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Music as a Mnemonic Device for Verbal Recall in Healthy Older Adults

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MUSIC AS A MNEMONIC DEVICE FOR VERBAL RECALL IN
HEALTHY OLDER ADULTS

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Music as a Mnemonic Device for Verbal Recall in Healthy Older Adults.

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The purpose of this study was to examine the effects of rhythm, melody, and harmony on verbal recall in typical older adults. This study also examined the relationships among participant demographic characteristics including age, cognitive functioning, and gender and the dependent variable of verbal recall. Current theory holds that music provides bottom-up (i.e., Gestalt perceptual structures) and top-down (i.e., schemata) cues that aid in remembering verbal information. Furthermore, previous studies suggest that music-based mnemonic devices are effective vehicles for verbal memory in older adults both with and without cognitive impairment. However, no research exists that delineates the roles of musical elements in recalling verbal information in this population.

Ninety older adults without a formal diagnosis related to memory impairment heard an audio recording of a 16-item grocery list in one of four auditory conditions: 1) Rhythmic Speech, 2) Sung Melody Only, 3) Sung Melody with Harmonic Accompaniment, or 4) Regular Speech. Each participant heard their assigned recording a total of five times and recalled the list as accurately as possible after hearing the recording once, twice, five times, and following a 10-minute distraction task. The musical audio recordings (i.e., conditions 1, 2, and 3) were derived from an original song

composed according to musical Gestalt structures and schemata intended to aid encoding and recall of the grocery list. Following the recall trials, participants also completed a narrative questionnaire regarding their perceptions and experiences of the audio recording.

Results indicated that participants in the Rhythmic Speech condition had the highest mean recall scores during all recall trials, compared to the Melody Only, the Melody and Harmony, and the Regular Speech groups. The Rhythmic Speech group's recall scores were significantly higher than the Melody Only and the Melody and Harmony group after hearing the recording once. However, both the Rhythmic Speech and the Melody and Harmony groups' recall scores significantly decreased between the third and fourth recall trials. In contrast, the Melody Only and the Regular Speech groups maintained their recall scores between the third and fourth recall trials.

These findings suggest that rhythm is an easily perceived pattern that can efficiently transfer verbal information into working memory for immediate recall. While melodic patterns may take more listenings to fully learn, this study's results suggest that the melody was encoded at a deeper cognitive level and enabled more accurate recall following the 10-minute distraction task. Similarly, the Regular Speech group's maintained recall scores following the distraction task clear comprehension of verbal stimuli is essential for efficient encoding and retrieval. Still, the Regular Speech group's recall scores were lower than the other three auditory conditions for the second, third, and final recall trials. Thus, this study's results advocate for the incorporation of both rhythmic and melodic structural patterns into mnemonic songs. However, the addition of harmonic accompaniment did not aid recall; this may reflect a dual-task cost in older adults when listening to music of higher aural complexity and recalling verbal information.

Further analyses found a medium, positive correlation between participants' cognitive functioning (as measured by scores on the St. Louis University Mental Status exam) and total recall scores. Also, participants who reported having musical training had significantly higher total recall scores than participants who had never received musical training. These results indicate that other variables that may impact older adults' verbal learning beyond the musical mnemonic itself. First, older adults with impaired cognitive functioning may require non-musical elements beyond the musical mnemonic device to support their encoding and retrieval of verbal information. In addition, musical training may have benefits to memory that extend into older adulthood, regardless of whether or not an individual continues to practice music actively.

This study's findings may be useful in explaining the mechanisms at work in musical mnemonics that can be applied to older adults' verbal learning. These results provide preliminary evidence for music therapy techniques utilizing music as a memory tool, such as Musical Mnemonics Training. Professionals, including music therapists, working with older adults to improve memory may compose original music featuring repetitive, distinct, and easily perceived musical patterns to aid encoding and retrieval of verbal information.

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Chapter One

Introduction

Statement of the Problem

The demographic makeup of the United States is growing older as a whole. Recent statistics report that the number of people 65 years and older is expected to double to 21.5 million by 2050 (Pew Research Center, 2015). With citizens living longer, rates of cognitive decline associated with aging are expected to rise exponentially in future decades. Personalized and in-depth music interventions may be a cost-effective tool for improving older adults' memory (Bugos, Perlstein, McCrae, Brophy, & Bedenbaugh, 2007). However, little research exists to explain how music facilitates learning and recall of information in older adults. Establishing music's mechanisms as a memory tool will provide stronger evidence for clinical applications of music to promote independent living and possibly slow cognitive decline in older adult populations.

This study examined the effectiveness of musical mnemonics training in healthy older adults. Many studies involving the use of musical mnemonics have compared sung and spoken text's effects on verbal recall (Moussard, Bigand, Belleville, & Peretz, 2012; Wallace, 1994). However, few studies to date have compared the effects of musical elements (e.g., rhythm, melody, etc.) in mnemonics training with an older adult population. With a greater understanding of musical characteristics' influence on verbal information, geriatric professionals can create therapeutic music experiences to target short-term memory improvement. In this way, therapeutic music interventions can be tailored to individuals' needs and maximize their independence in activities of daily living.

Studies involving older adults' clinical needs are especially relevant to music therapy practice today. According to the American Music Therapy Association (AMTA) Workforce Analysis (2016), 29% of music therapists work with "mature adults" or "seniors" and at least 8% of music therapists work with clinical populations characterized by memory deficits (e.g., Alzheimer's disease or dementia). This cohort's need for supportive services is expected to grow with the perpetual aging of the baby boomer generation (AARP, 2015). Thus, the demand for music therapy services to support memory function can be expected to grow in future decades.

However, the effectiveness of musical mnemonics must first be empirically established in a healthy older adult population. The systematic study of music's influence on a non-musical behavior in typical participants builds a framework for understanding the mechanisms that make music an effective therapeutic tool (Thaut, 2000). Therefore, establishing potential mechanisms in typical older adults may allow for findings to be extended to older adult clinical populations, including individuals with more pronounced cognitive deficits.

Without an understanding of how music can improve verbal recall in healthy individuals, the therapeutic applications of music's impact on recall would lack an objective base of evidence. To date, a number of studies have compared musical mnemonics in older adults with and without varying levels of Alzheimer's disease (Moussard, Bigand, Belleville, & Peretz, 2012; Simmons-Stern, Budson, & Ally, 2010; Simmons-Stern et al., 2012), but no known studies have exclusively focused on music as a memory device for older adults free of memory disorders. Thus, empirical evidence is needed to determine the efficacy of and mechanisms underlying musical mnemonics with older adults.

As a preliminary study to investigate musical mnemonics in healthy older adults, this thesis provides valuable insight into the effectiveness of music on recall in a population experiencing normal aging. The methodology incorporated an established neurologic music therapy technique (Musical Mnemonics Training; MMT) that provided a clinically established framework for the intervention design and translation of results into clinical practice. The effectiveness of MMT was analyzed by breaking down the role of music characteristics (e.g., rhythm, melody, harmony) on encoding and recall accuracy. The findings of this study will encourage greater tailoring of MMT to fit the unique cognitive processing needs of older adults. As a result, clinicians can target verbal retention and maintain cognitive functioning for older adult clients through musical mnemonics.

Need for the Study

Theoretical relevance. This study has important theoretical and clinical relevance for the therapeutic use of MMT to improve memory in aging populations. Theoretically, this study provides insight into how music aids the encoding and retrieval of verbal information. By comparing recall accuracy of text embedded within varying levels musical complexity, the effect of musical characteristics are delineated to reveal how music supports verbal learning. Furthermore, this study's results provide greater understanding of the effectiveness for MMT in older adults. Surprisingly, no studies involving older adults are referenced in the MMT chapter of the neurologic music therapy handbook (Gardiner & Thaut, 2014), despite the recommendation that MMT may be effective for typical older adults and those diagnosed with Alzheimer's disease or dementia. Thus, this study provides important theoretical evidence supporting the use of MMT in older adult populations.

Clinical implications. This study also holds clinical value by identifying which musical elements support accurate and efficient encoding, consolidation, and retrieval of verbal information in healthy older adults. Understanding the role of musical characteristics most important to creating a mnemonic helps music therapists incorporate musical structures that function therapeutically to meet memory-related goals. Furthermore, with a clear outline of which musical elements are essential to successful musical mnemonics, older adults can be trained to create their own musical memory aids and experience greater self-efficacy for maintaining and improving their memory. In turn, providing greater understanding of and control over an individual's musical mnemonic strategies may mitigate the negative effects of anxiety or depression associated with older adults' perceptions of memory loss (Cargin, Collie, Masters, & Maruff, 2008).

Definition of Terms

Verbal short-term memory. Verbal short-term memory (VSTM) consists of a temporary store of language or auditory information via a cognitive strategy known as the phonological loop. This verbal information is maintained through repetition via an internal, subvocal articulatory rehearsal (Vallar, 2006).

Musical mnemonic. A musical mnemonic is a memory-supporting rehearsal aid that is structured via musical elements such as melody and rhythm to strengthen the learning of non-musical material (Gardiner and Thaut, 2014).

Healthy older adults. For the purpose of this study, healthy older adults were considered individuals between the ages of 60 and 79 years of age. These individuals were free of any neurodegenerative disorders (e.g., Alzheimer's disease, dementia, etc.) which may negatively impact learning, retention, or retrieval of verbal information. Healthy older adults were living independently in the community and able to carry out tasks common to daily living such as driving, paying bills, or preparing food.

Purpose Statement

To achieve these theoretical and clinical intentions, this study examined healthy older adults' recall accuracy of words set to music. More specifically, this study investigated the effects of musical elements (rhythm, melody, harmony) on the immediate and delayed recall of verbal information in healthy older adults. The interactions between recall scores and age, cognitive functioning, and gender were also explored. Findings of this study add to the current literature surrounding the use of musical mnemonics as a memory tool for older adults experiencing normal aging.

Chapter Two

Review of Related Literature

This literature review provides a scientific rationale for studying the relationship between musical mnemonics and verbal recall in healthy older adults. This chapter includes a description of memory's basic processes in typically functioning adults and the central nervous system structures associated with the learning and recall of both non-musical and musical information. Additionally, research findings regarding mnemonics (both non-musical and musical) in the recall of verbal information with older adults are reviewed.

Memory

Although memory is a single term, this concept encompasses a myriad of survival and personal capacities to ensure daily function and a seamless sense of self over time. A breakdown in memory processes at any stage can result in a severe disruption to an individual's way of life. The famous case study of H.M. is one illustration of the devastating effects resulting from faulty consolidation of information. In 1953, H. M. underwent a surgery meant to resolve epileptic seizures that included the removal of bilateral medial temporal lobes and hippocampi; these neurologic structures are responsible for moving information into long-term memory (Steinvorth, Levine, & Corkin, 2005). Although his intelligence, personality, and ability to learn motor skills were intact, H.M. performed poorly on tests of semantic and episodic memory for post-surgical events. With an inability to acquire new knowledge, H.M. was without an anchor to time and had trouble independently carrying out activities of daily living (e.g., personal hygiene and eating; Shapin, 2013).

As rare as the neuroanatomical and behavioral specificity of H. M.'s memory deficits were, this case demonstrates the multifaceted and complex nature of memory. Clearly, memory requires the cooperation across many interconnected facets for a person to successfully meet the demands of daily life. The effects of aging may interrupt one or more of these components that contribute to memory's smooth working operation. As such, mnemonics may be one tool for overcoming natural memory's shortfalls. A mnemonic is defined as any device or pattern used to aid memory (Gardiner & Thaut, 2014). However, before considering the use of supportive aids, a foundational understanding of memory must first be established. Memory itself can be understood in a number of ways including: 1) the stages through which information is processed, 2) the storage capacity for that information, and 3) the types of information maintained.

Stages of memory and storage capacities. Atkinson and Shiffrin (1968) proposed a foundational multi-store model of memory involving an immediate sensory register, a short-term store, and a long-term store. First, sensory memory is a subconsciously processed memory stage that holds large amounts of incoming sensory information for a very brief amount of time with decay occurring as quickly as 500 milliseconds (Gazzaniga et al., 2009). An individual may actively or passively be attending to a myriad of multisensory stimuli including visual, auditory, and somatosensory (e.g., taste, olfaction) input. Due to sensory memory's extreme capacity and almost immediate deterioration, only a select amount of information is transferred to a storage network with greater capacity, also known as short-term memory.

Short-term memory (STM) is a cognitive system that holds information (e.g., sensory impressions, digits, words, etc.) for a longer time than sensory memory, although still relatively brief. According to Miller (1956), the average person's STM storage capacity is about seven units of information as dictated by Miller's Magic Number (7±2). However, if one's attention is turned away, this information is lost.

To permanently acquire information, knowledge must be moved from STM to long-term stores. The memory network comprising long-term memory (LTM) is thought to be permanent with informational stores lasting a lifetime (Gazzaniga et al., 2009). This learning process of moving information from STM to LTM can be broken into three discrete stages: encoding, storage, and retrieval. All three stages must work in tandem to ensure that any piece of information is appropriately recalled at the relevant time.

Encoding. The first stage, encoding, is comprised of two sub-stages: acquisition and consolidation (Roediger, 2007a). Through the transformation of internal thoughts and external events into neural representations, encoding allows for information to be perceived, understood, and elaborated upon via working memory (Craik, 2007). Baddeley and Hitch (1974) proposed the concept of working memory which includes the temporary capacity of STM, but adds the active manipulation of multiple streams of information. Four cognitive strategies are utilized in working memory to maintain and integrate multisensory information.

One strategy, the phonological loop, holds both auditory and verbal information and functions principally as a language processor (Baddeley, 1996; Christopher, 2014). Through the phonological store and sub-vocal rehearsal, verbal information is practiced in an immediate capacity. Similarly, the visuospatial sketchpad holds visual and spatial information involved in mental imagery and navigation. Third, the episodic buffer acts as a nexus for working memory by integrating information from different modalities (i.e., the phonological loop, visuospatial sketchpad, and long-term memory). Finally, overseeing these processes is the central executive, a fourth component of working memory. The central executive attends to and manipulates information from the phonological loop, visuospatial sketchpad, episodic buffer, and LTM. Together, this information is integrated under the supervision of the central executive which provides attentional direction, plans for the future, and coordinates behavior (Christopher, 2014).

Integration of verbal information into LTM is especially dependent on the phonological loop where both overt and covert rehearsal of verbal material can be maintained through subvocal articulatory rehearsal (Baddeley, 1986, 2000; Baddeley & Hitch, 1974). Overt rehearsal involves internal recall of verbal information which is then recited out loud. Alternatively, covert rehearsal is a form of inner speech in which verbal information is recited internally (Cowan, 2008). According to Robertson (2002), the neurological underpinnings of phonological rehearsal that supports encoding of verbal information are located in the dorsal and posterior areas of the prefrontal cortex.

Successful acquisition of information into the phonological loop allows for subsequent consolidation into LTM. Consolidation consists of a post-encoding stabilization of a memory (Squire, Genzel, Wixted, & Morris, 2015). This deeper level of processing links new facts with knowledge already in LTM. The connection between STM and LTM is reciprocal; while new information is continually integrated into one's existing knowledge base, LTM can in turn influence the perception of the incoming information (Robertson, 2002). This mutual exchange between STM and LTM strengthens the transfer of information into permanent storage.

Storage. Storage consists of one’s ability to remember information over long periods of time. In contrast to the limited information held in STM or working memory, this long-term memory (LTM) information holding refers to an unlimited capacity for information that is believed to be permanent. All types of information are stored in LTM including semantic knowledge (e.g., knowing what a bicycle is), episodic memory (e.g., picturing your first childhood bicycle), and procedural memory (e.g., being able to ride a bicycle; Anderson, 1995).

However, Mandler (1984) proposed that information stored in LTM is not an exact record of the original events. Instead, memories are stored as schemata, or generic representations of concepts that summarize previous experiences (McVee, Dunsmore, & Gavelek, 2005). Schemata are flexible and can be linked through shared associations or transformed by one’s experiences. Thus, the retention of information over time is not stagnant; schematic representations are constantly integrating new information per the mutual influence between STM and LTM as discussed earlier. Schemata may also provide the perceptual structures needed to efficiently integrate and move associated information (e.g., a word list) into memory’s long-term storage.

The psychological concept of verbal memory storage is further supported by neurological evidence that storage is enabled by several neural regions. Sepulcre et al. (2008) found evidence from lesion studies for the cortical structures associated with storage of verbal information. Their study employed magnetic resonance imaging (MRI) to compare white matter functionality during the storage and retrieval of declarative verbal memory in adults with multiple sclerosis. Results suggest that multiple left hemisphere cortical areas—the temporal lobe lateral to the hippocampus, anterior limb of the internal capsule, and bilateral anterior temporal stem—are critically important to the storage of verbal memories. Additionally, a review by Jeneson and Squire (2012) strongly implicates involvement of the medial temporal lobe (MTL) in memory storage with positive correlations found between MTL activity and long-term retention of information. While these neural structures provide evidence for the keeping of information, a final step is necessary to bring stored information back into conscious use after an extended period of time.

Retrieval. Retrieval is the third and final stage through which stored memories are accessed and brought back into conscious use (Roediger, 2007b). Successful remembering requires that the correct piece of information is brought to mind at the appropriate time. For this to happen, the target memory needs to stimulated by a direct or indirect representation of associated events as stored in schematic frameworks (Spear, 2007). According to Bartlett (1932), schemata can be based on a set of past, but similar experiences. For example, one's schema for a hotel room is built upon an abstracted representation of the features shared across many experiences of staying in hotels: two queen beds, similar room dimensions, generic artwork, etc. Thus, a memory for one's vacation accommodations includes a general schema for a hotel room, rather than remembering every detail of any one particular room (Lieberman, 2012).

Alternatively, retrieval cues can arise from associations paired with the target memory during the initial experience. These may take the form of contextual cues referring to external sensory stimuli that occurred when learning the material. For example, to recall the name of a new acquaintance you may imagine the party at which you met her. Additionally, retrieval cues can go beyond simple associational pairing and compound the actual encoding of the to-be-remembered information (Liberman, 2012). Tulving and Osler (1968) label this idea as *encoding specificity*: contextual codes assigned to information's meaning during encoding can be later used as retrieval cues. For example, remembering that a man works as a baker provides richer encoding content due to associations with baking (e.g., chef's hat, the smell of bread, etc.) than remembering that a man's last name is Baker.

Memory types. Memory can also be understood in terms of the type of information that is maintained. Two broad categories encompass the content of information stored in memory: non-declarative and declarative. Non-declarative memory involves information that cannot be consciously recalled, including learned motor and cognitive skills such as jumping on a pogo stick or being able to juggle. Such non-declarative memory may involve reflexes, classical conditioning, priming, and procedural learning like habits or skills (Gazzaniga et al., 2009).

On the other hand, declarative memory includes information that can be consciously recalled, such as autobiographical events and semantic information (i.e., knowledge or facts about the world; Squire & Zola, 1996). Verbal representation is a primary form through which declarative memories are encoded, stored, retrieved, and expressed. Multiple cortical structures support the learning of verbal information. Areas of the medial temporal lobe including the hippocampus, dentate gyrus, and entorinal cortex (Bayley & Squire, 2003) have been identified as essential neural regions implicated in encoding. The hippocampus itself plays a critical role, particularly in the acquisition of factual knowledge and episodic memory. Through a high prevalence of rapid synaptic transmission (resulting in long-term potentiation that underlies synaptic plasticity), the hippocampus is able to create associative representations and sequential organizations of memories (Eichenbaum, 2004). This process enables the constant update of available verbal information to be processed at a high rate of speed.

Memory and Aging

As one ages, memory's processing efficiency is more variable and prone to error. This may be due to multiple factors such as genetic and health influences (Rabbitt et. al, 2004). Verbal memory is one type of information that may become compromised with age. For example, recall of verbal information has been found to be difficult for older adults. Cargin, Maruff, Collie, Safiq-Antonacci, and Masters (2007) collected longitudinal data on a delayed word recall task from healthy older adults living in the community. Participants completed at least four delayed word list recall assessments over a period of six years. Results found that 30% of participants experienced a decline in memory function (on average, 1.5 fewer words recalled) while a majority of their sample's verbal memory capacity remained stable or improved. Cargin et al. (2007) highlight the relative subtleness of verbal memory difficulties present in normal aging, but do not point to an underlying cause for these observed declines.

Verhaeghen (2012) suggests that age-related memory deficits are due to interferences in working memory's central executive, a supervisory system that controls information flow. These changes may be due to older adults' inability to filter out unnecessary information. McCabe, Roediger, McDaniel, Balota, and Hambrick (2010) found a strong correlation (r = .97) between working memory capacity and executive control functioning across the lifespan. The authors highlighted attentional control as a mediating factor. In other words, older adults' attentional filters may not appropriately screen out obsolete information, leaving mental clutter that slows or inhibits learning.

This relationship between working memory and executive control are further supported by neuroimaging. Gazzaley, Cooney, Rissman, and D'Esposito (2005) employed functional magnetic resonance imaging (fMRI) to examine neural activity in healthy older adults during a visual working memory task. Results indicated that older adults showed higher activation in the left parahippocampal/lingual gyrus region of the brain, an area associated with attentional processing. These regions were even more active during passive viewing of a visual stimulus, as compared to a younger adult control group. Findings suggested that older adults are not able to make efficient use of attentional resources. Older adults may not be able prioritize task-relevant information and instead may be distracted by irrelevant information. Thus, attentional malfunctioning is one contributor to decreased memory capacity in older age. Without an adept attentional focus via one's central executive, new information may not be correctly encoded and moved into long-term memory.

