LEARNING A TECHNICAL LANGUAGE: THE MODALITY EFFECT IN NURSING STUDENTS' RETENTION OF NEW VOCABULARY

by

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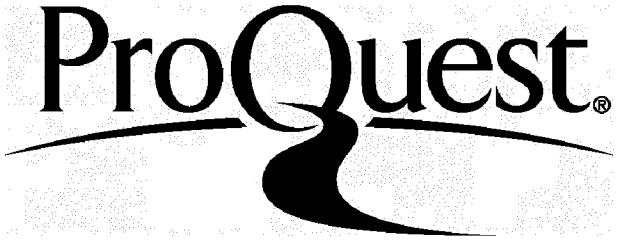

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DEDICATION

First, to three other women pursuing knowledge – my nieces Emma Scarlett Bell, a budding planetary scientist; Emma's sister Sabrina Rose, who will likely go into gameification or some future field not yet invented; and Lilli Gutoff, who has balanced a promising athletic career with the expectations of the classroom. Keep reaching.

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ABSTRACT

LEARNING A TECHNICAL LANGUAGE: THE MODALITY EFFECT IN NURSING STUDENTS' RETENTION OF NEW VOCABULARY

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This study explores the modality effect as it applies to beginning nursing students, and whether reading or audio recordings are more effective teaching formats for the highly technical vocabulary and pharmacological terms used in psychiatric nursing. Past research on health science students indicates that personal learning preferences may also have an impact on modality and learning. Nursing students have specific characteristics that influence personal learning preferences, and the use of digital audio recordings for learning, which also makes technical vocabulary especially challenging.

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CHAPTER ONE

INTRODUCTION

Beginning in the 1960s, research in psychology and cognitive science increasingly investigated a modality effect of improved memory and retention through auditory presentation, versus the same information presented in print format (Penney, 1989; Healy & McNamara, 1996). The human memory system was first theorized as a single, then a dual component system (Baddeley, 1992). Later a three-part system was proposed by Atkinson and Shiffrin (1968) and Baddeley and Hitch (1974). This tripartite system featured specific processing centers for auditory memory, and became more influential in later research on memory and modality.

Early modality research focused on the recall of digits or simple words, showing a recency effect that favored audio over print (Healy & McNamara, 1996). Murdock (1968) replicated this recency effect in tests of serial and paired information. This result suggested better storage availability for audio information. Pre-categorical acoustic storage, or PAS, a theory by Crowder and Morton (1969), suggested similarly that aural information would be stored prior to further categorization or identification, leading to the recency effect. Tests subsequently done by Engle (1974) on the PAS theory showed that a 'distraction item' affected, but did not remove, the recency effect. Later research by Drewnowski and Murdock (1980) and Penney (1989) explored the impact of phonemes, and the other phonological aspects of words, on recency and recall.

After an early focus on audio modality and memory, educational psychology research has drifted away from the study of audio-only modality. Chaiken and Eagly (1983) and other researchers in communications and media studies (Byrne & Curtis, 2000; Corston & Colman, 1997; Green, 1981; Potter & Choi, 2006) have continued to investigate the audio modality effect in advertisements and other messages, as well as the impact of content and structural complexity on recall. Valkenburg and Beentkes (1997) explored memory retention among young students, positing the supposed superiority of audio information for creative visualization, and thus 'faulty memory', but finding that successful recall had more to do with the age of their subjects, rather than modality. Other researchers, such as Gaver (1993), Sharps and Politt (1998) and Crutcher and Beer (2011) have called for more research on environmental audio and sounds and their impact on perception, recency, and recall.

Meanwhile, Paivio and Csapo's picture superiority effect theory (1973) and Paivio's dual coding theory (1971) have proved highly influential in the field of psychology, and influenced the continuing research done on modality, recency, and recall. However, the focus of this research has moved from audio-only modality, to visual graphics and multimedia modality. The majority of research on modality now focuses on the use of multimedia objects; for example Thompson and Paivio (1994) theorized that the combined use of multimedia audio and images improves recency. Contemporary modality research (Crooks, Cheon, Inan, Ari, & Flores, 2012; Mayer & Sims, 1994; Moreno & Mayer, 1999; Mousavi, Low, & Sweller, 1995) often assumes multimedia's superiority for recall over audio-only and print materials, though this conclusion contradicts much of the research done in the communications field. Corston and Colman

(1997) found that recall of a short health warning was superior in subjects exposed to audio and print presentation, rather than video presentation. Byrne and Curtis (2000) found that their teenage subjects best recalled an identical warning presented in print.

Likewise, modality research on the use of podcasts has been sparse. Comparing the use of print and audio-only podcasts in the classroom, Daniel and Woody (2010) generalize podcasts as inappropriate primary teaching tools. Yet, their study overlooks past communications research on the functions of signaling, repetition, stylistics, and pacing, and their impact on modality (Furnham, Gunter, & Green, 1990; O'Keefe, 1990; Wright, 1974).

Podcasts are an increasingly common educational tool, and also touted as an effective learning solution for specialty learners such as English as a Second Language, or ESL, students (Kaplan-Leiserson, 2005). Yet Booth (2007) notes an "evaluation bypass", a lack of evidence-based research and study. Students do not necessarily use podcasts as expected; for example, despite the popular perception of traditional age students as 'digital natives', students struggle to create their own podcasts (Middleton, 2009). Contrary to expectations, podcasts are not necessarily used as 'mobile' learning objects and review tools, with most students preferring to listen on desktop computers, and other students preferring different review methods (Lonn & Teasley, 2009; Stiffler, Stoten, & Cullen, 2011; Walls, Kucsera, Walker, Acee, McVaugh, & Robinson, 2010). Student characteristics also influence podcast acceptance; Carvalho, Aguiar, Carvalho, and Cabecinhas (2008) found undergraduate and graduate students vary in their preferences of podcast length and content. In their 2012 study, Kazlauskas and Robinson noted that students who worked more were less likely to use podcasts.

Nursing students express less confidence in their use of computers and technology than medical students, and find this a barrier in their use of reusable learning objects such as podcasts (Blake, 2010). Yet nursing students also self-report positively the flexibility afforded by podcasts, such as the opportunity to study in different places or times, and repeatedly review material (Kardong-Edgren & Emerson, 2010; McKinney & Page, 2009; Meade, Bowskill, & Lymn, 2009; Meade, Bowskill, & Lymn, 2011; Shantikumar, 2009; Stiffler et al., 2011). Some students even report a preference for podcasts over their textbooks (Blake, 2010; Stiffler et al., 2011), while others report use in conjunction with other media like visual aids, effectively creating their own multimodal instruction (Kardong-Edgren & Emerson, 2010). Certain characteristics are also more commonly found among nursing students than among their undergraduate and graduate classmates, and may impact their acceptance and use of podcasts. Nursing students in one study were older than counterparts in an unrelated course, and more likely to be ESL learners and immigrants (Kazlauskas & Robinson, 2012). Nursing students also tend to lack a more formative biological science background (Lymn, Bath-Hextall, & Wharrad, 2008; McKee, 2012), providing special challenges for their course of study.

Podcasts or similar audio-only objects might offer a solution for one of the most challenging aspects of nursing education – the retention of new vocabulary words, phrases, and drug names. One nurse studying pharmacology described it as a foreign language (Meade et al., 2011). Indeed, the drug names learned by nurses in pharmacology courses may qualify as "technical vocabulary" under Paul Nation's definition (2001); vocabulary learning research indicates that such words, learned as part of a technical curriculum or field, are often easier to learn than words defined as

'academic' (Vidal, 2003; 2011). Under Vidal's theory, students learning technical and scientific nursing concepts would make faster strides in learning associated vocabulary words, terms and drug names. Yet nursing students can be overwhelmed and unsure which salient facts need to be memorized in their courses.

> We had to learn too many drugs - know the generic names, what the names mean, and the trade names. We had 120 drugs that we had gone over in our lectures, and for the exam it was not made clear which ones we had to know. So we tried to remember all 120 drugs." (student, quoted in Manias & Bullock, 2001, p. 763).

One study of nursing students using podcast lectures found that they retained more knowledge, experienced higher exam scores, and scored higher overall marks, than historical cohorts who lacked access to podcasts (Meade et al., 2009). Therefore, this study proposes to examine the use of podcasts in teaching this new vocabulary to first year nursing students, and to explore the impact of modality on the recall of these new words.

Second language, or L2, learners are those who are engaged in learning a second language, whether it is English (ESOL), or another language. Research on these learners indicates that perceptual learning styles may also account for the success of learning new words, and influence the modality effect among students (Tight, 2010). Therefore, this study will also investigate whether perceptual learning styles impact nursing students' retention of new vocabulary. A popular method of analyzing student learning

preferences is the VARK (Visual, Aural, Read-Write, Kinesthetic) survey created by Fleming & Mills (1992) as a tool for instructors and students to improve both learning strategies and materials (Fleming & Baume, 2006). The VARK instrument focuses on different perceptual modes used to both communicate and learn information, and can be used to indicate a dominant learning preference, or a multimodal preference, where a learner prefers multiple modes. Specific fields of study, even within the smaller pool of health profession students, appear to either influence VARK learning preferences, or demonstrate a self-selection of profession by students with specific VARK learning styles. Differences appear between dental, nursing, medical and pre-health students taking the VARK survey (Alkhasawneh, Mrayyan, Docherty, Alashram, & Yousef, 2007; Dobson, 2009; Lujan & DiCarlo, 2006; Meehan-Andrews, 2009; Murphy, Gray, Straja, & Bogert, 2004). Gender differences also appear in health science cohorts taking the VARK survey or a similar test (Breckler, Joun & Ngo, 2009; Dobson, 2009; Slater et al., 2007; Wehrwein et al., 2007). James, D'Amore, & Thomas (2011) also suggest other demographics can have an impact on VARK survey responses, with significant learning style differences appearing between students enrolled at a rural campus, and those attending courses in a major metropolitan area.

VARK surveys are widely used, but further study is needed on the correlation of learning style preferences and academic performance (Dobson, 2009; Dobson, 2010; Koch, Salamonson, Rolley, & Davidson, 2010). Murphy et al. (2004) has also argued that at different times in a health science curriculum, specific learning preferences may be more critical to learning a specific kind of knowledge or practice, making it crucial to situate VARK survey data in a specific time in the curriculum sequence.

RESEARCH QUESTIONS

R1: Is there a mean difference in the short-term recall of vocabulary words based on audio-only or print modalities?

R2: Is there a relationship between learning styles preferences, and short term recall of these vocabulary words?

CHAPTER TWO

REVIEW OF LITERATURE

Introduction

Audio-only formats, such as podcasts, might offer a solution for one of the most challenging aspects of nursing education – the retention of new vocabulary words, phrases and drug names. Since the early 1960s, psychology and cognitive science researchers have explored a modality effect of improved memory and retention of new verbal information through auditory presentation. Learners have been theorized to learn better through the use of audio-only information, versus the same information presented in print format. In recent years there has been a dearth of recent research on audio-only modality and memory; research on modality has increasingly turned to multimedia formats. While research on sound and its impact on memory retention and visualization have continued in the fields of communications and media studies, audio podcasts, which have been implemented as a learning tool in a variety of fields, have not received much evidence-based evaluation. There are rules that apply to all vocabulary learning, but the technical vocabulary learned in the health science world is more specific than general or academic vocabulary words. Likewise, nursing students, the subjects observed in this study, have very specific characteristics that impact both their general learning, and their perceptual learning preferences. Modality appears to play a part in the ease or difficulty of learning specific kinds of vocabulary, including the highly technical words nurses and

other health professionals must learn. A closer look at the vocabulary and learning objects used by health science students, as well as the demographic and learning characteristics of nursing students, was called for.

