, a speech rate of 100 words per minute, and 3-second pauses between sentences, to allow for adequate notetaking time. During each session, both the control group (taking untrained notes) and the treatment group (taking trained notes) were presented with a voice-recorded standardized passage describing an event in one or two older persons' lives. Passages are approximately 300 words in length in 24 sentences, have been rated similarly in interest and difficulty levels, are structurally equivalent and well organized based on readability ratings, and contain approximately 160 propositions distributed at comparable importance levels, from 1 (main) to 7 (detail).

Homework assignments were given to the treatment subjects after each training session with explicit oral and written instructions, and consisted of practicing the notetaking skills taught during that day’s session by taking notes using the provided template during an auditory discourse passage. These passages were made available by pre-recorded identical digital recorders given to each treatment subject. We also instructed subjects in depth as to their use. The passages were taken from the same source (Dixon et al., 1989) and recorded with the same criteria as those used for in-class trainings and assessments.

**Experimental Procedure**

Our study was approved by the International Review Board -02 at the University of Florida, and all participants signed an Informed Consent. The intervention protocol was patterned after a substantial body of notetaking training and aging literature, and included instruction, modeling, distributed practice, and feedback, as well as homework assignments to be completed before each successive session. The five daily lesson
plans included training in active listening, selective notetaking, use of abbreviations and symbols, and organization of information into chunks for later recall (see Appendix A). An organizational template using the sequential outline framework was incorporated (see Appendix B) during trainings to help participants organize main and related ideas, thus providing an external compensatory technique to maximize intact semantics and minimize vulnerable executive control, working memory, and processing speed (Morrow & Rogers, 2008), and which later served as an internal retrieval cue. Each lesson was followed by a short quiz to ensure comprehension of the material, and included time for individual and group discussion and feedback afterwards, crucial for optimizing learning in older adults (Verhaeghen et al., 1992).

The 48 subjects who completed the study had been alternately assigned to control and treatment groups. Each 24-subject group was subdivided into smaller groups of one to four, and each met for five 2-hour sessions over the course of 2 to 3 weeks. During Session 1, all subjects were administered the Cognitive Battery, after which they listened to a voice-recorded standardized 4 ½-minute narrative without taking notes, then subsequently produced free recall protocols and, after 10 minutes, took a standardized 24-item yes/no recognition test. During Sessions 2 through 5, all subjects took notes while listening to identical standardized audiotaped 4 ½-minute narratives, a different passage each time, but only treatment groups received a notetaking lesson during each session. The notetaking training took approximately 1 hour per session. Subjects subsequently produced free recall protocols without referring to the notes they had taken, and after the delay completed the recognition tests. We collected the assessments daily.
Conditions across groups were identical except for the structured notetaking training program. The treatment subjects attended the sessions and took notes during the audiotaped passages, but also received training, took short quizzes afterwards, and completed daily homework assignments, which we collected to determine compliance. The order of training and testing was counterbalanced to control for fatigue effects. During testing sessions, we gave all subjects identical instructions and assessed them with the same outcome measures.

We distributed daily lesson plans to participants in the treatment group, which they were allowed to keep for their personal reference. The lessons incorporated a brief review of supportive literature, keys to taking high quality notes, instructions on how to use the strategy for information retrieval, a mnemonic to help reinforce strategy use, and completed template examples to facilitate selection of main and supporting ideas (Van Gerven et al., 2000). At each posttest, the treatment subjects completed a questionnaire (Appendix C) to determine whether they used the template structure or not, and why they did or did not use it. Subjects in both groups also completed a Likert-based questionnaire at posttest, also standardized by Dixon and colleagues (1989), rating the difficulty and interest level of the stimuli. At the conclusion of the study, we provided all participants with a certificate of appreciation thanking them for their participation.

The procedure is summarized in Table 3-1. The notetaking protocol incorporated the following strategies:

- Instructor introduced topic of notetaking by briefly describing the evidence that supports notetaking as a potential learning technique linking new information to prior knowledge
• Instructor used illustration, modeling, and group interaction to demonstrate notetaking methods

• Instructor taught subjects how to plan for notetaking, including knowing the topic beforehand, anticipating main and related ideas that will be covered, and organizing relevant information as guided by the notetaking outline template

• Instructor taught how to listen actively, to differentiate relevant from irrelevant information, and to take notes selectively using shortcuts, such as symbols

• Instructor provided individual and group interaction, feedback, and practice opportunities

• Instructor gave homework assignments after Sessions 1 – 4 to promote practice of notetaking techniques first using template then taking notes without it, for generalization of structure, while listening to a recorded discourse passage

**Scoring Procedures**

We scored note fidelity and free recall of the discourse material based on an aggregate score of propositions recalled across levels of importance, using the scoring methodology of the authors, Dixon and colleagues (1989). We used a gist criterion for scoring presence of propositions, allowing for synonyms and generalizations to count as correct (Dixon & Gould, 1998). We also tracked intrusions and perseverations.

In order to ensure unbiased proposition scoring, we asked an independent judge blind to group assignment and session number to score a random 30% of the note and recall protocols, and calculated Cronbach’s alpha coefficient for inter-rater reliability. Our research assistant also took great care to ensure that when scoring, we were unaware of the subject’s identity, group assignment, or session number. To achieve this, we scored the test packets after a delay of 1 to 2 weeks from the time of testing. Therefore, no connection could be made between handwriting and identity. Furthermore, prior to the scoring, the research assistant conducted a 2-step process of participant and group de-identification of each set of notes and recall protocols, first by
de-identifying each test packet by removing the assigned number indicating group assignment, testing order, and subject, and then randomly combining multiple control group packets with treatment group packets. In this way, as we chose each test packet to score from a stack, we were unable to determine the identity of the participant, the group assignment, or the test order, thereby minimizing potential bias during scoring.

**Data Analysis**

**Analysis**

To assess the effects of strategic notetaking training on note fidelity, recall, and recognition of discourse material, our primary aims, we conducted a one-way analysis of variance (ANOVA) model with repeated-measures. To address our secondary aims, investigating relationships among note fidelity, recall, and recognition, and cognitive predictors of performance, we conducted correlational analyses. We used the software PASW Statistics GradPack version 18.0 (SPSS, Inc., 2009) for all analyses. We set the Type I error rate at alpha = .05 for all analyses.

**Inter-rater Reliability**

We trained an independent judge how to conduct propositional scoring based on Dixon and colleagues’ criteria (1989). Reliability was based on our scoring compared to the independent judge’s scoring of a random 30% of notes and recall protocols. Scoring was characterized by very good inter-rater reliability, as evidenced by Cronbach’s alpha coefficient of .98.