Similarly, inadequate use of retrieval cues may be another contributing factor to age-related declines in memory. Free recall of information is challenging; it may be mitigated through the use of related clues or direction of attention to relevant information. Effective use of more easily accessed, but connected information can bring a target memory back to conscious awareness.

Thomas and Bulevich (2006) have demonstrated the benefit of retrieval cues for older adults' reports of past events. Participants included healthy younger (M =19.8 years) and older (M = 78.6 years) adults who either performed or imagined a series of simple action statements during an encoding session. After two weeks, participants were given a source-monitoring test in which they had to identify whether a presented action statement had been performed, imagined, or not presented at all. Results found that older adults were more likely than younger adults to claim that never presented actions had been performed. However, during a second, similar study, older adults who were given detailed instructions with perceptual and contextual cues performed significantly better on the memory test than younger adults. These findings indicate that effective retrieval cues may not be readily available without support beyond older adults' innate cognitive resources. Furthermore, it is worth noting that the older adults in Thomas and Bulevich's (2006) study were receptive to supportive memory training.

Mnemonic devices. To combat memory declines associated with normal aging, mnemonic devices have been suggested as adaptive strategies for supplementing memory function. A mnemonic is defined as any system for enhancing memory recall (Wilson, 2009). Mnemonics may be either external or internal. External mnemonic devices are cues placed in one's surroundings to support memory. An example of an external mnemonic may be a personal alarm indicating that a task needs to be completed. In contrast, internal mnemonic devices are cognitive strategies to enhance information processing (Worthen & Hunt, 2011). For example, a shopping list may be mentally chunked by the purpose of each item (e.g., dinner ingredients, tools, birthday decorations).

Worthen and Hunt (2011) name four internal mnemonic strategies following one or more encoding processes: organization, elaboration, distinctive processing, and mental imagery. The first, *organization*, relies on the grouping of individual items founded on shared relationships among items. For example, a list of random names from the phone book may be categorized into men's names (e.g., John, Chris, Daniel, etc.) and women's names (e.g., Lori, Rebecca, Allison, etc.). By creating chunks of information organized by items' similarities, the brain encodes these items through relational processing.

In contrast, *elaboration* is an encoding process that seeks to emphasize the meaning of discrete items. Information is embellished upon to uncover unique identifying cues through item-specific processing. Such elaborations can be meaningful and directly related to thematic content of the item itself. For example, a meaningful elaborative mnemonic may involve the learning of biographical trivia while memorizing names of United States presidents. Alternatively, non-meaningful elaborations involve processing apart from the information's content. An example of this non-content-specific encoding might include memorizing presidents' names with the text written upside down. Whether directly related to the content of the information or not, these encoding details later serve as salient retrieval cues. This effect is due to the deeper level of attentional processing when encoding information.

Distinctive processing is a third encoding technique that combines the previously mentioned techniques of organization and elaboration. For example, a list of animal names may be understood by similar grouping (e.g., native African animals), but individual items may be further grouped by categorically distinctive features (e.g., mammals, reptiles, etc.). Worthen and Hunt (2011) argue that distinctive processing is more beneficial for memory performance than organization or elaboration alone. Information organized by relationships provides a frame for the type of information to be remembered while elaboration on individual features allows for more detailed discrimination.

Finally, *mental imagery* is a technique used most frequently to support memory. Visual mental imagery generally involves multiple mental images interactively arranged around the item(s) to be memorized. Such visual cues draw upon humans' superior memory for spatial relationships and provide an additional layer of distinctive cueing. Mental imagery can provide a strong encoding strategy. Memory champions are known to create bizarre imagery that enables them to memorize long strings of information such as entire decks of shuffled playing cards (Foer, 2011).

Mnemonics and older adults. Older adults naturally utilize mnemonics strategies to supplement their memory functioning. Saczynski, Rebok, Whitfield, and Plude (2007) found that older adults' utilize a number of diverse memory aids to complete various recall tests. After completing a battery of memory tasks, older adults were asked to self-report the types of mnemonic strategies utilized for each task. Participants cited incorporating both simple (e.g., repetition, concentration) and complex (e.g., association) mnemonic strategies to complete the memory tests. Results found that general mnemonic use was positively related to memory test performance. In addition, some mnemonic strategies were found to be maximally effective for certain memory tests (e.g., visualization for digit span task). Sacyznski et al. (2007) concluded that no single mnemonic strategy is optimal for any one task or participant, but must be tailored according to the demands of the task and individual. Simple tasks may be best remembered with elaborative and enriching mnemonics while complex tasks may be best served with simple mnemonic strategies.

Remembering a grocery list is one task of daily living that has been shown to improve with memory training in older adult participants. Anschutz, Camp, Markley, and Kramer (1985) tested older adults' immediate and delayed recall of a 12-item grocery list. Participants memorized a grocery list without memory training and recalled an average of 7.5 items with a variety of spontaneous mnemonic strategies (e.g., repetition, listening, first letter of item). Then, participants were provided with small-group and individualized memory training in the method of loci, a strategy that creates associations by placing items within a location via mental imagery. Immediately and four weeks post-training, participants were taken to a grocery store to test their recall of the grocery items via physically retrieving items from the list and placing them in a shopping cart. Results found that item recall was significantly greater than pre-training recall during both shopping trips. Thus, older adults may be responsive to targeted memory training for recall of listed items. Furthermore, Anschutz et al. (1985) demonstrated that memory training can generalize to ecologically valid task performance and may last up to four weeks.

However, some evidence suggests that overt mnemonics training may not ameliorate memory deficits related to normal aging. As mentioned previously, noted declines in memory may be due to decreased memory capacity, inadequate retrieval cues, or an inability to filter out unnecessary information during encoding. Stark, Stevenson, Wu, Rutledge, and Stark (2015) investigated whether directive mnemonics could overcome poor memory performance. Healthy older adults who were shown 192 color photographs of everyday items. An encoding directive (e.g., indoor vs. outdoor object) during initial presentation of stimuli served as a categorization mnemonic strategy.

Results indicated that older adults' performance on recognition tests for the pictures was poor despite various encoding instructions given over a number of experiments. The researchers concluded that age-related memory deficits may not be easily overcome with a single mnemonic strategy. These findings support the idea that no perfect mnemonic exists; a successful mnemonic device must be structured, but individualized to the task and responsive to learner needs.

Music and Memory

Music is composed of rich auditory stimuli built from structures that have the potential to serve memory recall. Humans' capacity to enjoy and remember music requires multiple cognitive mechanisms to analyze and reconstruct sound elements into a larger whole (Deutsch, 2013). This process begins with the perception of auditory energy. To perceive sound, sensory information in the form of vibrational waves hits receptors on the hair cells of the cochlea. This information is transmitted to neural processing centers via the auditory nerve. From here, auditory information follows diffuse neural pathways for sub-cortical and cortical analysis including the brainstem, dorsal and ventral cochlear nuclei, superior olivary complex, and inferior colliculus. Additionally, the auditory cortex in the temporal lobe conducts primary analysis of auditory information (including music). Here, basic perceptual sound features are processed and bound together to become what we know as music (Dowling & Tillman, 2014). Bregman's (1990) concept of auditory scene analysis explains how sounds are organized into perceptually meaningful elements. Music can either be heard as an integrated whole or segregated into individual elements. This bottom-up sensory process is one cognitive strategy the brain uses to perceive structures in music.

Furthermore, higher cortical interpretations of music in diverse brain regions (e.g., premotor cortex, sensory cortex, etc.) lead to the perception of music as a complex and rich stimulus (Lipscomb & Hodges, 1996; Lotto & Holt, 2011). While music is processed in this bottom-up sequence moving from sensory to cognitive processes, the perception of newly heard music is also influenced by top-down associations (i.e., schemata) evoked upon listening. Previous music experiences including cultural context and familiarity with a piece of music contribute to expectations that impact the listening experience (Trainor & Zatorre, 2009). Thus, memory for music is formed by a combination of both sensory, bottom-up processes (i.e., musical Gestalts) and cognitive, top-down processes (i.e., musical schemata).

Gestalt laws of perception. The bottom-up processing of musical patterns emphasizes grouping of sensory input from auditory elements. Acoustical units of information are organized (i.e., chunked) according to Gestalt laws of perception. Snyder (2000) names three major types of primitive grouping principles that contribute to humans' perception of coherent auditory entities: proximity, similarity, and continuity.

First, *proximity* refers to the grouping of events close together in time. Thus, clusters of beats or pitches separated by relatively longer time intervals are perceived as related. For example, a string of isochronous beats can be split into two distinct groups by adding a beat of silence into the sequence. The relative space created between the two halves of the new groupings creates a temporal boundary that separates the otherwise regularly spaced beats. Of all grouping principles, temporal proximity has one of the strongest effects and may take perceptual precedence over other grouping principles (e.g., pitch proximity; Lerdahl and Jackendoff, 1983).

Snyder's (2000) second primary grouping principle, *similarity*, states that sounds perceived to be similar in quality (e.g., volume, timbre, pitch interval, duration) will be recognized as a common group. For example, a series of notes in a higher register followed by a jump down to a series of notes in a lower register will be understood as two distinct units. Likewise, larger sequences of event patterns may relate to each other, resulting in organization of musical ideas over a larger amount of time. Repetitions and contrasts of larger patterns contribute to an understanding of a musical piece's form.

Snyder (2000) considers *continuity* to be a third major factor of primitive auditory grouping. This grouping principle emphasizes that continuous changes in an auditory event's direction will naturally create its own perceptual unit. For example, a melody with a continually rising contour followed by continually falling notes will be perceived as two separate groups of notes. Thus, the relations between the notes (i.e., movement in a particular direction) can create a single unit of auditory information.

Musical schemata. In contrast to bottom-up systems, top-down processing relies on previously held knowledge to interpret an auditory stimulus. Musical schemata are the musical configurations stored in LTM that are often understood in terms of cultural contexts (Lipscomb, 1996). One way that schemata guide the perception of music is through the focusing of attention on certain aspects of music. For example, Western music is generally built upon a shared foundation of common patterns that organize listeners' rhythmic and melodic expectations.

Snyder (2000) points to the existence of a metrical hierarchy on perception of rhythmic patterns. He suggests that humans' ability to classify strong and weak beats within groupings may be an inherent memory phenomenon. For example, in a musical piece with a 4/4 meter, listeners are able to quickly identify the downbeat of a metric phrase due to its strong role in determining the basic pulse tempo across a piece of music. Moving down the hierarchy of metric strength, the third beat of a measure is next strongest, due to its position as an equal subdivision of the pulse. Finally, beats four and two are the weakest beats of the basic pulse tempo in 4/4 time.

A similar hierarchy has been shown in the processing of melodic information. Pearce and Wiggins (2006) proposed that statistic regularities in a culture's commonly heard music creates expectation for melody based on its complexity and context. The authors predict these melodic expectations become more complex and systematic with greater familiarity of a culture's music. In other words, with repeated exposure, listeners become increasingly sensitive to regular melodic features through comparison of more commonly heard versus rarely heard pitches. This leads to an understanding of which pitches provide the foundation for a culture's tonal systems. Similarly, the first note in a melody can provide a musical context for the diatonic center or accompanying harmony of a subsequent melody.

Additionally, melodic schemata create expectations by which listeners attend to certain features of a melody depending on context. Dowling's (1973) famous study of two interwoven melodies illustrates how priming can influence a listener's perception of music. In his experiment, Dowling played an auditory recording that contained a mixture of the melodies for "Frere Jacques" and "Twinkle, Twinkle Little Star". Prior to listening, Dowling told participants a "true" (e.g., Frere Jacques) or a "false" label (i.e., the title of a melody not contained in the recording). When listening expectations were primed with the true label, a majority of participants were able to discern the target melody. However, listeners given the false label did not report hearing either “Frere Jacques” or “Twinkle, Twinkle.” Thus, both rhythmic and melodic schemata serve as long-term knowledge structures that guide the perception and encoding of musical information.

Together, Gestalts and schemata offer two distinct ways (i.e., bottom-up and top-down) to understand how musical patterns are perceived and thus more efficiently committed to memory. These patterns contribute to a deeper cognitive processing, and thus memory for music. Through these organizational and elaborative informational processes, music is richly connected and provides potential for memory retrieval cues. Additionally, the patterns within music lightens the cognitive demand of the music itself and reduces of the perceived amount of information to be transferred into LTM.

Shared Mechanisms for Music and Verbal Information

As the extent literature reveals, verbal and musical information are perceived and learned through a number of shared psychological and neurological mechanisms. These include: 1) perception of grouping and schematic patterns, 2) rehearsal in working memory via the phonological loop, and 3) activation of common neural structures.

Perception of patterns. First, both music and verbal information are learned through initial perception of psychological patterns that organize information into chunks (Gobet et al., 2001). This bottom-up process of chunking allows for both verbal and musical information to be perceived and processed more efficiently in working memory and integrated into LTM stores. Musically, these chunks are created through the compositional elements of rhythm, melody, and harmony. These musical characteristics create patterned phrases which can be paired with non-musical (i.e., verbal) information. During later retrieval, the musical structures can serve as effective cues to aid the recall of verbal information due to their shared associations created during the encoding phase. In this way, music serves as a template to organize verbal information via musical characteristics of rhythm, melody, and harmony (Thaut, 2005)

Additionally, higher cognitive representations of music and verbal information are stored in LTM via schematic frameworks. These allow for top-down processing that creates a shared perceptual bridge between LTM stores and information actively attended to and manipulated in working memory. Musical schemata (e.g., culturally perceived tonal systems, meters, style, etc.) allow for efficient perception of structurally important musical features that create the essence of the musical stimulus (Snyder, 2008). The verbal information associated with music, then, can be similarly encoded without the cognitive burden of analyzing every musical element in isolation. Instead, a musical "snapshot" allows for the basic features of the music schematic patterns to be perceived and integrated into similar long-term associations.

Phonological rehearsal. Second, the phonological loop provides a common space within working memory in which auditory (i.e., musical and verbal) information can be rehearsed (Baddeley, Gathercole, & Papagno, 1998). The phonological loop provides opportunities for subvocal rehearsal and encourages the formation of stronger associations between music and verbal information through repetition. Thus, both verbal and musical components can be consolidated from STM into LTM via internal practicing of the musical mnemonic.

Shared neural structures. Finally, several shared neural structures are implicated in the learning of musical and verbal information throughout various stages of memory. During encoding, the ventrolateral prefrontal cortex, inferior parietal lobe, and motor areas are active during the processing of verbal information in STM. The phonological store that allows for internal rehearsal is associated with neural activation in motor and attentional areas, including the prefrontal cortex, Broca's area, and the anterior cingulate. These areas have been associated with subvocal rehearsal of musical and verbal information (Baldo & Dronkers, 2006; Zatorre & Halpern, 2005).

Additionally, the medial temporal lobe is implicated in the holding of both musical and verbal information in working memory (Jenson & Squire, 2012). During consolidation, the hippocampus plays a critical role in the formation of long-term auditory memories and the integration of new information into long-term stores. Finally, the retrieval of auditory-verbal memories is associated with activation in the bilateral precuneus and right prefrontal cortex (Fletcher, Frith, Grasby, Shallice, Frackowiak, & Dolan, 1995).

These psychological and neural mechanisms are common to the learning and recall of musical and verbal information. These mutual processes explain how music provides an organizational structure to hold verbal information in memory. Additionally, music is a rich auditory stimulus composed of many elements: rhythm, melody, harmony, timbre, form, style, etc. With endless combinations of these elements, originally composed music is a prime mnemonic candidate to provide a customizable information vehicle that can be responsive to informational load and learners' preferences. Furthermore, music is an engaging stimulus; holding emotional and personal associations with music is nearly ubiquitous (Juslin & Västfjäll, 2008). For these reasons, the application of musical mnemonics to verbal information can then be investigated with confidence.

Music as a Mnemonic Tool

Throughout history, music has been used as a mnemonic device to strengthen verbal memories via the organizational and patterned processing that musical structures offer. Orators such as Homer drew from a repertoire of metrical formulas to commit oral epics to memory (Kirby-Smith, 1999). Additionally, medieval composers took advantage of Carolingian modes and Psalm tones as memory aids to categorize liturgical chants and cue recall (Berger, 2005). To this day, music is used as a mnemonic device to transmit information, especially in educational settings. Singer (2008) highlights the use of music to teach children historic facts, foreign languages, and specific tasks (e.g., the steps to tying one's shoes). A clear example from early childhood education is an adaptation of "The Alphabet Song" to the melody made famous by Mozart's "Twelve Variations on 'Ah vous dirai-je, Maman.'" When looking up names in the phonebook, this tune may be internally referenced to recall the order of letters and successfully locate the appropriate listing.

Music as a mnemonic aid continues to be scientifically investigated due to the rich contextual information music provides. Multiple experiments conducted by Wallace (1994) provided a foundational understanding of how music operates as a mnemonic device for the recall of verbal information. Using previously unknown ballads' text and melodies, Wallace tested the effects of musical characteristics and repetition on adults' accuracy in verbal recall. Her first experiment compared sung and spoken presentation of three verses of text over five repetitions. Text recall accuracy was measured following the first, second, and fifth repetitions, as well as after a 20-minute delay involving a distractor task. Results found that verbal recall was significantly greater for sung text than spoken text, even after a 20-minute delay.

Wallace (1994) suggested the sung melody served as both an encoding and retrieval aid through several mechanisms. First, the melody's form may have increased perception of each verse as a coherent chunk, thus lightening the cognitive demand of memorizing the text. Alternatively, the rhythm may have acted as a temporal frame by which the number of syllables and words in each verse were bound. Thus, recall errors would have been minimized by melodic cues regarding the text's pattern or number of accents. Third, Wallace (1994) posited that melodic contour sequenced and linked the ordered textual lines together. Finally, the unique tone, rises, and falls of the melody may have helped participants form unique associations with the text, thus making the verbal information more memorable.

To further assess the roles of rhythmic and melodic structure in musically presented text, Wallace (1994) conducted a follow-up experiment to measure recall accuracy for text spoken to a rhythmic beat and sung text. Again, sung text facilitated significantly greater recall compared to the rhythmically spoken condition. From these findings, Wallace concluded that music provides more than simply rhythmic information. Instead, music operates as a multidimensional auditory template for verbal information via diverse musical characteristics.

Music's rich framework, however, may impair recall if the music mnemonic is insufficiently familiar. Wallace's (1994) third experiment highlights the importance of adequate knowledge of the musical stimulus accompanying the verbal information. In this study, Wallace investigated whether presentation of a verse and melody one time would impact verbal recall compared to repeated presentation over multiple verses. Participants heard only a single verse (sung or spoken) of a ballad, which was repeated over five trials and after a short delay. Results indicated that spoken presentation facilitated better recall of verbal information than the sung condition. With fewer repetitions of the melody heard, the results of Wallace's first two experiments were reversed.

These findings indicate that without sufficient exposure, music cannot act as a mnemonic vehicle. In Wallace's third experiment, the music became a distraction as both the novel music and text competed for the learner's attention, resulting in improper encoding of the text. Thus, when original music is being composed as a musical mnemonic, it should be written to fulfill listeners' expectations for quicker retention of the music. Only then can the music serve as an effective encoding vehicle and provide retrieval cues. Together, Wallace's extensive investigation into music's beneficial role in verbal recall provides a foundational understanding of how music operates as a mnemonic device.

Musical mnemonics training. Music has been recognized as a strong vehicle for information; naturally the therapeutic applications of musical mnemonics have been explored. Musical Mnemonics Training (MMT) is a Neurologic Music Therapy technique that utilizes music as a tool to sequence and organize non-musical information to enhance the ability to learn and recall said information (Gardiner & Thaut, 2014). The psychological mechanisms of pattern perception and rehearsal underlie memory improvement via MMT (Thaut, 2005). First, music provides immediate temporal-metrical structure that chunks information into manageable pieces. Musical elements such as meter, form, and rhythmic and melodic phrasing can organize information into more easily perceived chunks.

For example, “The Alphabet Song’s” melodic phrasing breaks down the string of 26 letters into four chunks of six to seven letters. Such chunking lowers the cognitive load of information and allows the brain to more efficiently encode, store, and retrieve this information. Concurrent encoding of music and words creates a learned association between these information sets. Thus, a melody can serve as a cue for its paired lyrics. Serafine, Crowder, and Repp (1984) attribute this strong relationship between melody and text to the *integration effect*. The integration effect refers to the tendency for a melody and text to be better remembered when they are originally presented together. The contextual relationship between music and verbal information can inform recall of the other. For example, people trying to recall the lyrics to the national anthem often sing through or rehearse the song subvocally to access the words. Thus, the integration effect offers an explanation of how musical components can cue the recall of verbal information (Sarafine, Davidson, Crowder, & Repp, 1986).

Clinical populations in need of cognitive rehabilitation (e.g., TBI, stroke, dementia) and healthy individuals looking to improve memory recall are potential benefactors of MMT. However, no studies have yet examined the effects of MMT in an exclusively healthy older adult population.

