

The Use of Rhyme, Rhythm, and Melody as a Form of Repetition Priming to Aid in Encoding,  
Storage, and Retrieval of Semantic Memories in Alzheimer's Patients

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## **Abstract**

Millions are diagnosed with Alzheimer's disease annually which can have debilitating effects on patient memory. Thus, finding new ways to help facilitate memory in these patients, especially through non-pharmaceutical means, has become increasingly important. I examined the use of melody, rhyme, and rhythm as encoding mechanisms to aid in the retrieval of long term semantic information by juxtaposing scholarly articles detailing experiments, each of which examined the effects of various facets of memory facilitation; this helped produce an idea of which devices are most effective. Additionally, I surveyed studies highlighting limitations of song implementation to craft an effective plan to aid Alzheimer's patients.

Melody, rhyme, and rhythm provide an organizational structure to facilitate the encoding of information. Specifically, chunking, the grouping of smaller units into larger 'chunks', helps facilitate long term encoding in patients, and is the byproduct of the organizational structure of a text. A major drawback of using these devices is the loss in the depth of encoding semantic information; however, it is important to recognize music still assists general content memory. Therefore, Alzheimer's patients would benefit from the use of melody as it would provide a moral support, helping familiarity with their surroundings, although they would not benefit from instructional song. Future experiments may study the combination of discussed factors in various settings to examine the unique benefits of music on memory in Alzheimer's patients.

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## **Introduction**

Alzheimer's disease (AD) is the currently one of the most prominent neurodegenerative diseases throughout the world, and the number of diagnoses of AD has been steadily increasing over the past decade. The brain is a collection of nerve cells, or neurons, which are interconnected and communicate through electrical signals. Alzheimer's disease is a progressive disease which involves the destruction of neurons, also referred to as neurodegeneration, and disruption of axonal signals throughout the brain. Over time, this destruction results in the atrophy of certain vital areas of the brain, especially the hippocampus. The exact reason for the neural destruction is unknown; however there are theories, one of the most prominent being the formation of plaques and tangles.

Plaques form due to fragments of the Beta-Amyloid protein, which tend to stick together and form clumps called plaques. Marx, Blasko, Pavelka, and Grubeck-Loebenstein (1998) theorized these clumps may both, disrupt signals in the brain and trigger an immune response which may lead to the destruction of neurons. Tangles are largely responsible for axonal injury due to formation of neurofibrillary tangles (NFTs) made up of hyperphosphorylated tau (p-tau). Tau is a protein found in neurons used to stabilize microtubules which support a neuron's structure. Hyperphosphorylated tau refers to tau in which a phosphoryl group ( $\text{PO}_3^{-2}$ ) is added to the protein and this process leads to the 'aggregation' of tau; these clumps are called NFTs. In tauopathies such as AD, these tangles form insoluble deposits which lead to many of the characteristics of these diseases (Williams, 2006).

The neurodegeneration found in AD leads to the deterioration of cognitive function, memory, and other related tasks. Memory is a process divided up into three distinct sections: encoding, storage, and retrieval. Encoding is the process by which information is received and processed in the brain. Storage deals with the manner in which memories are stored; there are two primary components: Short-Term Memory (STM) and Long-Term Memory (LTM). STM can store up to about 4-5 items for up to a few minutes (Cowan, 2001). On the other hand, LTM can store immeasurable amounts of information indefinitely. Additionally, Baddeley (1966) found that whereas STM encodes information acoustically, LTM encodes information semantically. This means LTM utilizes the meaning of a word or phrase to encode it whereas STM is largely independent of meaning. Retrieval is the manner by which memories are recalled, whether it is conscious or unconscious.

One of the primary and most devastating targets of AD is the hippocampus. In "Loss of Recent Memory after Bilateral Hippocampal Lesions," Scoville and Milner (1957) found the hippocampus is necessary "in the retention of current experience," (p. 21). In other words, the hippocampus is necessary to transfer information from short term memory to long term memory. Any degeneration would inhibit one's ability to successfully complete this transfer to long term memory, thus effectively reducing one's memorial capacity. The type of information involved in memory storage can be categorized in many ways. There are two major types of memory, explicit and implicit. Implicit memory, sometimes referred to as procedural memory, does not require conscious recall; rather it primarily deals with learning actions such as riding a bike or dressing one's self. Explicit memory, sometimes called declarative memory, does require conscious recall and is divided into episodic and semantic memory. Episodic memory memories often deal with memories of specific events and associated events whereas semantic memory

primarily deals with facts such as learning a chemical formula or a name.

