

EFFECT OF USING COMPUTERIZED GAMES FOR EPISODIC MEMORY TRAINING IN ELDERLY

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ABSTRACT

Memory deterioration is commonly encountered in aging. The use of computerized games for memory enhancement has been advocated among older adults. In this study, we investigated the effect of using targeted episodic memory training as a modality towards memory maintenance. A total of 30 elderly volunteers, aged 87 ± 7 , with clinical dementia rating scale of 0-2, completed a 6 weeks computerized gaming program in a home for the aged. They were divided into two groups, with one group assigned to play counting games and another group with targeted episodic memory training via playing a shopping game. Initial results indicated that there is no difference in cognitive functional changes between the two groups. However, for those individuals with $CDR > 0$ who has received targeted training in episodic memory, they showed greater improvement in short term memory ($p < 0.05$) as compared to those having non-targeted episodic memory training. Although statistical significance has not been established, subjects with cognitive limitations received targeted training in episodic memory showed trends of improvements in the Chinese Auditory Verbal Learning Test. Our findings suggested that targeted episodic memory training is a more effective way for memory enhancement for MCI subjects. To substantiate this observation, further studies with larger sample size are required.

INTRODUCTION

Decline in memory function is a characteristic feature of aging. Moreover, if this cognitive change is beyond what is expected in

normal aging, the person may have acquired mild cognitive impairment (MCI) and are at high risk of developing Alzheimer's disease. Recently, there are many published reports indicating that computer based cognitive training can produce positive outcomes. However, the design of these training software were usually quite general, covering all different aspect of memory functions. For MCI subjects who faced deficits in episodic memory, general memory exercises may not provide the best outcome for them. In this work, we hypothesized that targeted episodic memory training can provide beneficial effect in memory function enhancement, and this modality is of particular benefit to those with MCI.

METHODOLOGY

A total 41 older adults with good functional status living independently in a local home for the aged were recruited to participate in this study. Among these participants, only thirty of them (3 males, 27 females, aged 87 ± 7) completed the study. They were assessed with the clinical dementia rating (CDR) scale, and randomly assigned to either the control group (participate in non-episodic memory training, $n=14$) or the experimental group (participate in targeted episodic memory training, $n=16$). The CDR results of these participants are: 13 with $CDR=0$, indicating normal memory abilities ($CDR=0$); 10 have questionable memory abilities ($CDR=0.5$); 6 has mild memory problem ($CDR=1$) and 1 has moderate memory abilities ($CDR=2$).

Two computerized training games were developed for this study. A specific designed counting game which does not demand any

episodic memory usage in playing was developed for the control group. For the experimental group, a shopping game which requires the player to remember various items to purchase was purposely design to involve the use of episodic memory. After introducing the game procedures to the participants, the experiment was conducted for 6 consecutive weeks, 3 times a week for half an hour each session. Each participant was given a USB memory stick as their authentication key, in which their performances (response time, details of selections/input and score) during the gaming activities were recorded.

To examine the effect of targeted episodic memory training via computerized games, cognitive assessments using the following cognitive measures were conducted pre and post training:

Verbal Fluency test¹ (VFT) was used to examine memory executive function. The measure involves spontaneous reproduction of words from a given category within limited time duration. We used a Chinese word list in this study.

Spatial Search test (SST) evaluates the participant's ability to remember a task and manipulate the related information in spatial working memory to complete the task. This test involves finding circles of specific color. In the supermarket game, participants are required to search for the products that s/he needs to purchase.

Paired Association test (PAT) requires participants to remember the locations of objects hidden in different boxes, and pair them up. This is a paired-associate-learning evaluation.

Digit Span test² (DST) measures verbal attention and working memory. In this test, participants are required to remember a string of digits that appears on the screen and correctly recall them afterwards.