Musical mnemonics with older adults. Limited research exists that investigates the use of musical mnemonics with older adults. Most studies targeting an older population have compared the effects of music on recall in healthy older adults with those in the early stages of memory loss. Simmons-Stern, Budson, and Ally (2010) examined whether the learning of new information could be enhanced in patients with Alzheimer's disease (AD). Stimuli included sung or spoken recordings of four-line excerpts from 80 children's songs. In the first experimental phase, a sample of 40 recordings (20 sung, 20 spoken) were presented and accompanied by a visual display of the lyrics. Afterward presentation of these lyrics, participants were again visually presented with 80 stimuli lyrics and asked to make a recognition judgment ("old or new"). Results indicated that while patients with AD more often recalled old versus new lyrics that were accompanied by music during encoding, healthy older adults did not show any benefit for music presentation of stimuli. The authors suggested that healthy older adults' memory cortical circuits are intact and efficiently recruited for the recognition task, regardless of presentation context.

Deason, Simmons-Stern, Frustace, Ally, and Budson (2012) furthered the findings of Simmons-Stern et al. (2010) with a memory test over a longer time delay for a sample of healthy and probable AD participants. Twelve healthy older adults in Deason et al.'s (2012) experiment were again presented with either sung versus spoken recordings of 40 children's song lyrics. After a one-week delay, participants were visually presented with the lyrics of the original 40 songs and an additional 40 songs previously unseen. Participants identified whether the lyrics were old or new. Again, no significant advantage of sung or spoken presentation was found for lyric recognition in healthy participants. The authors posited that the typically functioning older adults relied more on familiarity (a general sense of a previous encounter) than recollection (remembering context and specific details) to complete the recognition task after longer periods of time.

As such, Deason et al. (2012) proposed that familiarity is not the cause of musical mnemonics and recommended their underlying mechanisms be studied more in-depth.

Moving toward a more functional use of musical mnemonics, Simmons-Stern et al. (2012) investigated whether musical presentation influenced retention of verbal content. Participants (12 patients with probable AD and 17 healthy older adults) were presented with novel lyrics whose content reflected typical activities of daily living (e.g., organizing medication). During the study phase, 40 recordings (20 sung, 20 spoken) were repeated three times and accompanied by visual presentation of the novel lyrics. Immediately following the study phase, lyrics for the 40 recordings and 40 additional dummy lyrics were presented. Participants' memories for the general content (e.g., "Did you hear song lyrics about pills?") and specific content (e.g., "According to the lyrics, what should you do with your pills?") of the lyrics was then tested. Findings indicated that musical encoding benefited general content memory in healthy adults, but not specific content memory. Simmons-Stern et al. (2012) considered a possible non-specific, but robust encoding for music outside the medial temporal lobe (MTL) that increases familiarity, but not specific details of musically presented content.

Together, these findings provide an initial start study of musical mnemonics for improving recall in typically functioning older adults. However, these studies are limited due to small sample sizes, incorporation of one type of music stimulus, and a lack of testing semantic recall. In the above studies, healthy older adults were not the population of interest, but served as a control group. Of note, no studies to date have examined musical mnemonics for a strictly healthy older adult population. Testing larger samples of healthy older adults may inform implementation of MMT by providing more power and a clearer idea of how music operates as a mnemonic aid for this population.

Additionally, many of the reviewed studies compared spoken and sung presentations of verbal information, without breaking down the music stimulus into its component parts**.** An in-depth understanding of individual musical elements' roles in the encoding and retrieval of text will illustrate the underlying mechanisms for MMT. With a better understanding of these musical mechanisms, more targeted MMT interventions can be designed for clinical populations. Finally, the previous studies (Moussard et al., 2012; Simmons-Stern et al., 2012; Simmons-Stern et al., 2012) tested for recognition (a test of episodic memory), rather than free recall. While these studies provide a starting point for understanding how music functions as a mnemonic in older adults, more research directly connecting music to verbal recall is needed. This study sought to rectify these limitations by focusing exclusively on a healthy older adult population, comparing the effects of musical characteristics, and measuring free recall of ecologically valid verbal information (i.e., a shopping list).

Summary of Literature Review

This review of literature provides a scientific rationale for the study of musical mnemonics training to increase recall in healthy older adults. Memory is a psychological process through which information is learned and utilized for daily functioning. Three distinct memory stages are involved in the learning and retrieval of information. First, encoding allows for sensory information to be perceived, processed, and combined with information existing in LTM stores. The working memory mechanism of the phonological loop is essential to the encoding and practice of both verbal and musical information via subvocal rehearsal and auditory stores. Consolidation of information creates a permanent record of encoded information that is stored in LTM. Finally, retrieval brings necessary information back into conscious awareness (i.e., working memory) for use in activities of daily living. Information recall can be cued by contextual factors paired with the information during initial learning.

Encoding and recall of verbal and musical information are influenced by bottom-up and top-down perceptual processes. First, chunking organizes information by shared features through Gestalt grouping principles. In addition, schemata provide long-term knowledge structures that inform perceptual expectations and help to integrate new information into permanent storage. Furthermore, a number of common neural structures are associated with these shared psychological mechanisms in both verbal and musical processing. For example, activation in the prefrontal cortex and Broca's area is associated with subvocal rehearsal in the phonological loop, while the hippocampus and medial temporal lobes are strongly associated with the learning of verbal and musical information.

These processes underlie the success of mnemonic devices (i.e., structured memory aids). Memory declines in normal aging call for the use of supportive mnemonics in older adult populations. Evidence suggests that mnemonic training can benefit older adults' recall, but a mnemonic's application must be tailored to the information load and learner needs. Music is one mnemonic device that has been shown to provide a rich, but flexible auditory stimulus to carry verbal information.

Though a limited number of studies have investigated the use of musical mnemonics training with older adult populations, the literature mostly compares healthy and cognitively impaired senior populations. Additionally, few studies have examined semantic recall or compared the effects of musical mnemonic presentation in older adult populations. Thus, more research is needed to establish music's mediating effects on verbal recall for healthy older adults.

Research Questions

Given this review of memory, musical mnemonics, and the need for research in aging populations, the current study sought to delineate the role of specific musical elements in the learning and recall of verbal information in healthy older adults. The following research questions were addressed:

1. What musical elements (i.e., rhythm, melody, harmony) best facilitate the recall of verbal information in healthy older adults?

2. What are the interaction effects between musical auditory condition (i.e., Rhythmic Speech, Melody Only, Melody and Harmony, Regular Speech) and demographic variables (i.e., age, cognitive functioning, gender) on the recall of verbal information in healthy older adults?

3. How do typical older adults perceive and experience a musical mnemonic for the purpose of verbal recall?

Chapter Three

Method

This chapter will describe the method of this study. Criteria for participant inclusion and recruitment are included, along with information regarding this study's design and variables. Additionally, measurements and materials are described in detail. Finally, the proposed procedure to examine the effects of musical mnemonics on verbal recall are reviewed. All methods were approved by the University of Miami Institutional Review Board.

Participants

Study participants were recruited in-person from various community organizations including university-affiliated lifelong learning centers, churches, and senior centers. Additionally, recruitment flyers (Appendix A) were posted in these community venues and emailed electronically to potential participants. The number of participants was determined by a prospective power analysis comparing small (.10) to medium (.25) effect sizes, and revealed that a sample of 40-232 participants was needed to achieve statistically significant findings based on the study design. A total of 92 participants, both females and males, between the ages of 60 and 79 years of age were recruited for study participation. All participants were healthy older adults living independently in the community who were able to carry out typical activities of daily living.

Participants ranged in age from 60 to 79 years. This range was chosen for its relatively low prevalence (<5%) of dementia-related diagnoses that are associated with neurodegenerative memory loss (Ferri et al., 2005). The age of 60 was chosen as the lowest-accepted participant age as this is the age at which increased rates of self-reported memory loss associated with normal aging begin (Adams, Deokar, Anderson, & Edwards, 2013). The upper age limit of 79 was chosen to minimize incidence of memory disorders beyond normal aging. Representative national and international samples have found that at 80 or more years of age, the prevalence of dementia increases significantly (Ferri, et al., 2005; Plassman et al., 2007).

To study music's effect on verbal recall in healthy older adults, eligible participants were fluent in English and able to hear within a normal range as indicated by self-report. Exclusionary criteria included impaired memory or cognitive functioning (e.g., Alzheimer's disease, mild cognitive impairment, dementia, etc.) as indicated by a self-reported medical diagnosis. Additionally, participants were screened for atypical memory function with the St. Louis University Mental Status (SLUMS) exam. If participants scored in the "dementia" range on the SLUMS Exam during the testing, the experimental procedure continued, but the data from these participants were not utilized.

Design and Variables

A mixed 4x4 repeated measures design examined the relationship between auditory condition of the mnemonic recording and verbal recall. The dependent variable of verbal recall was measured by scoring how accurately participants recalled a 16-item grocery list. Independent variables included a between-subjects factor of auditory condition. The between-subjects factor had four levels: Rhythmic Speech, Melody Only, Melody and Harmony, and Regular Speech. Additionally, the within-subjects factor of time had four levels related to the four time points in the experiment during which the grocery list was recalled. Participant assignment to one of the four mutually-exclusive auditory conditions was stratified by age and gender.

Additionally, age, gender, and cognitive functioning were examined as variables of interest. These three variables were chosen for their potential impact on participants' verbal recall scores. Bolla, Lindgren, Bonaccorsy, and Bleecker (1990) found intelligence and gender to be strongly associated with verbal fluency. Additionally, older adults' age has been found to influence working memory ability (Pauls, Petermann, & Lepach, 2013; Zinke, Zeintl, Rose, Putzmann, Pydde, & Kleigel, 2014).

Measures

Cognitive functioning. Although potential participants were asked to self-report a memory-related diagnosis (e.g., mild cognitive impairment, Alzheimer's disease) during the eligibility screening interview, the researcher also administered the St. Louis University Mental Status exam (SLUMS) as an additional measure of cognitive functioning. The SLUMS is designed to detect early impairment of working memory and executive functioning. This 11-item, 30-point cognitive screening measure assesses several cognitive domains including attention, immediate and delayed recall, abstract thinking, and visuospatial skills (Tariq, Tumosa, Chibnall, Perry, & Morley, 2006). Items were administered by the researcher reading questions or giving directions aloud. Participants answered questions related to reality orientation (e.g., "What is the year?") and completed other tasks, such as a delayed recall of five common objects, drawing a clock face, and remembering details of a short story. The SLUMS takes approximately 10 minutes to administer.

Word recall. Verbal recall accuracy for a 16-item grocery list (Appendix B) was measured via a researcher-generated Word Recall Form (Appendix C). Participants were instructed to listen to an auditory recording of the 16-item grocery list. Then, participants were asked to recall the list as accurately as possible. This involved recalling as many of the items as they could remember, and in the correct order if possible. Recall trials occurred at four time points: after hearing the recording once, twice, five times, and after a 10-minute distraction task. Thus, participants filled out four separate Word Recall Forms during the experiment.

The researcher scored the Word Recall Forms by recording the number of correct words written. Each correct word received one point; each correct word recalled in the correct order received two points. A repeated, but correct word was not awarded any points. The total possible score of each recall trial was 32. In addition, the researcher recorded the number of items incorrectly recalled (i.e., written items not included in the audio recording). However, participants' scores were not penalized for listing an incorrect word.

Demographic questionnaire. A researcher-generated Demographics Questionnaire gathered information on participants' demographic information including age, gender, ethnicity, education, and musical training (Appendix D). This questionnaire was administered following completion of the final recall trial of the grocery list. The researcher then coded and analyzed all participant responses.

Participant experience questionnaire. Participant perceptions of and responses to the study were collected through a researcher-generated Participant Experience Questionnaire (Appendix E). Questions were open-ended and participants responded by handwriting their answers in their own words. Participants reported on four topics related to the experimental task: 1) whether the audio recording helped their recall; 2) additional memory strategies employed; 3) challenges associated with the recall task; and 4) participants' perceptions of their memory performance. Information gathered in this questionnaire was transcribed by the primary researcher and analyzed via a summative content analysis for emergent themes related to participants' perceptions of their memory and testing experience.

Materials

Informed consent. Prior to beginning the study, participants read and signed an informed consent letter providing an overview of the study's purpose and procedures (Appendix F). Participants were also provided with the researcher's contact information if follow-up questions arose after the experiment.

Word list. Participants' verbal memory was measured by their ability to accurately recall a word list of 16 common grocery items (Appendix B). The word list for this experiment was adapted from the International Shopping List Test (ISLT), a 12-item verbal list-learning test composed of grocery items easily obtained in stores. The ISLT has been validated across diverse cultures (Lim et al., 2009) and has shown good test-retest reliability in older adult participants (Thompson et al., 2011).

An additional four items were added to the original 12-item ISLT to create a more challenging word list and avoid ceiling effects during recall. The researcher built this experiment's 16-item word list by randomly choosing ISLT grocery items with either one, two, or three syllables. The final 16-item word list featured four one-syllable words (e.g., tea, eggs), eight two-syllable words (e.g., apples, pickles), and four three-syllable words (e.g., vinegar, hamburger). The word list order was determined by grouping the words into syllabic patterns. The compositional intent of these syllabic patterns is explained in greater detail below in the musical mnemonic section. Audio recordings of this adapted 16-item list served as the verbal stimuli for each of the four auditory conditions (Rhythmic Speech, Melody Only, Melody and Harmony, and Regular Speech).

Word recall forms. Participants' verbal recall was measured via researcher-generated Recall Forms (see Appendix C). Participants were presented with a blank Recall Form and a writing utensil four times over the course of the experiment: after hearing the audio recording once, twice, five times, and after the distraction task. All trials featuring the Word Recall form are explained in full in the procedure section.

Musical mnemonic song. The researcher composed an original song (Appendix G) with specific rhythmic, melodic, and harmonic structures intended to support recall of the Word List. Every effort was made to create a memorable song that acted as an effective vehicle for the verbal information. The song's rhythm, melody, and harmonic accompaniment were strategically shaped with both bottom-up (i.e., auditory Gestalts) and top-down (i.e., musical schemata) characteristics to support efficient encoding of both the musical and verbal information contained within the song (Lee, Janata, Frost, Martinez, & Granger, 2015; Neuhaus & Knosche, 2006).

Several compositional techniques incorporated bottom-up Gestalt structures. The song's rhythm was based on word groupings within the 16-item grocery list. The final order of the Word List featured four word groups, each containing four words. These smaller four-word chunks each held one one-syllable word, two two-syllable words, and one three-syllable word. The organization of the words' syllable counts guided the structure of the rhythmic pattern. Two distinct syllabic/rhythmic patterns emerged. The first was a 2-2-3-1 pattern (e.g., apples, pickles, vinegar, tea) and the second was a 1-3-2-2 pattern (e.g., cake, potatoes, pizza, honey). The 2-2-3-1 pattern was featured in the first, second, and fourth phrases of the Word List; the 1-3-2-2 pattern was featured in the third phrase of the Word List.

The repetition of the 2-2-3-1 pattern three times within the song's rhythm exemplifies Snyder's (2000) primary Gestalt principle of *similarity*. This principle states that listeners tend to group together sounds that are perceived as being similar. In the rhythm, similarity was achieved when the words' syllables were articulated to common time interval patterns. Repetition of the 2-2-3-1 rhythmic phrase in the first, second, and fourth portions of the song emphasized that a common rhythmic pattern was present in the song. The repeated 2-2-3-1 structure was further distinguished when compared to the 1-3-2-2 pattern that acted as a "bridge" in the third portion of the song. Thus, the rhythmic patterns served as an expectant time structure with which listeners could anticipate the word list and commit it to memory.

The song's melody was also composed to aid in verbal encoding and recall using the auditory Gestalt principle of *continuity.* Continuity is a grouping factor observed when units of events consistently move in a common direction (Snyder, 2000). The melody organized pairs of words through 4-note patterns with a shared direction (i.e., ascending or descending pitches). For example, the first notes of the song (i.e., C-E-F-G) are all ascending. This 4-note pattern is repeated in measures 2 and 3 before being followed by a descending pitch pattern in a similar pitch range (i.e., F-E-D-C). Thus, the song features 4-note melodic groupings, each sharing a common pitch direction. These groupings were composed to be relatively short as extended melodic patterns in one direction are not common in Western music. Thus, the 4-note pitch patterns featuring musical continuity were meant to engage the listener's attention with the musical and verbal content.

The song's harmonic progression was also composed to support efficient encoding and recall of the Word List. During early pilot testing of the song's melody, young adults were most likely to forget list items set to a repeated melodic motif. Thus, the harmonic progression was composed to provide a slightly different harmonic context for repeated melodic motifs. The chord progression was composed in close collaboration with a Master's-level composer to determine harmonies that met this compositional intent and would sound appropriate to participants. For example, the first measure features the same melodic motif and rhythm as the third measure (i.e., C-E-F-G). The harmonic progressions, however, are different for each melodic pattern. The first measure is characterized by the I-V chords, while the third measure features the vi-ii chords. These differences in harmonic accompaniment created a unique sound for a repeated melodic motif. These auditory "markers" were intended to help listeners recall unique word sets, rather than confusing words set to the same melodic pattern.

In addition to these bottom-up structures in the rhythm, melody, and harmony, the song incorporated musical schemata meant to be familiar and easily perceived by participants living in a Western musical culture. The song's meter (i.e., 4/4 time signature) is commonly employed in Western popular music. This time signature was chosen as a predictable temporal structure through which the verbal information could be anticipated and more easily remembered. The rhythm facilitated this metric structure by placing the first syllable of most words on the strong first or third beats of each measure. Additionally, the melody was comprised of pitches from a tonal major scale recognizable to Western listeners. Furthermore, the harmonic accompaniment highlighted the melody's tonality with chords built primarily on diatonic pitches and played with a commonly-used instrumentation (i.e., piano). Together, these familiar musical schemata were intended to make the song sound familiar and interesting to Western music listeners to engage their attention and support anticipation of the auditory Gestalt structures outlined above.

The song's style and form were composed to be reminiscent of advertising jingles popular during the 1950s and 1960s. This compositional style was chosen for its high rate of repetition and "catchy" melodies to support rapid auditory learning. Furthermore, Yalch (1991) proposed that jingles are ideal musical containers for verbal content without inherent cues, such as a list of unconnected grocery items. Finally, jingles from the 1950s and 1960s served as stylistic inspiration due to older adults' strong recall for music from their young adulthood (Platz, Kopiez, Hasselhorn, & Wolf, 2015).

The song followed a modified ternary form (A-A'-B- A") that allowed for multiple repetitions of the main rhythmic A motif (i.e., the 2-2-3-1 pattern) to be repeated three times throughout the song. Melodic variation within this common rhythm was meant to direct a listener's attention to the music, and subsequently the word list carried by the song. The secondary rhythmic B motif (i.e., the 1-3-2-2 pattern) provided a rhythmic and melodic contrast to the A motif. This musical variation was meant to provide context for the order of the Word List's four-word groupings. Additionally, though jingles are generally performed at a fast tempo, Kamahara (2003) suggested that musical mnemonics be performed at a slower tempo to facilitate encoding. Thus, the final performed tempo of the musical mnemonic was set at a moderate pace of 95 beats per minute.

The three auditory conditions incorporating musical elements (Rhythmic Speech, Melody Only, Melody and Harmony) were derived from the researcher-composed prototype song (Appendix F). The most musically rich condition, Melody and Harmony, was essentially the prototype song as written. The remaining musical conditions paralleled the prototype song, but employed fewer musical structures. For example, the Melody Only condition used the same melodic and rhythmic patterns as the prototype, but the vocalist sang the song a capella without piano accompaniment (Appendix G). Furthermore, the Rhythmic Speech condition included the prototype song's rhythmic patterns, but the words were spoken to this rhythm, rather than sung to the melody (Appendix H). Finally, the Regular Speech condition did not employ any overtly melodic or rhythmic elements as the words were spoken.

Audio recordings. The researcher created four audio recordings, one for each of the auditory conditions of the Word List (Rhythmic Speech, Melody Only, Melody and Harmony, Regular Speech). All recordings were derived from the prototype song with the grocery items sung or spoken as appropriate to each auditory condition. A female vocalist from the University of Miami was chosen to record all vocal parts. Approximately 89% of music therapists in the United States are female (American Music Therapy Association, 2016); thus, a music therapist leading similar musical mnemonic trainings is likely to be female. This decision to use a female voice was made to increase the study's external validity and support translation of findings into music therapy practice.

Recording equipment included a Blue Snowball USB microphone and GarageBand© software on an iMac© computer. All recordings presented the words at a tempo of 95 beats per minute and lasted approximately 20 seconds. Descriptions of the four auditory recordings are below, beginning with the most musically rich recording (Melody and Harmony), followed by with the more musically simple recordings (Melody Only and Rhythmic Speech), and ending with the control condition recording (Regular Speech).

The Melody and Harmony recording was a performance of the prototype song as originally composed and consisted of the Word List sung by the female vocalist with simple harmonic piano accompaniment. The piano accompaniment was recorded first via microphone from an electronic keyboard at 95 bpm and uploaded to GarageBand ©. The vocalist then sang the Word List via microphone into GarageBand © while listening to the piano accompaniment track over headphones. Finally, the volume levels of both the piano and vocal parts were mixed so that the vocal and instrumental tracks were appropriately balanced before being exported as a .wav audio file.

The Melody Only recording consisted of the vocalist's sung Word List track from the Melody and Harmony recording, but without the piano accompaniment track (Appendix H). This a capella voice part was then exported as a .wav audio file. The Rhythmic Speech recording consisted of the vocalist speaking the Word List to the prototype song's rhythm (Appendix I). The vocalist recorded this Rhythmic Speech track via microphone into GarageBand © while listening to a metronome set at 95 bpm over headphones. This recording was then exported as a .wav audio file.