Melody and song differ from normal speech, the medium by which most auditory information is encoded. The use of song is well documented from orators reciting long epics to modern nursery rhymes. Despite the use of song for centuries, however, little is known about the mechanisms by which it aids in memory, if at all. Previous literature has explored portions of this issue, such as the use of chunking or repetition, but there is little to no study on a holistic approach to the use of a variety of factors. Thus, melody, traditionally used in nursery rhymes and other such devices for toddlers, may be extrapolated to be used as a memory aid for AD patients, especially for long-term, semantic memory. However, although melody facilitates the creation of structural cues such as chunking to provide an organizational structure and combines with factors such as arousal and repetition to aid in memory, melody may be ineffective in encoding semantic memory leading to better verbatim recall but a worse understanding of a given subject.

### **The Use of Rhyme, Rhythm, and Melody as an Organizational Structure**

Rhyme, rhythm, and melody form an organizational structure through the creation of stresses, breaks, and chunking which provide encoding cues for AD patients. The benefit of melody was first shown through a contrast between Kurylo et al. (1993) and White and Murphy (1998). White and Murphy (1998) used binary tone sequences through the experiment and found a significant memorial deficit in Alzheimer's patients, whereas Kurylo et al. (1993) found no such deficit when using melodies. This disparity between the two groups may indicate melodies provide encoding cues that benefit AD patients because while melodies showed no difference in musical memory, there was a difference without a melodic pattern.

The benefits of melody were first described by Wallace (1994) in "Memory for Music: Effect of Melody on Recall of Text," which outlined the methods by which melody aids in the encoding and recall of information. Wallace (1994) claimed music aids in the facilitation of encoding and recall, as melody contributes more than rhythm; it includes chunking, stress patterns, and clarified line lengths. Chunking involves grouping various, related segments to facilitate recall. For example, when memorizing a phone number, most people break the number down by area code, three numbers, and then four numbers. Chunking may also be aided by various other related cues used by songs such as breaks, rhythm and stresses. Breaks, similar to chunking, divide the phrase up into multiple parts, facilitating memory formation. Rhythm is important as it provides a separation between syllables throughout the song. Likewise, stresses differentiate the various parts of a song, making certain portions easier to remember than others. This combination is much more pronounced in song, helping facilitate memory formation. These cues occur more often in song than spoken text, which may explain song's enhanced role in memory.

The findings of Wallace (1994) set the groundwork for other future experiments such as Good, Russo, and Sullivan (2015) who proposed those in the sung group used "structural characteristics pertaining to rhythm" to aid in recall (p. 628). Those in the sung condition recalled more words than the spoken condition possibly due to the use of structural or rhythmic characteristics to aid in recall, supported by the fact that participants created the correct number of syllables even with incorrect words. Both Good, Russo, and Sullivan (2015) and Wallace (1994) agreed song contributes much more to facilitating encoding and recall than rhythm alone, with Good, Russo, and Sullivan (2015) claiming "poem appears to have provided fewer structural cues to support memory" due to other characteristics found in melody (p.637). Wallace

(1994) elucidated the role of each melodic characteristic, such as the ability of melody to distinguish verses from one another, create a structure in which certain parts are more unique than others, and act as a frame thereby creating an organizational structure for the information to be encoded and recalled. This would help Alzheimer's patients by providing a starting place for memory; it is not unlike setting up the borders of a jigsaw puzzle before filling in the middle. This would result in the patients being able to realize if they are missing any components to a song or verse. Melody also helps distinguish certain lines from one another, similar to chunking. This separation in memory is vital for distinguishing between memories and aids the overall structure in the process. Without these distinguishing factors, there would be no feasible way for patients to differentiate between various parts of a song. Structures such as syllable number, accents, and beginning or end all aid in memory cues. The syllable number and beginning or end act similarly to framing, in that both indicate whether a certain aspect is omitted from a song. Accents help differentiate between the various parts of a song, as accents are the fluctuation which build up a verse. In addition to these structures, melody acts as a form of outline for the song; it acts almost like a shelf, on which various parts of song such as stresses, rhymes, and lyrics are placed. Melody may help set apart certain aspects of a text through accentuation, making them more noticeable and memorable. Whereas a monotonous voice may not contain many fluctuations, thereby making it rather unmemorable, song may help aid memory.