**Participant Feedback**

At the end of each session, we asked participants in the treatment group to complete a questionnaire (Appendix C) addressing their perceived usefulness of the training components—1) active listening, 2) selective notetaking, and 3) use of template
to aid their note production, recall, and recognition. We also asked all participants to complete a survey of their perceptions of the content of each passage, standardized by Dixon and colleagues (1989). We used these responses to investigate relationships between performance on outcome measures and personal feelings about the passages. Results are summarized in the next chapter.
Figure 3-1. CONSORT diagram for participant recruitment and group assignment.
<table>
<thead>
<tr>
<th>Session</th>
<th>Treatment Group</th>
<th>Control Group</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Session 1</strong></td>
<td>Cognitive Battery</td>
<td>Cognitive Battery</td>
</tr>
<tr>
<td></td>
<td>1&lt;sup&gt;st&lt;/sup&gt; audiotaped passage</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; audiotaped passage</td>
</tr>
<tr>
<td></td>
<td>No notes taken</td>
<td>No notes taken</td>
</tr>
<tr>
<td></td>
<td>Immediate free recall</td>
<td>Immediate free recall</td>
</tr>
<tr>
<td></td>
<td>Delayed recognition</td>
<td>Delayed recognition</td>
</tr>
<tr>
<td></td>
<td>Stimulus questionnaire</td>
<td>Stimulus questionnaire</td>
</tr>
<tr>
<td></td>
<td>1&lt;sup&gt;st&lt;/sup&gt; notetaking lesson</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Quiz and discussion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Homework given</td>
<td></td>
</tr>
<tr>
<td><strong>Sessions 2 through 4</strong></td>
<td>2&lt;sup&gt;nd&lt;/sup&gt;-4&lt;sup&gt;th&lt;/sup&gt; notetaking lesson</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt;-4&lt;sup&gt;th&lt;/sup&gt; audiotaped passage</td>
</tr>
<tr>
<td></td>
<td>Quiz and discussion (lesson/testing order counterbalanced)</td>
<td>Notes taken</td>
</tr>
<tr>
<td></td>
<td>2&lt;sup&gt;nd&lt;/sup&gt;-4&lt;sup&gt;th&lt;/sup&gt; audiotaped passage</td>
<td>Immediate free recall</td>
</tr>
<tr>
<td></td>
<td>Notes taken</td>
<td>Delayed recognition</td>
</tr>
<tr>
<td></td>
<td>Immediate free recall</td>
<td>Stimulus questionnaire</td>
</tr>
<tr>
<td></td>
<td>Delayed recognition</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Treatment questionnaire</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stimulus questionnaire</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Homework given</td>
<td></td>
</tr>
<tr>
<td><strong>Session 5</strong></td>
<td>Same as Sessions 2-4, but no homework given</td>
<td>Same as Sessions 2-4</td>
</tr>
</tbody>
</table>
CHAPTER 4
RESULTS

Participants

We alternately assigned our total sample of 48 healthy older adults to treatment and control groups. The groups were relatively homogeneous (see Table 4-1 for a summary of descriptive information). We describe the details below.

We established an attendance criterion of 80% of the sessions prior to data collection. Four control subjects and one treatment subject each missed one of the five sessions. For these five cases, missing values were interpolated by calculating the arithmetic average between the two missed sessions. An additional two subjects were excluded from the study due to their failure to attend 80% of the sessions because of illness. Treatment subjects were 100% compliant with homework assignments.

The only demographic variable that was significantly different between groups was gender; the treatment group contained proportionately more women, $F(1, 40) = 7.15, p = .01$. The treatment group included 3 (13%) men and 21 (87%) women, whereas the control group included 11 (46%) men and 13 (54%) women. Although the treatment subjects were slightly older ($M = 73.83$, $SD = 7.76$, range = 61 - 89) than controls ($M = 70.29$, $SD = 7.91$, range = 60 - 91), the difference was not significant. Ethnicity differences were also nonsignificant, as 23 (96%) of participants in the treatment group described themselves as Caucasian, compared to 20 (83%) of controls. Education in number of years was comparable between treatment ($M = 13.75$, $SD = 2.23$) and control ($M = 13.92$, $SD = 2.00$) groups. We divided occupation level into categories of homemaker, skilled, and professional, with the treatment group consisting of 3 (13%) homemakers, 7 (29%) skilled, and 14 (58%) professional, and controls consisting of 2
(8%) homemakers, 6 (25%) skilled, and 16 (67%) professional, not significantly different.

We asked subjects to describe the frequency at which they take notes on a regular basis. We categorized notetaking routine from 5 for taking notes “every day” to 1 for “never.” One (4%) participant in the treatment group reported that they “never” took notes, compared with 3 (13%) controls. Three (13%) treatment subjects reported “rarely” taking notes, compared with 6 (25%) controls. Four (17%) participants in the treatment group reported “once a week” notetaking compared to 3 (13%) controls. Eight (33%) subjects in the treatment group reported “a few times per week” compared with 9 (38%) controls. Finally, 8 (33%) treatment participants said they took notes “every day” compared with 3 (13%) controls. The differences between groups were not significant.

We conducted one-way ANOVAs for comparison of age, gender, ethnicity, education, occupation, notetaking routine, cognitive measures, and session variables, including attendance, time of day of testing, and number of participants in group. Tests of normality showed nonsignificance for most of the data. Independent observations were assumed due to alternate group assignment. Levene’s test for equality of variances showed nonsignificance except for the following: gender, $F = 28.06, p = .00$, degrees of freedom adjusted from 46 to 40 (significantly more women in the treatment group, $F (1, 40) = 7.15, p = .01$); semantic fluency for animal category, $F = 5.13, p = .03$, degrees of freedom adjusted from 46 to 34 (significantly higher in the treatment group, $F (1, 34) = 5.50, p = .02$); ethnicity, $F = 8.77, p = .01$, but not significant between groups;
and Digit Symbol Substitution (DSST), $F = 5.43, p = .03$, but not significant between groups.

Cognitive measures between groups were equivalent, with the following exceptions: Digit Span Forward (DSF), $F (1, 46) = 6.20, p = .02$, written phonemic fluency for “k,” $F (1, 46) = 4.70, p = .04$, and written semantic fluency for sports, $F (1, 46) = 4.42, p = .04$, animals, $F (1, 34) = 5.50, p = .02$, and total semantic fluency, $F (1, 46) = 7.66, p = .01$, for which the treatment group exhibited higher scores. Age was slightly higher and educational level and occupation status lower among treatment subjects, though not significantly. Session variables, including attendance, time of day, and number of participants per group did not differ between groups. Descriptives for cognitive measures are summarized in Table 4-2.

**Results**

For our primary aims, we conducted one-way ANOVAs with repeated measures, and for the secondary aims, correlational analyses. All results were judged significant at the alpha level of .05. Propositions were scored by one primary judge, and 30% by a second independent judge blind to subject group and session number. Inter-rater reliability was determined to be very good (Cronbach’s alpha coefficient = .98).

**Specific Aim 1: Note Fidelity**

Determine if structured notetaking training improves fidelity of notes in healthy older adults.

**Hypothesis 1:**

Healthy older adults who are trained in a systematic notetaking strategy will produce notes with greater note fidelity, as measured by the number of accurate propositions transcribed, than healthy older adults who take notes but are not trained.
We found that the number of perseverations and intrusions among the propositions were minimal. Therefore, we excluded them from our analyses. We also found no significant effect of the training/testing order. Data for all outcome measures are displayed in Table 4-3.

We conducted a one-way ANOVA with repeated measures procedure with four levels of a within-subjects factor (session) and two levels of a between-subjects factor (group). The session factor reflected the four time periods during which participants took notes, from Session 2 through Session 5. The dependent variable was the total number of propositions transcribed accurately in notes concurrent with the discourse listening task. Assumptions of normality and equality of variances were met. The assumption of sphericity was violated based on Mauchly’s test \( \chi^2 (5) = 12.34, p < .05 \). Therefore, degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity (epsilon = .84).

We found the main effect of group to be significant, \( F (1, 46) = 15.69, p = .00 \). This suggests that the treatment group produced significantly more accurate propositions in their notes than controls. In addition, partial eta-squared was .25, suggesting that group explained about 25% of the variation. The main effect of session was also significant, \( F (3, 116) = 33.54, p = .00 \), and accounted for about 42% of the variation (partial eta-squared = .42), suggesting that note fidelity differed over time. Subjects did not produce notes during Session 1; thus, the baseline measure for notes was taken during Session 2. For subjects in the treatment group, the notes produced reflected one training session provided at Session 1. Therefore, this comparison does
not truly reflect baseline measures without training, which we address in the Strengths and Weaknesses section.

We conducted tests of the a priori hypotheses using Bonferroni adjusted levels. Results indicated that the average number of propositions transcribed in the notes was significantly lower at Session 3 than during all other sessions, all subjects producing significantly fewer propositions in their notes during Session 3 than during Session 2, but a greater number of propositions during the last 2 sessions. This suggests that both groups experienced more difficulty taking notes during Session 3, but improved thereafter.