History, Theories and Characteristics of the Modality Effect

Early modality effect experiments involved short-term memory recall and its interaction with delivery mode. According to Baddeley (1992), early and midcentury memory research began with an understanding of a single memory system, then evolved to a dual component model with short term and long term memory. Atkinson and Shiffrin (1968) were among the first to suggest a modal model, suggesting three memory stores - one for sensory materials (divided among visual, auditory, and haptic senses), another for short-term memory, and a third for long-term memory. Baddeley and Hitch (1974) theorized a tripartite system of working memory, with a central controller supported by a visuospatial sketch pad for imagery, and a phonological loop for speech-based information. As models of memory systems continued to be developed, a general modality effect was traced that showed higher retention of memorized information after material was shared in an auditory mode. Healy and McNamara (1996) note that early research subjects were asked to recall digits or other auditorily presented words. Observations showed a recency effect in which the last item was recalled best from an auditory list; a stimulus suffix effect that canceled the recency effect, by adding a redundant word previously stated to the end of the list; and a modality effect, where the final item on a similar visual list had no recency effect. Yet, because most of these tests revolved around short groups of digits, syllables, or very simple words, shared with more

randomized subjects, it is especially difficult to directly assess these results for the teaching of vocabulary words in a specific field, such as the technical terms required in nursing or medicine.

Murdock (1968) noted that his previous studies in 1966 and 1967 showed superior retention of both serial and paired information, among test subjects exposed to auditory presentation. In his 1968 follow up study, Murdock theorized that superior auditory recall reflected differences in the memory system's storage availability, rather than improved retrieval ability, and that information provided in visual format might be more vulnerable to interference, or otherwise less persistent.

Crowder and Morton (1969) suggested a passive system of pre-categorical acoustic storage, or PAS, which would store information heard aurally before it was identified or categorized, long enough for an immediate memory task of a few seconds or more. They suggested this material held in pre-categorical acoustic storage could be deleted by additional aural material, or would decay with time. According to Crowder (1970), pre-categorical acoustic storage would explain the modality effect favoring auditory information. However, even after revisions in 1978 and 1983 by Crowder, Crowder and Morton's proposed model did not explain all of the idiosyncrasies associated with the modality effect (Engle, 1974; Penney, 1989). Engle notes that the PAS model assumed the addition of a redundant suffix to aurally shared lists would cause recall to drop to the same level as found with visually presented lists. Instead, he found that the suffix interfered with recall, but did not remove the modality effect favoring auditory information. Gathercole, Gregg, and Gardiner (1983) later explored whether free recall of recency items presented in audio or print formats were influenced by a brief

amount of silence, and the addition of distraction items (a group of unrelated digits) presented in audio or print. They found that thirty seconds of audio distractions, but not a briefer period of three seconds, canceled the modality effect favoring auditory presentation.

In a 1975 review of modality and memory studies, Penney described auditory short-term memory to be superior for item information, but also for associations between serialized aural items. She noted that by comparison, successive visual item association was lessened, with item association between materials shared in different modes reduced to the same or worse levels. Like Murdock, Penney theorized that the auditory memory store was larger, "at least for sequentially presented verbal items" (p. 80). Penney (1989) later suggested two codes. The P code is a phonological code created from articulatory information or practices, generated from both auditory and visually-presented information. This code is added to existing traces of knowledge about words and phonemes. The A code, by contrast, is a parallel code created only through auditory presentation of material, but is more persistent, creating a modality effect for recency. Penney also suggested a model for short-term memory, suggesting a proceduralist view of short-term memory processing, where perceptual and sensory qualities provide the base of a new memory trace, with memory added secondarily. This would imply modality differences in long-term memory similar to that of short-term memory processing.

With the work of Drewnowski and Murdock (1980), we see more direct relevance to the question of audio modality and the teaching of new vocabulary words. Their research outlined the limitations of word lists used in previous modality studies. These

vocabularies were limited, and more likely to contain monosyllabic words, homophones and words with similar vowel sounds. They note a history of lessened recall among "acoustically confusable" words. In previous studies, they argue, test subjects also commonly used homophones as substitutes for forgotten words. To avoid these limitations in their own research, Drewnowski and Murdock chose instead to increase the stimulus vocabulary to well over 1000 words, with many words that would be unknown to test subjects, believing that this would disallow the use of partial memory and previous vocabulary knowledge. They found that partial recall occurred frequently when an intrusive word shared auditory features (such as syllable number, stressed vowel, or phonemes) with a forgotten word, leading the researchers to believe that words become remembered for their "phonemic and nonphonemic auditory features" (Drewnowski & Murdock, 1980, p. 330). Similarly, they suggested that auditory information might be remembered better than lexical information, when auditory features of the tested list were remembered better than the underlying lexical meaning of a word item.

This result has special relevance to the teaching of vocabulary to nursing students. Many nursing students enter the field with less general knowledge of the biological sciences (McKee, 2002). Students with lower lexical knowledge, due to their lack of familiarity with science, might therefore benefit from emphasis on auditory, rather than lexical, learning of new vocabulary words.

Chaiken and Eagly (1976) explored whether the modality effect changed in relation to the complexity of a message or other information. Three messages were created that ranged in difficulty, both in vocabulary and the structure of its prose, and were presented in three modalities - audio only, print, and video. Recall of the simple

message presented no significant modality effect between formats, but the most complex message was best understood and recalled by test subjects exposed to the visual text. Similarly, Green (1981) tested 48 teenagers with two sections of prose, one in auditory format, the other in written text. Green theorized that connected prose, on a topic judged new and difficult to the students, would make recall more difficult. She found that under these conditions, students better remembered what they had read, and made fewer errors in recall on the written prose, than on the prose they heard.

Paivio and Csapo (1973) indicated another type of modality effect influencing free recall, one that favored visual images over text. This impact, known as the picture superiority effect, has been further explained through the dual coding theory proposed by Allan Paivio, which suggests different cognitive processing for visual and verbal information (Paivio, 1971, 1979, 1990, 1991; Paivio & Csapo, 1973). Building on the picture superiority effect and dual coding theories, Thompson and Paivio (1994) later theorized a multimedia modality effect, in which memory recency was best with groups who were exposed to pictures and sound together, rather than auditory images or images alone. This result has been contradicted by other studies - for example, Corston and Colman (1997) presented a 446 word health warning to a group of 108 young adult and adult students, measuring subjects' recall of the message based on its modality. Recall was found to be superior in both audio and print format, over video presentation, with no significant difference found between audio and print modality. Extending Corston and Colman's research, Byrne and Curtis (2000) also found unexpected results. Their subjects, 175 female teenagers, best recalled an identical health warning when it was presented in print, under minimally distracting conditions. Seven different conditions

were created - three multimedia warnings (a 'talking head' video, and videos showing either irrelevant or relevant images), two audio warnings (either read in a local or foreign accent), and two print conditions (one where readers were timed; the other giving unlimited time to read the warning). The highest multimedia recall was found after subjects viewed the "talking head" video, which had been theorized to be the least helpful for recency, due to its lack of relevant images. Both the audio-only messages, whether presented by a foreign-accented or local-accented reader, had equal recall results among the subjects, showing that the accent was not a "distracting element," but instead an exotic or interesting quality that possibly served to further focus the attention of subjects. Similarly, in a 1983 study, Chaiken and Eagly found that 'likability' of a talking head or voice actor had an impact on the modality effect, as it applied to persuasive messaging; messages first presented by less 'likable' personalities saw a rise in recall when the message was applied in print format.

In recent years, with the increased popularity of multimedia animations and video, more research has been done on multi-channel modality effects in learning. This research often focuses on sound as just one aspect of multimedia learning, building on Paivio's dual coding theory and the tripartite memory model. There is a presumption that multimedia modality is superior; audio-only modality no longer receives wide scrutiny (Crooks et al., 2012; Koroghlanian & Klein, 2004; Mayer & Moreno, 2002; Mayer & Sims, 1994; Moreno & Mayer, 1999, 2000; Mousavi et al., 1995; Tabbers, Martens, & van Merriënboer, 2001, 2004). Likewise, given a choice between audio-only and multimedia objects, nursing students may select media-rich items, rather than audio-only

format materials, also assuming that its value for their education will be enhanced (Pilarski, Johnstone, Pettepher, & Osheroff, 2008; Shantikumar, 2011).

Studies of Sound Modality: Environmental Sounds, Visualization, and Complexity

The psychological study of audio-only modality has waned, while the study of multimedia modality has increased. The majority of studies of modality, and its role in memory and learning, now focus on multimedia and animation. Yet related research on audio and sound has continued in a variety of fields.

Gaver (1993) argues for additional study of sound perception and the impact of environmental sounds, stating that much of what we understand of sound perception and listening has historically been influenced by the study of music and the acoustics of musical instruments. He describes a gulf existing between the study of psychoacoustics, and sound cognition, where there is more focus on understanding the mechanisms controlling sound cognition than on an understanding of "everyday listening" and how ecological or situational dimensions might impact perception.

Crutcher and Beer (2011) argue that there is a natural analog for the picture superiority effect, comprising environmental sounds, but note that it has not received much study. Similarly, Sharps and Price (1992) were concerned with "auditory images," environmental sounds made by stimulus items, such as an animal cry or musical instrument. They assumed these sounds would have greater recency above verbal sounds; they found that auditory imagery had "a mnemonic value similar to that of visual imagery" (p. 86). Sharps and Pollitt (1998) found, in a study of university students tested

with comparable visual stimuli, auditory images, and print, that both pictures and auditory images were recalled better than print.

Studies from the field of communications and media studies have focused on the increased visualization and creative imagery supposedly evoked by audio-only presentations. Radio is often referred to as "theatre of the mind," (Bolls, 2002), and much advertising research has focused on broadcast material that can better evoke images, through the use of tools like sound effects, vivid verbal messages, and instructional speech (Miller & Marks, 1997). Studies by Brooks (1967), and Levin and Divine-Hawkins (1974), argue that recall of complex audio messages can be improved through the use of such visualization, as long as visual materials such as written text are not offered with the message information.

More recently, Potter and Choi (2006) have focused on 'structurally complex messages' for radio and the improvement of free recall memory. A structurally complex message has a greater number of sound effects, voice changes, and music. These messages raise cardiac response among studied listeners, who also report greater arousal, which may focus attention and assist in free recall.

How does the greater visualization afforded in audio messages impact recall? Valkenburg and Beentjes (1997) explored memory retention and visualization among young students through the "faulty-memory hypothesis," which suggested that as children forgot more salient details of a fictional story object, they were more likely to provide creative answers instead. Creative answers, then, would be correlated with lower story recall. Accurate recall of an audio-only story was assumed to be worse than a televised, multimedia story, due to audio's reputation for increased creative visualization.

Researchers assumed audio-only stories would actually make correct recall of story details more difficult. In addition, they hypothesized that recall of an audio-only story would be improved when the story was repeated twice for subjects. Instead, they found that the greatest differentiation in recall was the age of the students; regardless of whether the students had been exposed to the radio story once or twice, older students outperformed younger students. Story retention was not substantially improved by listening to the radio story twice, or by watching a television version of the story. Likewise, novelty in the students' retention of the story was tied more closely to their age group, than to whether they had heard the story through radio or television.