One of the most common organizational systems is chunking, in which certain facets of a melody or rhythm are grouped together, facilitating encoding and recall (Dowling, 1973). Chunking is a large factor in aiding memory, as it helps to compact information, encode, and recall. Moussard, Bigand, Belleville, and Peretz (2012) built on this, adding "songs tend to be organized in chunks in long term memory," (p. 522). This is supported by McElhinney and

Annett (1996) which found fewer yet longer chunks of information were formed when subjects were presented with song opposed to spoken text controls. The spoken group would recall more chunks than the sung group, but each chunk had fewer words than the latter group. This means the spoken group recalled a higher number of small chunks whereas the sung group recalled much larger chunks. Miller (1956) theorized since the memory span is a fixed number of chunks, we can increase the number of bits of information that it contains simply by building larger and larger chunks, each chunk containing more information than before (p. 91). If chunking does in fact aid in better long term recall, this may serve to explain why song aids in long term song advantage; song helps one form longer chunks of information, and these longer chunks can be encoded as efficiently as smaller chunks that would be formed with encoding due to speech.

Overall rhythmic structure also serves as a form of organizational structure. Good, Russo, and Sullivan (2015) proposed it was easier to detect the presence or absence of a syllable within the song due to the rhythmic structure (p. 634). In song, the presence and absence of each syllable is exaggerated, leading to greater memory. Good, Russo, and Sullivan (2015) expanded on this, performing an independent t test and finding those in the sung condition had significantly fewer syllabic errors in comparison to the spoken group, suggesting song “facilitated encoding of the rhythmic structure that was present in the lyrics,” (p. 634). This is likely due to the fact that syllabic presence leads to a higher chance of reconstruction (Wallace, 1994). This assertion was further supported by the experiment in Good, Russo, and Sullivan (2015) in which children in the sung group sang to recall the information, as well as used gibberish to fill in portions they did not remember, while the spoken group did not utilize any such devices (p. 637). Additionally, children would substitute nonsense syllables, indicating that they learned the melody, but not necessarily the words. Song facilitates the encoding of the rhythmic structures, in turn aiding the

memory of the entire text. Wallace (1994) explained this recall through the ability of interconnections to strengthen memory by tying portions of text together, providing other cues to memory, and increasing the probability of correctly guessing if the text cannot be recalled (p. 1482-1483). Improved recall often occurs because music helps strengthen memory, tying portions of text together. Music employs a variety of devices such as rhyme, rhythm, and chunking to organize text. These interconnections help recall because they point to other related mechanisms to help stimulate memory. They would aid in providing all the connections necessary for memory. This, in turn, produces a large network of cues which all lead to recall of other memories. It is not unlike a domino effect, where certain interconnections allow the reconstruction of memory by reducing alternative possibilities. If restricting parameters such as the number of syllables and rhythm are present, there are fewer possibilities available when reconstructing memory.

Wallace (1994) concluded music can “facilitate learning and recall of a text” through the organization due to the presence of structural characteristics and ease of committing these characteristics to memory (p. 1483) Music facilitates the learning, encoding, and recall of memories through three primary methods. The first method is the use of structural characteristics used to ensure enhanced memory. These structural cues include rhythm, rhyme, syllabic count, and more. Second, melody is easy to obtain and remember, making it fitting for Alzheimer's patients to use. This means melody is easier to learn and store, making music more efficient for the learning, encoding, and recall of information. The final method involves the facilitation of recall through proper organization and cuing. This means recall is aided by the organization of information in the brain, in the same way chunking organizes information, and cues may help one remember previously learned information.

