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Review Article

The Use of a Musical Mnemonic Strategy to Support Verbal Memory Recall in People with Alzheimer's Disease: A Review

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Abstract

The notion that long-term musical memory may be relatively spared in people with Alzheimer's disease has been acknowledged anecdotally for some time and is the focus of a growing number of research studies. This emerging body of research has investigated the status of different musical memory processes during the course of the disease and found evidence for some sparing of musical memory particularly in its early stages. A practical application of how this spared musical memory and capacity for engagement with music can be utilised is the focus of this review, namely the potential role that music can play in supporting verbal memory through the use of musical mnemonic strategies. Widely used in the teaching of children, including those with special needs, and in learning additional languages, this strategy is increasingly recognised as having potential as a means of enhancing verbal recall in people with dementia. This review considers the evidence from group experimental studies and identifies areas for future research and practical application. Although methodological differences and small sample sizes limit the confidence that can be placed in the findings, the majority of studies reviewed support the use of this approach in people with mild to moderate Alzheimer's disease and suggest that this is a field of research that could enhance the quality of life both of people with Alzheimer's disease and those responsible for their care.

Keywords: Alzheimer's disease; Music; Memory; Mnemonics

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Introduction

Context

Alzheimer's disease is characterised by a decline in cognitive function. This is typically characterised by memory impairment alongside other cognitive deficits [1], leading to a decrease in function and independence. Most patients have difficulties with expressive and receptive language [2]. This paper reviews studies that have explored the potential of music to aid learning, recall and the use of expressive language.

Musical Memory

Musical memory encompasses the neural coding of musical experiences, their storage and their subsequent recall [3]. The classification of general memory as proposed by Tulving [4], whereby long-term memory processes are divided into explicit (episodic and semantic) and implicit, can be applied to the different memory processes that function in a musical context. In a musical context, episodic memory can refer to a memory for specific musical experiences and the settings (spatiotemporal, personal and emotional) in which they were experienced [5,6]; semantic memory can relate to the identification of familiar music, the sounds of musical instruments, musical notation and the emotions felt on listening to a performance [7]; implicit memory can relate to the 'mere exposure effect'-an indication of preference for a melody if it has been listened to previously, irrespective of conscious recollection [8], learning new musical material [9] and procedural processes such as playing a musical instrument.

Musical Memory in Alzheimer's disease

The effects of dementia on musical memory are less well understood than its effects in other domains [7]. However, the notion that musical memory may be relatively spared in people with dementia has attracted growing research interest. To date, this has been largely restricted to an exploration of musical memory in Alzheimer's disease (AD).

The first work carried out in this field comprised eight case studies, each exploring the status of musical memory in participants with moderate to severe AD [10-17]. Tests of explicit memory, as assessed by tasks requiring subjects to recognise or name familiar music, demonstrated spared memory in two studies, [15,17] (Case 2) mild impairment in three [11,13,17] (case 1) and severe impairment in two [10,14]; tests of implicit memory demonstrated spared ability to play a musical instrument in seven studies [10-14,16,17] and spared ability to learn new musical material in two [13,16].

The findings of these studies are inconsistent and insufficiently robust to allow firm conclusions to be drawn, but were of sufficient interest for researchers to explore the field further. Subsequent studies sought greater rigour by carrying out group studies with participants from a range of musical backgrounds and at different stages of the disease.

These group studies explored the status of the different musical memory processes: Episodic [8,18-23], semantic [5,18,21,22,24] and implicit [8,19-21].

Results for episodic musical memory were consistent: the capacity to recall and retrieve musical information was severely impaired, even in mild AD. This impairment was demonstrated irrespective of methodological differences such as the use of familiar or unfamiliar musical stimuli, the number of presentations of the stimuli or whether the instructions were intentional (an active listening strategy in which participants are asked to remember the melodies presented to them), or incidental (a passive listening strategy). As Baird and Samson [1] conclude, episodic musical memory is as vulnerable as verbal or other non-musical memory processes in AD.

