Verification of the Impact of Storage by the Rhythm Phrase to be Repeated

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Abstract

Introduction

Alzheimer’s Disease (AD) accounts for a high percentage of dementia at over 60%. As dementia incidence doubles every 5 years from 65 years old onwards, developing a countermeasure is an urgent issue. As a countermeasure, the effectiveness of cognitive function training tasks such as dual-task (performing two tasks simultaneously) and n-back task (a delayed recall task for items shown n steps earlier) have been verified. Furthermore, it has been verified lyrics accompanied with sound or rhythm are stored easily by the memory, but difficult to remember when without sound or rhythm. It was hypothesized that combining rhythmic music with repeated memory tasks would improve memory performance. It was also predicted that stress associated with memory tasks would be alleviated by the relaxing effect of music. The purpose of this study is to verify a new training method combining rhythmic music and repeated memory tasks. An intervention study was conducted over 3 months, and compared results from the intervention group and the control group.

Method

Screening test for mild cognitive impairment: Montreal Cognitive Assessment (MoCA test) and; Stress check: Measured α-amylase levels of saliva taken from the sublingual gland. Analysis was conducted by a corresponding t-test, comparing the control group and intervention group results.

Results

In comparison to the control group, cognitive function was significantly improved and distress was reduced in the intervention group.

Conclusion

Repeated memory tasks combined with rhythmic music were effective both in improving memory capacity and reducing stress.

Keywords

Rhythm Music; Repeat Phrase; N-Back Task; Dual-Task; Distress

Introduction

According to the Japanese Ministry of Health, Labor and Welfare, the estimated prevalence of dementia is 15% of the over-65 population. The number of people suffering from dementia is estimated to be 4.62 million people of the elderly population of 30.74 million (2012 Statistics) [1]. Alzheimer-type dementia (AD) accounts for over 60% of cases of dementia, the highest of all types [2]. The number of dementia incidence continue to
increase every year [3] and incidence rates double every 5 years in elderly people over the age of 65 [4]. The task of developing countermeasures is urgent. However, the amyloid vaccine developed in 2000 could not suppress the decline in cognitive function even after the removal of amyloid-β from the brain [5]. Therefore, although preventative measures before the onset of dementia is most important in the present situation, implementation of these measures regionally is still at the exploring stages and effective implementation is being sought.

Participants from City Kashihara’s elderly population were recruited publicly and invited to participate in an intervention study of 3 months. Comparisons of the control group and intervention group were conducted before and after, and the effects of the experiment were verified.

In previous studies conducted on brain training, the effectiveness of the n-back task (a delayed recall task for items shown n steps earlier) was verified. Meta-analysis results showed activity in the frontal lobe and parietal cortex area [6, 7]. The brain has been reported to be more active during dual-task (performing two tasks simultaneously) than single-task (one-task activities such as exercise only, learning only) and activity in the anterior cortex has been verified [8, 9]. Based on these previous studies, synergistic effect was expected in combining n-back task and dual-task in this study experiment.

Furthermore, lyrics are remembered easily in daily life and can be recalled and sung even if months or years have passed. Many people surely know phrases with music are easy to remember, but difficult to forget. The condition for a musical phrase to be retained in memory like an earworm is said to be not too simple but not too complicated. In addition, the music must be simple, have a rhythmical pattern and a tempo fast and light enough for the body to move to it [10-12]. A rhythmic phrase with music can be expected to potentially have a promoting effect on memory. Rhythmic movement is known to activate serotonin [13, 14].

Serotonin is said to stabilize the mind and body, and influence memory and learning functions in the hippocampus in the brain. The aim is to improve memory abilities by developing upon previous studies through intervention experiments. In the pre-tests conducted, a negative correlation between stress and cognitive function was discovered. Higher scores on the memory test while participants were in a stress-free state [15]. Therefore, the second aim is to reduce stress through the intervention study.

The purpose of this study is to verify a new training method combining rhythmic music and repeated memory tasks, and aims to reduce stress and improve memory at the same time. An intervention study was conducted over 3 months, and compared results from the intervention group and the control group.