This result implies that the greater visualization afforded by an audio-only message does not interfere with better recall of salient information, such as story facts. An evocative, effects-rich message might instead increase recall among listeners, such as nursing students listening to a story message that teaches new vocabulary words. Any creative visualization associated with these messages, however, could serve to sharpen listener focus on new information, rather than encouraging listeners to create fanciful facts of their own.

According to Surprenant, Pitt, and Crowder (1993), undegraded, unprocessed speech sounds, either artificial or natural, make a key difference in recency for sound events, suggesting "a special processing mechanism for speech" (p. 221). Miller and Tanis (1971) also found that recognition memory was superior in remembering the verbal labels of sounds, over the sounds themselves.

Studies of a potential podcast modality effect, using audio podcasts and corresponding presentations in print, have been limited. Daniel and Woody (2010)

provided students in a developmental psychology course with the same article, randomized as either a 3,330 word article, or a spoken word podcast, running over 21 minutes, of the same material. Students were given two days to read or listen to the article, then given a short, multiple-choice quiz. Students who read the article performed better on the quiz than those students given the podcast. Daniel and Woody concluded that podcasts are inappropriate tools for teaching primary course material, including vocabulary, and should only be secondary content to bolster course concepts and material. However, in their responses to the experiment, students noted the podcast lacked signaling devices that would parallel bolding or italics used in text, and that they were less likely to review the podcast material than the written text. This is in line with communications research by Furnham et al. (1990) and O'Keefe (1990) regarding print's superior signaling functions, and greater ease for repetition. However, in discussing contradictory findings regarding message modality and recall, Furnham et al. (1990) noted that many previous communication studies simply adapted material first created for audiovisual mediums such as television, then converted it to audio-only or print presentation, "without regard to possible differences in stylistic practice" (p. 208), which could give an edge to audiovisual information.

O'Keefe (1990), writing about persuasion, or the use of influence to change attitudes or beliefs, disputes the idea that videotaped messages are more persuasive than messages in written form. He argues that control of the received message is crucial: written messages could more easily be reread in a study, unlike audio or video messages whose pace and playback were often controlled by a third party. He notes that the self-pacing available to learners using text is therefore absent in many supposedly equivalent

audio and video formats. Wright (1974) notes that self-pacing allows readers to consider what they have read, including creating arguments and questions, even as they assimilate the information to learn. In recent studies of nursing students who used podcasts for lecture and concept review, self-pacing and control of podcast playback featured heavily in the positive reflections by students (Blake, 2010; Kardong-Edgren & Emerson, 2010; McKinney & Page, 2009; Meade et al., 2009, 2011; Shantikumar, 2009; Stiffler et al., 2011). Likewise, nursing students who used multimedia objects also reported positive feedback about the flexibility and control they had with the objects (Blake, 2010; Lim, Doherty, & Honey, 2011; Windle, McCormick, Dandrea, & Wharrad, 2011).

Podcast Use in Education

Podcasts are widely used for educational purposes, but have not been studied for modality purposes. Booth (2007) argues that the rapid introduction of podcasts, along with other Web 2.0 tools such as blogs and wikis, are the result of an "evaluation bypass," where the technology has been put to use without critical exploration and evidence-based research. He notes that in hundreds of journal articles on these tools, virtually all are descriptive or editorial in tone, but that some evaluations do take place in otherwise descriptive pieces.

Kaplan-Leiserson (2005) theorizes that audio podcasts can be used as a tool for auditory-preference learners, and as supplementary or "blended" materials for overall learning. She suggests it may also provide support for second language learners, who can review recordings to better understand pronunciation and speech qualities. Another suggested idea, in response to a pilot project at Sheffield Hallam University, was an audio

glossary podcast, offering "complex ideas or jargon, created by students and/or tutors" (Middleton, p. 147), a use which might especially appeal to nursing students, with the mass of technical lingo, data, and drug names they must learn in their course of study.

Students' actual use of podcasts may not match instructor expectations. "I'd also assumed that the students would be more technically skilled than I am and that's not necessarily the case," noted one professor in the Sheffield Hallam pilot program, which also sought to have students produce their own podcasts for class, "...in practice, God help them, they're even worse off than I am" (subject quoted in Middleton, p. 152). Again, an assumption that students are more technically skilled, or 'digital natives' may put nursing students at a special disadvantage, since they appear to have lower confidence levels in their use of technology than medical students (Blake, 2010). Medical students, by contrast, appear to overestimate their technical prowess (Seago, Schlesinger, & Hampton, 2002).

In a study of almost 900 University of Michigan students across multiple fields, all of whom utilized iTunes to download syndicated educational podcasts produced by the university and its faculty, more than half of all students reported using podcasts to watch lectures, but only four percent noted using it to review confusing material (Lonn & Teasley, 2009). Despite the potential benefits of using podcasts for mobile learning, such as the flexibility to take a podcast outside a traditional study location (Cebeci & Tekdal, 2006; Evans, 2008; Walls et al., 2010), students are most likely to use their desktop computers for download and playback of podcasts (Lonn & Teasley, 2009; Stiffler et al., 2011; Walls et al., 2010).

Students' expectations and preferences may vary depending on characteristics ranging from the course of study they have chosen, to their age and development. In a study comparing reactions of three undergraduate courses and one graduate course to podcasts, students in two of the undergraduate classes, learning about research methods in science (RM), and about genes and genomes (GG), were negative about their experience (Carvalho et al., 2008). RM students wanted their podcasts to run 15 minutes rather than 35 minutes; despite the fact that their podcasts averaged about three minutes in length, GG listeners complained that they needed to be shorter - and that the podcasts were boring and tiring. In the remaining applied biology course for undergraduates, the students enjoyed the short length of their podcasts, which ran only 45 seconds to one minute. The master's degree class, a group of educational technology students, enjoyed podcasts. Therefore, students in different fields may self-select into groups that show greater or lesser usage and acceptance of podcasts, or other learning objects.

This self-selection, where students with more technical knowledge are more open to learning technology, could disadvantage nursing students. Nursing students often have variable or slight STEM (science, technology, engineering and math) backgrounds upon entrance (Lymn et al., 2008; McKee, 2002; Wharrad, Allcock, & Chapple, 1994), and display lower self-efficacy in relation to technology (Blake, 2010). Despite this lower self-efficacy with technology, and limited STEM backgrounds, nursing students also self-report positive experiences with reusable learning objects (Blake, 2010; Stiffler et al., 2011). Both medical and nursing students report a diminishment of anxiety after using podcasts and other learning objects (Manias & Bullock, 2001; Meade et al., 2011;

Pilarski et al., 2008), although nursing students appear to use reusable learning objects (RLOs), such as podcasts, more often than medical students (Blake, 2010).

In a study of two groups of Australian students using podcasts, students appeared to use similar learning objects studying strategies despite the difference in their fields (nursing and business). Only one clear trend differentiated the 20% of students in both groups that chose not to utilize podcasts - students who worked more listened less, with some indicating in survey responses that they had no time to use podcasts (Kazlauskas & Robinson, 2012) Students who have greater outside responsibilities, therefore, are less likely to adopt podcasts into their study strategies. Again, nursing students are more likely to be older, more likely to be non-traditional students, and can therefore be assumed to be a greater proportion of the 'working more' pool (Blake, 2010; Kazlauskas & Robinson, 2012).

Vocabulary Learning and Modality

Vocabulary learning takes place under specific conditions, regardless of field or topic. Hatch and Brown (1995) list the ways a learner adds new words to his or her vocabulary. The learner must first have access to resources where new words can be encountered and learned. The learner must also have access to a clear image of the new word in either audio or visual form, and access to a definition of the word's meaning. After seeing or hearing this new word, the learner must be able to generate a connection between the word's form, and its definition, and add it to his or her memory. Lastly, the learner must have the opportunity to practice and use the new word.

While analyzing how vocabulary is learned and retained, Paul Nation (2001) defined four vocabulary categories for words - high frequency, academic, technical, and

low frequency. Nation defined high frequency words as the most common 2,000 words used in English, while he described academic words as those commonly used across divergent academic fields. According to Nation's definition, technical words are closely related to a specific field. Nation classifies all other words as low-frequency. Using Nation's definitions of vocabulary, medical conditions, pharmaceuticals, anatomic terms and other jargon used only in the medical or nursing fields would be considered technical words. In studying incidental vocabulary acquisition, Vidal (2011) noted that the type of word had a strong impact on vocabulary gains; listeners were better able to learn new technical words than low-frequency or academic vocabulary. Learners studying academic vocabulary found reading a superior strategy to listening, regardless of learners' overall proficiency. This built on Vidal's previous research (2003), in which students listening to talks had particular difficulty learning new academic words. In the 2011 study, Vidal discovered that as student proficiency went up, the difference between listening and reading gains went down. She noted that low proficiency students seemed to benefit from the greater control provided by written texts, which they could re-read and review at their leisure, but concluded that listening might be preferable to encourage retention rates among higher proficiency students.

The speech-based phonological loop (Baddeley & Hitch, 1974) has been studied as a system that aids the long-term addition of native or foreign vocabulary, theoretically providing a temporary location for new words while long term lexical and meaning knowledge is being created (Baddeley, 1992; Baddeley, Gathercole, & Papagno, 1998). Among children, a connection exists between previous native language knowledge, the phonological loop, and long-term learning of new word sounds (Gathercole, Hitch,

Service, & Martin, 1997). Papagno and Vallar (1995) also found that polyglot university students, compared to unilingual contemporaries, had superior performance on tests utilizing phonological memory, while there were no differences seen by the two groups in visuospatial and nonverbal testing.

Tight's 2010 study of second language (L2) vocabulary learners questioned whether retention of new words was impacted by students' preferred perceptual learning styles, such as visual, auditory, or kinesthetic. In the study, instruction could be offered in a single, preferred or non-preferred format (such as visual or auditory), or a multi-modal method. During the immediate posttest, no major differences in retentions were tied to instructional methods. However, a study of retention during one week and one month post-tests showed that mixed modality instructions offered the best patterns of vocabulary retention regardless of students' expressed learning style, followed by students' chosen learning style, then followed by singular, less preferred learning styles. Tight argues that "this finding may be a result of the mixed-modality condition producing especially strong memory traces" (p. 819).

A closer investigation of L2 (second language) learning with podcasts suggests ways that podcasts can be better tooled for teaching vocabulary. Rosell-Aguilar (2007) suggested best practices in audio podcasting for L2 learning by analyzing two popular podcasts, Chinese Pod and Japanese101. He noted that these podcasts ran 15 minutes on average and that a variety of native speakers with different inflections and ages were used. Signaling came in the form of repeated or slowed pronunciation for certain words. These podcasts featured levels for learning and content, so that beginners, intermediate,

and advanced learners had different materials. The material was also divided into news, language points, cultural, and other types of information.

With many ESL learners enrolled in nursing courses (Kazlauskas & Robinson, 2012), their special needs must also be considered when developing vocabulary strategies. In their review of literature on Asian ESL nursing students, Scheele, Pruitt, Johnson and Xu (2011) observe that such students may have some English reading and writing skills, but rarely the opportunity to practice speaking English before entering an English-speaking classroom. The authors note that in Asian classrooms, more emphasis is placed on memorization of important facts than on synthesizing information after reading, which is more typical in English-language classrooms.