Chinese Auditory Verbal Learning Test³ (CAVLT) involves a series of tests to measure verbal learning and memory domain. This test consists of 5 consecutive displays of a list of 15 Chinese words. The participant's ability to perform a free recalled was evaluation in between these trials. Then, interference was

given and free recall was assessed again. After a delay of 30 minutes, free recall ability was examined.

The above tests were administered at pre and post intervention. Data analyses were performed using Statistical Package for Social Sciences with repeated-measures ANOVA.

RESULTS

Verbal Fluency Test

In VFT, older adults participated in the experimental group (i.e. engaged in targeted training of episodic memory) showed an increase in the VFT scores after 6 weeks of intervention. However, no statistical significant difference in VFT scores can be found between the control and experimental group. Further analysis of VFT scores among subjects with mild to moderate cognitive impairment (i.e. CDR>0) only, there is significant increase in VFT scores ($P<0.05$) after the 6 weeks of training. This suggested that targeted episodic memory exercise can enhance memory executive function of MCI subjects.

Spatial Search Test

In SST, post training scores were found to be significantly higher ($P<0.05$) for both the control and experimental group, indicating that both training modalities were effect in enhancing the participants' ability to retain and manipulate information in spatial working memory. However, no difference can be found between the two groups.

Pair Association Test

In this test, no significant difference can be found between pre and post-training as well as between the two groups.

Digit Span Test

There is significant increase ($P<0.05$) in DST scores from the experimental group after intervention. However, in analysis that only consider participants with CDR>0, DST scores from the experimental group were significant higher than the control group. This indicated that verbal attention and working memory of subjects with cognitive impairment can

enhanced through targeted episodic memory exercise.

Chinese Auditory Verbal Learning Test

Among all the tasks associate with the CADLT, no statistical significant results can be found between the two groups and between pre and post training. When comparing between those who have cognitive limitations within the two groups, it was found that those received targeted episodic memory training showed improvement in the free recall evaluation after interference ($P=0.06$).

DISCUSSION

This study supported the general believe that computerized memory games can be used to enhance cognitive function of older adults. Targeted cognitive training on episodic memory showed positive outcome to those individuals with very mild to moderate dementia (CDR scores of 0.5-1). As reveal through DST, verbal attention and working memory for MCIs were enhanced after 6 weeks of training. In addition, improvements were also found in the free recall test after interference (sub test of CAVLT) in subjects with targeted episodic memory training. Although between group differences failed to establish statistical significant in the majority of the cognitive tests used, this is properly due to the limited participants that can be recruited in the present study. Therefore, further work needs to be conducted with a larger sample size.

The training game that was developed for targeted episodic memory exercise was a shopping game which required participants to purchase some required items from a supermarket. This game has various levels of difficulties. To advance to a high level, the participant needs to score "all-correct" in 3 consecutive trials. At the beginners level of the supermarket game, participants were asked to purchase one to two items with quantity of one per item. Although this seems to be a relatively simple daily task to perform, our results indicated that 75% of participants remained at this fundamental level after 6 weeks of training. Detail examination of the experimental data showed that both the normal group (CDR=0) and dementia group (CDR=0.5) has only 25%

of their participants advanced to higher training levels of 10 and 17 (normal group) as well as 9 and 11 (dementia group). This indicates that targeted episodic memory training has equal beneficial effect to both MCI and older adults without cognitive impairments.

Being forgetful in aging is nothing special. In the supermarket game, we monitored the participant's performance in terms of whether s/he can identify the required purchase item when it was presented to the participant the first time on screen. The results showed that, before targeted episodic memory training, half of the MCI subjects and half of the participants without cognitive impairment cannot identify the required purchase item in the first go. However, there is no change in this situation for the adults with normal cognition, but for MCIs, 75% of them remains to have difficulties in picking up the required item in the first go. This could be due to the fact that as difficulties advanced in game levels, the memory recall demands increase.

One of the limitations of this work is the short training period and the relative small sample size. Therefore, further work is needed substantiate the findings from this preliminary study.

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