In contrast, tests of semantic musical memory demonstrated some sparing. For example, in a recognition test for a familiar melody, there was little, if any, impairment amongst participants with mild to moderate AD [18,21,22]; they had no difficulty in accessing their musical 'lexicon'-a music storage system that is accessed effortlessly when familiar music is recognised [25]. These findings led Vanstone et al. [21] to conclude that the memory processes involving recognition (episodic) are dissociated from those involving retrieval from the musical lexicon (semantic). However, in studies including participants with severe AD [5,24], the results were more varied. The authors concluded that although impairment may become more likely as AD progresses, there are exceptions. Further research is necessary to determine how widespread these exceptions are and whether, as Bartlett et al. [18] suggest, semantic musical memory reflects the deterioration seen for non-musical semantic memory in advanced AD.

Findings for implicit musical memory are also inconsistent. Of the four studies assessing the mere exposure effect, two found evidence for its preservation [8,20] whilst two did not [19,21]. There are no obvious reasons, such as differing cognitive abilities or methodologies, for the discrepancy in these findings. No conclusions can therefore be drawn.

Although not explored in group studies, there are examples of spared procedural memory, such as singing or playing an instrument. As McDermott et al. [26] observe, the ability to produce music by singing is often remarkably well preserved even in severe AD. Furthermore, a number of studies have demonstrated a spared ability not only to recall and sing familiar melodies, but also to learn and sing novel ones [27-29].

These findings are not conclusive but suggest that whilst some musical memory processes are severely impaired, others are spared in some, if not all, people. This sparing offers a means of preserving some engagement with music and of introducing effective interventions that improve quality of life. As AD progresses and the ability to recall words and facts declines, a strategy for retaining and communicating that information would be greatly valued, as much by carers as for people with dementia themselves. To this end, researchers in recent years have explored the potential of a musical mnemonic strategy. This approach, whereby information to be learned and recalled is set to music, is commonly used as a memory aid in advertising, in education and in foreign language teaching [30]. It is thought that the shared resources between the two domains of language and music could explain why the addition of music facilitates verbal encoding and recall [31]. Although learning two elements together increases the cognitive load, the combining of the two results in a deeper encoding, thus enabling the storage and retrieval of information over time.

A case study by Kirke et al. [32] demonstrates the practical use to which such an approach can be made. The daily routine of a participant with mild AD was set to a specially composed melody. This included tasks such as taking medication, cleaning teeth and eating meals. After a few weeks of listening to this song, it was reported that the individual had complete recall of both melody and lyrics. If a strategy of this kind could be found to reliably assist people with AD in the recall, and potentially the expression of verbal information, it would be of great practical benefit. Studies that have investigated the use of a musical mnemonic strategy to facilitate verbal recall are the focus of this review.

Articles were identified using systematic database searches of Cochrane, Embase, Web of Science, PubMed, Psych INFO, Emcare, Ovid, Science Direct and Sage Journals for the period 1995-2019. Searches were made using the keywords 'music', 'Alzheimer's', 'dementia', 'memory' and 'mnemonic'. References in these articles were searched to identify further relevant studies (in English). Criteria for selection were group experimental studies involving people with Alzheimer's disease; case studies were not included. Six studies fulfilled the criteria and are reviewed below.

Review

In order to assess the efficacy of a mnemonic strategy, these six studies employ two assessment measures, one assessing recognition, the other, recall. For the former, an old/new recognition test is employed. Recognition memory the ability to identify information previously encountered has two underlying processes, 'recollection' and 'familiarity'. Recollection is the conscious remembering of previously presented stimuli, whereas familiarity is a feeling of 'knowing' the previously presented stimulus [9], but without knowing why. First used by Bartlett et al. [18], the test was as follows. Participants listened to eight familiar melodies (Christmas music, nursery rhymes and folk tunes), approximately five seconds long, and were instructed to try to remember them. When presented a second time, the original melodies were intermixed with eight more. The participants' task was to say 'yes' if they were in the first presentation, or 'no' if they were not. This procedure was then replicated with sixteen unfamiliar melodies (deviations of the familiar ones and musically comparable). Subsequent studies have used variations of this test. Differences lie in the use of familiar and/or unfamiliar melodies, their number, their length and the choice of accompaniment. When familiar melodies are used, the process of recollection is required, in order to differentiate between the melodies played in the experimental session and those stored in a listener's musical lexicon. In other words, it requires memory for an event (the presentation of musical stimuli) and a time (recognition that the melody was played at a particular time). When unfamiliar melodies are used, the test relies on familiarity for the melodies played in the experimental session [22].

The assessment of recall the ability to retrieve information from memories is measured either by the proportion of words correctly recalled, or the amount of specific information recalled.