### **Augmentation of Melody to Maximize Memorial Benefit**

Melody must be repeated to induce familiarity to aid in memory and patients must be emotionally connected to the stimulus, especially through engagement and attention. Samson and Peretz (2005) showed melody repetition aided in both explicit and implicit memory recollection in amnesiacs through the sparing of memory following repetitive presentation of a melody to patients with lesioned brains (p. 419). Repetition is necessary for enhanced memory, as familiarity of a melody is directly related to memorization. Rehearsal may contribute to recall efficacy over time, evident by the probable presence of rehearsal in the sung group in Rainey and Larson (2002). Repeating a phrase or melody leads to dramatically better memory, and this is reflected in melody. Familiar melodies from one's childhood may compound with the structural cues in music to completely aid in familiarity and memory. Because most Alzheimer's patients are older than 65 years old, a children's song popular in the 1950s would likely be ingrained in their memory, leading to a higher probability of facilitation of encoding and recall.

Additionally, previous studies proved older memories tended to be more concrete than newer memories, indicating they are more beneficial for memory. This may be an indication of the types of neuronal changes associated with memory, such as the hardwiring changes in LTM. However, Wallace (1994) determined after only hearing a single verse, "acquisition of structural information is not improved relative to the spoken condition," (p. 1478) and that subjects had "better verbatim recall for the spoken version than for the sung version at every trial," (p. 1475). Wallace (1994) explained this is likely due to the fact that the brain is overloaded as it must now learn the melody and information; thus without sufficient learning, melody does not provide an organizational structure and may distract from recall (p. 1478). Similarly, Racette and Peretz (2007) claimed text and melody are represented separately in memory which makes singing a

dual task, and thus more difficult than a single task (p. 242). When one only hears a single verse, the spoken version is, in fact, more beneficial for recall than the sung condition. This is due to the lack of repetition of the song which leads to complications. Without repetition, melody simply adds more workload to the memory system indicating that if a melody is difficult to learn, it can significantly hinder memory. Moussard, Bigand, Belleville, and Peretz (2012) asserted this model explains why learning sung excerpts is more difficult than learning only lyrics alone at first (p. 522). Thus, in initial learning, music does not always help with memory; however if a melody is learned and repeated properly, it may significantly help with recall.

Repetition is necessary to induce a melody's familiarity, an important facet of encoding and recollection. Familiarity is necessary for memory, shown by the marginal sparing of musical memory found in Alzheimer's patients by Bartlett, Halpern, and Dowling (1995) as well as Cuddy and Duffin (2005) which recounted a case study of a patient who maintained the ability to recognize melodies despite not recognizing the lyrics, evident by the reactions of the patient throughout the experiment. Song advantage is present in familiar melodies, even when factors such as rate of presentation are accounted for, such as in the experiments of Good, Russo, and Sullivan (2015). Unlike these experiments, Kilgour, Jakobson, and Cuddy (2000) found no significant song advantage when using an unfamiliar melody; however, Rainey and Larson (2002) found a song advantage with similar circumstances except using a familiar melody ('Pop Goes the Weasel'). The contrast between Rainey and Larsen (2002) and Kilgour et al. (2000) in familiarity of melody indicated familiar melodies aid in long term song advantage. When the rate of presentation was the same and subjects are shown an unfamiliar song, the long-term song advantage disappears. In Rainey and Larsen (2002), 'Pop Goes the Weasel' was used, a song that most people recognize and is ingrained in their mind. This led to a much better long-term

response than the condition in Kilgour et al. (2000) in which a new melody proved detrimental to participants. As previously discussed, unfamiliar melodies may be detrimental to memory as one must encode both the song and the associated melodic information. Thus, those with AD may be aided by the use of familiar songs in childhood to aid in recall, opposed to introducing newer melodies.

Emotion and attention also impact the encoding of information through melody. Moussard, Bigand, Belleville, and Peretz (2012) claimed emotion can influence memory through a “general arousing effect,” which helps increase attention and motivation, thus aiding in learning and memory (p. 521). Attention is necessary for effective memory, as it is more unlikely one will remember something about which he or she is disinterested. Musical encoding may also aid in attentional issues by providing a more engaging environment (Good, Russo, and Sullivan, 2015). Engagement is necessary, as those who are engaged in a certain text tend to have enhanced memory compared to others. As hypothesized by Good, Russo, and Sullivan (2015), children who are more engaged will likely perform better on memory tests and academics. Additionally, if there is a STM reduction is due to attention control issues, such as in Ménard and Belleville (2009), it should result in a decrease in STM performance for all types of medium. That means that all different types of memory, such as verbal, musical, and so on, should all decrease to the same degree.