Furthermore, the session x group interaction was significant, $F(3, 116) = 5.72, p = .00$, explaining approximately 11% of the variation (partial eta-squared = .11). The treatment group exhibited significantly greater gains in note fidelity than controls at Sessions 4 and 5 ($t(39) = 3.1, p = .00$, df adjusted for variance inequality; $t(46) = 2.2, p = .03$, respectively). This interaction supports our hypothesis that healthy older adults trained in notetaking would transcribe a significantly greater amount of accurate information in their notes, particularly in later sessions as training proceeded, than those who were not trained. See Figure 4-1 for the comparison of group means across sessions for note fidelity.

**Specific Aim 2: Recall and Recognition**

Determine if healthy older adults who are trained notetakers exhibit significantly greater recall and recognition relative to healthy older untrained notetakers.
Hypothesis 2:

Healthy older adults who are trained in notetaking will exhibit significantly greater free recall and delayed recognition of material presented than healthy older adults who are not trained in notetaking.

To investigate recall and recognition, we conducted one-way ANOVAs with repeated measures with five within-subject levels and two between-subject levels. We assessed Session 1 recall and recognition without notetaking for both groups, intended as a baseline measure of auditory discourse memory. Assumptions of normality and equality were met. Mauchly’s test indicated that the sphericity assumption was not met ($\chi^2 (9) = 29.13, p = .00$); therefore, the Greenhouse-Geisser adjustment was made ($\epsilon = .78$).

For recall, the main effect of group was significant, $F (1, 46) = 15.24, p = .00$, suggesting that the treatment group recalled and produced significantly more accurate propositions than the controls. Partial eta-squared of .25 indicated that group explained approximately 25% of the variation. The main effect for session was also significant, $F (3, 143) = 39.08, p = .00$, explaining about 46% of the variation (partial eta-squared = .46). Post hoc comparisons using Bonferroni adjusted levels revealed that for both groups, Session 1 recall was significantly poorer than all subsequent sessions, and Session 5 recall was significantly superior to all previous sessions. Both groups showed a relatively linear increase across all 5 sessions.

The session x group interaction was also significant, $F (3, 143) = 2.81, p = .04$, accounting for 6% of the variation (partial eta-squared = .06). This interaction illustrates that treatment subjects exhibited a significantly greater improvement in recall from
baseline to Session 5, compared to controls ($t(46) = 2.2, p = .04$). See Figure 4-2 for the comparison of group means across sessions for recall.

Delayed recognition was measured using a standardized 24-question yes/no test (Dixon et al., 1989). The assumption of normality was met for most data. Assumptions of equality of variance and sphericity were met. The main effect of group was significant, $F(1, 46) = 5.42, p = .02$, indicating that participants in the treatment group recognized more information from the passages than controls. A partial eta-squared of .11 indicated a contribution of about 11% of variation. The main effect of session, $F(4, 184) = 1.67, p = .16$) was not significant, indicating that performance did not differ significantly session to session. However, the session x group interaction was significant, $F(4, 184) = 2.69, p = .03$, accounting for approximately 6% of the variation (partial eta-squared=.06). Similarly to the performance in recall, the treatment group displayed significantly greater improvement in recognition at Session 5 than controls ($t(46) = 2.3, p = .03$). In fact, controls recognized significantly less information from the passages at Sessions 4 and 5 than they had at Session 2. Thus, only the treatment group showed significant gains in recognition. See Figure 4-3 for the comparison of group means across sessions for recognition.

**Specific Aim 3: Note Fidelity/Recall and Recognition**

Determine if changes in note fidelity predict changes in recall and recognition in healthy older adults.

**Hypothesis 3:**

Greater note fidelity, as measured by the change in number of accurate propositions transcribed from pretest to posttest, will positively correlate with greater changes in free recall and delayed recognition of the material presented.
We conducted a correlational analysis to determine the relationships between change in number of accurate propositions in notes, change in number of accurate propositions in recall protocols, and change in recognition scores. Two-tailed tests of significance were conducted. The treatment group showed a significant positive correlation between change in note fidelity and change in recognition \((r = .48, p = .02)\) and between change in recall and change in recognition \((r = .55, p = .01)\). In partial support of our prediction that more information transcribed in notes would result in greater recall, the correlation between change in note fidelity and change in recall was positive. However, it was not statistically significant \((r = .10, p = .63)\).

None of the correlations for controls were found to be significant. Change in recall and change in recognition were positively correlated but nonsignificant \((r = .36, p = .08)\). These results suggest that only those participants in the treatment group who improved in notetaking also improved in recognition of the material.

**Specific Aim 4: Cognitive Correlates**

Determine if pretest cognitive measures—working memory, processing speed, semantic memory, episodic memory and executive control—in healthy older adults predict: a) baseline note fidelity and change from baseline to posttest, b) baseline free recall and change from baseline to posttest, and c) baseline delayed recognition and change from baseline to posttest.

**Hypothesis 4:**

Pretest cognitive measures—working memory, processing speed, semantic memory, episodic memory and executive control—will predict: a) baseline note fidelity and change from baseline to posttest, b) baseline free recall and change from baseline to posttest, and c) baseline delayed recognition and change from baseline to posttest.
In order to determine whether performance could be predicted by specific cognitive abilities, we conducted correlational analyses to examine the relationships between initial cognitive measures and both baseline scores and posttest changes made from Session 1 to 5 for all three outcome measures. Only the statistically significant findings are reported.

Because the groups were relatively homogeneous, we examined baseline measures for the entire sample. See Table 4-2 for means and standard deviations. Despite relative homogeneity between groups, however, the treatment subjects displayed higher scores in DSF, phonemic fluency category, “k,” and total semantic fluency, as detailed in the previous section. In addition, baselines for note fidelity were significantly higher for treatment subjects ($M = 64.38$, $SD = 18.12$) than controls ($M = 49.83$, $SD = 18.32$), $F (1, 46) = 7.65$, $p = .01$, as were baselines for recall ($M = 30.63$, $SD = 13.06$) higher than controls ($M = 20.83$, $SD = 9.85$), $F (1, 46) = 8.60$, $p = .01$. Therefore, some of the findings likely were influenced by these initial differences, which we discuss in the next chapter. However, recognition baselines were not significantly different.

As expected, baseline performance by both groups for all three outcome measures was significantly inversely correlated with writing fluency, a test of accurate writing speed (note fidelity: $r = -.42$, $p = .00$; recall: $r = -.39$, $p = .01$; and recognition: $r = -.47$, $p = .00$). Likewise, baseline performance was significantly positively correlated with Trails B (note fidelity: $r = .35$, $p = .02$; recall: $r = .47$, $p = .00$; and recognition: $r = .37$, $p = .01$) and DSST (note fidelity: $r = .51$, $p = .00$; recall: $r = .66$, $p = .00$; and recognition: $r = .65$, $p = .00$), measures of processing speed, immediate and delayed
HVLT (total immediate: note fidelity: $r = .44, p = .00$; recall: $r = .49, p = .00$; recognition: $r = .47, p = .00$; total delayed recall: note fidelity: $r = .47, p = .00$; recall: $r = .51, p = .00$; recognition: $r = .57, p = .00$; total delayed recognition: note fidelity: $r = .40, p = .01$; recall: $r = .28, p = .05$; recognition: $r = .44, p = .00$), except for trial 1, measures of episodic memory, the Shipley Vocabulary test (note fidelity: $r = .32, p = .03$; recall: $r = .46, p = .00$; recognition: $r = .55, p = .00$), a measure of semantic memory, and total phonemic fluency (note fidelity: $r = .48, p = .00$; recall: $r = .47, p = .00$; recognition: $r = .65, p = .00$) and semantic fluency (note fidelity: $r = .49, p = .00$; recall: $r = .50, p = .01$; recognition: $r = .51, p = .00$), measures of executive control.

In addition, baseline recall and recognition, but not notetaking, significantly correlated with DSF (recall: $r = .37, p = .00$; recognition: $r = .31, p = .03$) and the HVLT immediate recall trial 1 (recall: $r = .43, p = .00$; recognition: $r = .42, p = .00$). In contrast, only baseline note fidelity, but not recall or recognition, significantly correlated with phonemic fluency category, “k” ($r = .40, p = .01$) and semantic fluency category, animals ($r = .29, p = .05$). The only cognitive factor that failed to predict any of the three baseline measures was the DSB, a measure of working memory.