Finally, the Regular Speech recording consisted of the Word List spoken at the same rate as the musical recordings' tempo (i.e., one word per beat at 95 bpm). The vocalist was instructed to speak clearly and in a natural tone of voice that was not monotone, but free of overt rhythmic or melodic phrasing. The Regular Speech track was recorded by the vocalist via microphone in GarageBand © while she listened to a metronome set at 95 bpm over headphones. This recording was then exported as a .wav audio file.

Distraction task. A 10-minute distraction task (Appendix J) was administered to interfere with participants' memory for the Word List. The participants completed a mental arithmetic task in which they counted down by sevens from 1500. Participants were asked to do the mental math "in their head" and record only numeric values via writing utensil and paper. This distraction task enabled the researcher to determine whether verbal information could be held in participants' memories after a 10-minute delay.

Experimental Procedure

Pilot testing. Two rounds of pilot testing for the prototype song were completed prior to collecting the experimental data. First, composers (*n* = 3) holding a master's degree or higher in composition assessed the prototype song for the researcher's compositional intents as outlined above. The composers were given the sheet music and a recorded audio version of the prototype song. They rated the song on Snyder's (2000) Gestalt grouping principles and the song's overall musicality. Composers' perceptions were assessed using a 5-point Likert scale (1 = *strongly disagree*; 5 = *strongly agree*) via a Composer Piloting Questionnaire (Appendix K). The composers were also encouraged to provide written feedback on how to increase the song's memorability. Based on composer's feedback, the prototype song's melody, harmonic progression, and voicing of the piano accompaniment were revised to create a more pleasing musical aesthetic.

The final iteration of the prototype song underwent a second round of pilot testing with a small group (n = 3) of older adults between the ages of 60 and 79 years. The purpose of this pilot testing was to determine the best fit of verbal stimuli with the composed music. These older adults listened to a revised audio recording of the prototype song and were asked to write down the grocery items they heard. Multiple listenings of the audio recording were allowed. The older adults also rated the intelligibility of the lyrics (i.e., grocery items) and the song's perceived memorability on a five-point Likert scale via an Older Adult Piloting Questionnaire (Appendix L). The final prototype song's tempo and word order were revised following this round of pilot testing.

Informed consent and instructions. Experimental procedures occurred in a quiet room with a table and chair on the campus of the University of Miami, in participants' homes, or at community lifelong learning centers. Testing occurred either individually or in small groups (six or fewer participants). Before beginning the experiment, participants were verbally screened to ensure they met inclusion and exclusion criteria. This screening either occurred over the phone when participants initially contacted the researcher with their interest in the study, or prior to beginning the experiment if participants had not contacted the researcher previously. If participants met inclusion and exclusion criteria, they were assigned to one of the four auditory conditions (Rhythmic Speech, Melody

Only, Melody and Harmony, or Regular Speech). Assignment between the four groups was stratified by age and gender. The researcher the provided all participants with the informed written consent form, which was completed before continuing on with the experimental procedure.

St. Louis University Mental Status exam. Prior to beginning the listening and recall trials, participants completed the St. Louis University Mental Status (SLUMS) exam. The SLUMS was administered either individually or in a small group setting. When the SLUMS was given individually, the researcher read the items aloud and the participant responded either verbally or by writing down their answers for appropriate items. When administered in a group setting, the researcher read the items aloud and participants responded with written answers on a researcher-generated SLUMS Answer Sheet (Appendix M). When administering the SLUMS, participants were encouraged to take as much time as they needed to answer each directive, but were advised that each item could only be repeated once after the initial instruction.

Listening and recall trials. Following completion of the SLUMS, a series of listening and recall trials for the Word List began. The researcher provided a brief overview of the experiment and explained that participants would be hearing one recorded version of the 16-item grocery list a total of five times during the testing session. Participants were instructed to listen to the recording silently without tapping, humming, or singing along. The researcher then informed participants they would be recalling the word list as accurately as possible meaning, as many items as they could remember and in the correct order if possible. Participants were also shown a blank Word Recall form and given a chance to ask any clarifying questions.

Once all questions had been answered, participants began a series of listening and recall trials. During each listening trial, participants heard their assigned recording (e.g., Rhythmic Speech, Melody Only, etc.) played once. The recording was played on either an iMac computer if testing sessions were held on the University of Miami campus or via an iPad and amplified with a HMDX HX-A142 portable speaker for in-home or community testing sessions. All recordings were played at a moderately high volume. Prior to beginning the second listening, the researcher verified that the volume of the recording was comfortable. Based on participants' feedback, the volume was adjusted either higher or lower.

After hearing the audio recording once, twice, and five times, participants were given a blank copy of the Recall List and a writing utensil. During these recall trials, participants had up to three minutes to recall the grocery list as accurately as they could from memory. If participants felt that they could not remember any more, they were allowed to end the recall trial and hear the recording again; however, the researcher, encouraged participants to use the full three minutes. After hearing the audio recording the third and fourth times, participants did not write down the list. Instead, participants sat in silence for 30 seconds before listening to the recording again.

Following the fifth listening and subsequent recall trial, participants completed the 10-minute mental math distraction task. Then, participants were presented with the Final Recall list and asked to again remember the grocery list from the audio recording as accurately as possible. Between the end of the distraction task and the final recall trial, participants did not hear the audio recording. Thus, the experiment was structured as follows:

In Trial One, the participants:

1. Listened silently to the audio recording
2. Recalled and wrote down the list as accurately as possible in 3 minutes

In Trial Two, the participants:

1. Listened silently to the audio recording
2. Recalled and wrote down the list as accurately as possible in 3 minutes

In Trial Three, the participants:

1. Listened silently to the audio recording
2. Sat in silence for 30 seconds

In Trial Four, the participants:

1. Listened silently to the audio recording
2. Sat in silence for 30 seconds

In Trial Five, the participants:

1. Listened silently to the audio recording
2. Recalled and wrote down the list as accurately as possible in 3 minutes

In Trial Six, the participants:

1. Completed the distraction task for 10 minutes
2. Recalled and wrote down the list as accurately as possible in 3 minutes

Questionnaires. After the final recall trial, participants filled out the demographic and participant experience questionnaires. When all tasks were completed, participants were thanked for their participation and given the researcher's contact information if any questions arose. The approximate time to complete the experiment was 45 minutes: 10 minutes for the informed consent and cognitive screening (i.e., SLUMS exam), 20 minutes for listening and recall trials, 10 minutes for the distraction task, and five minutes for questionnaires.

Data Scoring

Once all data collection for a testing session was completed, the researcher scored all Recall Forms completed during the experiment. Each recall form had a total possible score of 32. One point was given for each correct grocery item listed. Two points were given to each correct grocery item listed in the correct order. Incorrectly listed grocery items not mentioned in the audio recording were counted for each recall trial, but participants' scores were not penalized. Additionally, if a correct grocery item was repeated within a single recall form, no points were given or subtracted for the repeated item.

Data Analysis

Statistical analyses. Statistical analyses were completed on IBM SPSS version 24. This study utilized a 4x4 repeated measures design with four auditory conditions (Rhythmic Speech, Melody Only, Melody and Harmony, Regular Speech) and four verbal recall trials. The researcher conducted a 4x4 ANOVA to determine whether musical presentation correlated to verbal recall accuracy. The alpha level for significance was set at 0.05, the standard rate for behavioral research studies. The researcher also conducted a series of post-hoc pairwise comparisons to analyze for significant interactions between auditory presentation and verbal recall accuracy across time. Finally, statistical analyses were performed to compare equivalency of demographic groups including but not limited to gender, age, educational level, etc.

Data on the mean number of incorrect words written was also examined as a secondary measure of participants' verbal recall. Encoding or retrieval errors may have led some participants to recall grocery items not mentioned in the recording as a compensatory mechanism. However, because compensatory mechanisms were not a focus of this study, further inferential analyses were not conducted.

Age, gender, and cognitive functioning were identified as variables of interest that may have impacted participants' verbal recall scores. Further statistical analyses were conducted to determine any relationships between these three variables and verbal recall scores. The relationship between age and verbal recall was examined with a repeated measures ANCOVA with age as a covariate. Similarly, a repeated measures ANCOVA with cognitive functioning (SLUMS score) as a covariate was also conducted. Additionally, a repeated measures ANOVA with auditory condition and gender as factors examined the relationship between gender and verbal recall.

Content analyses. This experiment did not employ a mixed-methods design; however, an exploratory, summative content analysis explored participants' general evaluations of the audio recording, their performance, and utilized memory strategies. Participants' handwritten responses on the Participant Experience Questionnaires (Appendix E) were transcribed by the primary researcher into a typed word document. Participant responses were organized by assigned auditory condition and question. Following transcription, typed responses were printed and read thoroughly to get a sense of general themes arising from each question. Emergent keywords and themes were then highlighted and counted. Themes and keyword were further broken down or combined as determined to be appropriate by the researcher

Chapter Four

Results

This chapter presents the statistical analyses of a mixed repeated measures factorial study design that measured musical elements' effect on recall of a 16-item grocery list by healthy older adults. The independent variable of auditory condition consisted of four groups: 1) Rhythmic Speech, 2) Melody Only, 3) Melody and Harmony, and 4) Regular Speech. The dependent variable measured word recall accuracy on a 32-point scale across four time points throughout the experiment.

This chapter reports the descriptive results derived from participants' demographic questionnaires and mean scores of the four auditory conditions by successive time points. Next, inferential results as related to the research questions are presented. Finally, this chapter presents the content analysis results of participants' responses on an open-ended participant experience questionnaire.

Overview

The recruitment and data collection phase of this study lasted approximately four months from October 2016 through January 2017. Participants were recruited from various community organizations catering to older adults including, but not limited to: university-affiliated lifelong learning centers, senior centers, and churches. Demographic and verbal recall data were collected and coded into nominal and continuous data points, as appropriate, for ease of analysis. Statistical analyses were computed using the software Statistical Package for Social Sciences (SPSS) version 24.

Descriptive Results

This section summarizes participants' demographic information regarding age, gender, ethnicity, education, musical training, and cognitive scores on the Saint Louis University Mental Status Examination (SLUMS; Tariq, Tumosa, Chibnall, Perry, & Morley, 2006). Additionally, results of participants' word recall scores across four recall trials are provided.

Participants. Study participants were independent, community-dwelling older adults. They had no formal diagnosis of a memory disorder, were fluent in English, and had no self-reported hearing issues. A total of 91 older adults completed all study tasks and measures. Of these, the data of one male and one female participant were excluded because they did not meet the study criteria as these scores on the SLUMS which placed them in the "dementia" category. One additional participant in the Regular Speech condition completed all study tasks through the distraction task and the demographic questionnaire, but did not complete the final recall task or participant experience questionnaire. This participant's score for the final recall trial was estimated by lowering his score for Recall Trial 3 by the average number of points lost across other participants in the Regular Speech condition.

The total sample size consisted of 90 participants, 34 male and 56 female. The mean age of the total sample was 69.47 years (*SD* = 5.38) with ages ranging from 60 to 79 years. Participants' average SLUMS score was 26.88 (*SD* = 2.51) with 61% of participants (*n* = 55) scoring within the "normal" category (i.e., a SLUMS score between 27 and 30) and 39% of participants (*n* = 35) scoring within the "mild neurocognitive disorder" category (a SLUMS score between 21 and 26). An overwhelming majority (*n* = 75) of participants ethnically identified as Caucasian with one participant self-identifying as African-American/Black, five participants identifying as Asian/Pacific Islander, four participants identifying as Hispanic/Latino, and five categorized their ethnicity as Other. Detailed demographic information for all participants is listed in Table 1 and by auditory condition in Table 2.

Table 1

Participant Demographics Total Sample (N = 90)

Demographic Variables	Total Sample
Gender	
Male	34
Female	56
Mean Age in years	69.47
(Standard Deviation)	(5.38)
Ethnicity	
African-American/Black	1
Asian/Pacific Islander	5
Caucasian	75
Hispanic/Latino	4
Other	5
Education	
High school degree/GED	3
Some college/Associate degree	20
Bachelor’s degree	29
Master’s degree	25
Ph.D., doctorate, J.D., M.D.	13
Self-Identified Musical Training	
Yes	54
No	35
Musical Experience	
Instrument(s)	49
Voice	4
Both	7
Neither	30
Mean Musical Practice in hours per week	.59
(Standard Deviation)	(1.88)
Average SLUMS score	26.88
(Standard Deviation)	(2.51)
SLUMS Categories	
Normal	55
Mild Neurocognitive Disorder	35

Table 2

Participant Demographics by Auditory Condition

Demographic Variables	Auditory Condition: Rhythmic Speech (n = 23)	Melody Only (n = 22)	Melody and Harmony (n = 23)	Regular Speech (n = 22)
Gender				
Male	9	9	8	8
Female	14	13	15	14
Mean Age in years (*SD*)	69.83 (5.12)	70.23 (5.79)	68.65 (5.63)	69.18 (5.20)
Ethnicity				
African-American/Black	-	-	1	-
Asian/Pacific Islander	-	2	2	1
Caucasian	23	16	18	18
Hispanic/Latino	-	3	-	1
Other	-	1	2	2
Education				
High school degree/GED	-	1	1	1
Some college/Associate degree	2	5	6	7
Bachelor's degree	8	6	11	4
Master's degree	9	6	4	6
Ph.D., doctorate, J.D., M.D.	4	4	1	4
Mean SLUMS score (*SD*)	27.74 (2.24)	26.82 (2.09)	26.87 (2.40)	26.05 (3.09)
SLUMS Categories				
Normal	17	14	12	12
Mild Neurocognitive Disorder	6	8	11	10

Regarding musical experience, sixty percent (n = 54) of study participants reported having formal musical training and forty percent (n = 35) reported having no formal music training. In addition, 49 participants reported having past experience playing musical instruments, four had vocal performance experience, seven reported both instrumental and vocal experience, and 29 participants reported having no past musical experience. Eighteen percent (n = 16) of participants reported playing music weekly, ranging from one to twelve hours of weekly practice. Of participants who were active musicians, the average participant reported playing music .60 hours per week (SD = .20). Detailed responses on participants' music experience by auditory condition are listed in Table 3.

Table 3

Participant Music Experience by Auditory Condition

Demographic Variables	Rhythmic Speech (n = 23)	Melody Only (n = 22)	Melody and Harmony (n = 23)	Regular Speech (n = 22)
Self-Identified Musical Training				
Yes	15	14	11	14
No	8	8	12	7
Musical Experience				
Instrument(s)	10	15	12	12
Voice	1	-	1	2
Both	5	1	1	-
Neither	7	6	9	-
Mean hours of practice (SD)	1.13 (1.98)	.18 (.50)	.41 (1.78)	.62 (2.62)

The researcher stratified participant assignment to the four auditory conditions by age and gender prior to all experimental tasks. Detailed demographic and music experience data of all participants are categorized by auditory condition in Tables 1 and 2. Participants assigned to the Rhythmic Speech condition (n = 23) were 61% female (n = 14) and 39% male (n = 9), with a mean age of 69.83 (SD = 5.12). In addition, the mean SLUMS score of the Rhythmic Speech group was 27.74 (SD = 2.24), with 17 participants scoring in the "normal" range and six participants scoring in the "mild neurocognitive disorder" range. Of participants assigned to the Melody Only condition (n = 22), 59% female (n = 13) and 41% male (n = 9) with a mean age of 70.23 (SD = 5.79). The Melody Only group's mean SLUMS score was 26.82 (SD = 2.09), and included 14 participants in the "normal" range and eight participants in the "mild neurocognitive disorder" range.

The Melody and Harmony condition (n = 23) was comprised of 65% females (n = 15) and 35% males (n = 8) with a mean age of 68.65 (SD = 5.63). In the Melody and Harmony condition, the mean SLUMS score was 26.87 (SD = 2.40) with 12 participants scoring within the "normal" category and 11 participants scoring within the "mild neurocognitive disorder" category. Finally, participants assigned to the Regular Speech condition (n = 22) included 64% women (n = 14) and 36% men (n = 8) with a mean age of 69.18 (SD = 5.20). In the Regular Speech condition, the average SLUMS score was 26.05 (SD = 3.09), which included 12 participants in the "normal" category and 10 participants in the "mild neurocognitive disorder" category.

Results from a Pearson chi-square test of association indicated no significant differences between participants in the four auditory conditions in gender ($\chi^2_{(3)}$ = .22, p = .98) and musical training ($\chi^2_{(3)}$ = 1.92, p = .59). In addition, results from one-way ANOVA tests suggested no significant differences between the four auditory conditions in terms of age $F(3,86) = .369$, $p = .98$), SLUMS scores $F(3,86) = 1.754$, $p = .16$), or hours of musical practice per week $F(3,86) = 1.07$, $p = .37$.

Word recall. The descriptive results of participants' word recall scores across four recall trials, including means and standard deviations, are shown in Table 4 by the four auditory conditions' results. In each of the four recall trials, participants' word recall scores could range from 0 to 32, with 0 indicating the lowest score and 32 indicating the total possible score in each recall trial. Data on the number of words incorrectly recalled (i.e., listing an item not presented in the grocery list) are also reported for each auditory condition.

Rhythmic speech. Twenty-three participants heard the grocery list presented in the Rhythmic Speech condition. During the first recall trial, participants in the Rhythmic Speech condition scored a mean recall score of 9.13 ($SD = 3.42$), which rose to 15.00 ($SD = 4.06$) in Recall Trial 2. In Recall Trial 3, Rhythmic Speech participants' mean recall score rose further to 21.96 ($SD = 6.10$); recall scores lowered to 19.09 ($SD = 5.99$) following the distraction task. These results are visually summarized in Figure 1.

Participants in the Rhythmic Speech condition incorrectly was generally steady at Recall Trial 1 ($M = .23$, $SD = .45$) and Recall Trial 2 ($M = .17$, $SD = .39$). An increase in the number of words incorrectly listed was observed at Recall Trial 3 ($M = .35$, $SD = .57$), which continued to rise following Recall Trial 4 ($M = .43$, $SD = .66$). These results are visually summarized in Figure 2.

Melody only. Twenty-two participants heard the grocery list presented in the sung Melody Only condition. Recall scores in the Melody Only condition followed a positive trend over Recall Trial 1 ($M = 6.59$, $SD = 2.40$), Recall Trial 2 ($M = 11.95$, $SD = 4.19$), and Recall Trial 3 ($M = 19.68$, $SD = 6.31$). Recall scores lowered to 18.18 ($SD = 7.03$) following the distraction task. These results are visually summarized in Figure 1.

Participants in the Melody Only condition incorrectly listed the highest number of incorrect words in Recall Trial 1 ($M = .91$, $SD = .81$), with a downward trajectory at Recall Trial 2 ($M = .73$, $SD = .83$) and Recall Trial 3 ($M = .41$, $SD = .50$). However, the number of incorrect words rose sharply following the distraction task ($M = .73$, $SD = 1.12$). These results are visually summarized in Figure 2.

Melody and harmony. Twenty-three participants heard the grocery list presented in the sung Melody and Harmony condition. During the first recall trial, participants in the Melody and Harmony condition scored a mean recall score of 6.65 ($SD = 2.72$), which rose to 12.13 ($SD = 3.56$) in Recall Trial 2. In Recall Trial 3, Melody and Harmony participants' mean recall score reached a high of 19.13 ($SD = 5.15$); recall scores lowered to 17.13 ($SD = 6.02$) following the distraction task. These results are visually summarized in Figure 1.

In the Melody and Harmony condition, participants' incorrectly listed words held steady over Recall Trial 1 ($M = .57$, $SD = .90$), Recall Trial 2 ($M = .57$, $SD = .79$), and Recall Trial 4 ($M = .57$, $SD = .84$), except in Trial 3 when the lowest number of incorrect words was listed ($M = .30$, $SD = .56$). These results are visually summarized in Figure 2.

Regular speech. Twenty-two participants heard the grocery list presented in the control Regular Speech condition. During the first recall trial, participants in the control Regular Speech condition scored a mean recall score of 8.91 ($SD = 3.02$), which rose to 12.86 ($SD = 3.64$) in Recall Trial 2. In Recall Trial 3, Regular Speech participants' mean recall score reached a high of 17.36 (*SD* = 4.76); recall scores lowered to 16.00 (*SD* = 4.49) following the distraction task. These results are visually summarized in Figure 1.

Finally, participants in the Regular Speech condition incorrectly remembered a mean of .45 words (*SD* = .67) following Recall Trial 1. The Regular Speech group's incorrect word scores continued to lower in Recall Trial 2 (*M* = .36, *SD* = .58) and Recall Trial 3 (*M* = .23, *SD* = .53), and held generally steady in Recall Trial 4 (*M* = .28, *SD* = .55). These results are visually summarized in Figure 2.