Simmons-Stern et al. [33] conducted the first study of this type pertaining to music. Their aim was to explore whether music facilitates

learning for new information in people with AD. Two groups-13 with AD (MMSE 24 ± 4.6) and 14 controls-took part. Assessment was made using an old/new recognition test with intentional instructions. The stimuli were 80 unfamiliar children's songs. Forty of the lyrics were presented visually, 20 with music, 20 without. Each was repeated twice. The task was to make an old/new recognition judgment when presented with all 80 of the lyrics without any audio recording.

The results demonstrated that the AD group achieved higher scores of recognition memory for sung lyrics rather than spoken lyrics. However, this was not replicated in the control group, where no benefit of musical encoding was found. The authors suggest three explanations. First, that the process for the encoding and retrieval of musical stimuli is different in people with AD. Second, that the task was too simple for the control group, thus creating a ceiling effect. Third, that cognitively healthy older adults have no need for an attentional aid such as music. This study demonstrated some of the first empirical evidence for the use of musical mnemonics in the AD population, but it was limited in its application - without any assessment of text comprehension it had no practical benefit.

The same research team carried out a further study [34] to explore whether a musical mnemonic strategy could facilitate the recall of specific as well as general content, and whether it could be recalled at a later time important for any practical use of this strategy. Two groups-12 with mild AD (MMSE 24.67 ± 3.45) and 12 controls-took part. The same musical stimuli were used, but here the lyrics were relevant to the participants' daily lives. Forty topics were selected, and each was given two treatments: one had general content, the other a related specific action. After three presentations of the stimuli in random order (20 of the 40 pairs were spoken, 20 were sung), participants were given three tasks. First, after each song, they rated liking on a 5-point Likert scale. Second, they answered two questions relating to the complete set of 80 stimuli, 40 studied and 40 unstudied. The first was whether the lyrics were about a particular topic (general). If they answered 'yes', they were asked what the lyrics had instructed them to do (specific). Third, following a 40-minute interval, an old/new recognition test of the 40 studied and 40 unstudied stimuli presented at random.

Results for both groups showed that memory for general content was significantly better when sung rather than spoken. However, this did not apply to specific content information – the results were the same for both conditions (for both groups). The authors suggest that musical encoding benefited the memory process of familiarity for general content questions but not the process of recollection for the retrieval of specific information. This suggests that the two processes are dissociated. The authors concluded that with no benefit to specific recollection, musical mnemonics may be ineffective for teaching information to people with AD.

However, these findings are not conclusive. As the authors suggest, alternative musical stimuli may elicit different results. Variables such as familiarity, valence and structure all need to be considered. The melodies used in these two studies had a simple structure, known to be beneficial to recall, but they were unfamiliar. Earlier research suggests that learning lyrics is easier when set to a familiar melody [35].

Results for the old/new recognition test demonstrated that the AD group showed no improved discrimination for the sung stimuli: There were fewer false alarm responses, but also fewer hit rates. Both false and true recognition were reduced. The authors suggest that these results were due to the AD group's inability to engage the distinctiveness heuristic (the expectation that sung lyrics are more easily remembered than spoken lyrics), which can lead to fewer false memories [36]. The individual assumes that they will remember a sung lyric already studied; if they do not, they assume that the lyric was not previously studied. Given their impaired recollection, the AD group's inability to use the distinctiveness heuristic to enhance discrimination is unsurprising.

In the same year, Moussard et al. [37] carried out a case study of a woman with mild AD. As in the previous study, they compared the learning and recall of new lyrics either spoken or sung (using both familiar and unfamiliar melodies). Recall, measured by the percentage of words that were exactly right, was assessed immediately, after ten minutes and then one month. Initial scores for the unfamiliar condition were significantly lower than for familiar or spoken, but these changed over time. Final scores showed a significant benefit of the sung conditions; initial difficulties did not predict the outcome. Scores for delayed recall were also higher in the sung condition. The authors concluded that although singing lyrics to an unfamiliar melody can overload memory and interfere with initial learning, over time, sung lyrics, even with unfamiliar melodies, may enable better long-term recall than spoken lyrics.

