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Effects of handedness and depth of processing on the explicit and implicit memory

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Abstract

In this research the effects of handedness and depth of processing on the explicit and implicit memory was evaluated. An experimental research was carried out individually on 80 students using computerized measurement tools and Edinburgh Handedness Inventory. The data were analyzed through Variance Analysis Method. Results showed that the difference between examinees under different depths of processing is significant in explicit memory. Moreover, there was also a significant difference in explicit memory between the three groups. Mixed-handed and left-handed participants had better recall performance but there was no significant difference in implicit memory. Better performance of the mixed-handed in explicit memory recall test indicates that explicit memory function is dependent on the interrelation between the two hemispheres.

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1. Introduction

Since the commencement of the 21st century, memory has emerged as one of the most important research issues in behavioural sciences. Memory is the process of storing information and experiences and their potential retrieval in the future. Therefore, memory is one of the cognitive operations playing an important role in an individual's activity (Eysenck & Keane, 2005). There is an increasing tendency to study human memory and the way this system can include various phenomena like preparation, familiarization, skill learning and knowledge. Cognitive psychologists have categorized these behaviours based on features and limitations. The most influential classifications are explicit and implicit memories (Jacoby, 1991; Schacter, 1992). Information is sometimes decoded deliberately and sometime with no decision in advance. The first case deals with explicit memory and the latter with implicit memory (Schacter, 1992). Brain studies have indicated that the left hemisphere is active when information storage happens and the right hemisphere is active when retrieval process is in progress (Cabeza & Nyberg, 2000). Tulving, Kapur, Craik, Moscovitch, and Houle (1994) introduced also Hemispheric Encoding/Retrieval Asymmetry (HERA) model about verbal episodic memory according to which, the left hemisphere is responsible for information

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storage and the right hemisphere for information retrieval. Therefore, interaction of both hemispheres is essential for the optimal performance of memory.

Recent studies have also shown that memory and handedness are interrelated (Lyle, McCabe, & Roediger, 2008; Christman, Propper, & Brown, 2006; Christman, Propper, & Dion, 2004; Propper, Christman, & Phaneuf, 2005). This interrelation indicates that left and mixed handers have larger spinal cords and so, more hemispheric interaction; since the explicit memory requires hemispheric interaction, it can be concluded that mixed and left handers have better explicit memory (Burckner, Logan, Donaldson, & Wheeler, 2000). It has been shown in an experiment that right handers perform better than strong right handers in the task of recalling words (Propper et al., 2005) and childhood memories (Christman et al., 2006). However, no difference was witnessed in the task of completion of words to evaluate the implicit memory (Propper & Christman, 2004). They believed in a third variable related to both handedness and memory. It was hemispheric interaction defined as the transfer of neurotic signals between left and right hemispheres through spinal cord and other neurotic linking tissues of the forebrain. So, since right handers have more hemispheric interaction than strong right handers, they recall better too (Propper et al., 2005). Cronin-Golomb, Gabrieli, and Keane (1996) found that in patients whose large part of the spinal cord was removed in surgery, no problems occurred to implicit memory due to the linkage under the cortex structures, but problems occurred to their explicit memory due to the failure of link between left and right hemispheres.

Researches of educational psychologists in the latest decades have indicated that education would be effective when teacher and instructors use modern methods. In one of these researches, Craik and Lockhart (1972) introduced the study of education based on the levels of processing (LOP) theory in which cognition of a stimulus is achieved in different levels of information processing. In the first level, the stimulus is cognized according to characteristics (physical and sensational features), while in next levels the cognition is achieved in deeper levels. In other words, levels of processing viewpoint emphasizes mainly on how information is processed instead of various structures of memory, i.e., information storage in the first level is based on the superficial and sensational features (superficial encoding) but in the second level it is based on semantic features and deeper levels in memory (deep encoding). In this viewpoint, retention of an item in the memory is dependent on the depth of processing of the information storage level. Craik (2002) showed in an experiment that when information is stored superficially, only 20% of the words are retrieved while in semantic processing the amount increases to 96%. They found in this experiment that factors like deliberate learning, efforts applied, complexity of the task, the time spent, and repetition and practice were not the main and determinant parameters in recall and recognition, but the qualitative nature of the task and the nature of cognition activity applied on subjects were important.