Table 4

Recall Scores by Auditory Condition

	Recall Trial 1 *M* (*SD*)	Recall Trial 2 *M* (*SD*)	Recall Trial 3 *M* (*SD*)	Recall Trial 4 *M* (*SD*)
Rhythmic Speech (*n* = 23)				
Correct Items	9.13 (3.42)	15.00 (4.06)	21.96 (6.10)	19.09 (5.99)
Incorrect Items	.23 (.45)	.17 (.39)	.35 (.57)	.43 (.66)
Melody Only (*n* = 22)				
Correct Items	6.59 (2.40)	11.95 (4.19)	19.68 (6.31)	18.18 (7.03)
Incorrect Items	.91 (.81)	.73 (.83)	.41 (.50)	.73 (1.12)
Melody and Harmony (*n* = 23)				
Correct Items	6.65 (2.72)	12.13 (3.56)	19.13 (5.15)	17.13 (6.02)
Incorrect Items	.57 (.90)	.57 (.79)	.30 (.56)	.57 (.84)
Regular Speech (*n* = 22)				
Correct Items	8.91 (3.02)	12.86 (3.64)	17.36 (4.76)	15.89 (4.42)
Incorrect Items	.45 (.67)	.36 (.58)	.23 (.53)	.28 (.55)

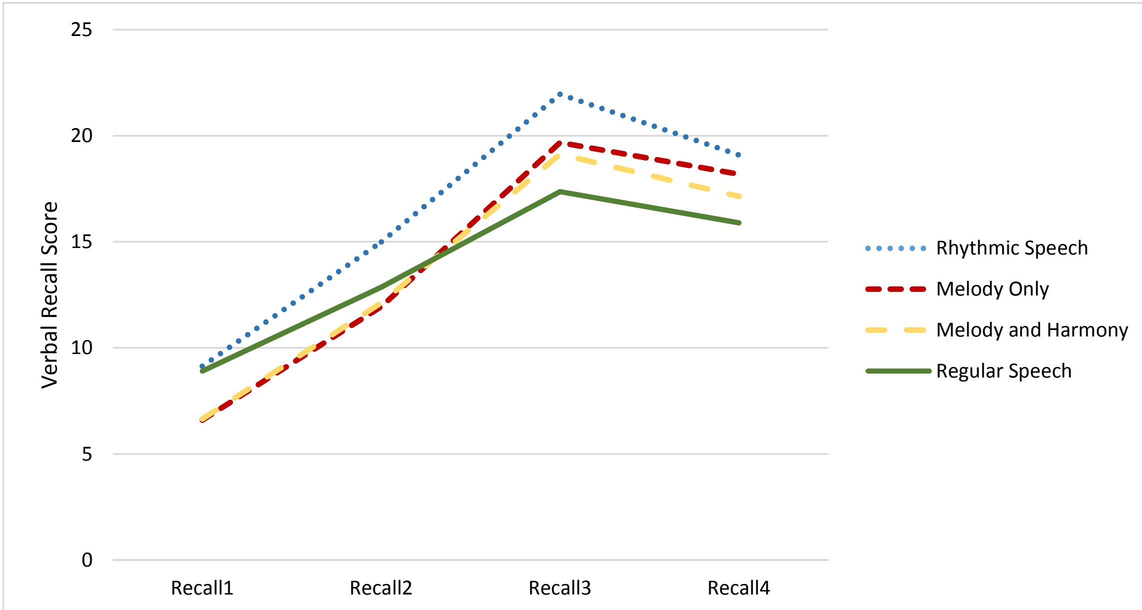

Figure 1. Verbal Recall by Auditory Condition

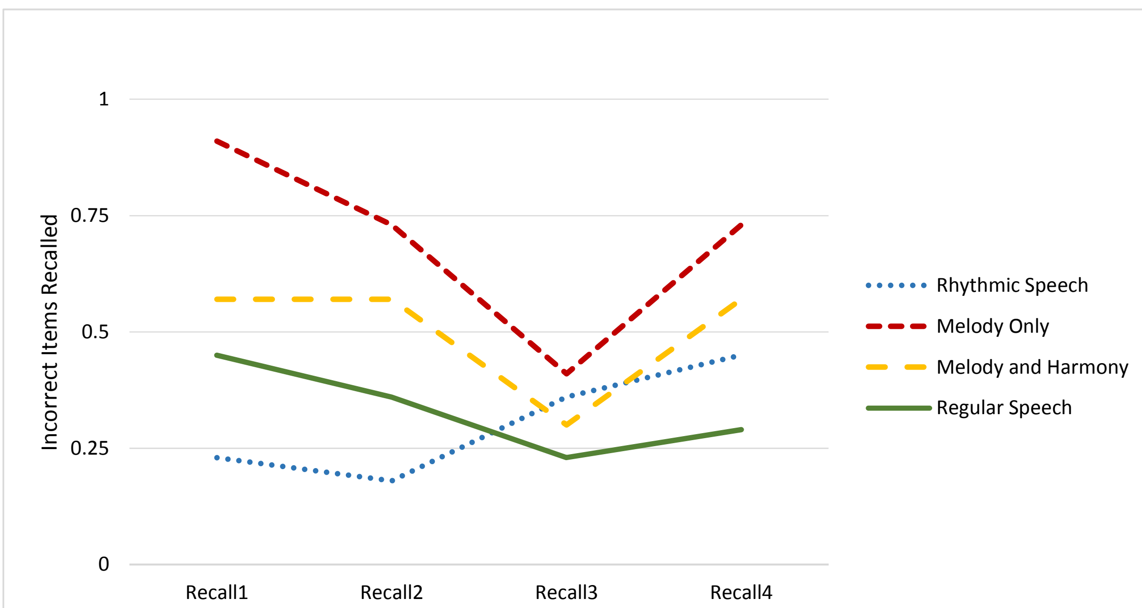

Figure 2. Incorrect Word Recall by Auditory Condition.

Word-recall by gender. Data on word recall were further analyzed by gender within each auditory condition. Tables 5 and 6 can be referenced for these descriptive results categorized by gender across auditory conditions.

Rhythmic speech. Females in the Rhythmic Speech (n = 14) condition achieved a mean score of 9.93 (*SD* = 3.08) in Recall Trial 1, which increased over Recall Trial 2 (*M* = 15.57, *SD* = 3.78) and Recall Trial 3 (*M* = 22.79, *SD* = 4.84), but decreased in Recall Trial 4 (*M* = 19.71, *SD* = 4.95). These results are visually summarized in Figure 3.

Males in the Rhythmic Speech (n = 9) condition achieved a mean score of 7.89 (*SD* = 3.72) in Recall Trial 1, which increased over Recall Trial 2 (*M* = 14.11, *SD* = 4.54) and Recall Trial 3 (*M* = 20.67, *SD* = 7.83), but decreased in Recall Trial 4 (*M* = 18.11, *SD* = 7.56). These results are visually summarized in Figure 4.

Melody only. Females in the Melody Only (n = 13) condition scored an initial mean score of 7.00 (*SD* = 2.71) during Recall Trial 1, which followed an upward trajectory in Recall Trial 2 (*M* = 13.08. *SD* = 4.19) and Recall Trial 3 (*M* = 21.85, *SD* = 5.37) and remained steady into Recall Trial 4 (*M* = 21.15, *SD* = 5.21). These results are visually summarized in Figure 3.

Males in the Melody Only (n = 9) condition scored a mean of 6.00 (*SD* = 1.87) during Recall Trial 1, which followed an upward trajectory in Recall Trial 2 (*M* = 10.33. *SD* = 3.84) and Recall Trial 3 (*M* = 16.56, *SD* = 6.06), but decreased in Recall Trial 4 (*M* = 13.89, *SD* = 7.34). These results are visually summarized in Figure 4.

Melody and harmony. Females in the Melody and Harmony condition (n = 15) achieved a mean recall score of 6.73 (*SD* = 1.58) in Recall Trial 1 which rose over Recall Trial 2 (*M* = 13.13, *SD* = 2.72) and into Recall Trial 3 (*M* = 20.73, *SD* = 5.15), but dropped to 18.73 (*SD* = 5.38) in Recall Trial 4. These results are visually summarized in Figure 3.

Males in the Melody and Harmony condition (*N*=8) achieved a mean recall score of 6.50 (*SD*=4.23) in Recall Trial 1 which rose over Recall Trial 2 (*M*=10.25, *SD*=4.33) and into Recall Trial 3 (*M*=16.13, *SD*=3.80), but dropped to 14.13 (*SD*=6.33) in Recall Trial 4. These results are visually summarized in Figure 4.

Regular speech. Recall scores for females in the Regular Speech condition began at 8.86 (SD = 3.75) and continued to increase in Recall Trial 2 (*M* = 13.79, *SD* = 3.75) and Recall Trial 3 (*M* = 18.00, *SD* = 5.07), but dropped slightly in Recall Trial 4 (*M* = 16.93, *SD* = 4.51). These results are visually summarized in Figure 3.

Recall scores for males in the Regular Speech condition began at 9.00 (*SD* = 1.20) and continued to increase in Recall Trial 2 (*M* = 11.25, *SD* = 3.01) and Recall Trial 3 (*M* = 16.25, *SD* = 4.23), but dropped slightly in Recall Trial 4 (*M* = 14.06, *SD* = 3.84). These results are visually summarized in Figure 4.

Table 5

Female Recall Scores by Auditory Condition

	Recall Trial 1 *M* (*SD*)	Recall Trial 2 *M* (*SD*)	Recall Trial 3 *M* (*SD*)	Recall Trial 4 *M* (*SD*)
Rhythmic Speech (*n* = 14)				
Correct Items	9.93 (3.08)	15.57 (3.78)	22.79 (4.84)	19.71 (4.95)
Incorrect Items	.29 (.47)	.21 (.43)	.29 (.47)	.36 (.50)
Melody Only (*n* = 13)				
Correct Items	7.00 (2.71)	13.08 (4.19)	21.85 (5.37)	21.15 (5.21)
Incorrect Items	.69 (.48)	.69 (.95)	.31 (.48)	.38 (.51)
Melody & Harmony (*n* = 15)				
Correct Items	6.73 (1.58)	13.13 (2.72)	20.73 (5.15)	18.73 (5.38)
Incorrect Items	.57 (.90)	.57 (.79)	.30 (.56)	.57 (.84)
Regular Speech (*n* = 14)				
Correct Items	8.86 (3.75)	13.79 (3.75)	18.00 (5.07)	16.93 (4.51)
Incorrect Items	.36 (.63)	.14 (.36)	.21 (.58)	.29 (.61)

Table 6

Male Recall Scores by Auditory Condition

	Recall Trial 1 *M* (*SD*)	Recall Trial 2 *M* (*SD*)	Recall Trial 3 *M* (*SD*)	Recall Trial 4 *M* (*SD*)
Rhythmic Speech (*n* = 9)				
Correct Items	7.89 (3.72)	14.11 (4.54)	20.67 (7.83)	18.11 (7.56)
Incorrect Items	.22 (.44)	.11 (.33)	.44 (.73)	.56 (.88)
Melody Only (*n* = 9)				
Correct Items	6.00 (1.87)	10.33 (3.84)	16.56 (6.06)	13.89 (7.34)
Incorrect Items	1.22 (1.09)	.78 (.67)	.56 (.53)	1.22 (1.56)
Melody and Harmony (*n* = 8)				
Correct Items	6.50 (4.23)	10.25 (4.33)	16.13 (3.80)	14.13 (6.33)
Incorrect Items	.38 (.74)	.38 (.52)	.38 (.52)	.38 (.52)
Regular Speech (*n* = 8)				
Correct Items	9.00 (1.20)	11.25 (3.01)	16.25 (4.23)	14.06 (3.84)
Incorrect Items	.63 (.74)	.75 (.71)	.25 (.46)	.28 (.45)

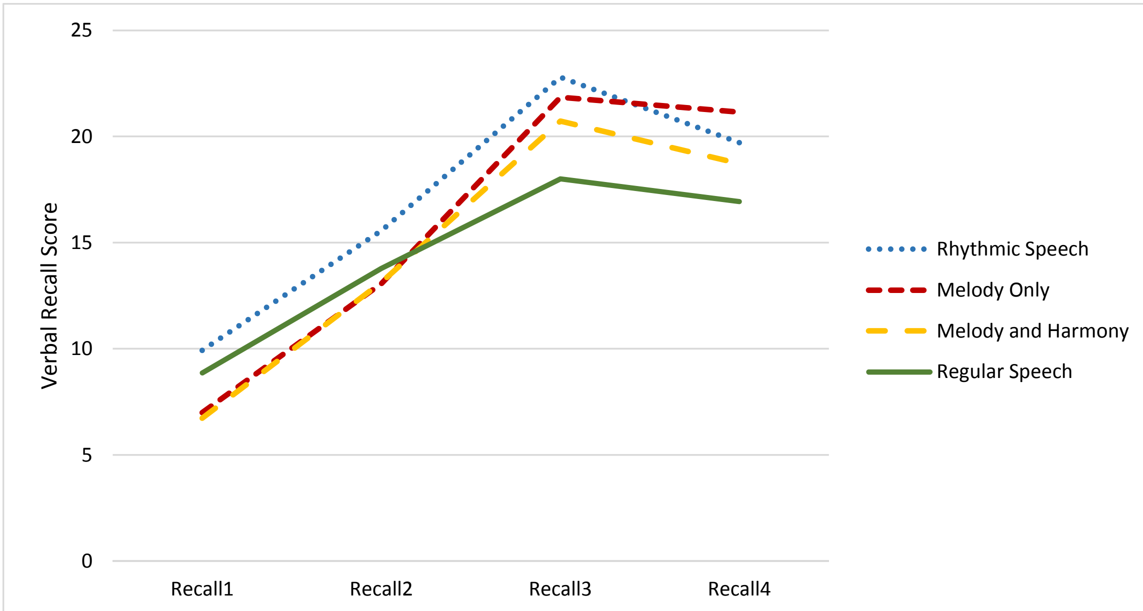

Figure 3. Female Verbal Recall by Auditory Condition.

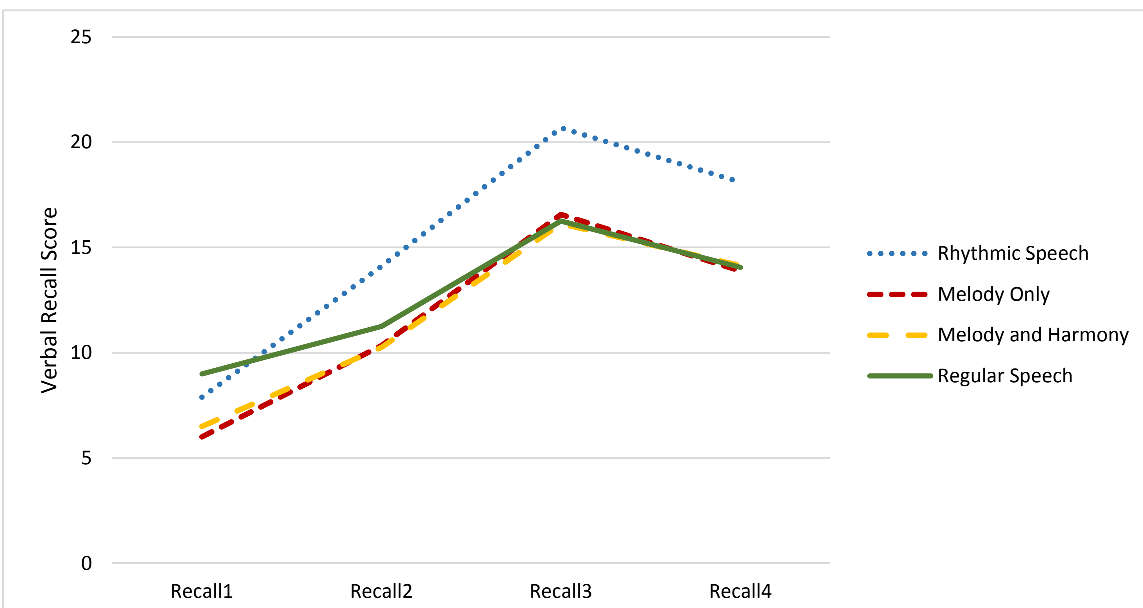

Figure 4. Male Verbal Recall by Auditory Condition.

Inferential Results

A mixed 4x4 repeated measures ANOVA was conducted to determine whether significant differences in recall scores existed between the auditory conditions and recall trials. Further inferential analyses determined whether demographic characteristics of interest (i.e., age, cognitive functioning, gender) had significant interaction effects in verbal recall. All results reported below reflect repeated measures ANOVA and ANCOVA tests with the Huynh-Feldt adjustment. Additionally, all post-hoc test results comparing mean differences reflect the conservative Bonferroni adjustment.

Research question #1: What musical elements (i.e., rhythm, melody, harmony) best facilitate verbal recall in healthy older adults?

Null hypothesis #1: No significant difference on verbal recall will exist when comparing auditory conditions (i.e., Rhythmic Speech, Melody Only, Melody and Harmony, Regular Speech). The researcher rejected the null hypothesis. A repeated measures ANOVA indicated a statistically significant interaction existed between time and auditory condition $F(9,5.61) = 2.71$, p =.02. The effect size of this interaction was medium to large *(*η_p^2*= .10*; Richardson, 2011*).* These results of the within-subjects and between-subjects repeated measures ANOVAs are illustrated in Tables 7 and 8.

Table 7

Repeated Measures Analysis of Variance (ANOVA) Within-Subjects

Source	*SS*	*df*	*MS*	*F*	*p*
Time	7314.81	1.87	3911.65	291.71	.000
Time*Condition	203.71	5.61	36.31	2.71	.018
Error (time)	2131.43	158.95	13.41		

Table 8

Repeated Measures Analysis of Variance (ANOVA) Between-Subjects

Source	*SS*	*df*	*MS*	*F*	*p*
Intercept	74625.16	1	74625.16	1127.93	.000
Condition	401.52	3	133.84	2.02	.117
Error	5623.70	85	66.16		

Post-hoc between-subjects comparisons of auditory conditions by recall times revealed significant differences amongst specific auditory conditions. Participants in the Rhythmic Speech group scored significantly higher than the Melody Only group (M_{diff} = 2.54, *SE* = .86, *p*= .03) and the Melody and Harmony group (M_{diff} = 2.48, *SE* = .87, *p* = .03) during Recall Trial 1, but not Regular Speech. The Rhythmic Speech group's higher mean recall scores approached significance (M_{diff} = 3.05, *SE* = 1.16, *p* = .06) compared to the Melody Only group at Recall Trial 2. At Recall Trial 3, the Rhythmic Speech group's higher word recall scores approached significance (M_{diff} = 4.48, *SE* = 1.70, *p* = .06) over the Regular Speech group, but not the Melody Only and the Melody and Harmony groups. All other pairwise comparisons of auditory conditions were not statistically significant over the four recall trials.

Additionally, post-hoc within-subjects pairwise comparisons across by auditory conditions indicated significant changes in word recall scores across the four recall trials, with a few exceptions. Compared to word recall scores in Recall Trial 3, the word recall in Recall Trial 4 did not significantly change for the Melody Only group (M_{diff} = *-1.50*, *SE* = .63, *p* = .12) or the Regular Speech group (M_{diff} = *-1.48*, *SE* = .65, *p* = .15). These findings suggest that no significant decrease occurred in word scores following the distraction task for the Melody Only and the Regular Speech groups.

Research question #2. Do demographic variables (i.e., age or gender) or cognitive status interact with word-recall across time?

Research question #2a. What is the interaction effect of age and auditory condition presentation on word recall in healthy older adults?

Null hypothesis #2a. No interaction effect of age and auditory condition will exist on word recall in healthy older adults. The researcher rejected the null hypothesis. A repeated measures ANCOVA with age as a covariate indicated a statistically significant interaction existed between time and auditory condition after controlling for age $F(9,5.68) = 2.89$, $p = .01$. The effect size of this interaction was medium to large ($\eta_p^2 = .10$; Richardson, 2011).

Post-hoc between-subjects comparisons of auditory conditions by recall times revealed where significant changes in word recall scores existed. Participants in the Rhythmic Speech group scored significantly higher than the Melody Only group ($M_{diff} = 2.51$, $SE = .87$, $p = .03$) and the Melody and Harmony group ($M_{diff} = 2.57$, $SE = .86$, $p = .02$) during Recall Trial 1, but not the Regular Speech group. At Recall Trial 3, the Rhythmic Speech group's word recall scores were significantly higher ($M_{diff} = 4.72$, $SE = 1.66$, $p = .04$) than the Regular Speech group. All other pairwise comparisons of auditory conditions were not statistically significant over the four recall trials when controlling for age.

Post-hoc within-subjects pairwise comparisons by auditory conditions indicated word recall scores significantly changed across the four recall trials after controlling for age, with a few exceptions. Compared to word recall scores in Recall Trial 3, the final word recall scores did not significantly change for the Melody Only group (M_{diff} = -1.57, *SE* = .63, *p* = .09) or the Regular Speech group (M_{diff} = -1.44, *SE* = .65, *p* = .17). These findings suggest that there was no significant decrease in word scores following the distraction task for the Melody Only and Regular Speech groups.

Research question #2b. What is the interaction effect of cognitive functioning and auditory condition on word recall in healthy older adults?

Null hypothesis #2b. No interaction effect of cognitive functioning and auditory condition will exist on word recall in healthy older adults. This researcher rejected the null hypothesis. A repeated measures ANCOVA with cognitive functioning (i.e., SLUMS scores) as a covariate indicated that a statistically significant interaction between time and auditory condition existed after controlling SLUMS scores *F*(9, 5.74) = 2.33, *p* = .04. The effect size of this interaction was found to be medium (η_p^2 = *.08*; Richardson, 2011).

Post-hoc between-subjects comparisons of auditory conditions by recall times revealed where significant changes in word recall scores existed after controlling for cognitive functioning. The Rhythmic Speech group's scores approached statistical significance over the Melody Only group (M_{diff} = 2.29, *SE* = .86, *p* = .06) and the Melody and Harmony group (M_{diff} = 2.24, *SE* = .85, *p* = .06) during Recall Trial 1. At the same time point, the Regular Speech group scored significantly higher than the Melody Only group (M_{diff} = 2.45, *SE* = .88, *p* = .04) and the Melody and Harmony group (M_{diff} = 2.41, *SE* = .87, *p* = .04), but not the Regular Speech group. All other pairwise comparisons of auditory conditions were not statistically significant over the four recall trials when controlling for age.