In order to build on these initial findings, the same authors carried out a group study [31]. As well as a comparison of the learning and recall of sung and spoken lyrics, they assessed the influence of melodic familiarity. Two groups-eight with mild AD (MMSE 25.3 ± 1.6) and seven controls-took part in a two-phase study. Phase one comprised the learning and recall of lyrics (immediate and delayed recall). There were four conditions: spoken lyrics, lyrics set to an unfamiliar melody, lyrics set to an unfamiliar melody that was previously learned without lyrics, and lyrics set to a familiar melody. An adaptive procedure, comprising line-by-line learning, was used to encode the material during six once-weekly sessions. Phase Two, involving the AD group only, comprised the assessment of learning speed and delayed recall after four weeks.

As found in the case study, music conditions did not benefit immediate recall scores. Scores for sung and spoken conditions were similar, the lowest being found in the unfamiliar melody condition. However, as before, initial difficulties did not predict the outcome. Scores for the sung conditions increased over the six sessions, finally achieving higher scores of correctly recalled words (irrespective of melodic familiarity). These two studies, by demonstrating enhanced long-term recall of sung lyrics, provide some support for the use of a mnemonic musical strategy. The authors suggest two strategies to enhance these findings: pairing the lyric content with the acoustic traits of the melody and using lyrics that are relevant to daily life.

The next study to explore this subject was carried out by Palisson et al. [38]. There were three conditions: music with an instrumental accompaniment, spoken and spoken accompanied by a silent movie. The inclusion of the latter was to investigate whether benefits to verbal recall are due to the binding together of two items in a dual-coding process (musical or not) or are specific to music. Two groups-12 with mild AD (MMSE 19-28) and15 controls-took part. Each condition was assigned a text relating to everyday life (as suggested by Moussard et al. 2014). The instructions were intentional and lyrics

were presented visually. An adaptive learning procedure was used for encoding, similar to that used by Moussard et al. (s2014). There were three assessments: the number of lines learned, the immediate recall score (the percentage of correct words recalled) and the delayed recall score (after five minutes).

Scores for each of the assessments were higher in the familiar music condition in both groups. This benefit of the musical association was robust, being observed in 92% of the AD group, and indicates that musical mnemonics facilitate retrieval of specific as well as general content. Although less than music, some benefit was found for the 'spoken plus movie' condition. The authors therefore suggest that a binding effect is insufficient in itself; music facilitated a superior result.

These four group studies all suggest that music facilitates the encoding and recall of general information [31,33,34,38]. However, only one study [38], demonstrates that music may also facilitate the encoding and recall of specific information, thereby providing some support for a musical mnemonic strategy. These differing results may be due to differing methodologies such as the choice and presentation of the stimuli and encoding procedures.

Some of these methodological issues informed the study carried out by Baird, Samson et al. [39]. For example, lyrics were relevant to daily life and set to a familiar melody. However, their particular interest was the influence that musical training might have on the effectiveness of a mnemonic strategy. In the studies discussed above, this was not explored in any detail. Simmons Stern et al. [33,34]. made no analysis of any musical training effect and there were no trained musicians in the studies by Moussard et al. [31] and Palisson et al. [38]. Two groups took part-11 with mild/moderate AD (MMSE 20.09 ± 4.15 (musicians); 17.50 ± 4.28 (non-musicians) and 22 controls-with each including a subset of musicians, five in the AD group, 15 in the control group. The lyric stimuli comprised two items each relating to a day of the week, a time and a task. These were set to a familiar song, Waltzing Matilda. Participants were given intentional instructions and listened to each of the two items (one sung, one spoken) once. They then had five 'learning trials'. There were two assessment sessions: in the first, immediate recall followed by a 30-minute delayed recall; in the second, 24-hour delayed recall (by phone). The measure was the accurate recall of specific information relating to the texts, either free or cued recall.

Overall results showed that there was no mnemonic effect for the recall of sung information as compared to spoken information in either group. Indeed, for non-musicians in the AD group, scores for learning spoken information were significantly higher than for the sung condition, whilst for AD musicians, there was no difference between the two modalities. Neither were there any differences between the two groups for delayed recall or in recognising spoken or sung information. The authors suggest several methodological issues to explain these findings: setting new lyrics to a familiar song required participants to inhibit recall of the familiar lyrics, thus increasing the cognitive load, particularly in the AD group; slowing the speech rate to match that of the sung stimuli may have facilitated memory for the spoken stimuli; assessing recall of specific information, rather than counting the proportion of words correctly retrieved, as in Palisson et al. [38] and Moussard et al. [31,37]; the unfamiliar context of a phone call for the 24-hour delayed recall; the lack of accompaniment to the melody; the 30-minute delayed recall task (this may have been too long for those with lower MMSE scores).