Analyzing the success rates of South Korean L2 students using a web-based English vocabulary program, Kim and Gilman (2008) note "Replacing text and graphics with spoken text can create an unnecessary distraction for ESL learners who are accustomed to memorizing new words without knowing exactly how they are pronounced" (p. 124). This suggests that past educational experience and cultural differences may also impact the successful use of audio for vocabulary learning. Similarly, Yang (2005) notes that students in Asia are frequently expected to memorize vocabulary through repetition. Yang specifically notes that students in Chinese classrooms were more likely to refer to a dictionary for issues with a word, due to Confucian traditions; in respecting their teachers' authority, students would avoid approaching them for direct help with a word.

In a 2005 study of Taiwanese nursing students, who were learning medical terminology, Yang found that higher level learners were more likely to use a greater

variety of learning strategies, such as taking notes, practicing verbal or written repetition, or re-reading vocabulary in assigned textbooks. Despite evident difficulties Taiwanese subjects had in pronouncing medical words properly, Yang found that listening to recorded word lists and social exercises (using the word aloud in a group activity or asking the teacher for a sentence with the word) were among the least used strategies in a medical terminology course. Yang also noted that the medical terminology class did not provide an audiotape to second language learners. These educational differences may explain how L2 nursing students approach podcasts designed in an English-speaking country: in a study of undergraduate and graduate nursing students using podcasts, ESL status students had low scores of posttest attitude towards use of the technology (Schlairet, 2010).

Characteristics of First Year and Continuing Nursing Students

ESL and other L2 nursing students are a known population with unique needs, but all nursing students, regardless of backgrounds, are more likely to share certain characteristics and learning needs.

One of the primary challenges in nursing education is the lack of a biological science background among many first-year students, which can negatively impact their learning abilities (McKee, 2002). In a study of British nursing students aged 21 and over, 72% of subjects indicated that life sciences was the most difficult subject to master; this figure was raised to 80% when only students aged over 25 years were included (Glackin & Glackin, 1998). In Great Britain, nursing schools have not reached consensus on how much biological training is necessary prior to nursing school entry (Wharrad et al., 1994).

Lymn et al. (2008) notes that almost half of the British students in a nurse

pharmacology course "had no more than a GCSE in a biological science subject". A GCSE, or General Certificate of Secondary Education, is a qualification taken by teenagers in the United Kingdom (UK), generally aged 14-16 years old, according to the British government ("GCSEs", 2013.). In other words, these college-age nurses had stopped studying science midway through their teenage years. Ofori (2000), in a study of over 200 British nursing students, notes that there are additional methods that allow entry for these students, such as the UK National Vocational Qualifications, which allow prospective nurses without GCSEs to qualify through work experience. He argues that age, rather than qualifications such as the GCSE, better predicts performance, with students under 20 more at risk, and students over 34 years of age predicting better performance. Kevern, Ricketts, and Webb (2001) and El Ansari (2002) confirm this performance trend for "mature" nursing students in their studies, with Kevern et al. noting also that students with at least two UK "A" levels prior to entry also perform well.

However, Glackin and Glackin (1998) argue that literature on nursing education assumes nursing students are traditionally-aged. These traditional students are assumed to be 18 to 21 years of age and single with no family obligations. They are also expected to have limited work histories. In a study of 233 students, nursing students were also older on average than medical students (Blake, 2010). Kazlauskas and Robinson (2012), in a study of two groups of Australian students using podcasts, also found that nursing students were older, more likely to be non-traditionally aged, and ESL learners, than business students in a statistics course. The unique characteristics of nursing students – their greater propensity for being non-traditionally aged and/or L2 learners – may also set

them apart from other students in the health professions, as well as impact the way they utilize podcasts and other reusable learning objects, or RLOs.

Reusable Learning Objects in Nursing and Medical Education

The use of technology, including the use of podcasts and other RLOs, has been widely studied among health profession students. According to Blake (2010), who conducted an online questionnaire with 233 nursing medical students, RLOs were more commonly used by student nurses, than medical students. In the same study, however, nursing students were three times more likely than medical students to express a lack of confidence using computers and technology, and find this a barrier to using RLOs.

In several studies of audio-only podcasts used in medical and nursing education, the flexibility of audio podcasts appears to be key to students' acceptance and positive feedback. Students report being able to study at different times and places, confirm or clarify specific points, and their ability to repeat the podcasts when needed, in order to revise their knowledge or make up for a missed class (Kardong-Edgren & Emerson, 2010; McKinney & Page, 2009; Meade et al., 2009; Meade et al., 2011; Shantikumar, 2009; Stiffler et al., 2011.)

Schlairet (2010) found that undergraduate, second-degree, and graduate students of nursing listened to podcasts for slightly different reasons - undergraduates to reinforce learning, second-degree students for exam review, graduate students for clarification of course content. Some students report a preference for podcast materials, either for overall learning or specifically for revisions, than their assigned textbooks (Blake, 2010; Stiffler et al., 2011).

Both nursing and medical students reported greater relief from anxiety through the use of podcasts or other learning objects, especially when their entry knowledge was particularly weak, such as during the first semester of medical school, or when non-prescribing nurses were learning pharmacology (Manias & Bullock, 2001; Meade et al., 2011; Pilarski et al., 2008). Meade et al. (2011) suggest that "the knowledge that lecture recordings are available may allow students to focus better on the lecture material itself rather than making notes, listening and trying to develop an understanding simultaneously" (2001, p. 8).

In a study comparing nursing students in two courses, one (2007 group) receiving instructions through traditional lectures, and the other (2008 group) receiving the same information through podcasts, no significant difference existed in their scores on course exams (Vogt, Schaffner, Ribar, & Chavez, 2010). However, in comparing a course of students who used podcasts to learn pharmacology concepts, to historical groups who had not had access to the same resource, the students using the podcasts had higher retention of the new knowledge, higher mean exam scores, and a higher overall range of marks (Meade et al., 2009). Interestingly, students often self-reported using audio-only podcasts in conjunction with other media, whether it was their textbooks, visual aids, or other materials - in effect, creating their own multi-modal instruction (Kardong-Edgren & Emerson, 2010). In a study of both undergraduate and graduate nursing students, ninety percent of undergraduate and second-degree students looked at textbooks while listening to podcasts (Schlairet, 2010). Other podcasts were designed deliberately to work in tandem with other visual aids: pharmacology lectures used successfully by British, non-

prescribing nurse students were chunked to match slides on the lecture handout (Meade et al., 2009).

Given a choice, students may gravitate to richer instructional media, rather than audio-only format materials, assuming that its value for their education will be enhanced (Pilarski et al., 2008; Shantikumar, 2011). Nursing students using multimedia, incorporating audio, text, and images, generally appear positive about the flexibility and control they experience (Blake, 2010; Lim et al., 2011; Windle et al., 2011). Tanaka, Catalan, Zemiack, Pedro, Cogo, and Silveira (2010) also found that a class of nursing students felt positive about a multimedia learning object, and that it increased their feeling of responsibility for their own learning. Even negative comments, in a study of chemistry RLOs used by nursing students, focused on control of the educational experience, with some students wanting greater ownership (Windle et al., 2011).

Perceptual Learning Styles and Modality in Nursing and Allied Health Education

In positing a difference in modality of materials developed to teach nursing students, it may be valuable to consider the implications of learning styles upon modality. Many learning style models have been developed to identify the preferences of learners, including those in nursing and allied health education (Partridge, 1983). For example, the Kolb Learning Style Inventory (Kolb, 1976, 1984; Kolb & Kolb, 2005) classifies learners on two scales influenced by experiential learning theory. Kolb (1984) suggests that a specific profession may influence existing learning styles; studies of nursing students and other allied health students utilizing the Kolb inventory also confirm specific

trends in their learning needs (Cavanagh, Hogan & Ramgopal, 1995; Rassool & Rawaf, 2008; Williams, Brown & Etherington, 2012; Williams, Brown & Winship, 2013).

By contrast, the VARK (Visual, Aural, Read-Write, and Kinesthetic) survey created by Fleming and Mills (1992) was developed not as an inventory, but as a method of encouraging students to reflect on the way they learn. VARK's purpose is to encourage a conversation between instructors and students about learning styles, and to help both align learning strategies and the use of materials for better learning (Fleming & Baume, 2006). Fleming and Mills (1992) noted that VARK was developed partially in response to students' complaints about the long, vague and tedious nature of learning style inventories. The VARK instrument was created by identifying the different perceptual modes used to both communicate and learn information: Visual, or (V) mode, which utilizes graphics, symbolic, or diagrammed information; Read/Write, or (R) mode, which utilizes the printed word; Aural, or (A) mode, utilizing heard information; and Kinesthetic, or (K) mode, a mode "used to connect the student to reality, either through experience, example, practice or simulation" (Fleming & Mills, p. 141). The VARK survey would then indicate a single dominant learning preference, or a multimodal preference, in which multiple preferences would be valuable in helping learners synthesize new information. After taking the shorter VARK survey, students would then be given "help sheets" to help adapt their preferred learning styles for future study.

Far from arguing that VARK should be used prescriptively, Fleming states that VARK deals "with only one dimension of the complex amalgam of preferences that make up a person's learning style" (Fleming, n.d., p. 2). According to Fleming, multimodality is the case for all learners, and those who have a mild to strong preference

simply have a preference that is stronger than others. In looking at the database sample from the thousands of people who have taken the VARK test online, he notes that the population is dominated by learners and practitioners in education, and therefore should not be used to generalize about a total population of learners.

Nonetheless, VARK has become increasingly popular for learning style studies of nursing, physiology, medical, and other allied health students. Trends in student responses to the VARK test appear to depend on specific fields of study – for example, a study of all pre-doctoral dental classes at Temple University found that 44% had a single, dominant learning preference, with read/write being the most common, and kinesthetic being the least common (Murphy, Gray, Straja, & Bogert, 2004). Meanwhile, in a study of 166 first-year medical students in Michigan (Lujan & DiCarlo, 2006) 38% of students had a dominant learning preference. Among these Michigan students, kinesthetic learning was the most popular preference, while the aural learning style was the least common. In a study of over 900 pre-health majors taking a first or second year course in human physiology, students were given a multiple-choice test at the end of each semester, and assigned a unimodal learning preference. Visual preference was the most popular, and kinesthetic was the least common choice, with women students selecting the aural learning style in significantly higher numbers than men (27% to 17% respectively) (Dobson, 2009).

Studies of nursing students taking the VARK test do suggest some possible trends; a study of third year nursing students in Jordan found that of the smaller number (42%) of students preferring a single mode of learning, the majority preferred a kinesthetic learning style (Alkhasawneh, Mrayyan, Docherty, Alashram, & Yousef,

2007). Another study of Australian first-year health science students (most of them prospective nurses), also found kinesthetic learning to be the most popular unimodal preference (Meehan-Andrews, 2009.) A VARK study of first year health science students in Australia, noted that the sample included those who planned to enter nursing, public health, behavioral science, or oral health. The majority of students in this survey were nursing students; however, the survey was collected anonymously and did not differentiate the results between students' planned fields of study. The majority selected a multimodal learning style, chosen by 46 respondents, or 53.5%. Survey data also showed a distinct preference for the kinesthetic learning style, with 43% of the 86 respondents selecting that unimodal style. Very few students chose the aural learning style, just 2.3%, or two survey participants.

Subtle to strong gender differences have been observed in health science cohorts taking the VARK questionnaire, or a similar test (Slater et al., 2007; Wehrwein et al., 2007; Breckler, Joun & Ngo, 2009; Dobson, 2009). Breckler et al. suggest that these gender differences may also further differentiate field of study differences; for example, the authors suggest that male premedical students were almost twice as likely to prefer multimodal learning to their non-premedical male counterparts.