Simmons-Stern (2010) agreed with Moussard, Bigand, Belleville, and Peretz (2012), claiming “music heightens arousal,” in AD patients, allowing for “better attention and improved memory,” (p. 3164). Similarly, Jäncke (2008) asserted there is a “memory-enhancing effect of emotions and arousal,” due to associations between memories due to strong emotion and arousal (p. 1). Other experiments further reached the same conclusion; Kensinger and Corkin (2003)

found a memorial benefit for emotional words over neutral words (p. 1169) and Eschrich, Münte, and Altenmüller (2008) found strong emotions related to musical experience facilitates memory formation and recall (p. 48). Strong emotions also contribute to memory, as many remember emotions associated with certain types of memory. This is especially seen in situations such as flashbulb memories, in which people tend to remember events that have a strong emotional tie. These events are often lucid and strong memories, such as people remembering their environments during events such as Kennedy's assassination, the 9/11 attacks, and natural disasters. General arousal associated with music may aid in memory as it helps increase attention and motivation, both necessary facets of memory. Thus, there is a combination of emotion linked with music and engagement which may contribute to the increased memory of musical elements.

Other factors also affect the encoding of melodies; Good, Russo, and Sullivan (2015) found vowels are more integrated in melody than consonants (p. 629-633). This means a heavily vowel based phrase is much more likely to be encoded compared to a consonant heavy one. Good, Russo, and Sullivan (2015) also proposed speech in song is presented more slowly than in normal speech, allowing for more time for encoding and recall (p. 629). Song usually has slower speech than normal speech which provides ample time for encoding and rehearsal, leading to a better memory. The type of information paired with melody also has an effect on the ability of one to encode information; Rainey and Larson (2002) found music helps connected texts opposed to unconnected words. In other words, a story or song is easier to remember than a list of names or cities. The disparity between the previous studies, which used connected texts, and Rainey and Larson (2002) showed unconnected texts are more difficult to encode in the STM.

**Limitations to the Pragmatic Use of Melody as a Memorial Aid**

There are limitations to the implementation of song such as the lack of a link between verbatim or semantic recall and familiarity or recollection. Also, there is a continuum of integration between melody and lyrics which points to the difference between encoding mechanisms in AD patients. Craik and Lockhart (1972) proposed a framework in which information may be first processed phonetically before being processed semantically. However, Calvert and Billingsley (1998) found “there was no relation between reciting and understanding that material,” as the way the information is processed focuses on superficial compared to deeper processing of information (p. 97). This indicates there is no conclusive relationship between reading and reciting a melody paired poem and being able to semantically encode information such as one's names. To combat this issue, Good, Russo, and Sullivan (2015) utilized direct-paired associate method, a technique often used to pair foreign language and native language material to maximize lexical and conceptual memory. Through experimentation, it has been determined the direct pair association method, where a word is directly matched with a definition, is one of the best methods for memory. Specifically, Groot and Keijzer (2000) found the use of the direct-paired associate method significantly aided in the encoding and recall of cognates and concrete terms. This tactic may be employed in AD patients with song to pair the phonetic aid of melody with semantic memory to ensure patients understand the target material.

Riches, Wilson, and Brown (1991) found certain neurons in the anterior and medial inferior temporal and rhinal cortex helped with familiarity and whether there was a previous occurrence. Similarly, Peters et al. (2007) found increased activity in the anterior parahippocampal area in Alzheimer's patients indicating a separate pathways between familiarity-based recognition and effortful recognition (p. 10). Familiarity deals with general

recollection as opposed to specific recollection. Whereas familiarity deals with recalling whether something has been experienced before or not, specific recollection deals with actual details of encounters. There is a difference between the various types of recognition and recollection. to properly utilize these mnemonic devices, Alzheimer's patients would require both familiarity and recollection. This means the two groups must both be separated and examined more closely to create a useful memory technique for practical applications. In previous experiments, only recognition was tested which resulted in a rather inconclusive result.