Although the results did not support the use of a musical mnemonic strategy, they demonstrated some benefit of music training to memory in AD. There were two main findings: first, the learning of sung information was significantly better in the AD musicians group; second, scores for the AD musicians were not significantly different from those of the control group musicians for the recall of sung and spoken information at a 30-minute delay or of spoken information at a 24-hour delay, thus suggesting that ability levels in both groups were similar. By comparison, the AD non-musicians could not recall any information on delayed recall.

Although these results suggest that musical training had some benefit to the five AD musicians, it should be noted that an individual analysis of their scores showed that the lack of significant difference with the control musicians was due to the superior performance of two participants; the remaining three were unable to recall any information on delayed recall. This supports previous findings that there are exceptions in individual musical memory impairments [5,24]. The small sample size also limited the reliability of these results.

In the most recent study to be carried out in this field, Ratovohery et al. [40]. explored whether the effectiveness of a musical mnemonic strategy was dependent on emotional valence. In their earlier study of a non-AD population (2018), a positively valanced melody was found to be effective whilst a negatively valanced melody was not. Two groups-13 with mild to moderate AD (MMSE 22.4 ± 3.5) and 26 controls took part. Levels of musical expertise were balanced between the groups. There were three conditions: spoken, 'positive' music and 'negative' music. The two music stimuli (presented on the piano) were Ode to Joy by Beethoven (positive valence) and Funeral March by Chopin (negative valence). The lyric stimuli comprised three texts relevant to daily life, one being assigned to each condition. The instructions were intentional and the encoding process similar to that of Palisson et al. [38]. Assessment was made at encoding, immediate and delayed recall (at 10-minutes and 24-hours) with the latter being carried out over the phone.

Although scores achieved by the AD group were lower than the controls in all tasks, the AD group had higher scores for the sung texts both at immediate and delayed recall. Of particular interest, in the light of the findings of Baird, Samson et al. [39], was the participants' lack of musical expertise, thus suggesting that musical training is unnecessary for the successful use of a musical mnemonic strategy. The authors attribute the results to methodological issues: the use of familiar music, the combined visual and auditory presentation of the texts and the reinforced encoding process. Results for the influence of valence showed a group difference. For controls, the benefit of musical encoding was seen only in the positive valence condition, thus suggesting a positivity bias. However, for the AD group, although the positive valence condition was effective at immediate recall, there was no difference at delayed recall, whether after 10 minutes or 24 hours, thus suggesting that the positivity bias disappears during the course of AD. A possible explanation for this lies in the familiarity of the music excerpts; both of them may have elicited positive emotions and/or autobiographical memories which facilitated memory, irrespective of the melody's valence.

These findings suggest that a musical mnemonic strategy, irrespective of the music's valence, may facilitate the recall of both specific and general information.

Discussion

With the exception of the study by Baird, Samson et al. [39], the findings from these studies suggest some benefit of a mnemonic strategy for the retrieval of verbal information in people with mild to moderate AD. However, the findings lack consistency. Reasons for this may be due to the small sample sizes (the largest AD group had 13 participants, the smallest, eight) which limit the degree of confidence that can be placed in the findings. Methodological differences may also contribute to the varying results and hinder a proper comparison of the results.

These differences can be seen in the choice of stimuli, the method of encoding and the assessment of learning. The lyrics selected for the stimuli vary as to content, length and mode of presentation (audio/visual); the music selected for the stimuli vary as to familiarity and whether or not they were accompanied; encoding varies as to the number of presentations and type of procedure; assessment measures vary as to the type of test (recognition or free recall), scoring method (proportion of words recalled or recall of specific information) and time of assessment (immediate and delayed). Where reported, these are presented in the table below. As this review is a discussion of group studies rather than case studies, that of Moussard et al. [37] is not included in the table. However, their methodology was replicated in the 2014 study (Table 1).