Several demographic factors showed significance, including age, which negatively correlated with baseline recognition scores ($r = -.47, p = .00$), and female gender, which positively correlated with note fidelity ($r = .38, p = .01$). No correlations were identified for either education or occupation. Of particular interest was that all three baseline measures significantly positively correlated with participants’ reports of personal notetaking routine (note fidelity: $r = .31, p = .03$; recall: $r = .41, p = .00$;
recognition: $r = .39, p = .01$), with better performance reflecting more frequent notetaking as part of daily life.

To examine relationships between cognitive measures and performance changes from baseline to posttest for all outcome measures, we conducted correlational analyses separately for each group. The treatment group’s improvement in note fidelity was significantly positively correlated with HVLT delayed recognition ($r = .51, p = .01$), and semantic fluency category, animals ($r = .48, p = .02$). This supported our hypothesis that episodic memory and executive control would predict note fidelity improvement, although we anticipated that more tests would be significant. Surprisingly, however, change in note fidelity revealed significant inverse correlations with vocabulary ($r = -.41, p = .05$) and phonemic fluency ($r = -.40, p = .05$), just achieving the significance criterion of .05. Also somewhat surprising was that change in recall failed to show a significant correlation with any cognitive measure, and change in recognition scores was negatively correlated with the HVLT trial 1 ($r = -.44, p = .04$).

We also examined correlations between baseline performance and changes in performance per group. We identified significant positive correlations between baselines and Session 5 performance for all outcomes in both groups, indicating that the higher the baseline score, the higher the final score. However, this did not prove true for performance change. In the treatment group only, we found negative correlations between baseline note fidelity and change in note fidelity ($r = -.4, p = .05$) and between baseline recognition and change in recognition ($r = -.46, p = .02$). This suggests that subjects with higher baseline measures gained less from training than those with lower baseline measures. We address these findings in the next chapter.
For controls, neither change in note fidelity nor change in recognition was significantly correlated with any cognitive measure. Change in recall, however, did correlate significantly with DSB (r = .41, p = .04), Trails B (r = .55, p = .01), vocabulary (r = .55, p = .01), and total semantic fluency (r = .44, p = .03).

Unrelated to cognitive measures, but of considerable note, all three outcome measures showed an inverse correlation with the number of participants in the group for both treatment and control groups (note fidelity: r = -.43, p = .04; recall: r = -.43, p = .04, recognition: r = -.54, p = .01). Thus, smaller group size was advantageous for improved performance.

**Participant Feedback**

We reviewed the questionnaires (Appendix C) that we had provided to participants in the treatment group each day to determine whether or not they had learned from the training protocol, and which components they felt had been most useful. Overall, the participants reported that they learned and implemented the material taught, and that they believed the training had helped them take better notes and remember more information than they otherwise would have. The percentage of subjects who indicated that they did not believe a particular component of the program helped them gradually decreased from the first two sessions (10%, 8%, respectively) to the last (6%), with one exception. Session 4 showed the highest percentage (16%) of “no” responses, indicating that Session 4 should be amended in some way. It could be that the lesson plan for that day needs modification, that fatigue was setting in, or that individuals were unhappy with their own performance, as many of their comments indicated. Without further analyses, we are unable to determine the reason. However, 100% percent of the participants reported at the last session that they would use the
strategy in their daily lives. It would prove valuable to statistically analyze these results in future studies, in order to modify the training protocol to optimize its learning effect.

We also examined the 12-question questionnaires (Dixon et al., 1989) assessing participant perceptions about passage content to determine whether they influenced performance. We were particularly interested in the notable decline in performance during Session 3 for note fidelity by both groups. We collapsed the 5 Likert-based responses into classifications of primarily positive or primarily negative, and compared the responses to each question across all sessions and between both groups. However, we did not find any differences in responses for Session 3 compared to the other 4 sessions. Thus, it does not appear that the participants’ reaction to the story was the cause of the performance change. However, a complete statistical analysis of these results in future research may identify differences that we did not.

**Strengths and Weaknesses**

We believe that this study is a strong experiment because of its relatively large sample size, multiple-session novel intervention, and alternately assigned 2-group design. We recruited participants from diverse segments of senior and business communities in Northeast Florida, enabling our sample to be relatively representative of the larger population of healthy older adults. Our hypotheses and methodology were firmly grounded in the empirical foundation of a diverse range of relevant literature. For our stimuli, we utilized passages specifically standardized for research with older adults. We implemented training techniques from educational research proven to facilitate learning of notetaking skills and subsequent recall. Our design paralleled designs from previous cognitive aging intervention studies that resulted in significant positive effects.
of training. Our scoring procedure was statistically shown to have very good inter-rater reliability.

However, in designing our study, we planned a recall baseline of "no notetaking" on Session 1, in order to capture the participants’ recall and recognition without use of taking notes. We then conducted our first training session with treatment subjects at the end of Session 1, subsequently instructing them to take notes from Session 2 forward, thereby neglecting to obtain a true baseline for notetaking without training. This methodological error confounded the comparison of baseline note fidelity measures during Session 2 between groups, because the treatment subjects had already received a training session and homework assignment. It also confounded comparison of the recall and recognition measures between groups at the first several sessions, due to the fact that Session 1 measured these outcomes without the effect of notetaking.

We also note that despite our alternating group assignment, the treatment group was composed of a greater proportion of females, demonstrated higher cognitive measures of working memory and phonemic and semantic fluency, and displayed higher baseline measures for note fidelity and recall. Without covarying for these group differences, we are unable to definitively attribute the outcomes to effects of the treatment protocol alone. Further statistical analyses should be conducted to assess the impact of these differences.

In addition, we recognize that the total intervention time for the groups was not equivalent in terms of duration of exposure. Treatment subjects not only received five 1-hour instruction sessions and 1-hour assessments in person, but also spent approximately four additional hours between sessions completing homework.
assignments. In contrast, controls received only the exposure time for completion of the five 1-hour assessments. Future studies should provide controls with a cognitively stimulating activity complete with written homework assignments, comparable in time expenditure, to more accurately assess the effects specifically attributable to notetaking training.

Notwithstanding these deficiencies, we did identify statistically significant treatment effects from the notetaking training intervention. We encourage future researchers to replicate our study, correcting for our weaknesses, obtaining pure baseline note fidelity measures pre-training and providing more equivalent exposure time to both groups, in order to confirm our findings. We also believe it would be valuable to compare spontaneous notetaking groups and trained notetaking groups with non-notetaking groups. Incorporating these comparisons would help tease apart the effects of taking spontaneous notes and taking trained notes from not taking notes at all.
Table 4-1. Demographics for each group

<table>
<thead>
<tr>
<th>Measure</th>
<th>Treatment Group</th>
<th>Control Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n = 24</td>
<td>n = 24</td>
</tr>
<tr>
<td>Mean age in years (SD)</td>
<td>73.83 (7.76)</td>
<td>70.29 (7.91)</td>
</tr>
<tr>
<td>Mean education in years (SD)</td>
<td>13.74 (2.23)</td>
<td>13.92 (2.00)</td>
</tr>
<tr>
<td>Gender distribution*</td>
<td>3 male</td>
<td>11 male</td>
</tr>
<tr>
<td></td>
<td>21 female</td>
<td>13 female</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>23 Caucasian</td>
<td>20 Caucasian</td>
</tr>
<tr>
<td></td>
<td>1 Non-Caucasian</td>
<td>4 Non-Caucasian</td>
</tr>
<tr>
<td>Occupation level</td>
<td>3 homemaker</td>
<td>2 homemaker</td>
</tr>
<tr>
<td></td>
<td>7 skilled</td>
<td>6 skilled</td>
</tr>
<tr>
<td></td>
<td>14 professional</td>
<td>16 professional</td>
</tr>
<tr>
<td>Self-reported notetaking routine distribution</td>
<td>(Never) = 1</td>
<td>(Never) = 3</td>
</tr>
<tr>
<td></td>
<td>(Rarely) = 3</td>
<td>(Rarely) = 6</td>
</tr>
<tr>
<td></td>
<td>(Once a week) = 4</td>
<td>(Once a week) = 3</td>
</tr>
<tr>
<td></td>
<td>(A few times/week) = 8</td>
<td>(A few times/week) = 9</td>
</tr>
<tr>
<td></td>
<td>(Every day) = 8</td>
<td>(Every day) = 3</td>
</tr>
</tbody>
</table>

*Significantly different between groups, \( p < .05 \).