Simmons-Stern et al. (2012) claimed musical encoding may aid in familiarity, but not recollection, and that musical mnemonics were only able to improve general content memory, not specific content memory. General content memory is largely benefited by the use of musical mnemonics. Specific memory is not affected by musical mnemonics. General content memory simply involves the recognition or familiarity of a given stimulus. For example, if one is presented with three colors, red, blue, and green, general content memory allows one to remember they saw a color. Specific content memory would be knowing that the second color presented was blue. Because only general content memory is affected by music, music may not help with semantic encoding, therefore reducing its efficacy in the use of musical mnemonics.

Simmons-Stern et al. (2012) found musical encoding “preferentially facilitates familiarity but not recollection,” (p. 3300). This indicates the two, familiarity and recollection contribute differently to memory. This is because the two have drastically different characteristics and thus likely use different mechanisms in the brain to process information, such as those proposed by Peters et al. (2007). According to Simmons-Stern (2012) familiarity is mainly associated with Medial Temporal Lobe (MTL) structures such as the hippocampus, in addition to extra-MTL structures. This means familiarity utilizes a wide array of cranial areas including the MTL and

surrounding area. Meanwhile, recollection is mostly based on the MTL. This likely means that familiarity is based in extra MTL structures and that musical encoding would help with memory in those areas evident due to the difference between the structures used in the two, indicating the area in which familiarity is processed.

Simmons-Stern (2012) explained musical encoding enhances general content memory but does not benefit specific content memory (p. 3299). Musical encoding aids in both familiarity and memorial confidence (i.e. being confident in recognizing something). This is necessary for Alzheimer's patients, in a moral sense, as it may motivate many to continue rehabilitation. Musical mnemonics help general memory which may help in AD patients; however, musical mnemonics are largely unable to aid in specific content, indicating a disparity between the two. Specific content memory may be linked to semantic memory, thus song only aids in the surface characteristics of memory, not the semantic meaning. However, there are still benefits of musical therapy in AD patients such as increased mood, increased familiarity with one's surroundings, and confidence in one's location. This would contribute a moral boost to patients' confidence and help with their daily lives.

There is likely a form of dual encoding of memory and lyrics, with an integration of the two, thus recall of one leads to the recall of the other group. Patel (2003) showed there are similarities between music and language and that an overlap of syntaxes showed music and language share similar pathways in the brain (p. 679). This integration is evident through instances such as kids singing gibberish to a known melody or the fact that priming one aspect may induce the other.

A contrast of a poem and song shows song has more retrieval cues throughout leading to increased rates of recall. In other words, a hint, or prime, would significantly help the sung group

in comparison to the spoken group. Rainey and Larson (2002) found the number of trials to relearn the data in either experiment was lower than the sung condition than the spoken condition (p. 183). When the sung group was presented with a hint, students were able to replicate the song better, demonstrating song's dual integration between lyrics and music. This indicates that when song is encoded, lyrics and music are connected in memory. Moussard, Bigand, Belleville, and Peretz (2012) proposed this overlap may be responsible for the connections between lyrics and melody (p. 521). Sammler et al. (2010) found a 'continuum' of integration from independent processing in the anterior temporal regions to an integrated processing in the mid-STS (p. 3576). Lyrics and melody are both integrated and independent in a way, as the two are on a continuum where the two are integrated but become more separate over time. Through an fMRI to examine the usage of certain areas of the brain associated with particular functions, Sammler et al. (2010) found as the lyrics are processed, they travel through the Superior Temporal Sulcus (STS). They begin integrated in the front and progress to independent processing in the back of the brain. This progression through the brain indicates a path through which lyrics and melody both travel. In particular, the left hemisphere is more heavily involved in the processing of lyrics than the right hemisphere. This indicates this part may be more involved in the lyrics. This also suggests there is a fundamental difference between the processing of lyrics and melody. Additionally, the anteroventral section of the brain is more adept at processing lyrics than tunes or melody, suggesting a slight schism between the two. The anteroventral section of the brain is located towards the front of the brain, indicating this area is better equipped to process words than tunes. However, upon first hearing the music, there is no connection between lyrics and melody in the brain. This means the initial detection and sensory input does not receive connected data in the form of lyrics and melody. However, this integration is intermediate in certain aspects of the