A sample of 92 third-year nursing students taking a maternity class at a public university in Jordan found that most (58%) students preferred multimodal learning (Alkhasawneh et al., 2007). Sixteen percent preferred a single mode of learning, kinesthetic; another 12% preferred read-write mode, with only 3% and 1% picking aural and visual mode respectively. Yet a significant difference was found after the class was introduced to problem-based learning curricula, and then given a post-test, with the

number of students choosing multimodal preference rising from 54% to 68%. The authors argue that the use of problem-based learning not only helped the male nursing students in the course better understand maternity and women's health, but that it encouraged all students to consider and value multimodal learning more. Interestingly, Murphy et al. (2004) argue that at different times in the curriculum, specific learning preferences may be more critical; for example, foundation knowledge in the first years of medical school may be best shared or learned through visual and written text, while clinical knowledge may be better gained in later years through kinesthetic learning. Therefore, it may be crucial to situate VARK survey data at a specific time in a course- or degree-specific sequence of learning.

James, D'Amore, and Thomas (2011) also argue that not all demographic characteristics have been traced for their influence on learning styles, particularly ethnic or cultural factors. In their study of 345 first-year nursing and midwifery students at two Australian campuses, there were significant learning style differences between students enrolled at a rural campus, and those attending courses in a major metropolitan area. Rural students were significantly more likely to select a single mode preference, and more likely to prefer visual and kinesthetic learning, whether in a unimodal or multimodal learning style. English L2 learners had similar kinesthetic scores to those who were native English speakers, but L2 learners had significantly less preference for visual and aural learning styles; the former was unexpected. By contrast, the survey data showed no significant differences in the mean VARK scores based on gender, age, previous education or tertiary entry type. However, there was a trend of women students selecting unimodal modes in greater numbers (21.6% of women students compared to

18.2% for men students). Again, the majority of students (78.7%) selected a multimodal learning style, with kinesthetic scoring highest among unimodal preferences, while aural unimodal selections were lowest.

There is limited data regarding the correlation of learning style preferences and academic performance. In his initial 2009 study of 901 Florida pre-health students, Dobson indicated that students with a kinesthetic unimodal preference had the poorest performance in their human physiology class, throughout each portion of the class, including the laboratory section that features more 'hands-on' or kinesthetic-style learning. Meanwhile, aural learners had the highest overall class score. Though women students preferred aural learning in higher numbers to men students, there was no significant difference in class scores overall, between men and women. A 2010 follow-up survey by Dobson utilized a created multiple-choice test and the VARK survey, utilizing 67 undergraduate and graduate students in exercise and sports physiology courses, and again found that Kinesthetic learning preference students had significantly lower course scores, with Dobson noting that this may indicate a need for additional assistance for K-preference students. By contrast, Koch, Salamonson, Rolley, & Davidson (2010) found, in a study of 62 accelerated graduate entry nursing students at an Australian university, that kinesthetic preference on the VARK test predicted better academic performance. In comparison to the data collected by James et al. among rural and metropolitan Australian nursing and midwifery students, Koch et al. found that native English speakers had higher mean scores of visual and kinesthetic preference.

Summary

There is no clear cut answer regarding which modes of learning or types of learning objects will best assist nursing students in learning new vocabulary. This is due in part to a dearth of recent research on audio-only modality and memory. Podcasts, despite their popularity, have not received much evidence-based evaluation as a learning tool either.

However, nursing students appear to exhibit common characteristics, including learning preferences that can be analyzed or at least considered through the use of VARK surveys. Nursing students' other common characteristics correlate with higher average age, previous schooling, the greater likelihood of being second language students, and having a lower familiarity and comfort level with science and/or technology. Nursing students receive podcasts positively, and they appreciate podcast flexibility for the study and review of new knowledge.

Since modality appears to play a part in the ease or difficulty of learning specific kinds of vocabulary, including the highly technical words nurses and other health professionals must learn, a closer look at audio-only learning objects, in comparison with print-only learning objects, is called for.

CHAPTER THREE

METHODOLOGY

The purpose of this study was to explore the influence of modality and self-perceived learning preferences on nursing students' recall of new vocabulary words. Survey and assessment data was collected from a purposeful sample of nursing students located at a large, urban community college campus in Southeast Texas. This data was analyzed using a two-tailed independent t-test and Pearson's correlation coefficients. This chapter presents an overview of the research problem, an operationalization of key constructs, research purpose and questions, research design, population and sampling selection, instrumentation, data collection procedures, data analysis methods, as well as privacy and ethical considerations.

Overview of Research Problem

During the 1960s, psychological and cognitive science researchers explored how modality impacted the recall of digits or simple words (Healy & McNamara, 1996). A modality effect has been described by Penney (1975, p. 1) as "differences in recall as a function of auditory and visual presentation of verbal items." Information first provided in audio format appears more easily remembered by test subjects than the same information provided in print format (Penney, 1989; Healy & McNamara, 1996). However, in the last forty years, learning theories that focus on visual imagery and multimedia have gained in popularity, such as the picture superiority effect and dual

coding (Paivio, 1971; Paivio & Csapo, 1973). As a result of this popularity, current educational psychology literature shows a deficit in study of the audio-only modality effect, while the expected superiority of multimedia modality has become a common topic of study (Crooks, Cheon, Inan, Ari, & Flores, 2012; Mayer & Sims, 1994; Moreno & Mayer, 1999; Mousavi, Low, & Sweller, 1995). By contrast, researchers in communications and media studies have continued to investigate the audio modality effect in advertisements and other messages, alone or alongside multimedia modalities (Byrne & Curtis, 2000; Chaiken & Eagly, 1983; Corston & Colman, 1997; Green, 1981; Potter & Choi, 2006).

Meanwhile, audio podcasts have become a more frequently used instructional tool, but little data exists on their efficacy for learning (Booth, 2007). In several qualitative studies, nursing students have positively self-reported their use of podcasts for learning (Blake, 2010; Kardong-Edgren & Emerson, 2010; McKinney & Page, 2009; Meade, Bowskill, & Lymn, 2009, 2011; Shantikumar, 2009; Stiffler et al., 2011). Since one of the most challenging aspects of nursing education is the retention of new vocabulary words, phrases, and drug names (Meade et al., 2011), the efficacy of learning new words through audio-only files such as podcasts is an important topic of study. Research on second language (L2) learners also appears to show that perceptual learning style preferences impacts both the modality effect and success in learning new words (Tight, 2010). Therefore, this study will also investigate whether perceptual learning styles impact nursing students' retention of new vocabulary.

Operationalization of Key Constructs

This study consisted of three constructs: (a) modality, (b) learning style preferences, and (c) recall. *The Cambridge dictionary of psychology* (2009) defines modality as "a channel of sensory perception, such as vision or hearing." For the purposes of this study, modality was defined as the transmission type used to communicate new information to test subjects, offered in either an audio-only or text format. Learning style preferences are defined by Tight (2010) as the single perceptual channel that individual learners prefer to receive new information through. This may be a perceptual visual channel focused on graphical and photographic data, a perceptual visual channel focused on print, an aural channel, or a concrete channel involving the use of touch. The VARK (Visual, Aural, Read-Write, Kinesthetic) survey will be used to assess test subjects' learning style preferences. Recall is defined as a function of memory. This function represents the ability of learners to retrieve information they have learned. Recall is being measured in this study by a researcher constructed assessment, the *Recall of Nursing Terms Assessment.*

Research Purpose and Questions

The purpose of this study was to analyze whether vocabulary taught to nursing students is best learned through audio or print. The research questions guiding this study will be:

1. Is there a mean difference in the short-term recall of vocabulary words based on audio-only or print modalities?

H_a: There is a mean difference in the short-term recall of vocabulary words, based on modality of transmission.

2. Is there a relationship between learning styles preferences, and short term recall of these vocabulary words?

H_a: There is a relationship between learning styles preferences, and short term recall.

Research Design

For purposes of this study, a causal comparative research design was used to assess the influence of modality and learning preferences on short-term recall of new nursing vocabulary. A purposeful sample of first year nursing students located at an urban community college campus in Southeast Texas was asked to respond to the VARK (Visual, Aural, Read-Write, Kinesthetic) learning preference test, followed by the Recall of Nursing Terms Assessment. Participants were divided into two groups, pre-tested, introduced to a group of vocabulary terms provided in either audio or visual text modalities, and then post-tested on their short-term recall of these words. Demographic information was provided by the nursing department at the college in a spreadsheet

organized by student identification numbers. Quantitative data was analyzed using a two-tailed independent t-test and Pearson's product moment correlation.

Population and Sample

For this study, the population was sampled from first year students in the Licensed Vocational Nursing program at an urban community college campus in Southeast Texas. This Licensed Vocational Nursing program comprises approximately 160 students who are seeking a vocational nursing license. This purposeful sample of community college students seeking a licensed vocational nursing (LVN) certificate was chosen to complete a learning styles survey, and then to test the modality effect of vocabulary words shared through audio-only and written text, and the relationship of perceptual learning preferences on recall of the same vocabulary words. This cohort was selected due to the shorter pace of the LVN program, and because first year students are less likely to have been exposed to highly technical vocabulary and pharmacological terms. The cohort also spanned a wide range of ages and was ethnically diverse. Only a small portion of entering students was predicted to have previous post-secondary training, baccalaureate or higher degrees, or experience in allied health, biology or a related scientific field or trade. Any students who had previously taken a course in mental health nursing, or advanced psychology, where they may have been exposed to these terms, were excluded from the study.

The approximate demographic breakdown of the entering class of Spring 2013 (n = 73) was as follows: 28.77% of the Spring 2013 cohort defined their ethnicity as white; 26.03% of the cohort selected the ethnicity "Hispanic", or Latino/Latina; 28.77% of the cohort listed their ethnicity as African-American; and 5.48% of the cohort listed

their ethnicity as Asian or Pacific Islander. Permanent residents or other foreign nationals made up 2.74% of the cohort. A majority of students in this cohort are female, 83.56% of the cohort. All students in the cohort were 19 years of age or older, at the beginning of spring 2013. Almost a third, or 30.14%, of the class was aged 34 or older, with 10.96% born between 1964-1969; and 19.18% born between 1970-1979. Of the remaining cohort, 17.81% was born during 1980-1989; 43.84% was born during 1990-1993.

Only 4.11% of the cohort listed their marital status as divorced; 24.66% listed their marital status as married. Fourteen students (19.18%) did not note their status, leaving 52.05% who listed "single". Of those who indicated children or other dependents in their household, ten, or 13.7% listed one dependent; another 13.7% listed two dependents; 2.74%, or two students, listed three dependents. One student each (1.37%) listed four dependents, and five dependents, respectively.

All students in the program were required to have completed some college at entry; 12.33% of the cohort noted that they had received a GED, rather than a high school diploma, prior to attending some college. The GPA range ran from 2.27 to 4.0, with more than a third, or 36.99%, receiving a 3.0 or higher. Three students, or 4.11%, had perfect 4.0 GPAs. Students also were required to take the HESI exam prior to entry; scores ranged from 79.33 to 98. Three students (2.74%) indicated they had visual impairments; no other learning disabilities or challenges were listed by students at entry.

At entry, one student (1.37%) had an allied health certificate, two (2.74%) had an associate degree in biology; seven (9.589%) had another type of associate degree; 5.479%, or four students, had a bachelor's degree. A minority of the cohort (n=11) were already certified nursing assistants (CNAs), or certified medical assistants (CMAs),

indicating that they had some prior nursing training. Just one student (1.37%) identified as a military veteran.

