Case Report

Case Report - Perceptual and Semantic Memory Encoding in People with Mild Cognitive Impairment

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Abstract

Previous literature shows that the elderly people are able to take the advantage using semantic memory encoding to aid with their memory retrieval. However, people with mild cognitive impairment may not seem to take such benefit. This case report therefore sought to take an overview of the memory encoding processes in MCI. Two cases participated in an experimental paradigm involving encoding tasks by studying a list of words using perceptual and semantic memory encoding strategies and then making studied or unstudied judgment in the recognition phase. Results showed that they performed better using the perceptual encoding strategy. The process of memory encoding as shown by the event-related potentials data did not show consistent findings on whether they engaged in semantic processing under the semantic encoding condition. This case study gave the insights on the benefits using perceptual and semantic memory encoding strategies in people with mild cognitive impairment. Further study with more participants with MCI would be necessary.

ABBREVIATIONS

MCI: Mild Cognitive Impairment; ERPs: Event-Related Potentials; SME: Subsequent Memory Effect

INTRODUCTION

Mild cognitive impairment (MCI) is considered a transitional period between normal aging and mild dementia [1]. People with MCI often experience memory problems. However, how information can be efficiently encoded to support successful recall for this population is not fully understood. A recent study by Hudon et al. [2] manipulated encoding processes by asking healthy older participants and MCI participants to identify a word in a pool of 15 words while supportive cues were provided, for example, to identify a word in a certain semantic category (such as a vegetable category) with information that it belongs to a vegetable to be cue provided. The results showed that the MCI group did not benefit as much from semantic cues as the older control group. The study demonstrated that the MCI sufferers did not benefit from semantic cues as much as the healthy control group, indicating that they may have difficulty in using semantic information.

Only results from a handful of studies offer insight into the factors contributing to deficits in encoding and retrieval in people with MCI. A study, led by Clément, investigated brain activations associated with encoding and retrieval processes in older and MCI adults using fMRI [3]. During retrieval differences in activation pattern between the two groups were shown to be minimal. On the contrary brain activations during encoding were mostly reduced in the MCI group. It suggested that encoding process would play a more important role in the degraded memory performance for people with MCI.

Given the evidence, this case report seeks to take an overview of the memory encoding processes in MCI.

Experimental paradigm

Participants were asked to perform in an encoding task followed by a recognition task. In the encoding phase, the participants studied a series of Chinese characters either perceptually (by inspecting orthographic components – whether it is composed of top and bottom components; called the perceptual condition) or semantically (by determining whether the depicted object referred to by the word makes sounds; called the semantic condition) (Figure 1A). In the recognition phase, the
participants made judgments whether items have been studied or not (Figure 1B).

Responses at the recognition phase were identified as ‘correctly identified’ (i.e., a studied item that was correctly identified as studied), or ‘missed’ (i.e., a studied item appeared in the encoding phase that was not correctly identified as studied in the recognition phase).

Electroencephalograms (EEGs) were recorded. Event-related potentials (ERPs) were computed by averaging epochs at the encoding phase that were subsequently classified as ‘correctly identified’ or ‘missed’ during the recognition phase. Subsequent memory effect (SME), which is the differential ERP between successful and unsuccessful encoding, was reported [4-6]. The detailed description of methods can be found in Kuo et al. [4,5].

CASE REPORT

The case report described reviewed two persons with MCI who lived at home independently with family at the time of the report. Tom (a pseudonym) was a 75-year-old Chinese gentleman. He received 16 years of formal education. Another participant Peter (a pseudonym) was a 73-year-old Chinese and had 6 years of formal education. They were recruited through the memory clinic of a local Hospital in Hong Kong. A reimbursement of HKD $300 (around USD $38) was provided to them as a compensation for transportation. The study was approved by the local ethics committee. Informed consent forms were signed by both participants.

Behavioural results

For Tom, in encoding, the accuracies to classify the words by means of sounds in the semantic condition were the same (73.8 percent). However, he took longer to complete the perceptual task (794.71ms for the overall reaction time in perceptual condition versus 644.11ms in the semantic condition). During the recognition phase, he correctly identified the studied words in the perceptual condition slightly better than in the semantic condition although both were just above the 50% chance level (Table 1). The reaction time for such performance was however slower in the perceptual condition than in the semantic condition.