Table 4-2. Cognitive measures for each group

<table>
<thead>
<tr>
<th>Measure</th>
<th>Treatment Group</th>
<th>Control Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n = 24</td>
<td>n = 24</td>
</tr>
<tr>
<td>Mean writing fluency (SD)</td>
<td>89.96 (18.10)</td>
<td>96.46 (17.91)</td>
</tr>
<tr>
<td>Mean DSF (SD)*</td>
<td>9.46 (2.62)</td>
<td>7.46 (2.93)</td>
</tr>
<tr>
<td>Mean DSB (SD)</td>
<td>7.46 (3.08)</td>
<td>6.79 (2.72)</td>
</tr>
<tr>
<td>Mean Trails B (SD)</td>
<td>9.79 (4.08)</td>
<td>7.67 (3.67)</td>
</tr>
<tr>
<td>Mean HVLT trial 1 (SD)</td>
<td>5.63 (1.81)</td>
<td>5.58 (1.47)</td>
</tr>
<tr>
<td>Mean HVLT trial 2 (SD)</td>
<td>8.67 (2.24)</td>
<td>8.00 (1.72)</td>
</tr>
<tr>
<td>Mean HVLT trial 3 (SD)</td>
<td>9.46 (2.19)</td>
<td>9.00 (1.93)</td>
</tr>
<tr>
<td>Mean HVLT total (SD)</td>
<td>24.08 (5.54)</td>
<td>22.58 (4.70)</td>
</tr>
<tr>
<td>Mean HVLT delayed recall (SD)</td>
<td>9.29 (2.49)</td>
<td>8.50 (2.28)</td>
</tr>
<tr>
<td>Mean HVLT delayed recognition (SD)</td>
<td>11.25 (1.51)</td>
<td>10.46 (1.56)</td>
</tr>
<tr>
<td>Mean DSST (SD)</td>
<td>45.00 (14.38)</td>
<td>40.58 (9.50)</td>
</tr>
<tr>
<td>Mean Shipley vocabulary (SD)</td>
<td>32.25 (6.05)</td>
<td>31.37 (5.45)</td>
</tr>
<tr>
<td>Mean S (SD)</td>
<td>23.42 (6.18)</td>
<td>24.92 (9.58)</td>
</tr>
<tr>
<td>Mean K (SD)*</td>
<td>10.38 (4.78)</td>
<td>7.50 (4.40)</td>
</tr>
<tr>
<td>Mean phonemic fluency total (SD)</td>
<td>36.79 (11.58)</td>
<td>32.42 (12.81)</td>
</tr>
<tr>
<td>Mean vegetables (SD)</td>
<td>9.88 (2.79)</td>
<td>8.46 (2.54)</td>
</tr>
<tr>
<td>Mean sports (SD)*</td>
<td>9.42 (2.39)</td>
<td>8.17 (1.66)</td>
</tr>
<tr>
<td>Mean farm animals (SD)*</td>
<td>10.04 (4.03)</td>
<td>7.87 (2.07)</td>
</tr>
<tr>
<td>Mean semantic fluency total (SD)*</td>
<td>29.33 (7.01)</td>
<td>24.50 (4.90)</td>
</tr>
</tbody>
</table>

*Significantly different between groups, \( p < .05 \).
Table 4-3. Outcome data for each group

<table>
<thead>
<tr>
<th>Measure</th>
<th>Treatment Group</th>
<th>Control Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n = 24</td>
<td>n = 24</td>
</tr>
<tr>
<td><strong>Note Fidelity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean Session 2 (SD)</td>
<td>64.37 (18.12)</td>
<td>49.83 (18.32)</td>
</tr>
<tr>
<td>Mean Session 3 (SD)</td>
<td>55.00 (14.87)</td>
<td>39.88 (15.92)</td>
</tr>
<tr>
<td>Mean Session 4 (SD)</td>
<td>73.21 (19.65)</td>
<td>47.75 (20.62)</td>
</tr>
<tr>
<td>Mean Session 5 (SD)</td>
<td>75.42 (18.99)</td>
<td>51.46 (22.30)</td>
</tr>
<tr>
<td><strong>Recall</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean Session 1 (SD)</td>
<td>30.63 (13.06)</td>
<td>20.83 (9.85)</td>
</tr>
<tr>
<td>Mean Session 2 (SD)</td>
<td>40.75 (15.74)</td>
<td>31.04 (11.70)</td>
</tr>
<tr>
<td>Mean Session 3 (SD)</td>
<td>40.58 (16.89)</td>
<td>26.88 (11.28)</td>
</tr>
<tr>
<td>Mean Session 4 (SD)</td>
<td>45.96 (17.49)</td>
<td>28.29 (14.13)</td>
</tr>
<tr>
<td>Mean Session 5 (SD)</td>
<td>62.17 (22.23)</td>
<td>40.96 (20.84)</td>
</tr>
<tr>
<td><strong>Recognition</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean Session 1 (SD)</td>
<td>19.04 (2.68)</td>
<td>17.96 (3.00)</td>
</tr>
<tr>
<td>Mean Session 2 (SD)</td>
<td>19.29 (3.07)</td>
<td>18.75 (2.83)</td>
</tr>
<tr>
<td>Mean Session 3 (SD)</td>
<td>19.46 (3.49)</td>
<td>17.83 (2.78)</td>
</tr>
<tr>
<td>Mean Session 4 (SD)</td>
<td>19.12 (3.60)</td>
<td>16.83 (3.16)</td>
</tr>
<tr>
<td>Mean Session 5 (SD)</td>
<td>20.13 (2.63)</td>
<td>17.17 (3.64)</td>
</tr>
</tbody>
</table>

*Note.* \(^a\) Number of accurate propositions out of possible 160. \(^b\) Number of correct responses on 24-item y/n recognition test.
Figure 4-1. Comparison of group means across sessions for note fidelity, with 95% confidence interval error bars.

Figure 4-2. Comparison of group means across sessions for recall, with 95% confidence interval error bars.
Figure 4-3. Comparison of group means across sessions for recognition, with 95% confidence interval error bars.
Summary of Results

Our study investigated the effects of teaching healthy older adults how to take structured notes concurrently while listening to a naturalistic discourse passage. We compared note fidelity, immediate free recall, and delayed recognition, of individuals who were trained in this novel notetaking strategy, with individuals who took spontaneous notes without training. Outcome measures included the amount of information noted during, and recalled after, passage presentation, as well as scores on a delayed recognition test. We analyzed the relationships among performance changes in each measure in order to determine whether change in note fidelity predicted change in recall or recognition. Finally, we examined individual differences to identify any cognitive correlates of performance.

The results supported our two primary hypotheses, and partially supported our secondary hypotheses, as discussed below.

Hypothesis 1:

Healthy older adults who are trained in a systematic notetaking strategy will produce notes with greater note fidelity, as measured by the number of accurate propositions transcribed, than healthy older adults who take notes but are not trained.

We found the main effects of group and session and the interaction to be significant for note fidelity. The treatment group sustained higher note fidelity over all, with gains significantly exceeding controls’ performance during the last two sessions, providing evidence for the positive effects of training. This supports our hypothesis that the training program of notetaking and use of the notetaking strategy for encoding and
retrieval would improve the amount of information participants wrote in their notes when compared to individuals who took notes but did not receive training.