Based on the specific demographics of the Psychiatric Nursing course offered at this urban community college in the summer of 2012, as well as the makeup of the Spring 2013 class, class participants were expected to be ethnically diverse. Test subjects were expected to range in age from 19 to 49 years old. Males were expected to make up approximately 10-15% of the class.

A purposeful sample of first year nursing students located at an urban community college campus in Southeast Texas was asked to respond to the VARK (Visual, Aural, Read-Write, Kinesthetic) learning preference test (Fleming & Mills, 1992), followed by a recall vocabulary test. Participants were divided into two groups (an audio-only group, and a reading-only group), pre-tested, introduced to a group of vocabulary terms provided in either audio or visual text modalities, and then post-tested on their short-term recall of these words.

Instrumentation

Visual, Aural, Read-Write, Kinesthetic (VARK) Survey

This study employed the VARK (Visual, Aural, Read-Write, Kinesthetic) questionnaire, version 7.1, which is used to measure perceptual learning style preferences. The VARK questionnaire was developed by Neil Fleming, a New Zealand based educational consultant, and Colleen Mills of Lincoln University, to help test-takers analyze which perceptual learning preferences they have (Fleming & Mills, 1992). The survey indicates whether learners have a unimodal, or multimodal, learning preference, and which perceptual channel or channels (visual, aural, read-write, kinesthetic) learners prefer to receive new information through. Visual, or (V) mode utilizes graphics,

symbolic, or diagrammed information; Read/write, or (R) mode utilizes the printed word; Aural, or (A) utilizes heard information; and Kinesthetic, or (K) mode utilizes reality, simulation, and first hand experiences.

Structurally, the VARK survey is a multiple choice test with 16 questions regarding preferred modality used in learning and communication opportunities, such as learning how to ride a bike, playing a new computer game, or providing directions to an out-of-town friend. Each question has four answer choices that correlate to preferences for visual, aural, read-write, and kinesthetic learning and communication. The survey can be taken as a printed paper test, or as an online test scored by the VARK website.

The research use of VARK has been controversial, and has resisted modeling (Leite, Svinicki, & Shi, 2009). Svinicki also noted in correspondence that while VARK was insufficient in validating research, "no one has been able to design an instrument along these lines that does" (quoted in Fleming & Baume, p. 3). Leite et al. state that VARK is acceptable as "a low stakes diagnostic tool...those who wish to use the instrument as a way of helping student identify their preferences should feel comfortable in this use." (p. 336). The authors suggest that more validity for VARK scores could be collected through the measurement of task performance on single learning style activities and its comparison with VARK survey scores.

There are additional difficulties with using the VARK survey data to validate research. While a table compiled in November 2011 from VARK survey users (Fleming, n.d., p. 8) distinguished groups based on gender and whether a user was a teacher or a student, it did not distinguish between grade level of the student (e.g., K-12, undergraduate, graduate level). Additionally, 8.2% of the 45,826 users listed in the

database by November 2011 had taken the test more than once, which could impact responses; in subsequent studies that compare the main VARK survey data with a specific cohort, it is often unclear how these repeat surveys factor into researcher calculations. VARK has been used frequently in studies of nursing, physiology, medical, and other allied health students, where test subjects' perceptual learning style preferences are matched to educational attainment, test scores, and other assessments (Alkhasawneh et al., 2007; Breckler et al., 2009; Dobson, 2009; James et al., 2011; Koch et al., 2010; Lujan & DiCarlo, 2006; Murphy et al., 2004; Meehan-Andrews, 2009; Slater et al., 2007; Wehrwein et al., 2007).

Recall of Nursing Terms Assessment

The purpose of the Recall of Nursing Terms Assessment was to assess how well students retain difficult pharmacological names, and highly technical mental health vocabulary, after being briefly exposed to new terminology. The Recall of Nursing Terms Assessment uses 30 multiple-choice questions, offering three potential answers to each question. Half the terms tested are of pharmacological compounds used to treat mental illnesses and psychiatric states or conditions. The remaining terms are of specific psychiatric states and conditions. The Recall of Nursing Terms Assessment was developed by the student researcher in conjunction with a subject matter expert, a registered nurse, and a university professor. Terms used in the assessment come from the glossary of an assigned text used in the LVN program's Psychiatric Health Nursing courses. Test subjects' responses were scored according to the number of correct and incorrect answers provided on the pre- and post-test.

Data Collection Procedures

Prior to the first meeting with the class, a copy of that years' entering class was provided in spreadsheet form, along with a class roster, to the researcher. This spreadsheet provided demographic information about each student. Using information from the class roster, and the spreadsheet provided by the nursing education department, the student subjects were randomly assigned into one of two groups. All collected data listed subjects by student information number, not by name; this protected the integrity of the test, and assisted with privacy concerns.

Students were given a release form that outlines the experiment. They also received a data sheet requesting that they describe their past classes and other exclusion criteria. The researcher outlined the experiment further by visiting the class and explaining in person what the study entails.

All signed data sheets were collected, with students noting their student identification number on the form. Students then took the VARK questionnaire (version 7.1), and provided researcher with the results, marking their student identification number on the printed page. The time needed to complete the test was approximately 15 minutes or less. Students were also given a copy of their questionnaire results, along with authorized copies of Fleming's VARK "SWOT" (Study Without Tears) study sheets for their future reference.

Each student within the class was randomly assigned to one of two classrooms for the experiment. Half of the students entered a classroom where a screen showed a written text definition of thirty (30) vocabulary words. The remaining students were assigned to a classroom that played a recording of thirty (30) vocabulary words, read aloud by a

speaker. The total time needed for the entire process (pre-test, instructional recording/text, and post-test) was approximately half an hour.

Test subjects were pre-tested on the vocabulary by being provided with a pre-test of vocabulary terms. After they were exposed to vocabulary definitions in either audio-only or plain text format, the students were directly post-tested. The pre-test and post-test was the same paper-based multiple choice test, listing three potential answers for thirty vocabulary questions. The number correct on each test was tabulated by the researcher, who assigned a pre- and post-test score for each identification number.

All data was collected over a space of three hours, within a single (long) class period, and stored on a computer hard drive and data stick. Paper items will be scanned to PDF and then shredded. The faculty sponsor will store the data for three years prior to destroying it.

Data Analysis

All data were analyzed using SPSS. To answer research question one, baseline data was analyzed using a two-tailed independent t-test to determine if a statistically significant mean difference existed between the two groups' recall of vocabulary words first introduced through audio and visual text formats. The independent variable in research question one data is the modality of the transmitted vocabulary. This variable is measured on a nominal scale, as either audio-only or text-based information. The dependent variable is a score indicating each test subject's recall of the vocabulary words, measured on a scale of 1 to 30.

To address research question two, Pearson's product moment correlations (r) were conducted to analyze whether a statistically significant relationship existed between

learning preferences (Visual, Aural, Read-Write, Kinesthetic) and the number of vocabulary recalled. The variables are the post-test scores and the perceptual learning preferences. Learning style preference data was divided into four groups – Visual, Aural, Read-Write, and Kinesthetic perceptual learning preferences, each with their own interval score, designating how many times a learning preference was selected in response to the questions on the VARK questionnaire. All variables are continuous in measurement.

Privacy and Ethical Considerations

Before collecting data, permission was obtained from the community college's Institutional Review Board (IRB) and from the Committee for the Protection of Human Subjects (CPHS) at the University of Houston-Clear Lake. The community college's IRB and CPHS were each provided with a sample consent form and an outline of the planned research, and its immediate and long-term impact on the research subjects, and future students in the nursing program. Student subjects were provided with a cover letter and release form, detailing the purpose and type of research to be conducted. Immediately prior to the test, the student researcher reiterated the study design, goals, and the process of the test, as well as the purpose of release forms and the privacy protections for student subjects. Confidentiality was maintained by asking students to identify themselves on all testing materials by their student identification number, not their actual names. A spreadsheet key matching their names and their student identification numbers was kept privately on a single computer used by the researcher. This information was stored for three years, then destroyed by the researcher.

Research Design Limitations

This research design has some limitations. Given that this is not an experimental design with random sampling, generalizability is questionable. Participants were not randomly chosen, but selected from a small community college nursing program. These participants were generally predicted as new to the specific topic of psychiatric nursing, and to nursing in general. Student subjects were also selected from a very specific and limited learning cohort – licensed vocational nursing students. Extrapolation to a broader population of nurses, for example, registered nursing students in a baccalaureate program, should be viewed with caution.

The researcher cannot control other compounding variables impacting study findings, such as whether students have a prior background in the subject of psychiatric nursing or mental health, whether they are repeating the class, or are part of the minority in the cohort with a higher educational attainment at entry. Students who are repeating the course or who have a prior background in health science may have an edge in recall due to previously being exposed to technical vocabulary and pharmacological terms. Likewise, students who had a higher overall education level (such as a bachelor's or master's degree) at entry may also have been exposed to a wider amount of technical and academic vocabulary, and may retain prior knowledge of some of these terms. More highly educated students may have taken Latin in secondary or post-secondary school, or otherwise received greater exposure to Greco-Latin root words, which can be found in many terms specific to medicine and nursing.

CHAPTER FOUR

RESULTS

The purpose of this study was to explore the influence of modality and self-perceived learning preferences on nursing students' recall of new vocabulary words. This chapter presents the results of the quantitative data analysis of this study. Additional findings, such as an analysis of the impact of demographics on the study subjects' recall of new vocabulary words, are also provided in this chapter.

Demographic Characteristics of the Participants

Prior to beginning the next phase in the first level of vocational nursing study, students from two courses were pooled into a larger group and then randomly assigned into either the audio-only or print vocabulary test groups. Of 52 students who began the study, one dropped out during the first vocabulary test, leaving a total of 51 participants (N=51). Tables 1 through 4 provide demographic characteristics of the participants. Table 1 displays the participant demographics regarding gender, ethnicity, and age. Table 2 displays the language status of the participants. Table 3 displays the prior educational attainment and health science background of participants. Table 4 displays participants' prior work experience or certification in the medical field.

Table 1

Gender, Ethnicity, and Age of the Participants

	Frequency (*n*)	Percentage (%)
Gender		
Male	6	11.8
Female	45	88.2
Ethnicity		
African-American	18	35.3
Asian-American	4	7.8
Caucasian	13	25.5
Hispanic or Latino	14	27.4
Two or more races	2	3.9
Age		
Born 1963 or earlier	1	1.9
Born 1964-1969	6	11.7
Born 1970-1979	9	17.6
Born 1980-1989	22	43.1
Born 1990-1994	13	25.3

Table 2

Language Status of Participants

	Frequency (*n*)	Percentage (%)
Language status		
L1 (Native English speaker)	27	52.9
L2 (English as Second Language)	24	47.1

Table 3

Prior Educational Attainment and Health Science Background of Participants

	Frequency (*n*)	Percentage (%)
Associates degree or higher		
Bachelor's degree	3	5.9
Associates degree	10	19.6
No degree	36	70.6
Unspecified degree	2	3.9
Associates degree or higher in unrelated field		
Bachelor's degree	3	5.9
Associates degree	2	3.9
Degree in Biology, Physiology, or related field		
Related college degree	3	5.9
Degree in Psychology		
Psychology degree	1	1.9
Degree or certification in Allied Health field		
Unspecified	5	9.8

Table 4

Participants' Prior Work Experience or Certification in Medical Field

	Frequency (*n*)	Percentage (%)
Medical Assistant Experience		
Certified Medical Assistant (CMA)	6	11.8
Certified Nursing Assistant (CNA)	18	35.3
No prior CNA/CMA experience	27	52.9
Clinic/field experience		
Mental Health Clinic experience	6	11.8
Other prior clinical Experience	3	5.9
No prior experience	42	82.4

Male test subjects comprised 11.8% ($n = 6$) of the sample. Females were in the majority, with 88.2% ($n = 45$). Twenty-seven percent ($n = 18$) of the participants self-reported as African-American, with 25.5% reporting as Hispanic or Latino, and 25.3% reporting as Caucasian or White. Four participants, or 7.8%, reported as Asian-American, and another 3.9% ($n = 2$) reported two or more races. Thirteen participants, or 25.3%, reported a birthdate between 1990 and 1994. Forty-three percent ($n = 22$) reported a birthdate between 1980 and 1989, while another nine participants, or 17.6%, reported being born between 1970 and 1979. Seven participants, 11.8%, were born between 1964 and 1969, while just one respondent (1.9%) was born earlier than 1963. A very slight majority of the study participants, 52.9% ($n = 27$), reported themselves as L1, or native

English, speakers. Another 24 students, 47.1%, reported that they were L2 learners, for whom English is an additional language.