Post-hoc within-subjects pairwise comparisons of mean scores across by auditory conditions indicated word recall significantly changed across the four recall trials after controlling for cognitive functioning, with a few exceptions. Compared to word recall scores in Recall Trial 3, the final word recall scores did not significantly change for the Melody Only group (M_{diff} = -1.52, *SE* = .63, *p* = .11) or the Regular Speech group (M_{diff} = -1.63, *SE* = .65, *p*=.09). These findings suggest that no significant decrease existed in word scores following the distraction task for the Melody Only and Regular Speech groups when controlling for cognitive functioning.

Research question #2c. What is the effect of gender and auditory condition on word recall in healthy older adults?

Null hypothesis #2c. Gender will have no effect on word recall by auditory condition in healthy older adults. The researcher rejected the null hypothesis. A repeated measures ANOVA with auditory condition and gender as factors revealed a significant interaction between recall over time *F*(3,2.00) = 5.60, *p* = .00. This interaction between auditory condition and gender was found to have a medium effect size on recall score over time ($\eta_p^2 = .06$; Richardson, 2011). Post-hoc pairwise comparisons of mean recall scores by gender revealed no significant difference between females and males at Recall Trial 1 (M_{diff} =.79 *SE* = .64, *p* = .22). However, females performed significantly higher than males in Recall Trial 2 (M_{diff} = 2.41, *SE* = .82, *p* = .00), Recall Trial 3 (M_{diff} = 3.44, *SE* = 1.18, *p* = .01) and Recall Trial 4 (M_{diff} = 4.09, *SE* = 1.22, *p* = .00). A repeated measures ANOVA revealed no significant three way interaction of time, auditory condition, and gender *F*(9,6.03) = 1.26, *p* = .28.

Additional findings. Further statistical analyses were conducted to determine whether significant relationships existed between other variables of potential interest. The first set of analyses examined whether musical background was related to word recall performance. An independent samples t-test was conducted to determine whether mean total recall scores were different between participants with and without musical training. Results suggested participants who reporting having musical training had significantly higher total recall scores (i.e., pooled recall scores for Trials 1 through 4) than participants without musical training (M_{diff}= 7.89, t_{88}= 2.30, p = .02). Additionally, a Pearson correlation was conducted to examine the relationship between hours of musical practice per week and total recall score; however, no significant relationship was found between hours of musical practice per week and total recall score (r = .06, N = 90, p = .56).

Further analyses examined whether age or cognitive functioning (i.e., SLUMS scores) were related to verbal recall accuracy. A Pearson correlation was conducted to investigate the relationship between age and participants' total recall scores. No significant relationship was found between age and total recall scores (r = -.18, N = 90, p=.08). Results from another Pearson correlation found a significant, positive relationship between SLUMS scores and total recall scores (r = .34, N = 90, p = .00).

Content Analysis Results

Following the four Recall Trials, participants completed a Participant Experience Questionnaire (see Appendix E) which included four open-ended questions about their perceptions of the experimental task. The primary researcher transcribed participants' handwritten answers and organized responses by participants' assigned auditory conditions. The primary researcher then categorized responses according to emergent keywords and themes that arose in each question's responses. Keywords and themes were grouped and counted. The results for this summative content analysis (Hsieh & Shannon, 2005) are below.

Question 1. The first question asked whether participants felt that the auditory recording they heard over the course of the experiment was helpful to their verbal memories and to elaborate the reasons behind their answer. Across the four conditions, answers were broadly categorized into "Yes", "No", "Mixed" and "I Don't Know" answers. Ten participants in the Rhythmic Speech group felt that the audio recording had aided their verbal recall. Responses pointed to a number of elements of the recording that were perceived to be helpful, including the rhythm to which the words were spoken or "triggered" and the organization of the words that grouped objects. Two participants in the rhythmic speech group felt that the recording was not helpful and listed a "verbal reading" or "rhyming" of words would have provided better assistance. Eight responses had a mixed interpretation of with many of the responses again naming the rhythm as a helpful element of the recording, but reported that one word was difficult to understand, or suggesting that a lack of rhyming was a hindrance to recall.

For participants in the Melody Only condition, 14 affirmed that the recording was helpful in recalling the grocery list. The heard melody was said to be helpful for maintaining focus and adding associations and a sequence to the word list. One participant reported that listening to the "relaxing melody" put her in a better mood which aided concentration. Similarly, the rhythm and repetition were named as elements of the recording that were helpful in remembering the words. Two participants in the Melody

Only condition reported the recording was not helpful, naming that the melody was distracting. An additional two participants said the recording helped "somewhat", but reported that the unfamiliarity of the music added to the learning process. Finally, three participants reported they were unsure if the recording was helpful.

Of participants who heard the Melody and Harmony recording, 13 reported that the audio recording was helpful; again, the melody, rhythm, and repetition were often referenced as supportive elements to the verbal recall task. However, two participants did not find the recording helpful, specifically because the music was a "distraction to the words." Furthermore, four participants had mixed feelings about the Melody and Harmony recording, due in part to the recording not being completely clear or distraction. And additional three participants in this group were unsure if the recording aided recall.

Finally, twelve participants in the Regular Speech group found the recording the following elements helpful in recalling the grocery list; the repetition, clarity, and patterns of the recording. An additional three participants did not find the Regular Speech recording helpful, in part due to one participant reporting they were a visual learner and another simply not remembering. A further three participants had mixed views of the recording. Multiple responses cited a lack of overt pattern or organization to the list. See Figure 5 for more detail regarding participant responses to the first question.

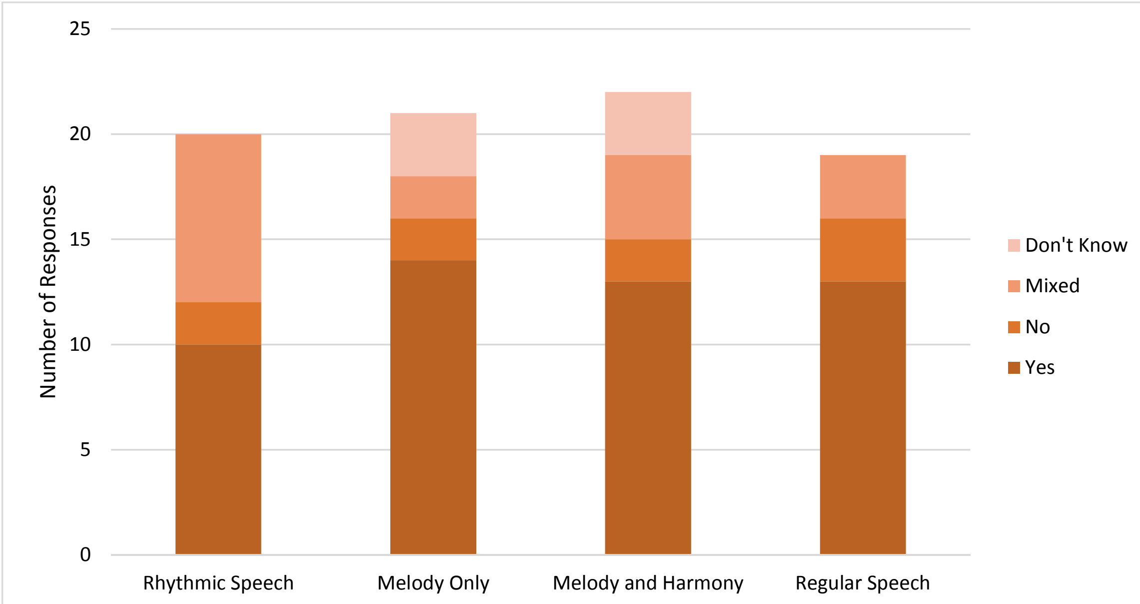

Figure 5. Participant responses to “Did the audio recording help you recall the list?” by auditory condition.

Question 2. For the second question, participants listed any memory strategies they used beyond the auditory recording to remember the shopping list. A number of mnemonic strategies were common across the four auditory conditions. The first, remembering words’ first letters, involved participants trying to memorize the first letter of each item to cue the item’s full name. A second strategy, visualization, involved a participant using mental pictures (e.g., walking through the grocery store, picturing the item) to remember the list. The third named strategy, grouping, was incorporated in one of two ways. First, participants reported categorizing items by shared qualities (e.g., sugar, cake, honey are all sweet). Another common grouping strategy involved chunking items by shared first letter (e.g., pizza, potatoes begin with the letter P).

Fourth, participants often relied on their perception of patterns (e.g., grouping the list into four groups of four words) to sequence list recall. Finally, alphabetization, mental repetition, and concentration were named as mnemonic strategies. Participants in each condition commented that some of these strategies were helpful in their verbal memory, or were merely attempted but were not ultimately helpful. In addition, some participants reported using no extra-musical strategies to aid recall. See Figure 6 for a detailed analysis of these strategies by auditory condition.

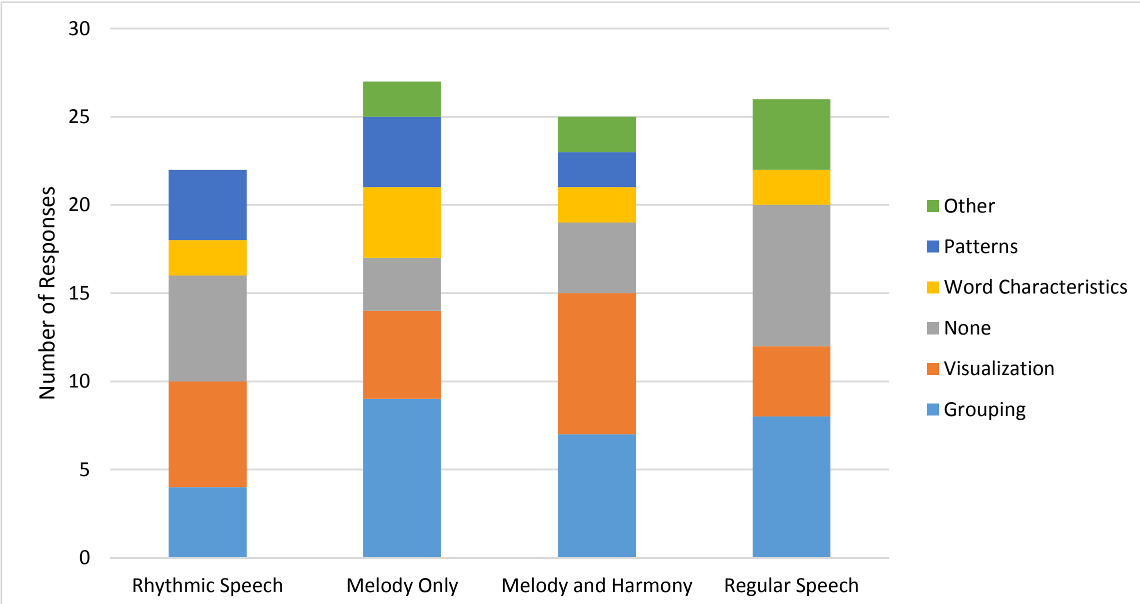

Figure 6. Participant responses to “What other memory strategies did you use?” by auditory condition.

Question 3. The third question asked participants to elaborate on what was challenging about remembering the shopping list. Again, similar themes arose from participants narrative responses across all auditory conditions. The distraction task was viewed as a major challenge, which participants described as “a major distraction” and “mentally exhausting.” Other challenges included the time elapse between recall trials, recalling the middle items of the list, or simply “not remembering.” Additionally, a few participants noted that some words were difficult to understand. Many participants specifically wrote that remembering the order of the grocery items was difficult, particularly the items in the middle of the list. Finally, a few participants cited their emotional responses (e.g., anxiety) as a hindrance to their verbal recall. See Figure 7 for more information on responses to this third question.

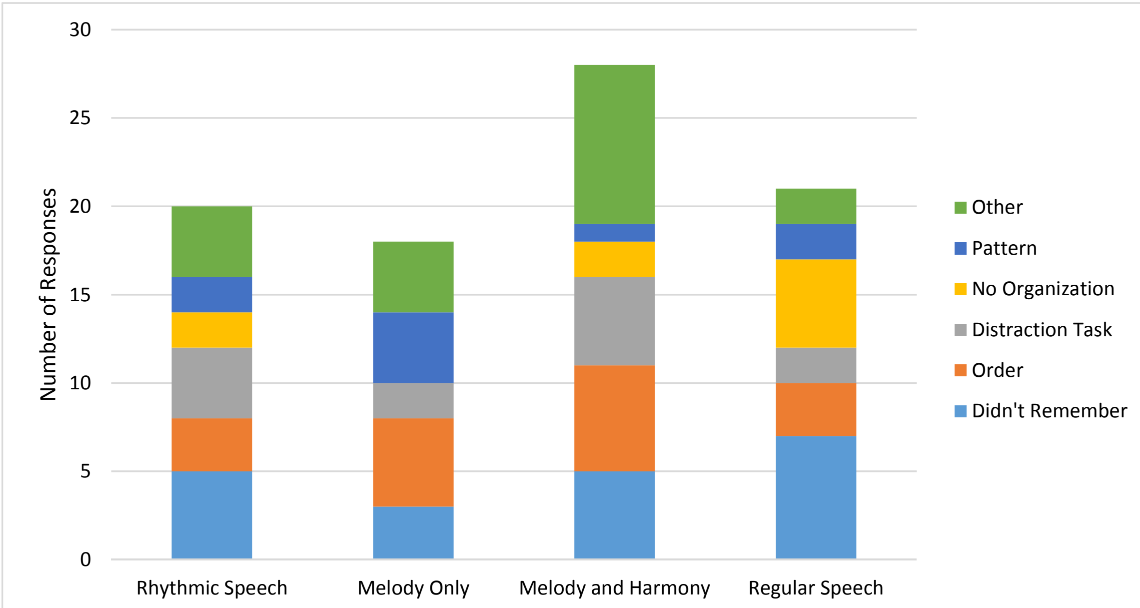

Figure 7. Participant responses to “What was challenging about recalling the list?” by auditory condition.

Question 4. In the final section of the Participant Experience Questionnaire, participants shared whether they felt they had recalled a reasonable number of words during the experiment. Across all four conditions, these responses were broadly categorized into “Yes”, “No”, “Mixed” and “I Don’t Know” answers. In the Rhythmic Speech group, nine participants believed they recalled a reasonable number of words, while six did not think they did well. An additional three participants had mixed perceptions of their recall and one participant was unsure whether his or her recall was reasonable. For participants in the Melody Only group, 11 believed they had performed well on the task, while four did not find their memory performance reasonable. An additional four participants in the Melody Only group had mixed views on their recall, and one participant was unsure about his or her recall. In the Melody and Harmony group, 13 participants felt they had recalled a reasonable number of words, four participants felt they had not performed well, three participants had mixed opinions of their recall abilities, and an additional two participants were unsure of their performance.

Of participants who felt, they recalled a reasonable number of words, the most cited evidence for this belief was within the context of the long and random list of grocery items. For example, one participant wrote, “reasonable, considering the list was 16.” Participants who felt they had not recalled a reasonable number of words reported that they felt their memory was poor for words or that they were disappointed they did not remember all 16 items. Mixed responses to Question 4 often cited similar themes to those mentioned previously, including one participant who wrote, “Reasonable, but certainly not extraordinary. Repetition helped the list sink in a little deeper each time.” See Figure 8 for visual representations of these reported data categorized by auditory condition.

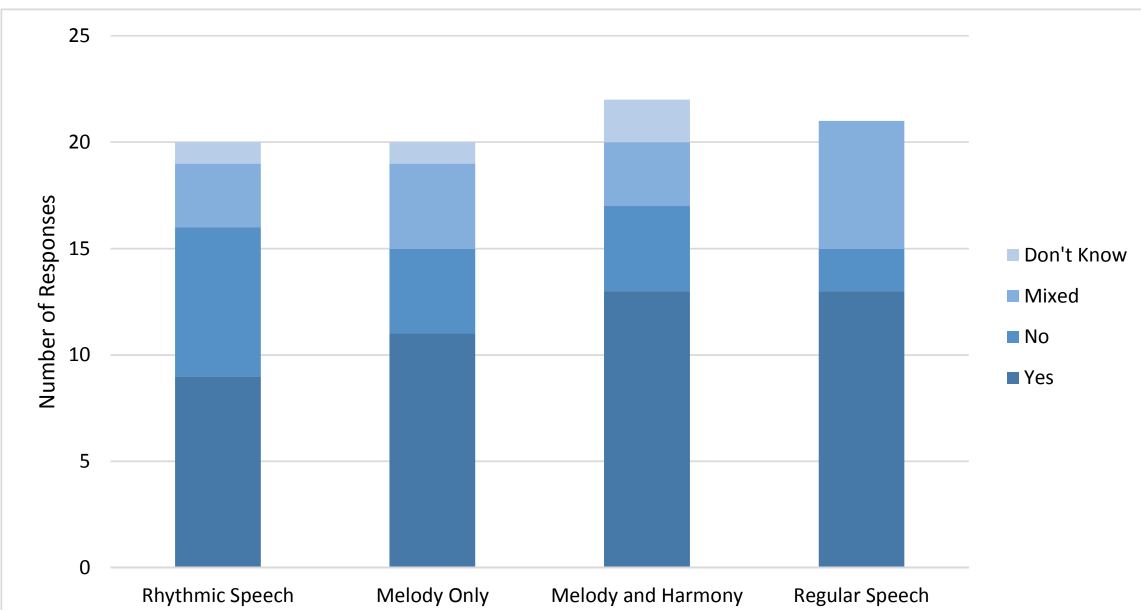

Figure 8. Participant responses to “Do you think you recalled a reasonable number of words?” by auditory condition.

Chapter Five

Discussion

The purpose of this study was to examine the effects of musical elements (i.e., rhythm, melody, harmony) on the immediate and delayed recall of verbal information in healthy older adults. Although recent research has provided evidence that music can serve as an effective mnemonic device in older adults (Simmons-Stern et al., 2012), such studies have not yet examined how individual musical elements serve as a mechanism for recall in this population. Therefore, this study sought to determine how rhythm, melody, and harmony influenced verbal learning and recall in typical older adults. Each participant heard a recording of a 16-item grocery list a total of five times. The recording heard by each participant was in one of four auditory conditions: 1) Rhythmic Speech, 2) Melody Only, 3) Melody and Harmony, or 4) Regular Speech. Participants were asked to recall the list as accurately possible at four time points following Listening Trials 1, 2, 5, and a 10-minute distraction task.

Results indicated that the Rhythmic Speech group had the highest mean recall scores in all recall trials, compared to the Melody Only, the Melody and Harmony, and the Regular Speech groups. After one listening of the mnemonic recording, the Rhythmic Speech group's recall scores were significantly higher than the Melody Only and the Melody and Harmony groups. However, only the Melody Only and the Regular Speech groups maintained their recall scores following a 10-minute distraction task.

This chapter provides an interpretive analysis of this study's results. Findings are organized by research question and discussed in detail. The results are contextualized as appropriate with narrative responses from the Participant Experience Questionnaire.

Finally, the study's theoretical implications, clinical recommendations for music therapy, limitations of the study, and recommendations for future research are also presented.

Discussion of the Research Questions

Effect of music on verbal recall. The first research question asked what musical elements (i.e., rhythm, melody, harmony) supported healthy older adults' verbal recall over time. Results indicated a significant interaction existed between auditory condition and time. This interaction had a significant impact on verbal recall scores, meaning that the recording a participant heard impacted their recall scores at certain time points during the experiment. More specifically, the Rhythmic Speech condition was associated with significantly higher recall scores across the experimental task. After hearing the grocery list once, the Rhythmic Speech group's recall performance was significantly higher than both the Melody Only and the Melody and Harmony groups, but not the Regular Speech group. After the second listening, the Rhythmic Speech group's higher recall scores approached significance over the Melody Only group, but not the Melody and Harmony or the Regular Speech groups. After hearing the recording five times, the Rhythmic Speech group's recall scores approached significance over the Regular Speech group's scores, but not the Melody Only and the Melody and Harmony groups.

The Rhythmic Speech group's higher scores at all time-points suggest that rhythm is a bottom-up framework that enables efficient verbal encoding and recall. As outlined in Chapter 3, the rhythm was composed to group the grocery list into 4-word "chunks" characterized by the Gestalt principle of similarity. The two rhythm patterns within the song were determined by the number of syllables contained within these word groups when spoken. The first pattern organized groups of four words into a sequence of 2-2-3-1 syllables (e.g., apples, pickles, vinegar, tea) and was featured in the first, second, and fourth sections of the song. The second rhythmic pattern organized the third chunk of words into a sequence of 1-3-2-2 syllables (i.e., cake, potatoes, pizza, honey), but was only featured once in the recording.

These rhythmic patterns were repetitive and predictable across the audio recordings of the grocery list. Thus, the rhythm may have provided an easily perceived temporal pattern by which participants could anticipate and rehearse the word list. With only two patterns to retain (i.e., 2-2-3-1 or 1-3-2-2), participants in the Rhythmic Speech group had less auditory information to discern. This may have allowed the Rhythmic Speech group to have greater cognitive focus to attend to the words themselves while listening. These insights suggest that rhythm is the musical structure that best serves working memory. Because working memory operates within a limited capacity for information (i.e., 7 ± 2 pieces of information), the predictable rhythmic patterns may have provided an easily-processed perceptual structure that benefited immediate recall of the grocery list (i.e., after one or two listenings).