We must, however, note several caveats regarding our results. First, we neglected to obtain a true baseline note fidelity measure in the treatment group, since their first note fidelity score was measured after they had received one notetaking lesson. Second, although the groups were relatively homogenous, the treatment group contained proportionately more females, in addition to displaying higher scores in working memory as assessed by one of the two measures, phonemic fluency in one of the two categories, and total semantic fluency. These cognitive differences, combined with the fact that note fidelity was first measured after they had already received a lesson, likely contributed to the higher baseline note fidelity, and possibly the performance gains evident throughout the course of treatment. Third, the treatment effects may not be solely attributable to the treatment protocol, due to the fact that the contact time provided to each group was unequal. The treatment group received two hours of direct contact per session, combined with approximately four hours of indirect intervention via homework, whereas controls received a total of approximately one hour of direct contact per session. Thus, these issues require resolution in future research.

**Hypothesis 2:**

Healthy older adults who are trained in notetaking will exhibit significantly greater free recall and delayed recognition of material presented than healthy older adults who are not trained in notetaking.

We also found the main effects of group and session and the interaction to be significant for immediate free recall. Even though baseline recall was significantly
higher in the treatment group, they showed increasingly greater gains over the course of the intervention, significantly greater during the last session than controls. This supports our hypothesis that the training program of notetaking and use of the notetaking strategy for encoding and retrieval would improve the amount of information participants recalled, without reviewing or referring to their notes, when compared to individuals who took notes but did not receive training.

The main effect of group and the interaction were also significant for delayed recognition, but the main effect of session was not. For recognition, baseline measures were not significantly different. Both groups performed similarly between Sessions 1 and 2, but the treatment group showed significantly greater gains overall at Session 5, whereas controls declined in performance, recognizing significantly less information at Sessions 4 and 5 than they had at Session 2. This suggests that only with training did individuals recognize more of the information that they had heard, even 10 minutes following presentation.

These findings support our hypotheses. However, again we make reference to the caveats previously discussed.

**Hypothesis 3:**

Greater note fidelity, as measured by the change in number of accurate propositions transcribed from baseline to posttest, will positively correlate with greater changes in free recall and delayed recognition of the material presented.

A correlational analysis revealed that for the treatment group, increases in the amount of accurate information transcribed in notes and in recall predicted higher recognition scores. While more accurate information transcribed in the notes correlated
positively with superior recall, it was not statistically significant. In contrast, for controls, none of the correlations were found to be significant, indicating that only the participants who improved their notetaking after training also improved in recognition of the material. Thus, we suggest that training in increased information production in notes over time may result in improvements in recognition of that information, and subsequently may increase recall.

**Hypothesis 4:**

Pretest cognitive measures—working memory, processing speed, semantic memory, episodic memory and executive control – will predict: a) baseline note fidelity and change from baseline to posttest, b) baseline free recall and change from baseline to posttest, and c) baseline delayed recognition and change from baseline to posttest.

An examination of cognitive correlates revealed that baseline performance on the three outcome measures for all subjects was predicted by most of the cognitive measures tested. We expected this finding. Note fidelity was differentially predicted by additional executive function measures, and recall and recognition were the only outcome baseline measures predicted by working memory. We were surprised that the DSB was not predictive of any baseline score, since a wealth of literature has shown this measure of working memory to be a strong predictor of cognitive function, especially in older adults. We found it interesting that self-reported notetaking routine was predictive of all three baseline performances.

We expected to see strong relationships between performance changes and all tests of working memory, speed of processing, semantic memory, episodic memory, and executive function, since the preponderance of the literature indicates these
measures to predict cognitive ability, especially in older adults. Indeed, when we examined correlates of change in the treatment group’s note fidelity, we found significant positive correlations with one episodic memory measure and one executive control measure, semantic fluency. Unexpectedly, however, none of the measures of working memory or processing speed predicted improvements in the three outcome measures.

We were also surprised to find an inverse relationship between note fidelity improvement and vocabulary and phonemic fluency. These findings suggest that lower vocabulary and phonemic fluency scores resulted in greater gains from training. In addition, recognition improvement correlated inversely with the first episodic measure trial. These results are consistent with our finding that individuals with higher baselines gained less from training than those with lower baselines. In contrast, none of the improvements in recall by the treatment group correlated with any cognitive measure.

It must be reiterated, however, that these results likely were confounded by our methodological error of providing training to the treatment group prior to measuring baseline note fidelity. Treatment subjects received training at Session 1, prior to the time during which the first notes were taken. Therefore, the predictive value of cognitive measures may have been offset by early training effects.

Neither the controls’ changes in note fidelity nor recognition scores correlated significantly with any cognitive measure. However, as would be expected, recall changes were predicted by scores on the DSB, Trails B, vocabulary, and semantic fluency. These outcome measures were the only ones predicted by the DSB measure of working memory.
Additional Noteworthy Findings

Several unexpected findings are of import. First, we were surprised by analyses of the predictive value of demographic variables. For example, the only measure with which age correlated was baseline recognition performance, an inverse relationship as expected. We expected age to be more predictive of performance, since our subjects ranged from 60 to 91 years old. Moreover, the finding that female gender predicted higher baseline note fidelity was unexpected, although more females were assigned to the treatment group. In addition, we failed to identify any correlations with education or occupation level, which is a relatively consistent finding in the literature.

Second, we identified several study conditions that influenced performance. We found that faster and more accurate writing ability predicted all baseline measures, and all participants in smaller groups performed better overall than those in larger groups, both of which have been noted in previous studies. Unique to our study, however, all three baseline measures significantly positively correlated with participants’ reports of personal notetaking routines, with better performance reflecting more frequent notetaking as part of daily life. These findings have significance for future research.

Finally, further analyses showed a strong significant positive correlation between baseline performance and final performance for all three outcome measures in both groups, suggesting that individuals who took better notes and remembered more information in the beginning also performed better at the end. However, only for treatment groups did baseline note fidelity negatively correlate with change in note fidelity, suggesting that with training, higher baseline note fidelity resulted in less improvement overall. Similarly, baseline recognition negatively correlated with change in recognition. These findings mirror some of the educational psychology research that
showed that individuals who were better at notetaking and had higher cognitive scores prior to training benefitted less than those with lesser abilities. However, reciprocally, those with lower initial abilities gained the most from intervention, a finding that offers promise to the potentially ubiquitous nature of this treatment’s effects.

In summary, we found that executive control, necessary for identification, manipulation, and organization of key content from the passages, was a significant predictor of notetaking performance. Likewise, episodic memory, crucial for learning and retaining information, had a pervasive effect on note fidelity improvement. In addition, working memory, processing speed, writing speed, semantic and episodic memory, and executive control were predictive of baseline performance, as well as improvement in recall through practice effects by controls. However, overall, the treatment group showed minimal cognitive correlates for their treatment gains over time, suggesting that perhaps this type of cognitive intervention is not dependent on cognitive aptitude in order to generate an effect, and may even be disproportionately beneficial to individuals with lower levels of cognitive aptitude.
CHAPTER 6
CONCLUSION

General Discussion

Because the world’s population is aging at a dramatic rate, and episodic memory declines with age, a critical need exists for a simple, cost-effective, evidence-based strategy for older adults to enhance their episodic memory, essential for remembering information such as medical advice. Achieving this would enable them to maintain functional independence for as long as possible. In this study, we assessed the effects of a novel notetaking training program and the use of the strategy to facilitate encoding and retrieval as a prospective ecologically valid memory enhancement technique.

Our literature review of diverse fields of study across all age groups showed that the process of notetaking, without note review, facilitates recall of information, both written and spoken, and programs of structured notetaking result in further memory improvement. Moreover, cognitive interventions with healthy older adults have proven to result in neuroplasticity. However, to our knowledge, ours was the first study to examine the effects of a systematic program of notetaking training of adults 60 years old and older, on the number of accurate propositions transcribed in their notes, subsequent free recall of the information heard, and delayed recognition of the material.