In reporting their prior educational attainment, 70.6% (n = 36), reported no existing undergraduate degree. Of the remaining 15 students reporting an undergraduate degree, three students, or 5.9%, specifically reported attaining a bachelor's degree; one of these students, or 1.9% of the sample, reported a psychology degree, and another single subject, 1.9% of the sample, reported a biology, physiology or related degree. The remaining bachelor's holder (1.9%) reported her degree was unrelated to either health, psychological or biological science. Two subjects did not specify whether their degrees were associates or bachelor's degrees. Ten test subjects (19.6%) reported achieving an associate's degree, with one subject, or 1.9%, reporting an associate's degree in biology, physiology or a related field, and another subject. Five of these associate's degree holders, or 9.8%, characterized their degree as being in an allied health field, with two subjects (3.9%) reporting specific degrees in health care administration. Two students, or 3.9%, reported that their associate's degree was in an unrelated field. In other words, their degrees were not in biology, physiology, psychology, or allied health; another two student subjects (3.9% of the sample) with associate's degrees did not note their degree field.

Participants were also asked about prior work experience or certification in the medical field. Eighteen participants (35.3%) reported that they were Certified Nursing Assistants (CNAs) and six (11.8%) reported that they were Certified Medical Assistants (CMAs). Of those who had special field experience, six (11.8%) reported work in a mental health clinic, and three (5.9%) reported other prior experience in a clinic. The

majority, 82.4% (n = 42), reported no prior clinical work experience.

Gender, Race/Ethnicity, Age, Language Status and Test Scores

Gender

To find out the correlation, if any, between gender and test scores, a two-tailed independent t-test was first used to analyze baseline data of male and female students in the test. No statistically significant mean difference existed in the baseline data, $t(49) = 1.500, p = .140$, so the post-data was analyzed using a two-tailed independent t-test to determine if a statistically significant mean difference existed between the two groups' recall of vocabulary words. The t-test revealed no statistically significant difference between the mean score of male students ($M = 17.67$, $SD = 4.59$) and female students ($M = 19.67$, $SD = 2.07$), $t(49) = -4.025, p = 0.067$. Neither gender had significantly better recall on the post-test task.

Race/Ethnicity

A one-way ANOVA test was then used to analyze pre and post-test data from test subjects identified as being African-American, Anglo (non-Hispanic White), or Latino/Latina (Hispanic). This one-way ANOVA was conducted to compare the potential influence of race/ethnicity on test scores. Given the smaller sample size of 4 and 2 subjects respectively, study subjects identified as Asian-American and multi-racial were excluded from the analyses. There was no statistically significant mean difference between the three groups in the pre-test, $F(2, 42) = .09, p = 0.91$, but there was a statistically significant mean difference between the three groups in the post-test, $F(2, 42) = 3.12, p = .06$, suggesting that ethnicity does not play a role in vocabulary

recall.

Age

To analyze the test scores of student participants based on age group, a one-way ANOVA was conducted to compare the potential influence of age on post-test scores. Again, to improve reliability, a single participant that was the only test subject in their age group (1963 or earlier) was removed. There was a statistically significant mean difference between age groups (1964-1969, 1970-1979, 1980-1989, and 1990-1994) and post-test scores, $F(3, 46) = 4.81$, $p = .01$, $n^2 = .238$. Approximately 24.0% of variance in recall, the study's dependent variable, could be attributed to the independent variable, age group. This result suggests that age plays a role in vocabulary recall, with the oldest students performing better than younger students on the post-test.

Post-hoc comparisons using the Tukey HSD test indicated that the post-test scores for students born 1980 to 1989 ($M = 16.0$, $SD = 4.63$) were significantly different from those born between 1964 and 1969 ($M = 21.83$, $SD = 3.13$), and those born from 1990 to 1994 ($M = 19.85$, $SD = 2.88$), indicating that post-test scores increased with test subject's age. The Bonferroni test also found a statistically significant difference between post-test scores by students born 1964 to 1969 ($M = 21.83$, $SD = 3.13$), and those born from 1980 to 1989 ($M = 16.0$, $SD = 4.63$), indicating that the oldest students scored significantly higher than younger students born in the 1980s.

Language Status

L1 versus L2. Student participants' scores were also analyzed based on their language status. Participants were separated into two sets, L1 (comprised of native English speakers) and L2 (comprised of English as a Second Language speakers).

Baseline data from each group – L1 and L2 – was analyzed using a two-tailed independent t-test, indicating no significant mean difference between the two groups on the pre-test. Then, the post-data was analyzed using a two-tailed independent t-test to determine if a statistically significant mean difference existed between the L1 and L2 groups and their post-test recall of vocabulary words. There was no statistically significant mean difference between language groups taking the post-test, $t(49) = -.85$, $p = .14$, suggesting that language status did not influence the post-test scores.

L1 only. Among students who were L1, or native English speakers, there was no statistically significant difference between pre-test scores of students who received written vocabulary instruction and those who received audio-only instruction. On the post-test, L1 students who received written vocabulary instruction out-performed L1 students who received audio-only instruction, $t(24) = -2.847$, $p = .009$, $d = 1.18$, $r^2 = .26$. Twenty-six percent of the variance in recall, the dependent variable, could be attributed to the independent variable, the mode used to instruct subjects (audio-only or read-write).

L2 only. Among students who were L2, or English as a second language (ESL) subjects, there was no statistically significant difference between pre-test scores of those who received written vocabulary instruction, and those who received audio-only instruction. On the post-test, L2 students who received written vocabulary instruction out-performed L2 students who received audio-only instruction. Results were $t(24) = -2.48$, $p = .009$, $d = -0.99$, $r^2 = .20$. Twenty percent of variance in recall could be attributed to the modality of vocabulary instruction.

Prior Achievement, Education, and Certification

Prior Achievement

To analyze the influence of prior GPA on vocabulary score, a two-tailed independent t-test was used to analyze baseline data of students in two different groups, test subjects whose GPA was equal or higher than 3.0 at program entry, and test subjects whose GPA was lower than 3.0 at program entry. The results of the t-test showed that a statistically significant mean difference did not exist in the baseline data, $t(49) = 1.536$, $p = .131$. Post-data was then analyzed using a two-tailed independent t-test to determine if a statistically significant mean difference existed between the two groups' recall of vocabulary words. Results of a t-test revealed no statistically significant difference between the mean post-test recall of those participants whose GPA was 3.0 or higher at entry ($M = 18.83$, $SD = 3.90$) and those whose GPA at entry was lower than 3.0 ($M = 17.14$, $SD = 4.71$), $t(49) = 1.37$, $p = 0.312$.

Prior Education

In order to analyze the influence of prior undergraduate education on vocabulary score, a two-tailed independent t-test was used to analyze baseline data of students in two different groups, those who had achieved an associate's degree or higher at program entry and those who had not yet achieved an associate's degree. The results of the t-test showed no significant difference between the two groups' pre-test scores, $t(49) = -13$, $p = .92$. The post-data was then analyzed using a two-tailed independent t-test to determine if a statistically significant mean difference existed between the two groups' recall of vocabulary words. Again, the t-test results revealed no statistically significant difference between the mean post-test recall of those participants who had achieved an associates'

degree or higher at program entry ($M = 11.44$, $SD = 3.31$) and those who had not yet achieved an associates' degree at program entry ($M = 11.54$, $SD = 3.21$), $t(49) = .80$, $p = 0.98$.

Prior Certification

To analyze the test scores of student participants based on prior certification status, a one-way ANOVA was conducted to compare the effect of prior certification on post-test scores. Again, to improve reliability, three study participants were removed who did not specify their certification type. There was no statistically significant difference between the three groups – participants with prior Certified Nursing Assistant status, participants with prior Certified Medical Assistant status, and participants with no prior certification, $F(2, 45) = 1.92$, $p = .16$.

Research Question One

Research question one, *Is there a mean difference in the short-term recall of vocabulary words based on audio-only or print modalities?,* was answered by first using a two-tailed independent t-test to analyze the baseline data of students in the two groups, those receiving audio-only vocabulary definitions and those receiving print definitions. Findings indicate that no statistically significant mean difference exists between the two groups in terms of vocabulary knowledge, $t(49) = .805$, $p = .425$. As a result, the post-data was analyzed using a two-tailed independent t-test to determine if a statistically significant mean difference existed between the two groups' recall of vocabulary words. The results of the t-test revealed a statistically significant mean difference in the mean scores of those receiving the print vocabulary instruction ($M = 20.21$, $SD = 3.176$) and those receiving the audio vocabulary instruction ($M = 15.85$, $SD = 4.374$), $t(49) = -4.025$,

$p < .001$, $d = 1.14$, $r^2 = .248$. It can be concluded that participants receiving print instruction were able to recall significantly more words than participants receiving audio-only instruction. Approximately 25.0% of variance in recall, the study's dependent variable, could be attributed to the independent variable, the mode used to instruct test subjects (either audio-only, or read-write).

Research Question Two

Research question two, *Is there a relationship between learning styles preferences and short term recall of these vocabulary words?,* was analyzed using Pearson's product moment correlations to determine the relationship between the post-test recall score and the Visual, Audio, Read-Write, and Kinesthetic scores. Given that a majority of students indicated a multimodal group of preferences on the VARK survey, each student's independent score for Visual, Audio, Read-Write, and Kinesthetic answers were collapsed separately. These scores for each section of the VARK (Visual scores, Audio scores, Read-Write scores, and Kinesthetic scores) were then correlated to the post-test recall scores. Findings indicated that a statistically significant relationship was not found to exist between learning style preferences and short term recall of these vocabulary words (see Table 5). Three out of the four learning style preferences (Visual, Audio, and Read-Write) exhibited negative correlation coefficients. Student recall scores decreased as Visual, Audio and Read-Write learning style preference answers increased. With the fourth learning style preference (Kinesthetic), a positive correlation coefficient effect was exhibited during the study; as the number of Kinesthetic answers increased for a test subject, so did the overall post-test score.

Table 5

Correlations of VARK Answers Scores with Post-test Scores.