The selection of the musical stimulus is an important element of the study design. Indeed, it may be one of the defining factors on which the effectiveness of the mnemonic strategy rests. As Kirke et al. [32] suggest, results depend on the music used and the way the lyrics are set to it. There are several variables that need to be considered. Much has been written about the advantages of using a familiar stimulus as opposed to an unfamiliar one and there is wide support for the notion that lyrics are learned more successfully when set to a familiar melody. It is also the case that familiar music is widely held to be an important factor in achieving a positive response to therapeutic interventions in the AD population. This was the approach taken by Palisson et al. [38], Baird, Samson et al. [39] and Ratovohery et al. [40]. However, Moussard et al. [31] took a different approach by comparing the effectiveness of both familiar and unfamiliar melodies to assess the verbal recall of lyrics. They found the sung condition to be more effective, irrespective of melodic familiarity. They concluded that using an unfamiliar melody interferes with initial learning, due to the increased memory load of learning a new song and lyrics together, but that performance increases resulting in a robust memory trace that enables retrieval over time [31].

There are other elements to consider when selecting a melody. Kirke et al. [32] remark that 'some melodies and lyrics are simply more memorable than others'. To that end, Simmons-Stern et al. [33,34] recommend that melodies be simple and repetitive and Moussard et al. [31] that melodies should be simple, with a stable, standard meter and in a major key. Each study fulfilled these criteria either using simple children's songs, or, in three cases using Ode to Joy by Beethoven [31,38,40].

Author	Population	Age	No. of Stimuli	Conditions	Type of assessment	Number of exposures	Lyric content, length and mode	Music presentation, and length	Time of assessment
Simmons-Stern et al. (2010) [33]	13 (AD) 14 (control)	77.3 73.7	80	Music: unfamiliar. Spoken.	Recognition.	2	Four-line excerpts from unfamiliar children's songs. Duration of sung and spoken versions were matched. Visual presentation.	Female singer with instrumental accompaniment.	Immediate
Simmons-Stern et al. (2012) [34]	12 (AD) 17 (control)	81.17 78.63	80	Music: unfamiliar. Spoken.	Recognition.	3	Four-line excerpts of unfamiliar children's songs. Relevant to daily life. Duration of sung and spoken versions were matched. Visual presentation.	Female singer with an instrumental accompaniment.	Immediate
Moussard et al. (2014) [37]	8 (AD) 7 (Control)	77.8 75.7	16	Music: familiar (Ode to Joy), unfamiliar, slightly unfamiliar. Spoken.	Free recall.	Six once-weekly sessions, using an adaptive procedure.	Six texts of 8 lines. 21 seconds in length. Unknown repertoire of a folksinger. No visual presentation.	36 seconds in length, a stable metre, major mode. Female singer, unaccompanied.	Immediate and delayed at 10 minutes and at 4 weeks.
Palisson et al. (2015) [38]	12 (AD) 15 (Control)	82.8 77.1	5	Music: familiar (Ode to Joy). Spoken: with movie sequence. Spoken.	Free recall.	One presentation followed by an adaptive learning procedure.	3 texts of 8 lines. Relevant to daily life. 26 seconds in length. Visual presentation.	34 seconds in length. Female singer with a familiar instrumental accompaniment.	Immediate and delayed at 5 minutes.
Baird et al. (2017) [39]	11 (AD) 22 (Control)	75.75 72.43	2	Music: familiar. Spoken	Free and cued recall, recognition.	One session with five 'learning trials' for each modality (carried out on one occasion).	2 texts of 2 short sentences. Relevant to daily life. Duration of sung and spoken versions were matched – 15 seconds. No visual presentation.	Female singer performed a capella. 15 seconds in length.	Immediate, delayed at 30 minutes and at 24 hours.
Ratovohery et al. (2019) [40]	13 (AD) 26 (Control)	77.9 77.1	3	Music: familiar, high valence (Ode to Joy). Familiar, low valence. Spoken	Free recall.	One presentation followed by an adaptive learning procedure.	3 texts of 8 lines. Related to everyday life. Visual presentation.	Female singer, piano accompaniment.	Immediate, delayed at 10 minutes and at 24 hours.

Table 1: The condition, stimuli and assessment measures used for the assessment of a musical mnemonic strategy to facilitate verbal memory.

The melodies in each study were performed by a female singer, but the accompaniments varied: instrumental, piano or none. It is not known whether a simple unaccompanied melody is more or less effective than more complex material [41]. However, there is support for the notion that a familiar accompaniment can aid learning and retention [38]. This is something to be explored in future research.