Similar to Tom, Peter took longer in the perceptual task (1361.80ms in perceptual condition versus 1267.74ms in the semantic condition). He was able to classify slightly more words correctly by inspecting orthographic components in the perceptual condition than by determining whether the depicted object referred to by the word makes sounds in the semantic condition (88.8 percent in perceptual condition versus 82.5 percent in the semantic condition). His performance at the recognition phase was similar to that of Tom. He correctly identified the studied words in the perceptual condition slightly better than in the semantic condition, also just slightly above the 50% chance level (Table 1). The reaction time for such performance was also slower in the perceptual condition than in the semantic condition. He performed slower than Tom in both conditions.

Event-related potentials (ERPs) results

According to Kuo et al. [7], there are five stages in memory encoding. It includes early processing in pre-P2 (0-120ms), to selection of information in P2 (120 to 240ms), semantic processing in N3 (240 to 360ms), updating of working memory in P550 (360 to 700ms) and elaborate processing in late positive components (LPC from 700 to 1000ms).

In both Tom and Peter, the SME was evident in pre-P2, P2, and P550 in both the perceptual and semantic conditions (Figures 2 and 3). Except in Tom’s semantic condition, the SME was also evident in N3. For LPC and in perceptual encoding, the SME was evident in F3, F7 and P7 in Tom. This process for Peter was as not evident as in Tom; the SME could only be identified briefly in C3, P3 and P7. In semantic encoding, the SME could be identified in all channels except F3, F4, F7 and P8 for Tom; and in F3, F4 and F7 for Peter.

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<th>Table 1: Results at the recognition phase.</th>
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<td>Correctly identified - percent</td>
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<td>Tom Perceptual condition</td>
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<td>Missed - percent</td>
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<td>Tom Semantic condition</td>
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<td>Peter Semantic condition</td>
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Note. ms = milliseconds
‘correctly identified’ refers to a studied item that was correctly identified as studied;
‘missed’ is a studied item appeared in the encoding phase that was not correctly identified as studied in the recognition phase.
DISCUSSION

The accuracies of completing the perceptual and semantic tasks during encoding were comparable. It showed that both tasks introduced similar difficulty level to Tom and Peter [5]. Both Tom and Peter took a longer time to complete the perceptual task. This could indicate that a more complete memory encoding with elaborate processing were engaged in the perceptual encoding condition [7,8]. It could also due to the possibility that perceptual task was more difficult than semantic task. On the contrary, the shorter reaction time in semantic encoding could indicate that encoding processes might be incomplete. Other possible explanation would be related to the educational level of the participants. For example, Tom had 16 years of formal education, he might also found it a relatively automatic and easy access to the meaning of the words; and hence, he could have considered the semantic condition to be "easier" than the perceptual condition and have responded quickly. The behavioural benefit by perceptual encoding was similar during the recognition phase. Perceptual encoding seemed to assist retrieval more when compared with semantic encoding although the benefit was only minimal and statistical test could not be completed to compare them.

When reviewing the ERPs data, early perceptual processing, prelexical feature detection and early lexical processing (Stage 1); initial selection of information from competing information for processing in the working memory (Stage 2); and updating of working memory with the newly created item representation (Stage 4) in both the perceptual and semantic conditions for Tom and Peter were evident. Inconsistent results in semantic processing, syntactic processing or lexical processing (Stage 3) was observed. This process was demonstrated in both conditions for Peter, but only in the perceptual condition for Tom. It seemed that Tom did not engage in such processing in the semantic condition. It could be related to his behavioral performance close to chance level with 52.50 percent correctly identifying studied words in this condition. The stage 3 of the memory encoding processing (semantic processing) for Tom was not observed. This obviously contradicts with the processing happened in healthy older adults [4,7]. Healthy older adults benefit from using semantic encoding as a more successful encoding was observed. For elaborate processing (Stage 5), the results showed

Figure 2 (A) SME of Perceptual condition for Tom  (B) –SME of Semantic condition for Tom.

Figure 3 (A) SME of Perceptual condition for Peter (B) –SME of Semantic condition for Peter.
such process in various sites in both perceptual and semantic conditions for Tom and Peter.

This case study gave the insights on the different benefits using perceptual and semantic memory encoding strategies in people with mild cognitive impairment. However, as there are only two participants; the results could not be interpreted with confidence. Further study with more participants with MCI would be necessary.

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REFERENCES