On the other hand, the melody may not have been as easily perceived, encoded, and learned as the rhythm. The melody was composed to group the grocery list into 2-word “chunks” with pitch patterns. However, the auditory conditions featuring a sung melody (i.e., the Melody Only and the Melody and Harmony groups) had significantly lower initial recall scores than the Rhythmic Speech group during the first recall trial. Multiple factors may have contributed to the lower recall scores in the audio recordings with the melody.

In contrast to the rhythm, the melody featured a greater variety of pitch patterns. The melody's four-note pitch patterns "chunked" the 16-item grocery list into eight pairs of words. Individual pitch patterns for each word pair appeared a different number of times within the song's contour. For example, the first ascending sequence of pitches (i.e., C-E-F-G) was repeated in the first three measures. A modified version of the same motif was repeated again in measure seven. In contrast, measures four, five, six, and eight featured four-note pitch patterns unique to those associated word pairs. Thus, the melody was characterized by five distinct pitch or grouping patterns across the song.

This variety in melodic patterns may have been less predictable to listeners, compared to the two rhythmic-group patterns. The relative diversity of pitch patterns may be a factor in the Melody Only and the Melody and Harmony groups' lower recall scores. Perceiving and encoding this variety of pitch patterns (in addition to perceiving the rhythm), may have taken more cognitive focus and effort from participants. Hence, the presence of more layers of musical information may have initially diverted participants' attention away from the verbal information.

This potential relationship between musical richness and cognitive diversion may in part explain the Melody and Harmony group's lower mean recall scores. This group heard the most aurally complex recording with three musical elements (rhythm, melody, harmonic accompaniment) each exemplifying different types of perceptual structures. However, the multitude of timing and pitch patterns did not translate into supportive scaffolds for memory. This finding may be explained by the concept of dual-task cost which states that when performing two tasks simultaneously, performance on one or both skills may decline (Klima et al., 2013). A meta-analysis by Verhaeghen, Steitz, Sliwinski, and Cerella (2003) found that in older adults this dual task cost is additive and impacts latency and accuracy of responses. Thus, for the Melody and Harmony group the dual tasks of perceiving the full musical stimulus may have detracted from the additional task of remembering the grocery list.

While the Melody Only and the Melody and Harmony groups had lower mean recall scores, this study's results suggest melody served a different, but nonetheless beneficial purpose for verbal memory. The Melody Only group's recall scores had no significant decrease following the 10-minute distraction task. This finding may be explained in one of two ways. First, participants in the Melody Only group may have needed more listenings than those in the Rhythmic Speech group to fully acquire their recording's musical structures. Although learning the novel melody and rhythms of the song may have taken longer, this may have resulted in a deeper level of encoding which ultimately helped verbal memory.

For example, listening to the Melody Only recording may have allowed participants to fully overlay the word list onto these pitch structures. Once the melody was adequately learned, the pitch patterns may have served as unique auditory "markers" for the associated words. This benefit to recall may have been most apparent following the distraction task. The pitch patterns may have provided more engaging retrieval cues for their associated word pairs via encoding specificity (Tulving & Osler, 1968), thus resulting in the Melody Only group's maintained recall scores after 10 minutes. As a richer auditory stimulus, melody may have served as a both a Gestalt and schematic bridge that transferred the word list from working memory into the long-term "storage" stage of memory that could be recalled following a delay.

Another explanation for the Melody Only group's recall scores following the distraction task may have been the sequential nature of the melody. The pitch patterns across the song's melodic contour provided a linear context within which the word order unfolded over time. The specific order of pitch patterns within the melody may have in turn provided unique frameworks enabling the correct recall of the order of the grocery items. For example, the last measure with the ascending G-A-B-C notes is tonally distinct for two reasons: 1) this pattern is the only instance of these sequenced pitches, and 2) the pattern occurred in a higher range than the rest of the song. Thus, the words associated with this pitch pattern (i.e., spaghetti, rice) would have a higher likelihood of being associated with these four notes and correctly remembered as the last word pair. This and the other melody-related pitch "chunks" may have provided contextual cues to signify the words' position within the song's contour. After a delay, mental recall of the melody may have provided strong cues for the word list and its order.

On the other hand, delayed recall of the rhythmic patterns may not have created a compelling order for the word "chunks." Participants in the Rhythmic Speech group may have quickly associated the rhythmic structures with the words, but may have mixed up the correct order of words associated with an individual 4-word chunk. Perhaps due to the lack of variation in the rhythmic patterns, the sequential context with words may not have been not maintained. For example, the 2-2-3-1 syllable rhythm was repeated a total of three times during the Rhythmic Speech recording. Thus, three different chunks from the Word List could have been associated with the same rhythmic structure. When recalling the grocery list following a delay, the rhythm alone may not have been adequate to retain the word chunks' order.

Furthermore, the rhythm's predictability may not have been a compelling strategy when reconstructing the word order. For example, for participants trying to remember the first half of a "2-2-3-1" syllabic chunk (i.e., two syllable word, two syllable word), a total of eight possible words and 56 unique ordered pair combinations for this 2-2 rhythmic pattern were possible. Although the rhythmic patterns were predictable, they may not have provided enough information to cue the correct order of the word list. Similarly, the rhythmic auditory stream may not have been complex enough to encourage encoding of the word list on a deeper level, potentially resulting in the Rhythm Speech group's significant decrease in recall scores following the distraction task.

Harmonic accompaniment of the melody did not appear to help or hinder verbal recall. No significant difference existed between recall scores in the Melody Only and the Melody and Harmony groups across all recall trials. The compositional intent of the piano accompaniment was to harmonically differentiate repeated melodic phrases and to support the melody's tonal center. However, no significant advantage on recall scores manifested. If anything, this extra musical element may have distracted participants' attention from the word list as the Melody and Harmony Group scored lower than the Melody Only group after the fifth listening and the distraction task.

Finally, the Regular Speech recording served as the auditory control condition. The grocery list was read in a natural tone of voice, but without any overt rhythmic or melodic phrasing. Results indicated that the Regular Speech group did not significantly outperform the Rhythmic Speech, the Melody Only, or the Melody and Harmony groups in any recall trial. Still, post-hoc comparisons found that the Regular Speech group's recall scores did not significantly decrease after the distraction task.

This maintained recall ability after a time delay may be due to participants' unhindered perception of the words that was not distorted by the music. Similar to the Melody Only group, the Regular Speech group maintained their previous recall scores following the distraction task. Thus, word clarity may be an essential non-musical element to the initial encoding of verbal information by older adults. While this insight is notable, the Regular Speech group's total recall scores were the lowest on average compared to conditions with any musical structure. As such, the findings of this study support the incorporation of music into older adults' mnemonic learning.

This study's results can be contextualized within previous literature exploring music's role as a mnemonic device. For example, Wallace's (1994) second of four experiments compared the recall of rhythmically spoken and sung text in order to compare the impact of rhythm and melody on verbal recall. Wallace's results suggested that sung ballad verses were better recalled than rhythmically spoken ballad verses, even after a delay. She concluded that music provides more than rhythmic information, thus text was easier to acquire when sung rather than rhythmically spoken.

Interestingly, this study's findings are inconsistent with Wallace's findings. Instead, results from this study suggested that rhythm is the perceptual structure that enables immediate recall of verbal information, while melody maintains retention of this information over time. While these findings appear to be in conflict, this study made many of the same conclusions regarding the importance of both rhythm and melody as perceptual structures to recall. In particular, both Wallace's and this study's results suggest that melody provides more aurally-rich information than rhythm alone.

Furthermore, direct comparison of this study and Wallace's studies is difficult. While this study's verbal stimuli was an unconnected grocery list, the text for Wallace's experiments included ballad verses with a narrative element and ending rhymes. These differences in verbal stimuli between this study and Wallace's (1994) study may indicate that musical structures have different effects on recall for shorter, unconnected words (i.e., this study's grocery list) and longer, narrative verbal stimuli (i.e., the ballads in Wallace's study).

Other researchers have also investigated rhythm and melody as perceptual structures for verbal recall. Purnell-Webb and Speelman (2008) used the same ballads in Wallace's 1994 study, but set the text to both melody and rhythm. Again, verbatim recall of the ballads' lyrics was measured over time. Their results suggested that familiar rhythms best supported accurate recall of the text. These findings support the present study's findings that the Rhythmic Speech group had the best overall recall scores.

Purnell-Webb and Speelman (2008) also found that text accompanied by an unfamiliar melody compromised recall abilities. The authors suggest that recall was lower for novel melodies because processing new melodic, rhythmic, and textual information was a cognitive burden. This study's findings for the melodic conditions also align with Purnell-Webb and Speelman's findings. Still, direct comparison between Purnell-Webb and Speelman's study and the present study is difficult. The authors examined the impact of both familiar and unfamiliar versions of ballad text set to rhythm and a melody. However, all musical conditions in the present study were novel to participants. Hence, current literature on musical mnemonics do not yet clearly delineate the roles of rhythm and melody on verbal recall, which may be depend in part on the listener's familiarity with the music.

Relationship between demographic variables and verbal recall. The second research question explored whether interaction effects between auditory condition (i.e., Rhythmic Speech, Melody Only, Melody and Harmony, Regular Speech) and demographic variables impacted recall of verbal information in typical older adults. Discussion items are organized below by the three main variables of interest in relation to recall scores: 1) age, 2) cognitive functioning, and 3) gender.

Age as a covariate. The results of a repeated measures ANCOVA with age as a covariate indicated a significant interaction between auditory condition and verbal recall after controlling for age. Observed trends for results comparing all data were similar to general findings described above, but stronger after controlling for participants' age. After one listening, the Rhythmic Speech group recalled significantly more words than the Melody Only and the Melody and Harmony groups, but not the Regular Speech group. After five listenings, the Rhythmic Speech group scored significantly higher than the Regular Speech group, but not the Melody Only and the Melody and Harmony groups. These findings indicate that when the effects of age were removed, the Rhythmic Speech condition had a stronger impact on recall accuracy.

These results support the use of rhythm as a core bottom-up structure when chunking verbal information via music in older adults regardless of age. Past studies have indicated that older adults' perception of rhythm is maintained with age. Krampe, Engbert, and Kliegl (2001) found that older adults' rhythmic timing variability was similar to young adults' rhythmic timing for isochronous time intervals, but not for anisochronous intervals. Thus, the Rhythmic Speech group's higher performance may be attributed to a preserved ability to perceive rhythm efficiently. The Rhythmic Speech recording's predictable and repetitive temporal framework served as an easily processed structure onto which the verbal information could be encoded and later retrieved, which resulted in higher recall scores across the experimental task.

From another perspective, age may have been a covariate that obstructed efficient encoding of the song's unfamiliar melody during the first listening for the Melody Only and the Melody and Harmony groups. Lynch and Steffens (1994) found that older adults' recognition of unfamiliar melodies was less accurate compared to younger adults. The authors attributed their findings to a possible weakening of auditory memory storage. This explanation echoes that of McCabe and colleagues (2010) who found older adults had trouble filtering out unnecessary information during verbal learning. Thus, as adults age they may not be able to encode novel melody structures efficiently, nor disregard long-term representations for familiar melodies.

Post-hoc analyses revealed that the Melody Only and the Regular Speech groups' recall scores did not significantly decrease after the 10-minute distraction task when controlling for age. The Rhythmic Speech group and the Melody and Harmony group did have significant decreases in recall scores after the distraction task. These findings provide further evidence for melody's role in maintaining verbal information over a delayed time-period after controlling for age.

Cognitive function as a covariate. The results indicated that a significant interaction existed between time and auditory condition after controlling for participants' pre-existing differences in cognitive functioning (i.e., SLUMS scores). Recall score differences between auditory conditions in this analysis were greatest following the first listening of the audio recording. At this time point, the Melody Only and the Melody and Harmony group's lower recall was significant or approached significance when compared to the Regular Speech and the Rhythmic Speech groups' performance. These findings indicate that when removing the effect of cognitive functioning, the Rhythmic Speech condition had a weaker impact on recall accuracy compared to melodic conditions. Similarly, cognitive functioning suppressed the effect of the Regular Speech condition.

Additionally, the Rhythmic and the Regular speech conditions both significantly outperformed the melodic conditions on recall scores when controlling for cognitive functioning. The auditory conditions with melody may have been too complicated for initial perception of the musical structures and efficient word encoding for participants who were at a cognitive disadvantage. This explanation for a melodic disadvantage aligns with the idea that cognitive functioning can impact the perception and learning of melody. Belleville, Ménard, and Lepage (2011) found that older adults with mild cognitive impairment (MCI) had greater impaired recognition of novel melodies when compared to well-known melodies. The authors attributed this trend to a disadvantage of persons with MCI to encode new information in a deep and elaborate way, leading to less accurate recall. In the context of this study, participants with lower cognitive functioning who heard recordings featuring melody may have been at a disadvantage for learning the melodic structures. Thus, efficient pairing of the word list with the music upon the first listening may not have been achieved, leading to lower initial recall scores.

Once more, post-hoc analyses revealed that the Melody Only and the Regular Speech groups' recall scores did not significantly decrease after the 10-minute distraction task when controlling for cognitive functioning. This trend was also found in the initial repeated measures ANOVA and a repeated measures ANCOVA controlling for age. Together, this shared trend across within-subjects comparisons provide strong evidence for melody's role in longer-term retrieval of verbal information despite participants' differences in cognitive functioning.

Relationship between gender and verbal recall. A significant interaction between time and gender was found to impact recall scores. Specifically, female recall scores were significantly higher than males' recall scores after hearing the recordings twice, five times, and after the distraction task. These results indicate that females perform similarly to males after hearing the audio recording once, but outperform males on recall scores with multiple repetitions of the recording.

Females' higher verbal recall scores over time may be due to an underlying gender difference in declarative memory, which may impact the learning and retrieval of both musical and verbal memory. Miles, Miranda, and Ullman (2016) conducted a study in which females recognized familiar melodies significantly faster than males. The authors attribute this finding to a relationship between declarative memory (as similar to the conscious recall of this study's grocery list) and the learning of new material. Within the context of this study, females may have been able to learn the novel word list within each auditory condition due to a pre-existing advantage for learning and recalling verbal information. This recall advantage became apparent after hearing the Word List twice and was consistent over time. Finally, no significant three-way interaction between gender, time, and auditory condition was found in this study. However, Miles, Miranda, and Ullman's (2016) results warrant further investigation into the relationship between females' strong memory recognition for melody and verbal recall.

Relationship of Musical Training and Recall

This study's results found that musical training was related to better recall across the experimental task, regardless of which auditory condition in which participants heard the grocery list. The benefit of musical training to verbal memory for younger adults has been established in a number of studies (Brandler & Rammsayer, 2003; Chan, Ho, & Cheung, 1998). This study's results extend support for musicians' greater verbal memory beyond young adults and into older adulthood. These findings might be explained in part by Zendel and Alain's (2014) observations that older adult musicians experience less age-related decline in their ability to process auditory information. Specifically, older musicians' right auditory cortices were found to have an increase in attention-related activity in response to auditory stimuli. In this way, musical training may have helped some participants overcome the lack of attentional control that may hinder acquisition of new information (Lynch & Steffens, 1994; McCabe, Roediger, McDaniel, Balota, & Hambrick, 2010).

While participants' musical training was related to higher recall scores, no relationship was found between hours of current musical practice and verbal memory. These findings indicate that early musical training provides the strongest cognitive boost for verbal recall in older adulthood; this effect does not necessarily depend on a continued practice of music. Many participants verbally confirmed they had taken music lessons as young children, but had not played music in recent years or decades. Thus, active music involvement may not provide an additional benefit to cognitive functioning, but early neural changes in the auditory cortex induced by music lessons may have enduring benefits for older adults in nonmusical cognitive domains.

Relationships Between Variables of Interest and Recall

This study's analyses also examined the relationships between participant variables of interest (i.e., age and cognitive functioning) and recall performance. A Pearson correlation revealed no significant relationship existed between age and total recall scores. This finding suggests that age was not a significant factor that determined participants' recall accuracy across the entire experiment.

Results from a second Pearson correlation suggested a significant relationship exists between participants' scores on the St. Louis University Mental Status (SLUMS) exam and their total recall scores. This relationship was found to be positive and of a medium effect size, meaning that participants with a higher level of cognitive functioning were more likely to have higher total recall scores. This finding suggests that older adults in the early stages of cognitive decline may not best recall verbal information only contained within music mnemonic, but may need additional non-musical support structures in addition to music.

Discussion of Content Analysis

The third research question explored how older adults perceive and experience a music mnemonic for verbal recall. Participants completed an open-ended Participant Experience Questionnaire (Appendix E) following the experimental task. Participants' narrative responses regarding their experiences throughout the experiment also provided important qualitative information that can inform interpretation of this study's quantitative results. Questionnaire responses also contribute important feedback that can improve the therapeutic implementation of musical mnemonics training. A preliminary summative content analysis suggested that older adults use diverse memory strategies beyond auditory learning to learn and retain verbal information.

These findings are in agreement with Saczynski, Rebok, Whitfield, and Plude (2007) who found that both simple (e.g., repetition) and complex (e.g., association) memory strategies were used by older adults. While Saczynski et al. recommend that the complexity of a mnemonic strategy be tailored to the cognitive demand of the recall task, the participants of this study did not seem to report meaningful differences in the types of mnemonic strategies they used across auditory conditions. Instead, a minimum of four and a maximum of seven different types of non-musical mnemonic strategies were reported in all the auditory conditions: remembering first letters, visualization, grouping, use of patterns, alphabetization, repetition, auditory strategies, concentration, and association. These strategies fell into Saczynski et al.'s simple (e.g., repetition, concentration) and complex (e.g., visualization, association) groupings.

Additionally, many participants commented that the "middle" part of the list was hardest to remember. This feedback may be due to inherent challenges to recalling sequenced information. First, the middle part of sequenced verbal information is hardest to remember, due to *primacy* and *recency effects***.** Hurlston, Hitch, and Baddeley (2014) define the primacy effect as the better memory for a verbal sequence when recalling it in a forward order. Similarly, the recency effect occurs when recall performance improves for verbal sequences presented in the final portion of a series. Recall accuracy is generally lowest for information presented at the intermediate portions of a sequence.

This issue inherent to the learning of sequenced information may explain the difficulty participants had in recalling information in the middle of the list.

The compositional structure of the prototype song itself may have further compounded these recall difficulties. For example, the same rhythmic pattern was repeated in the first, second, and last parts of the prototype song. However, the “bridge” section with a different rhythmic pattern was composed for the third section of the word list. The interruption of the predictable rhythmic pattern may have hindered efficient encoding of the words tied to this new rhythmic pattern. Insights gleaned from the statistical results and supporting content analysis can inform the theoretical and practical implications of this study.

Some participants also reported that some grocery items were difficult to understand. Anecdotally, participants were most often confused by the word “spaghetti.” This confusion may have been due to an accent discrepancy between how that item was sung in the recording (i.e., SPA-ghe-tti) versus how the item is generally pronounced (i.e., spa-GHE-tti). This incongruity may have prevented some participants from perceiving and encoding this item into their memory. A study by Gingold and Abravanel (1987) found that recall for lyrics was significantly lower when the words’ prosody did not match the music’s rhythm than when the lyric and musical prosody were in agreement. These results further support the idea that recall is best when the prosody of the verbal information and the music are congruent. The clinical implications of this insight are discussed more in the limitations section.

Interestingly, the emotional impact of the song was commented upon by a few participants as an influence on their recall performance. These participants’ comments generally reported that the music put them in a better mood or lowered their anxiety. Recent research suggests that anxiety and negative affect can impair cognitive function, including verbal memory, in community-dwelling older adults similar to participants in this study (Yochim, Mueller, & Segal, 2013). Thus, musical mnemonics may serve to vector mood in a positive direction that indirectly improves verbal memory.

Theoretical Implications

This research study provides theoretical insight into how cognitively healthy older adults (i.e., adults free of a memory-related diagnosis) perceive and retain verbal information when musically presented. Results helped explain the unique roles of musical elements (specifically, rhythm and melody) in the recall of verbal information in older adults. By using newly composed music, this study demonstrated how individual musical elements function in the initial and delayed verbal recall. Thus, this study's results provide a preliminary understanding of the mechanisms that link music and verbal recall.

These findings can inform the theoretical evidence supporting the Neurologic Music Therapy technique Musical Mnemonics Training (MMT). Currently, the therapeutic mechanisms for MMT are outlined by the non-musical memory mechanisms that facilitate recall (Gardiner & Thaut, 2014). These mechanisms include repetition, emotion, confidence, action, linking, and learning. While these memory techniques are valuable to supporting verbal recall, they lack any direct connection to music, the key structural component for MMT. This study's findings begin to elucidate the grouping and structural roles music plays in older adults' verbal memory encoding and retrieval.

First, rhythm may enable older adults' to easily perceive temporal patterns that help to group verbal information into easily recalled chunks. Rhythm's bottom-up grouping structure most benefitted working memory immediately after hearing the novel music. Furthermore, this study's findings suggest melody may support the sequencing of patterns and the associated verbal information. The pitch patterns and order established in a melody's contour required more repetitions to fully acquire, but this deeper level of encoding appeared to benefit the delayed recall of verbal information.