This study was grounded in the theoretical foundation built over many decades of educational psychology and cognitive aging research. First, based on a synthesis of relevant literature, we proposed a mechanism by which episodic memory in healthy older adults would be facilitated through the use of a notetaking strategy. Second, we created a novel training program based on learning principles and research across multiple fields of study. Finally, we examined the effects of our training program with a
sample of older adults relatively representative of this population in the Northeast Florida area. Conducting a methodologically sound 2-group pretest posttest alternatingly assigned multiple-session intervention study, we demonstrated that in a relatively homogeneous sample of healthy older adults, our novel notetaking training strategy significantly improved note fidelity, free immediate recall, and delayed recognition of spoken discourse material.

**Future Directions**

We sincerely hope that future researchers will pursue the line of research we have instituted. Research should focus on replication and improvement of our study and extension of our findings to gather additional data that either supports or does not support notetaking training as a valid cognitive intervention. Studies that control for the group differences that we found, as well as correcting for the unequal exposure time between groups, are crucial in order to confirm our findings.

Future studies should not only target the effects of structured notetaking training similar to ours, but also include a third group of subjects who listen to the passages and recall and recognize the material, but who never take notes. In this way, comparisons can be made among listeners who take no notes, those who take spontaneous, untrained notes, and those who take trained notes. The results of this type of study would provide additional evidence supporting the value of notetaking training and strategy use in healthy older adults.
Appendix A
Notetaking Training Protocol Lesson 1

Lesson Plan
Day 1: Just the Facts

Man’s mind, once stretched by a new idea, never regains its original dimensions.
~Oliver Wendell Holmes

Today’s Goals:
1) To make introductions
2) To discuss the rationale for notetaking as a memory strategy
3) To review the basics of effective notetaking
4) To demonstrate notetaking

Aim 1: Introductions
Welcome! I am pleased that you have volunteered to participate in this study, and am looking forward to working with each of you over the next several weeks. Please refer to your booklet and follow along as we discuss each topic. My name is Jill McClung, and I am conducting this study to fulfill the dissertation requirement for attaining my doctoral degree at the University of Florida. I am very interested in ways in which researchers might be able to help older individuals keep their memories from declining over the years, in order to allow them to live independently for as long as possible. What I will be teaching you has not been done before, so there is no guarantee that it will in fact help your memories. However, that is what I want to find out. And I encourage you to get out your pens and paper and begin practicing taking notes as we have our discussion. Let’s go around the room and introduce ourselves, and please tell us a little bit about why you volunteered to participate in this study.

Aim 2: Rationale for taking notes to remember main and supporting ideas
Research has shown that targeted, intensive training can help older individuals improve their learning and memory abilities (Jobe et al., 2001). I am interested in learning whether or not taking systematic, structured notes while listening to auditory passages will improve your memory, perhaps more than merely taking spontaneous notes. I have developed a training protocol that I will be teaching you that is based on a combination of research that has been done with school-age students as well as middle aged and older adults. Many notetaking studies have been conducted in educational settings, and most research has found that taking notes during lectures help students remember the information better for tests. For example, several different research groups found a significant positive relationship between taking notes and recalling the material that they had recorded in their notes, compared to those who did not take notes (Hartley & Davies, 1978; Kiewra, 1985; Ladas, 1980; Jacobsen, 1989). These results were found
even when the students had had no training to take notes, but training has been shown to improve the amount of information recalled over and above simple notetaking, in both younger (Carrier & Titus, 1981; Gall et al., 1990; Hughes & Suritsky, 1993; Jacobsen, 1989; King & Stahl, 1985; Pollio, 1990; Spires, 1993) and older individuals (Meyer, Young, & Bartlett, 1989). Most of the studies with middle aged and older adults have shown that notetaking increased memory, especially when the skill was taught. Some studies, however, have also shown that notetaking caused too much strain on people’s memory processes, especially if the passage they listened to was dense with information and read quickly. So, that’s what we are here to find out—whether you will better remember information you hear if you are trained in notetaking, or not. One research group in particular has conducted many years of research in teaching younger and older adults to take notes while reading passages, and this deliberate strategy of using a structured way to take notes and remember that structure when recalling the information has been shown to be effective in overall memory of the material (Meyer et al., 1989). I will be teaching you how to use a notetaking structure, with a template, to create a mental image in your mind that you can use to help you retrieve the information you heard. I hope that you might be able to apply these lessons to your daily life’s activities, such as listening to your doctor give you medical recommendations, or listening to your friend tell you about her recent vacation.

Aim 3: Introduction of notetaking strategy: “Record ‘n Recall”

Use this mnemonic device to help you remember the crucial components of notetaking:

R = RECORD – if you record information, it strengthens its retention
E = ESSENTIAL – only write down the essential, important key facts
C = CHUNK – organize the main points and their supporting details into chunks
A = ABBREVIATE – use abbreviations and symbols
L = LISTEN – be sure to listen actively for key words and verbal signals
L = LEARN – learn by recalling the organization of the chunks

First, let’s try our hands at notetaking. I am going to play you a brief passage and I want you to take notes as you hear it. Keep in mind that the purpose of your writing things down is to help you remember the main ideas and supporting details of the story, not the story verbatim.
Let’s discuss what you discovered as you took notes, the pros and cons. What problems did you have? What benefits did you see? Later, I’ll show you how I would recommend taking notes on that passage.

There are 2 keys to taking effective notes:
(1) Active Listening &
(2) Selective notetaking (Bligh, 2000; Gall et al., 1990).

In order to use notetaking to reinforce your memory, you must:
(1) listen attentively to comprehend the material, and (2) only write down key words and phrases. Do not write complete sentences, and do not write what you hear verbatim – just the facts. Also, do not repeat what you already wrote. You will not have time. If a phrase conveys the meaning, write only the phrase. If a word conveys the meaning, write only the word (Pauk, 2000).

(1) Active Listening:
1. Be attentive

Have a positive attitude and be prepared to listen. Be active in your listening. Teaching students (Engraffia, Graff, Jezuit, & Schull, 1999) and adults (Lundgren & Shavelson, 1974; Wolvin et al., 1979, in Gall et al., 1990) how to actively listen for notetaking purposes has been shown to increase their attention skills, self-confidence, and overall achievement. Listen for the meaning, the ideas, of the passage, and try to tie it to what you already know about the topic. Connect it to your own experiences. Be attentive to the end. Some studies have shown that students take less complete notes and lose concentration after the first 30 minutes of a lecture (Ladas, 1980). Now let’s see what you should be listening for.

2. Identify key words

It is important to listen for verbal cues that indicate main or important ideas, such as a person’s name, what he or she did, where he or she went, and other informative content words. Generally, the nouns and verbs are the most essential words, with adjectives and adverbs adding supporting information. Words that address questions such as who, what, when, where, how, and why are the ones that should draw your attention.
3. Identify signals

It is also important to listen for words or phrases that signal a new idea (Meyer et al., 1989), such as “for example,” “therefore,” “now,” “you can imagine,” “the problem is” (Bligh, 2000). Signals are words that convey a transition from one idea to the next. Here is a list of commonly used verbal and nonverbal, or voicing, cues used in discourse to “signal” that important information is coming. You must listen attentively and actively for these cues, focusing on the overall meaning of each sentence, as well as the content words and transition words. When you listen to a passage, listen for the overall theme, focusing on these content words and signals and how they help relate the ideas to each other.

(2) Selective Notetaking:

1. Be selective

Write only those words that are essential for understanding and remembering the meaning of the utterance. Leave out superfluous words that don’t add significantly to the meaning. You should write down only the content words, such as nouns and verbs, and not connecting words, such as prepositions (in, under, against), conjunctions (and, after, if), and articles (a, the). The connectors are important to determine the meaning of the sentence, but writing down the content words as you comprehend the sentence meaning should highlight the meaning as you recall it later. In addition, write the information accurately. It does no good to remember it incorrectly! Be precise and concise.