mid-STS. This, along with the previously mentioned evidence, show integration slowly unravels over time. This means an integration must be formed after hearing the music at first before the integration unravels over time. As the information travels along the brain, it travels back until it reaches the posterior. From a contextual perspective, lyrics and melody begin integrated in the initial phonemic stage, but separate later between structural and semantic sections. Although the two are not related when first detected, there is a connection that forms before it is split up into various groups.

The mechanisms through which Alzheimer's patients encode information also differ from normal mechanisms. Baddeley et al. (1986) found the central executive component of working memory was impaired (p. 603). Executive control systems are areas of the brain in which the attention among other functions is controlled. As previously discussed, attention is vital facet of memory and encoding. A degeneration of this area may point to problems with memory due to the inability of subjects to pay adequate attention to a given topic or become engaged in a stimulus. Similarly, Belleville, Peretz, and Malenfant (1996) found a "central executive and phonological loop dysfunction," (p. 204). Peters et al. (2009) went further as to claim an executive control system supervises the phonological loop (p. 2). A phonological loop refers to the hold in which rehearsal, the process by which a stimulus is repeated to prepare for storage, occurs. Peters et al. (2009) suggested that due to the altered phonological processing of short-term memory lists, Alzheimer's patients recruit a 'semantic' recognition pathway (p. 11). In other words, Peters et al. (2009) found alternative recognition pathways which involve the recognition of semantic features rather than explicit, phonological recall may be used by AD patients in addition to altered phonological processes (p. 12). A contrast between White and Murphy (1998) and Kurylo et al. (1993) indicates that Alzheimer's patients likely use an

alternative method to process information, as normal processing would have resulted in a similar increase in performance in both groups.

### **Conclusion**

Melody aids memory through rhyme, rhythm, stresses, breaks, and other such structural cues. One of the most effective structural cues is chunking, which breaks up the stimulus in 'chunks', which are more easily encoded in long term memory. Other factors such as arousal and attention also significantly help with memory, as one is more easily engaged and thus, encoding is greatly improved. Repetition assists in introducing familiarity, a necessary facet of effective encoding; familiarity with a melody or stimulus is vital to ensure a new melody does not interfere with the encoding of information, which would prove detrimental to memory as a whole. Additionally, slowing the rate of presentation of information helps phonological loops, vowel heavy sentences are encoded more easily than consonant-laden ones, and connected texts are much easier to encode than unconnected words.

Nevertheless, there is no relation between verbatim recall of information and understanding that material. Alzheimer's patients may be able to recall a song reminding them to brush their teeth, but it is unlikely they will be able to follow the instructions of the song effectively. Analysis of brain structures, such as the contrast between MTL and extra-MTL structures, supports that song only helps with familiarity and general content memory over recollection or specific content memory. Furthermore, the integration of lyrics, melody, and meaning often slides along a continuum of integration, ranging from completely independent at first exposure and posterior regions, but it is at least slightly related in anterior regions. This indicates there is at least a relation between the three factors, indicating some form of connection in memory. In AD patients, there is also a failure in the central executive system, which leads to

inhibited attention and phonological loops, forcing AD patients to rely on a diminished semantic pathway opposed to the traditional phonological methods.

Alzheimer's patients would greatly benefit from the use of a slow, vowel-heavy text accompanied by a repeating, familiar melody from AD patients' childhood. This text would aid in general memory, such as comforting AD patients about their location (i.e. "I wake up in bed every morn'/and find I'm in a nursing home"). Structural cues such as rhyme and rhythm should be arranged to facilitate the ability of patients to chunk information, both acoustically and semantically. Music, such as instrumental accompaniment, may be added to increase engagement and attention, to not only allow for more effective encoding, but to create a comfortable environment for patients. Future studies may be conducted to test the efficacy of these methods, as well as to test other related ways to make the lives of AD patients more pleasant.

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