**Methods**

**Target group:** Participants from the elderly population of City Kashihara

**Period:** April - September 2016

**Intervention:** Once a month, over 3 months

**Intervention method developed:**

1. Select simple and rhythmic patterns and music with repetitions

2. Implement dual-task with rhythm. Dual-task is a task to perform two tasks simultaneously where the right hand performs the task on a two-beat rhythm, and the left hand on a three-beat rhythm (see Figure 1). Registered with the Japan Cognicise Executive Office who promotes dual-task exercise methods.

3. Implement n-back task before, during and after music is played. n-back task is a delayed recall task which increases the difficulty as items are recalled n steps back. For example: 1-back task: answering what the previous task was. 2-back task: answering what the task 2 tasks ago was. 3-back task: answering what the task 3 tasks ago was.

**Evaluation method**

Evaluated with the following screening tests and measuring instruments

1. Screening test for mild cognitive impairment (MCI): Montreal Cognitive Assessment (MoCA test) was
conducted 3 times. Before intervention, after the control period and after the intervention. Full marks being 30 The higher the score, the higher cognitive function. Cut-off value score is 26 points. Permissions to conduct the test from Dr. Ziad Nasreddine, the developer of the test, and Dr. Hiroyuki Suzuki of Tokyo Metropolitan Institute of Gerontology, the translator of the Japanese version of the test, were obtained.

2. α-amylase levels of saliva taken from the sublingual gland were measured to measure eustress and distress. As shown in Figure 2, sympathetic nerve activity is reflected. Unpleasant stimulation causes levels to rise and pleasant stimulation causes it to decrease. Eustress and distress were measured in 30 seconds using saliva. The standard values of α-amylase levels in saliva from the sublingual gland according to Nipro, the manufacturer of the α-amylase test kit, are as shown in Table 1.

### Analysis Method

To compare the scores of MoCA test and the concentrations of α-amylase in sublingual saliva before and after the intervention, the corresponding t-test was carried out. Pearson correlation coefficient was used for the relationship among each of test items.

### Ethical consideration

This study was approved by Research Ethics Committee of Nara Medical University before the implementation (approval number: 741).

Subjects were explained verbally and in a written form about study purposes and methods, free-will participation and the right to refuse, privacy protection, data management methods, and release of the results. They participated in this study by signing in the letter of consent.

### Clinical Trial Registration

This study has been registered in the clinical trial registration database: University Hospital Medical Information Network (UMIN); registration number: R000028956. ([https://upload.umin.ac.jp/cgi-open-bin/ctr_view.cgi?recptno=R000028956](https://upload.umin.ac.jp/cgi-open-bin/ctr_view.cgi?recptno=R000028956)).

### Result

Among the 108 participants, data of the 79 that participated until the end were analyzed. The average age of the subjects is 75 ± 8.2, with 12 being male and 67 being female. For the cognitive function, the average value of score for each category on the MoCA test and the t-test results are indicated in Figure 3.

**Figure 3:** Comparison before and after the intervention and control of the mean value of MoCA test

<table>
<thead>
<tr>
<th>Corresponding paired t-test, n = 79.</th>
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<td><strong>Significant at 1% level</strong>, <em>Significant at 5% level</em>*</td>
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Table 1: The reference values of salivary α-amylase

| 0-30 KU/L | There is no negative stress. |
| 31-45 KU/L | There is slight negative stress. |
| 46-60 KU/L | There is negative stress. |
| 61 KU/L | Lot more there is a high amount of negative stress. |
The average total score in the MoCA test before the intervention was 23.4 points (< 26 points), and it did not meet the cut-off value. After the non-intervention control period of 3 month, when measured again, it was 24.7 points (< 26 points), though with a slight increase in the total score, there was not much changed in each cognitive category. After the intervention, the average total score was 25.8 points (< 26 points), it increased to a score significantly closer to the cut-off value.