2. Be organized

Here is an organizational template onto which you will be learning to take and practice your notes. It is a hierarchical structure, an outline, which is the most common and simplest organization of discourse and one I’m sure you are all familiar with. An outline format is considered to be the best way to take notes to recall the most important information, especially if what you are listening to is well-organized (Bligh, 2000). It is important to take organized notes, and this provides you with a guideline. We will be talking about a memory technique called “chunking,” which is a way to remember information in organized packages. The template shows you how to chunk each main point with its supporting details, so that you can later remember that all those ideas were related. This is a way to compartmentalize information so that you can cue yourself to retrieve it later. You also must endeavor to write legibly in order to maintain your note organization.
It has been shown that learning the structure of a passage, whether written or heard, helps people “encode” it, or process it, and that if it is used when you try to recall it, it serves as a retrieval cue to facilitate memory (Craik & Lockhart, 1972; Meyer et al., 1989; Pauk, 1989, 2004). We will be using the structure of the main idea and support template to cue our later retrieval.

3. Use shortcuts

Studies have shown that verbatim notes are the least effective for helping people remember information (Bretzing et al., 1979). Instead, the most effective notes for later recall have been shown to be paraphrases of main ideas (Fisher & Harris, 1973; Locke, 1977; Bretzing & Kulhavy, 1979; Kiewra, 1984). Do not use complete sentences when you take notes. You will fall behind. Write only key words, and use abbreviations and symbols as shortcuts.

Abbreviations and symbols are essential for taking thorough notes, since we can’t record everything we hear. It is just too fast. We speak at around 125 words per minute or faster (Wolvin & Coakley, 1988, in Gall et al., 1990), but can only write at about 15-20 words per minute (Rodriguez-Aranda, 2003). So I’ve given you a page of common abbreviations and symbols to help you note the information more quickly. Use these shortcuts for connecting words, such as “and,” “with,” “without” (Wolvin et al., 1988, in Gall et al., 1990). You can also shorten content words, such as “diff” for “difference” or “pt” for “point.” I’ve also given you a page of common signals to listen for when you listen selectively for important information. You can also make up your own. Let’s go through these shortcuts.

Aim 4: Illustrations

Hummingbirds

*The hummingbird is about one inch long and weighs less than an ounce. It lives in the Western hemisphere, primarily along the equator in the rain forests. It is not only the smallest bird alive today, but also the smallest bird to have ever existed. Even its wings are the smallest of all our feathered friends and are smaller than those of many insects.*

Let’s eliminate the unimportant words:
The hummingbird is about one inch long and weighs less than an ounce. It lives in the Western hemisphere, primarily along the equator in the rain forests. It is not only the smallest bird alive today, but also the smallest bird to have ever existed. Even its wings are the smallest of all our feathered friends and are smaller than those of many insects.

That leaves us with only the essential content words, organized in chunks. See the sample notes next. How do your notes compare??

Here are some more examples with which to identify the key facts:

Aardvarks
The amazing aardvark looks like a grayish pig with rabbit ears. But the termites of East Africa don’t find it the least bit funny. The aardvark, completely indifferent to their bites, enjoys opening up their nests and dining on all the termites it can capture with its long, sticky tongue.

Porcupine Fish
In the coral reefs carpeted with sea urchins, there lives a fish that has no fins on its belly and has a beak instead of a mouth. It’s a fat, tiny thing that’s slightly egg-shaped – an appetizing shape that attracts predators. But when they try to snap it up, the porcupine fish, also known as a puffer fish, turns itself into an inedible, prickly ball.

Mosquitoes
The male mosquito never bothers us at all. Only the female mosquito infuriates us with her bite because she needs blood to feed her eggs. The itch from a mosquito bite doesn’t come from the bit itself but from an irritating chemical injected during the bite, which helps stimulate a greater flow of blood.

Aim 5: Discussion and Conclusion

Are there any questions??

To review the essence of what we have discussed:

1. The two key necessities to taking effective notes are:
Active Listening & Selective Notetaking

2. Shortcuts such as symbols and abbreviations are crucial for taking notes quickly.

3. Learning to note the main and supporting ideas in an outline structure helps you form a mental format image into which you can chunk related information and retrieve it later.
4. Finally, here’s the tip to help you remember critical listening and notetaking elements:

RECORD ‘N RECALL
R = RECORD – if you record information, it strengthens its retention
E = ESSENTIAL – only write down the essential, important key facts
C = CHUNK – organize the main points and their supporting details into chunks
A = ABBREVIATE – use abbreviations and symbols
L = LISTEN – be sure to listen actively for key words and verbal signals
L = LEARN – learn by recalling the organization of the chunks

Now, let’s take a little quiz to see how well I did to help you understand this material. This is only for your own benefit and learning, and it won’t be scored. We’ll discuss it afterwards.

Aim 5: Homework assignment 1
Practice taking notes using the template:
“A Pilot” – 2 sets of notes:
* 1 set on template
* 1 set on plain lined paper

When you come in for your next assessment, you will not be given a template. I will give you plain writing paper to take you notes on while you listen to another short story. I highly recommend that you keep in mind the outline structure, and apply it as you take the notes. So, when you are practicing tonight, practice it both with the template and then without the template. Your notes should look the same!
APPENDIX C
POST-TEST TRAINING QUESTIONNAIRE

The following questions ask you about the extent to which you used your notetaking training as you took notes to the short story today. For each item, please answer Y (yes) or N (no), and add your comments below.

1. I used the information presented in class to take my notes today. Y N
   If so, why?
   __________________________________________________________
   If not, why not?

1a. I believe that using the information presented helped me take better notes. Y N
   If so, why?
   __________________________________________________________
   If not, why not?

1b. I believe that using the information presented helped me remember the material. Y N
   If so, why?
   __________________________________________________________
   If not, why not?

2. I used the active listening strategies (being attentive, listening for the meaning and signals, tying information to your own knowledge) presented in class to take my notes today. Y N
   If so, why?
   __________________________________________________________
   If not, why not?

2a. I believe using the active listening strategies presented helped me take better notes. Y N
   If so, why?
   __________________________________________________________
   If not, why not?

2b. I believe that using the active listening strategies presented helped me remember the material. Y N
   If so, why?
   __________________________________________________________
   If not, why not?
3. I used the selective notetaking strategies (writing only key words, abbreviations, and symbols) presented in class to take my notes today. Y N
If so, why?
________________________________________________________
If not, why not?

3a. I believe that using the selective notetaking strategies presented helped me take better notes. Y N
If so, why?
________________________________________________________
If not, why not?

3b. I believe that using the selective notetaking strategies presented helped me remember the material. Y N
If so, why?
________________________________________________________
If not, why not?

4. I used the notetaking template structure (organized outline of main and related ideas) presented in class to take my notes today. Y N
If so, why?
________________________________________________________
If not, why not?

4a. I believe that using the notetaking template structure presented helped me take better notes. Y N
If so, why?
________________________________________________________
If not, why not?

4b. I believe that using the notetaking template structure presented helped me remember the material. Y N
If so, why?
________________________________________________________
If not, why not?

Any other comments or suggestions?
________________________________________________________

Thank you!
LIST OF REFERENCES


Knight, R. G., McMahon, J., Green, T. J., & Skeaff, C. M. (2006). Regression equations for predicting scores of persons over 65 on the Rey Auditory Verbal learning test, the mini-mental state examination, the trail making test and semantic fluency measures. *British Journal of Clinical Psychology, 45, 393-402.*


BIOGRAPHICAL SKETCH

Jill S. McClung completed a Bachelor of Arts degree in psychology at Rutgers University and a Master of Science degree in speech-language pathology at Nova Southeastern University. Through her career, she has served in various clinical, consulting, and management positions, primarily in geriatric rehabilitation, prior to founding her own company, Clinical Ed Central, Inc., through which she provided continuing education programs to speech-language pathologists, occupational therapists, physical therapists, nurses, and other health care professionals. She returned to academia at the University of Florida in 2005 and, upon doctorate completion, plans to continue conducting cognitive aging and rehabilitation research and publishing educational material pertinent to healthy and pathological aging for the public.