The studies also differed in their presentation of the lyrics. When lyrics are set to music, the speed of delivery is typically slower than when spoken. Some of the studies, in order to ensure that the delivery of the stimuli was as ecologically valid as possible, presented the spoken versions at a speed consistent with natural speech [31,38]. Thus, the difference between sung and spoken conditions was as much as 15 seconds. However, in other studies, the speed of the spoken versions was slowed to match the length of the sung versions [33,34,39]. Making the sung and spoken stimuli equivalent in this way may have given participants more time to encode the spoken words. A further difference between studies was the use of a visual presentation of the lyrics. This method, as used by Simmons-Stern et al. [33,34,38,40], may have facilitated a richer and deeper encoding.

In addition to the quality of the stimuli, there were differences in the quantity, both of numbers used and presentations. The number of stimuli ranged from two [39] to 80 [33,34]; the number of presentations during the encoding stage ranged from two [33] to six [31], with the latter extending over a six-week period. There were also differences in the delay period between encoding and retrieval; this ranged from five minutes [38] to four weeks [31]. Some of these differences are explained by assessment type (recognition and/or free recall), but others may have contributed to the varying results. For example, it is probable that the adaptive learning procedures, employed by Moussard et al. [31], Palisson et al. [38] and Ratovohery [40], resulted in a deeper encoding than the one session strategy of Baird, Samson et al. [39].

Task difficulty is another issue. The difference in cognitive ability between participants with AD and healthy controls can result in floor or ceiling effects: if the task is too challenging for the AD group, a floor effect may ensue or if the task is too easy for the controls, a ceiling effect may ensue [33,39], making it impossible to distinguish the effects of each condition.

MMSE scores are helpful in assessing the severity of the disease; they are not sufficient as a diagnostic tool. The participants in these studies were, for the most part, in the mild stages of AD. Only in the studies by Baird, Samson et al. [39] and Ratovohery et al. [40] did they include participants with moderate AD. It is notable that in each of the studies whose participants are described as having mild dementia, the range of MMSE scores includes those in the high 20s (27-28). Although the allocation of MMSE scores to different dementia stages is not firmly established, a score of between 20 and 24 commonly denotes mild dementia, whilst a score of between 25 and 30 is regarded as normal cognition. This designation was used by both Baird, Samson et al. [39] and Ratovohery et al. [40] scores for their control groups ranged from 25 to 30. However, other health professionals consider that a score of 26 or 27 denotes mild dementia and this was the criterion that the other studies adopted. For example, in the study by Palisson et al. [38], seven of the twelve participants in the AD group had scores between 25 and 28 and in the study by Moussard et al. [31], six of the eight AD participants had scores between 25 and 27. These would all have qualified to be in the control group in the studies by Baird et al. [39] and Ratovohery et al. [40]. It is notable that in the latter study, the highest MMSE score in the AD group was 28, whilst the lowest in the control group was 25, thus indicating that some of the AD group participants had very mild levels of cognitive impairment and, in some cases, an equivalent or superior cognitive capacity to that of the control participants. Although group differences in MMSE scores were reported as being significant in the studies by Baird et al. [39], Ratovohery et al. [40] and Simmons-Stern et al. [33,34], future research would benefit from having more distinct MMSE group profiles.

Conclusion

These findings provide some basis, as suggested by Ratovohery et al. [40], for the application of a mnemonic strategy for learning and communicating simple everyday information. However, the findings are often contradictory and the small sample sizes limit the degree of confidence one can have in them. It is hoped that the growing interest in the field can be channelled into research that addresses at least some of the limitations of these studies. Given the potential for practical applications in the AD population, they are of sufficient importance to explore further.

There are several areas for future research. These might include investigation into the most effective characteristics for the stimuli, both musical and spoken, for optimal verbal recall. Although some of the lyrics used in the studies discussed in this review have used information relevant to daily life, they have not, as yet, been of any potential use to the participants. A strategy of learning practical, everyday information could be investigated.

Future research could also conduct larger-scale trials. Although challenging to achieve in this population, it would allow for greater insight into the types of patient profiles likely to benefit from a strategy of this kind and give greater confidence in the findings. It would also be of interest to widen the investigation to people with more severe AD and with other dementia diagnoses.

There is the potential for positive therapeutic outcomes if a musical mnemonic strategy can be found to reliably assist people with AD in the recall, and perhaps the expression of verbal information. Although there may be some who would benefit to a greater extent than others, this is a field of research that could enhance the quality of life, both of the people with AD themselves, and also those with responsibility for their care.

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