VARK Answers Score	Correlation (*r*)	p-value	r^2
Visual score	Pearson Correlation	-.082	.0067
	Sig. (2-tailed)	.569	
Audio score	Pearson Correlation	-.062	.0038
	Sig. (2-tailed)	.666	
Read-Write score	Pearson Correlation	-.133	.0176
	Sig. (2-tailed)	.353	
Kinesthetic score	Pearson Correlation	.116	.0134
	Sig. (2-tailed)	.416	

Summary of Findings

Results indicate a mean difference in the short term recall of vocabulary words, based on modality of instruction, with test subjects exposed to print instruction remembering significantly more words than test subjects exposed to audio-only instruction. Additionally, results did not also show a relationship between post-test recall scores and perceptual learning preferences. Students who scored higher on Visual, Audio, and Read-Write questions given in the VARK Questionnaire tend to display lower scores

of recall. Students who answered more Kinesthetic questions on the VARK questionnaire tend to recall a higher number of post-test questions.

CHAPTER FIVE

DISCUSSION

Explanation

This study explored a potential modality effect in nursing students' learning of new technical vocabulary. Introduced to challenging pharmacological names and technical terminology, students given written instruction remembered new vocabulary items better than those who received audio instruction. Read Only students received post-test scores that were significantly higher than their Audio Only counterparts. By contrast, students with stronger perceptual learning preferences, which include Read-Write and Audio Only modalities, did not show a significant mean difference in their post-test scores from those of fellow students with less strong perceptual learning preferences. While students with higher Read-Write, Audio and Visual preferences tended to receive lower post-test scores, and students with higher Kinesthetic preferences tended to receive higher scores, this weak correlation did not reach the point of statistical significance.

There are several factors that might have influenced the greater post-test score success of student subjects receiving Read Only instruction, beginning with the difficulty inherent in highly technical vocabulary definition sentences. Chaiken and Eagly (1976), and Green (1981) found that more complex, difficult messages were better remembered by groups exposed to print, rather than audio, instruction. The high difficulty level of test vocabulary and definitions was confirmed by two of the students' instructors; during the experiment, students in the Read Only group were observed by the researcher sighing,

rubbing their heads or faces, or otherwise signaling trepidation during the pre-test and definitions. One intimidated Read Only student handed her pre-test to the researcher after a few minutes, explaining "I don't know any of these words," and shaking her head. Another student walked out of the Audio Only group midway through the pre-test, clearly overwhelmed, withdrawing from the study.

Students receiving Read-Only instruction also had more control over their learning. O'Keefe (1990) argues this control is crucial for learning new messages. Read Only subjects had the option of re-reading each vocabulary definition in the approximately thirty seconds allotted for each text explanation. Audio Only subjects were limited to the pace of the audio recording, also approximately thirty seconds per vocabulary word and definition.

In her 2011 study, Vidal noted that lower proficiency students benefited from the greater control afforded in written texts, where students could spend more time reviewing words. Since these vocational nursing students were in the first semester of their course of study, and a majority did not have a prior undergraduate degree or certification, their learning abilities might hew closer to that of a lower proficiency student at this point in their nursing careers. As a result, students receiving written vocabulary definitions may have experienced an advantage in recall.

The type of words learned may have also influenced the different scores of Read Only and Audio Only test subjects. Vidal (2011) states that students listening to talks are better able to learn technical words, versus students receiving the same vocabulary instruction in written format. However, as more complex and unusual words, these terms may also have lacked auditory similarity to other vocabulary already present from

previous academic courses students had taken at the community college; which, as Drewnowski and Murdock (1980) pointed out, may assist the partial recall of vocabulary provided in audio format.

The students in this study did match many of the expected characteristics of nursing students described in the literature. Like the Australian students in Kazlauskas and Robinson's study (2012), many of the students were non-traditional, and almost half were second language learners. There was no significant difference in the post-test achievement of second language learners, although the literature suggests this is an area where more study is needed. Meanwhile, the significant difference in post-test scores seen by age group was not predicted by any of the existing literature.

The highest post-test scores were reached by the oldest students (those born in the mid to late 1960s), which may be due to a greater overall lexical knowledge, suggesting that greater age may predict better performance. However, this does not explain why the mean score for younger students born in the 1990s was greater than the mean score for older students born in the 1980s, another area where significant statistical difference was seen. It is possible that the students born in the 1990s, who were more traditional in age, may have spent more recent time in school, being more immediately familiar with test-taking, or a broader academic vocabulary. However, that condition would appear to negatively impact other older students, such as those born in the 1970s, whose mean score was also higher than students born in the 1980s. This indicates that another factor may come into play between age groups, perhaps that students born in the 1980s may be more likely to have younger families, providing less time for study and recent education.

While all students tested had some college courses, the majority of test subjects did not have extensive biological science training (such as an undergraduate degree or allied health certification), a situation described in other studies of nursing students (McKee, 2002; Lymn et al., 2008). Some students had certified nursing or certified medical assistant experience, but not a majority. Therefore, it is likely that these students did not know underlying Greco-Latin root words, or prefixes used in similar medications and terms. Exposure to these roots or prefixes in either a biological science classroom, or on the job, might have assisted with learning and recall of new words.

In this study, perceptual learning style preferences did not play a significant role in retention of vocabulary. Tight (2010) had previously found a similar result while observing immediate post-test retention of new vocabulary words offered in different modalities. However, the 2010 study by Koch et al. suggested that greater Kinesthetic preference on the VARK predicted better academic performance, among a population of accelerated graduate entry nursing students in Australia. Students in this study who selected more Kinesthetic answers on the VARK questionnaire did slightly better on the post-test of vocabulary assessment, but again, not to the point of statistical significance. Dobson, by contrast, in his studies of prehealth students (2009) and exercise/sports physiology students (2010) found that Kinesthetic learning preference predicted lower academic performance.

The dominant VARK preference seen among health science students has varied on different studies; for example, while Lujan and DiCarlo (2006) found kinesthetic preference the most popular among first year medical students, Murphy et al. (2004) found it the least popular among pre-doctoral dental students. Several studies of nursing

students, or a mixed cohort of health science students where nursing students dominate, have found that kinesthetic preference is the most popular unimodal preference among student nurses (Alkhasawneh et al., 2007; James et al., 2011; Meehan-Andrews, 2009). Perhaps greater kinesthetic preference indicates students who are better suited to the specific career and learning requirements of nursing.

Limitations

This study's scope was limited by the relatively small sample size available. Generalizability to the population of all nursing students and working nurses is questionable. Ideally, a randomized and much larger sample of nursing students would be available for testing. While the study was initially designed to test students who had little prior experience with psychiatric nursing terms and medication, testing students who were further along in their education may clarify differences in recall. Students with more clinical nursing experience and at least two semesters under their belt, but who have still not taken an advanced psychology or psychiatric nursing course, may pose a more generalizable population to sample.

Another limitation that may have impacted the results is the format of the pre-test and post-test. All students, whether they were in the Read Only or Audio Only group, were exposed to the same pre-test/post-test document, in print format. Therefore, students in the Read Only group actually had the opportunity to see the vocabulary and potential answers multiple times during the pre-test period, before again reading and rereading the vocabulary definitions, receiving an overall longer period of exposure to words offered in Read Only modality. Meanwhile, students in the Audio Only group also read the pre-test,

but did not hear the pre-test items prior to receiving the vocabulary definitions. The post-test was also formatted in print format, not audio format; this might blunt any presumed phonological advantage described in the literature (Baddeley, 1992; Baddeley, Gathercole, & Papagno, 1998; Baddeley & Hitch, 1974). The Audio Only students, therefore, had a lower overall period of exposure to the words in Audio Only modality, compared to the Read Only modality group. In other words, the Read Only group was exposed to print throughout the experiment, while the Audio Only group was exposed to both audio and print, receiving a smaller overall proportion of the modality of instruction they were tested on.

Additionally, as in the study by Daniel and Woody (2010), students in the Audio Only group had much less control over their exposure to the instructional audio, as opposed to the control given to the Read Only group. The student researcher tried to equalize the vocabulary instructions given to the two groups by making each written definition last approximately 30 seconds on screen, the audio definitions were repeated in the recording to last the same amount of time. However, as Furnham et al (1990) and O'Keefe (1990) have described, print information is more readily repeated by the subject event when a print definition is controlled for time; within the 30 second time constraints, test subjects in the Read Only group could still conceivably read and reread the screen definition based on their own reading speed. A subject in the Audio Only group could not, in this case, speed up or slow down, or repeat the audio definitions.

Recommendations for Future Research

In developing a similar experiment, a larger and randomized sample of nursing students or working professionals would be more generalizable to nursing education practice. Students or working professionals with more experience under their belt might also have an edge on vocabulary recall. An experiment using nursing students who are near the end of their program of study, and graduates in their second year of practice might also elucidate how vocabulary learning differs in clinical practice and in the classroom. Likewise, an experiment comparing nursing students or professionals with others in the health science field, such as medical students, pharmacists, or veterinarians (groups who have more science education at program entry), would help clarify different learning challenges of health professionals, especially those experienced by nurses and other allied health personnel with more limited biological or physical science backgrounds.

Papagno and Vallar's 1995 research indicated that multilingual university students had an edge on tests of phonological memory. A review of literature indicates special learning needs for second language learners, but also a track record of prior learning that differs from how native English learners are taught new vocabulary knowledge (Kim and Gilman, 2008; Scheele, Pruitt, Johnson and Xu, 2011; Yang, 2005). Further research should focus on second language learners, not only by making language status a component observed in future experiments, but by developing a qualitative understanding of their prior experience learning in their home countries, and their experiences of technical vocabulary learning in an English-language setting. This understanding would certainly enable researchers to build better, more thorough

instrumentation, and improve future research design impacting the great number of second language nursing students and nurses.

The structure of the existing experiment could also be improved. An audio-format pre-test (perhaps with students answering the question aloud or responding to an aural list of answers on a computer screen or smartphone) would not only give more Audio exposure to the Audio Only group, but also provide a way to better test Crowder and Morton's precategorical acoustic storage theory (1969), Penney's A and P code theory (1989), and theories evolved from Baddeley and Hitch's 1974 phonological loop concept (Baddeley, 1992; Baddeley, Gathercole, & Papagno, 1998). In order to match the subject control of the instructional material, a digital soundboard or similar application could be designed to allow students to press and hear an aural word or vocabulary repeatedly, better matching the control experienced by the Read Only group. However, these instruments would be considerably more complicated and challenging to build for use in a testing classroom.

Future experiments could also test whether scaffolding or aural similarity would boost vocabulary gains. The experiment would need to range over additional months. Students could be introduced to some root words and prefixes relevant to psychiatric nursing terms introduced later in the experiment. Students could also be introduced to aural vocabulary sounds relevant to drug names that would also be introduced later in the experiment, therefore seeing if auditory similarity, as described by Drewnowski and Murdoch (1980) boosts recency among an Audio Only group, or whether lexical scaffolding offers better recency and vocabulary gains.

The modality experiments designed by Corston and Colman (1997) and Byrne and Curtis (2000) offered students a health warning message, in order to test recency of the message. An experiment offering a health warning message that incorporates a new vocabulary term would better test the role that context plays in new vocabulary recency. A future experiment could test whether these contextual messages, or more prosaic vocabulary definitions, as used in this study, better boost recency.

Conclusion

While multimedia modality studies are valuable for understanding the most recent instructional tools used in classrooms and professional training, single-format modality studies can still offer insight into how students learn. Booth's "evaluation bypass" still largely stands: audio podcasts are widely used, but not fully understood for learning potential. Unfortunately, the silo effect has trapped much relevant research on audio modality in such fields as cognition, music, communications, and media studies: interdisciplinary research could be fruitful. Meanwhile, the role of language status, as it impacts modality-limited vocabulary gains, and the overall learning experience of nursing students and practitioners, should receive further scrutiny.

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