For each cognitive item, a significant function improvement was acknowledged in trail making and clock drawing (visual-spatial cognitive ability), verbal fluency (exploration of semantic memory), repetition immediate memory, short-term memory, recall delayed-memory, recall repeat, reciprocal number, target detection, subtraction task concentration, attention, memory (p < 0.05).

Next, for α-amylase of the stress measurement results, as indicated in figure 4, there is a correlation with the age. In it indicates that the older the person was the stress level was greater (Pearson product-moment correlation r=0.25) Table 2.

Subsequently as for the results of measuring stress (α-amylase), the control group did not show any significant change, while the intervention group showed a significant decrease in negative stress from 47.88 (before the intervention) to 40.51 (after the intervention) on average (p < 0.01).

In addition, there was a negative correlation between the result of MoCA test and salivary α-amylase, and subjects with higher cognitive functions had lower negative stress as shown in Figure 5 (Pearson correlation coefficient, r = –0.397).

Discussion

The implementation of preventive intervention of AD in each municipal is still under development and the trial-and-error stages. Therefore, in the present situation, establishing effective techniques and accumulating verifications of intervention study results is an urgent task at hand. What is noteworthy in this study is it verified that repetition of rhythmic phrases in combination with music promotes memory retention. The conditions for rhythmic phrases to be retained in the memory like an earworm have been mentioned above [10-12]. An earworm is a phenomenon where rhythmic phrases are automatically recalled repeatedly. This condition was utilized in conjunction with brain training. It was predicted that the
effect of brain training will be enhanced through the use of the memory promoting effects of rhythmic phrases with music.

The results of the MoCA test showed this method was effective as the intervention group scores improved significantly compared to the control group. The method used was combining brain training activities: dual-task and n-back task; and rhythmic phrases and music. The effectiveness of dual-task and n-back task had already been verified in previous studies [16-18]. In particular, since it has been verified to activate the prefrontal cortex, which tends to deteriorate with age, these brain training tasks are suitable for the elderly [19, 20].

Although continuous brain training was accompanied by stress in some cases, distress was significantly reduced instead, using the method in this study. It can be inferred that music influenced recovery from fatigue [21, 22]. From the findings of this study, a negative correlation between cognitive function and stress was discovered (p<0.01). Therefore, it can be seen to maintain improvement of cognitive functions, it is imperative to reduce stress. Stress increased significantly as age increased (p<0.05). From this result, it can be seen that physical and mental disorders increase with age. A recent survey by the Ministry of Health, Labor and Welfare revealed that physical and mental disorders accompanying age, and the unease accompanying the disorders [23]. As the aged society is an issue, the significance of stress prevention is also extremely large. The fact the method developed in this study promoted stress prevention and brain training is a noteworthy benefit.

The method developed in this study utilized “ostinato”, a rendition often used in music such as jazz. This method repeats a short phrase multiple times. As it has a trait which makes it easy retain and recall, it is easy to recall during memory and recall tasks when incorporated into these activities. A repeated melody which speeds up steadily is easily retained in memory.

Music can also help recollecting memories [24-26] and through this, recalling memory and emotional activity can both be anticipated [27-29]. The hippocampus is activated when the participant recalls emotionally stimulating images. In comparison to recalling an emotionally neutral image, one which is more emotionally strong links to stronger activity in the hippocampus. A synergistic effect can be expected when the hippocampus is stimulated through recollection through music as well.

For the above reasons, brain training tasks combined with repeated rhythmic phrases and music effective for memory tasks. It can be expected for emotion to be influenced by music leading to activity in the hippocampus.

Conclusion

This study combined repeated rhythmic phrases and music with brain training memory tasks. This music method proposed a new brain training method by combining dual-task, where two tasks are performed simultaneously, and n-back task, where tasks from n tasks earlier are asked to be recalled.

This intervention study verified this method improved memory test results significantly and a reduction in stress value.

Acknowledgments

We thank the elderly who continue to participate in this study. In this study, under the guidance of music therapists Yukiko Ueda and Megumi Okuno, we developed a rhythm phrase combining a dual task and n-back task. Thanks to both lecturers, the intervention method has evolved into a more effective program. We sincerely thank everyone for their support.

References