Finally, this study's findings indicate that typical older adults can quickly learn novel musical and verbal information. After only five repetitions of the song, participants integrated the musical and verbal information into their short-term memory and retained it after a 10-minute delay to some degree. This suggests that originally composed music is an appropriate vehicle for improving older adults' memory for words. Together, this theoretical evidence for music's role in verbal memory can further inform best practices for music therapists implementing MMT.

Practical Implications for Clinical Practice

The results of this study indicate that rhythm is the most effective element for immediate perception of patterns that chunk verbal information. Melody, meanwhile, may be a more effective musical element for the maintenance of non-musical information over a delay. These findings suggest that songs that serve as mnemonic devices should include of these both musical elements. Verbal information set to a rhythmic chant alone may enable older adults to immediately recall the information, but adding a sung melody may provide encoding and retrieval cues necessary to access the target information in real-world situations beyond a therapy session.

Additionally, when musical mnemonics training (MMT) is used to teach older adults new verbal information, the presentation of each of these elements may need to be scaffolded to enhance deep and meaningful learning that persists across time. For example, when pairing novel music with verbal information, music therapists may first only present the rhythmic structures (i.e., a rhythmic chant) so that older adult clientele can efficiently map the verbal information onto this simple, structural element. After sufficient rehearsal, a sung melody may then be incorporated to the same rhythm with further repetition to encode the verbal information on a deeper level and strengthen recall abilities for future situations.

Music therapists may also consider gender differences when utilizing MMT with older adults. Although statistically significant results were not found in a three-way interaction of auditory condition, recall scores, and gender, a visual analysis of Figures 3 and 4 reveals interesting trends. In particular, the Rhythmic Speech group appeared to have the highest overall recall scores among men. Furthermore, males in the Melody Only, the Melody and Harmony, and the Regular Speech groups had nearly identical recall performance during after hearing the grocery list two times, five times, and after the distraction task. The recall scores for these three groups was consistently lower than the Rhythmic Speech group for male participants. Hence, music therapists teaching verbal information may want to emphasize the rhythmic elements of a song via drumming, or simply teach verbal information as a rhythmic chant to enhance verbal learning for male clients.

Finally, participants' feedback can inform the composition of original songs intended for cognitive rehabilitation in older adults. Musically, participants found the rhythm and the melody helpful in several ways. Participants in the Rhythmic Speech group reported that the rhythmic patterns were helpful because they acted as a recall "trigger" and helped with the "grouping of objects." Additionally, participants who heard the melody said that the "catchy tune stayed in my head" which allowed them to "associate the words with the tune." Similarly, a participant in the Melody Only group reported that the melody helped to sequence the grocery list by "[making] the words run in order."

The narrative responses also suggested non-musical elements that would further support their learning of the Word List. A few participants commented that they were "visual learners." Music therapists should strongly consider presenting verbal information visually (e.g., printed handouts of target verbal information) when teaching via an auditory format. This recommendation is made for a number of reasons. First, a printed handout of the lyrics of a song would help visual learners integrate the verbal information efficiently in conjunction with the music. Secondly, many participants reported that some words were acoustically unclear, especially in auditory conditions featuring sung melody. From the researcher's anecdotal perspective, aurally unclear words had a higher likelihood of being recalled incorrectly. A visual presentation would integrate target information multi-modally which would enhance the music's encoding role.

Regardless of auditory condition, participants often cited repeated listenings of the audio recording as a helpful strategy that aided their memory. For example, one participant in the Melody Only group reported, "As the recording repeated, I learned the tune and going over the music in my head helped." Similarly, a participant in the Regular Speech group shared that repetition was important because recall "got easier when I heard [the recording] three times in a row." Clearly, repetition was a helpful element in the auditory learning process for these participants. Music therapists or other professionals working with older adults should ensure sufficient rehearsal practice of aurally presented information to support the encoding process.

Combining participant feedback on what musical and non-musical features of the recording were helpful provides insight into how music therapists can best support older adults' audio-verbal learning. Taken together, greater rhythmic and melodic repetition in therapeutically composed song (i.e., strophic form) may be most beneficial because it provides the predictable musical structures for verbal encoding and recall.

Limitations and Implications for Future Research

This study's findings create a compelling case for continued research examining music's role as a memory tool in older adults. However, a number of limitations existed in this study. One limitation was inherent to the composition of the melody which created an accent discrepancy for the word "spaghetti" in the musical conditions. Specifically, the word "spaghetti" is commonly spoken with emphasis on the second syllable (i.e., spa-GHE-tti). This grocery item, however, was rhythmically spoken/sung with the emphasis on the first syllable (i.e., SPA-ghe-tti). This inconsistency in the sung and spoken performances of "spaghetti" was not identified during pilot testing.

Anecdotally, this resulted in several participants in the three musical conditions not correctly perceiving this word. The researcher was often asked for clarification on this word by these participants. This mismatch between the sung and spoken accents may resulted in some participants not being able to perceive and ultimately integrate this word into their memory, which may have affected their recall scores. Hence, songs composed for a mnemonic purpose should strive to match the natural accents of the verbal information so the music does not interfere with encoding.

A second limitation was the large age range of participants that spanned 20 years. When controlling for participants' ages, trends differed on both between- and within-subjects comparisons in relation to all participants' data. This finding indicates that age may be factor that moderates older adults' verbal recall abilities. For example, participants in their early 60s may have perceived the musical mnemonic differently than the participants who were in their late 70s. Future research should compare how listeners' use music as a mnemonic device in early versus later older adulthood.

A third limitation was the administration of the St. Louis University Mental Status (SLUMS) exam in both individual and group settings. The SLUMS was designed to be verbally administered to individual participants. To optimize participant numbers, the researcher administered the SLUMS in both individual and group settings. An estimated 20 participants (22% of the sample) completed the SLUMS in a group format in which all items were verbally administered, but answers were written on a researcher-designed answer sheet (Appendix M). This alternate administration may have resulted in questions being presented with different timing or wording, potentially impacting these participants' cognitive functioning scores.

A fourth limitation of this study was the imbalance of gender proportions in the participant sample. Females outnumbered males in an almost 2:1 ratio. This lack of male participants resulted in an underpowered three-way interaction between recall scores, auditory condition, and gender. Research should also continue to investigate the impact of gender, and cognitive functioning on verbal recall in older adults.

That said, a visual analysis of female and male recall scores by auditory condition as seen in Figures 3 and 4 revealed interesting differences in recall by auditory condition.

It is possible that each gender perceives and/or uses music differently to encode and retrieve verbal information. Specifically, melody may be more effective for females in maintaining verbal information of time, while rhythm may be the most essential element to recalling verbal information for men. However, due to an underpowered sample size, this study found no statistically significant findings. Future research should focus on gender differences in the perception and retention of verbal information set to music. These findings would provide a deeper understanding of how gender impacts auditory learning and could provide important insights into how clinical implementation of music should be tailored by gender.

Finally, the interaction between cognitive functioning, music, and verbal recall is another area of future research. While this study originally intended to include only older adults who scored in the “normal” range on the St. Louis University Mental Status exam, 39% of this study’s sample scored in the “Mild Neurocognitive Disorder” range. This study’s findings suggest a medium, positive relationship exists between cognitive functioning and recall score. However, the specific impact of music for verbal recall in adults with mild neurocognitive disorder remains unclear. Future studies might investigate whether music is an effective mnemonic device comparing older adults with and without mild cognitive impairment. Additional long-term studies could provide insight into whether music-based cognitive rehabilitation can slow rates of cognitive decline in older adults as measured by both behavioral and neuroimaging methods. Finally, future research may continue to investigate how individual musical elements (rhythm, melody, harmony) are processed by older adults within each auditory condition to examine a threshold for dual-task costs to verbal recall as aural complexity rises.

Summary and Conclusions

As the general populace continues to age, the need will grow for innovative and cost-effective strategies to maintain cognitive health for older adults. Verbal learning and recall in particular may be one area of cognition that can be improved through the therapeutic use of music. This study began to uncover the unique contributions of rhythm and melody to older adults' verbal memories. Findings suggest that both rhythm and melody are essential perceptual structures that aid in the encoding and retrieval of verbal information.

This study's results provide a preliminary understanding of the musical mechanisms involved when music is used as mnemonic device by older adults. Thus, a stronger evidence base for the therapeutic use of music for verbal recall (i.e., Musical Mnemonics Training) exists. Professionals like music therapists who work with older adults on memory rehabilitation should incorporate both elements meaningfully when composing and teaching mnemonic songs. Such integration of music and verbal information would provide musical support for older adults' immediate and delayed recall. This improvement to memory via music may in turn increase older adults' self-efficacy for their memories, decrease forgetfulness of needed verbal information, and provide an engaging and motivating mode of maintaining their memory. Future research should extend this study's findings to examine potential longer-term benefits of MMT related to the slowing of cognitive decline in older adults.

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Appendices

Appendix A: Recruiting Flyer

FROST
SCHOOL OF MUSIC
UNIVERSITY OF MIAMI

Does music improve older adults' memory?

Want to participate in a music study?

This research study examines how music can serve as a memory aid for verbal information. Participants will listen to words set to music and recall as many of the words as possible in an hour-long experiment.

You are eligible for this Frost School of Music, University of Miami study if you:

- Are between the ages of 60 and 79
- Can speak, understand, and write in English fluently
- Hear within normal limits
- Have no formal diagnosis of a memory disorder (e.g., Alzheimer's disease, mild cognitive impairment)

Please contact Brea Murakami, MT-BC by email at bxm428@miami.edu or
By calling/texting (xxx) xxx-xxxx to sign up!

Appendix B: Word List

1. Apples
2. Pickles
3. Vinegar
4. Tea
5. Chocolate
6. Carrots
7. Hamburger
8. Eggs
9. Cake
10. Potatoes
11. Pizza
12. Honey
13. Sugar
14. Ginger
15. Spaghetti
16. Rice

Appendix C: Recall Forms

Participant #______________

Word Recall List 1

1. ____

2. ____

3. ____

4. ____

5. ____

6. ____

7. ____

8. ____

9. ____

10.____

11.____

12.____

13.____

14.____

15.____

16.____

Participant #______________

Word Recall List 2

1. ____

2. ____

3. ____

4. ____

5. ____

6. ____

7. ____

8. ____

9. ____

10.____

11.____

12.____

13.____

14.____

15.____

16.____

Participant #_______________

Word Recall List 3

1. ____

2. ____

3. ____

4. ____

5. ____

6. ____

7. ____

8. ____

9. ____

10.____

11.____

12.____

13.____

14.____

15.____

16.____

Participant #______________

Final Word Recall List

1. ____
2. ____
3. ____
4. ____
5. ____
6. ____
7. ____
8. ____
9. ____
10. ____
11. ____
12. ____
13. ____
14. ____
15. ____
16. ____

Appendix D: Demographic Questionnaire

Participant number: ___________

Please fill out the questionnaire to your fullest potential. The information you provide will be used strictly for this study. Anything you share will be kept confidential.

1. Age: ____________________

2. Gender (circle): Male Female

3. In which ethnic group do you mostly place yourself? Circle one.

   African-American/Black Caucasian

   American Indian/Alaskan Native Hispanic/Latino

   Asian/Pacific Islander Other__________________

4. Please circle your last completed educational level.

   Less than high school Bachelor's degree

   High school degree/GED Master's degree

   Some college/Associate degree Ph.D., doctorate, J. D., M.D.

   Other ______________________

5. Have you ever had musical training (Yes/No) ___________________

6. What musical instrument(s) have you played? Please list below.

7. How many hours per week do you currently practice your instrument/sing?________________

Appendix E: Participant Experience Questionnaire

Please fill out the questionnaire to your fullest potential. The information you provide will be used strictly for this study. Anything you share will be kept confidential.

1. Do you think the audio recording helped you memorize the shopping list? Why or why not?

2. Beyond the audio recording, did you use any other memory strategies to remember the shopping list? Please list and provide a brief definition of these strategies.

3. What did you find challenging about recalling the shopping list at the end of the study?

4. Do you think you recalled a reasonable number of words? Why or why not?

Appendix F: Informed Consent

University of Miami
CONSENT TO PARTICIPATE IN A RESEARCH STUDY
Music as a mnemonic device for verbal recall in healthy older adults

The following information describes the research study in which you are being asked to participate. Please read the information carefully. At the end, you will be asked to sign if you agree to participate.

Eligibility:
Adults between the ages of 60 and 79 who understand and can write in English are eligible to participate in this study. Additionally, adult participants must be free of a memory disorder diagnosis (e.g., Alzheimer's disease, mild cognitive impairment).

Purpose of the Study:
You are being asked to participate in a research study entitled, "Music as a Mnemonic Device for Verbal Recall in Healthy Older Adults." The purpose of this study is to investigate the effects of music as a mnemonic device (e.g., memory tool) on verbal information in community-dwelling older adults.

Procedures:
You will be randomly assigned to listen to an audio recording presented in one of four ways:
1) rhythmic speech, 2) sung melody only, 3) sung melody with harmonic accompaniment, or 4) regular speech.

You will be asked to learn and recall a list of words after listening to an audio recording using words set to music. This recording utilizes a memory strategy called a "musical mnemonic." A musical mnemonic is the rehearsal of new information aided by musical elements, such as learning the letters of the alphabet to the tune of "Twinkle Twinkle." It is possible you will be assigned to listen to a recording that does not involve music.

During the session, you will hear the audio recording multiple times. At various points during the study, you will be asked to write down as many of the items mentioned in the audio recording as you can remember. This protocol can be outlined in five trials:

In Trial 1 you will:
a. Listen to the audio recording
b. Recall and write down as many words from the list as possible

In Trial 2 you will:
a. Listen to the audio recording
b. Recall and write down as many words from the list as possible

In Trial 3 you will:
a. Listen to the audio recording

In Trial 4 you will:
a. Listen to the audio recording

In Trial 5 you will:
a. Listen to the audio recording
b. Recall and write down as many words from the list as possible

Following this protocol, you will be asked to perform a simple mental math exercise for 10 minutes. Then, you will be asked to remember and write down as many words from the previous list as possible. Finally, you will be asked to complete two questionnaires. The first will be about your experience with the study and the second will be a demographic questionnaire about your background.

Risks and/or Discomforts:
There are no risks or discomforts associated with this study.

Benefits:
No benefits can be promised to you from participating in this study. However, you may learn a new rehearsal technique that will help improve your memory.

Confidentiality:
All information you provide throughout this study will be kept strictly confidential. The investigator will consider your records confidential to the extent permitted by law. The U.S. Department of Health and Human Services (DHHS) may request to review and obtain copies of your records. Your records may also be reviewed for audit purposes by authorized University or other agents, who will be bound by the same provisions of confidentiality.

The collected data will not contain any information that could be used to identify you. All data will be identified by an assigned code and not by your name. All paper and electronic records will be stored in a locked filing cabinet and a password-protected computer, respectively, to which the researcher, Brea Murakami, will have the only access. All records will be kept in this locked location for a period of seven years. After that time, all data will be destroyed. Only the principal investigator and the student investigator will have access to individual data.

Compensation:
You will receive no compensation as a result of participating in this study.

Right to Decline or Withdraw:
Your participation in this study is voluntary. You are free to refuse to participate in the study or withdraw your consent at any time during the study. The investigator reserves the right to remove you without your consent at such time that they feel it is the best interest for you.

Contact Information:
Teresa L. Lesiuk, Ph.D., MT-BC will gladly answer any questions you may have concerning the purpose, procedures, and outcome of this project. You can contact her at (305) 284-3650. If you have any questions concerning the research study, please contact Brea Murakami, Master's Degree Candidate at bxm428@miami.edu or at (xxx) xxx-xxxx. If you have questions about your rights as a research subject you may contact the Human Subjects Research Office at the University of Miami at (305) 243-1790.

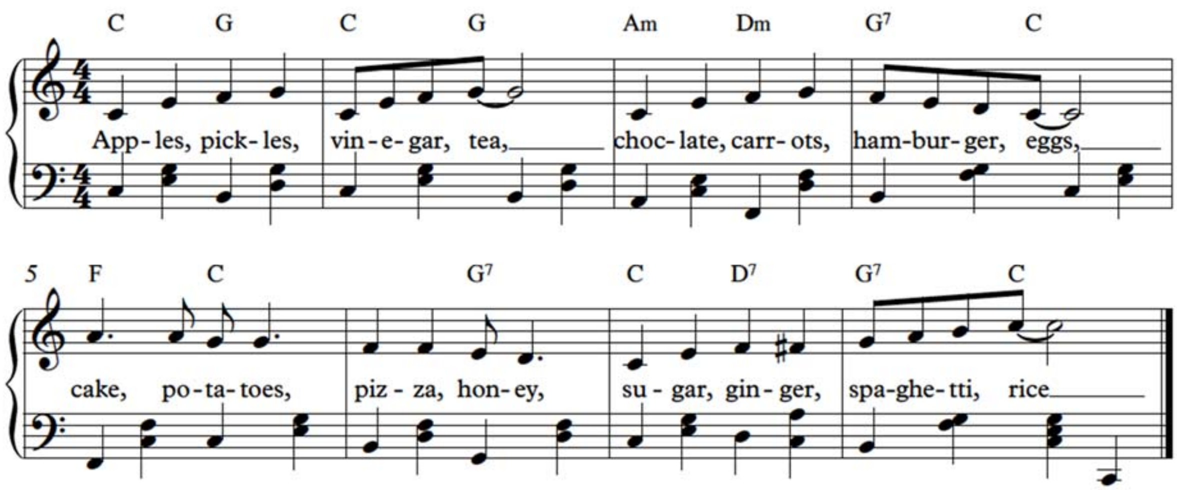
Participant Agreement: I have read the information in this consent form and agree to participate in this study. I have had the chance to ask any questions I have about this study and they have been answered for me. I am entitled to a copy of this form after it has been read and signed.

Signature of Participant **Date**

Signature of person obtaining consent **Date**

Appendix G: Musical Stimuli

Grocery Song Prototype (Melody and Harmony)

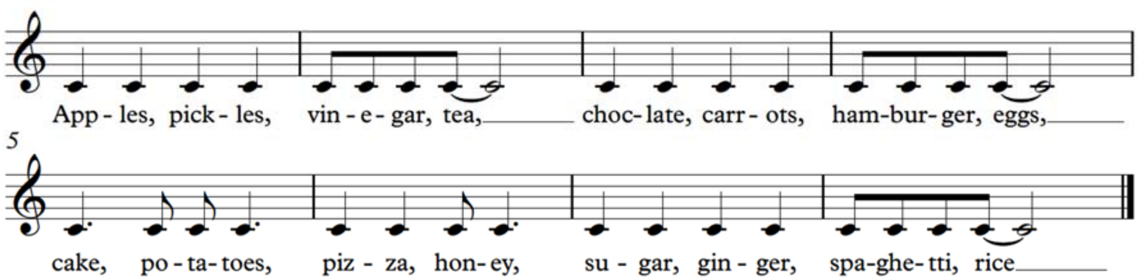


Appendix H: Musical Stimuli

Grocery Song Melody Only

Appendix I: Musical Stimuli

Grocery Song Rhythmic Speech



Appendix J: Distraction Task

Count down by 7 from 1,500.

(Do not show your work. Please do the math in your head)

1,500...1,493...1,486...etc.

Appendix K: Composer Piloting Questionnaire

Pilot Testing: Composers

Please rate the following statements on according to the following scale:

Strongly Agree	Somewhat Agree	Neutral	Somewhat Disagree	Strongly
		Disagree		
5	4	3	2	1

1. The song's melody features repetition ________
2. The song's melody features step-wise motion________
3. The song's melody could be characterized as "simple" ________
4. The song's melody features the Gestalt principle of "proximity" (i.e., musical events grouped together in time and/or space are perceived as a unit) ________
5. The song's melody features the Gestalt principle of "similarity" (i.e., similar musical patterns are perceived as a unit) ________
6. The song's melody features the Gestalt principle of "continuity" (i.e., the melody's direction creates patterns perceived as distinct units) ________
7. The song's melody is composed according to Western music rules ________
8. The song's lyrics are intelligible _______
9. The song's harmonies are commonly found in Western music ________
10. This song's harmonies could be characterized as "simple" ________
11. The tempo of this song could be described as "moderate" ________
12. Generally, the song's lyrics fall on metrically strong beats ________
13. The song is reminiscent of an advertising jingle ________
14. The melody would be easy for the average person to sing along to ________
15. The melody is easy to remember after the first hearing ________
16. This song's emotional tone is positive ________

Please write any other comments or thoughts about how the song could be more memorable:

Appendix L: Older Adults Piloting Questionnaire

Pilot Testing: Older Adults

Please rate the following statements on according to the following scale:

Strongly Agree	Somewhat Agree	Neutral	Somewhat Disagree	Strongly Disagree
5	4	3	2	1

1. I understood all the lyrics of the song ________
2. The song's tempo (speed) allowed me to hear patterns in the music ________
3. The song's tempo (speed) allowed me to understand all the lyrics _______
4. The song reminded me of an advertising jingle _______
5. The song's melody was "catchy" and/or stayed with me after listening ________
6. I could easily sing along to this song ________

Please write any other comments or thoughts about how the song could be more memorable:

Appendix M: SLUMS Written Answer Sheet

Participant #______________

St. Louis University Mental Status Exam

1. ____

2. ____

3. ____

5a. ____

5b.____

7. ____________________

____

____

____

____

8a. ____________________ 8b. ____________________ 8c. ____________________

11a. ____

11b. ____

11c. ____

11d. ____

Appendix M: SLUMS Written Answer Sheet (back)

6.