Influences of the depth of processing and handedness factors on the performance of memory have been investigated in many studies and sufficient evidences have been obtained on their positive effects. However, the combined effect of both factors on the performance of explicit and implicit memories has not been studied so far. Therefore, this research was carried out to study the performance of memory in recalling process under different levels of processing and various kinds of handedness.

2. Method

In this experimental project, 80 female first grade students of Payam-e-Noor University of Ferdows were selected through stratified random sampling method, i.e., sampling population was classified according to different fields of study and then the density of the sample population was determined – and individuals were chosen randomly - considering the mass of sampling population of every field of study. All subjects were divided randomly but equally into four subgroups and four learning situations were assigned to them based on depth of processing: deliberate learning plus three cases of incidental learning (structural, phonemic, and semantic). It was assumed that deep processing would happen in deliberate and semantic learning while superficial processing in structural and phonemic learning. The tool used in this study was a list of 24 words with medium frequency in the population which had been used as a testing tool in master degree thesis (Aerab-Sheybani, 2004). This study was carried out individually by means of the developed software. For deliberate learning group the software showed, the 24 words consecutively – every word was shown for 5 seconds on the screen – and examinees were being asked to memorize the words for later recalling. For the other three groups, a part of the task was exactly the same. For them, initially a question was being displayed for 2 second and then a word from the mentioned list was on screen for 5 seconds. Informants had to press YES or NO button to go to the next question. For the three groups the content of the questions were different: Those in structural learning group were being asked “Does the word start with a diacritic
letter?” Phonemic learning group was being asked “Does the word ---- have the same rhythm with the word you are going to see?” Informants in semantic learning group were being asked “is the sentence a proper explanation for the word you are going to see” Just after running the computer program, examinees completed Edinburgh Handedness Inventory. This test has been normalized in Iran by Alipour and Agah-e-Harris (2000) for which Chronbach’s alpha reported as 0.97. The Purpose of this questionnaire was create an appropriate time interval (approximately 15 minutes) allowing the information transfer from short term to long term memory but not giving examinees a chance to review the words process them further in their minds.

Besides this categorization, groups were also studied from handedness point of view. Those gained 80 to 100 scores were grouped as strong right handers; 0 to75 scores as mixed handers; and -80 to -100 scores as strong left handers.

Once the questionnaire completed, the second part of the test, i.e., words recall, was started. Examinees were provided with two lists of the initial three letters of 24 words written down on an A4 paper. 50% of these words have been seen before by the examinees and the other 50% not. Examinees, not knowing the relationship between the incomplete words with those seen in the test, were asked to write down the very first word coming to their minds when they see the initial three letters (evaluation of the implicit memory). After they answered the first sheet, a similar second sheet was given to them and examinees were asked to recall the words seen before in the test and used them to complete the words of the second sheet (evaluation of the explicit memory). One point was being given to every word recalled correctly (both in the first and the second sheets). Data were analyzed using Analysis of Variance Method.

3. Findings

Table 1. Average of the words recalled correctly in different learning and handedness groups

<table>
<thead>
<tr>
<th></th>
<th>Deliberate learning</th>
<th>Structural learning</th>
<th>Phonemic learning</th>
<th>Semantic learning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Left hander</td>
<td>Mixed hander</td>
<td>Right hander</td>
<td>Left hander</td>
</tr>
<tr>
<td>Explicit memory</td>
<td>n = 6</td>
<td>n = 6</td>
<td>n = 8</td>
<td>n = 7</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>13</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>Implicit memory</td>
<td>n = 6</td>
<td>n = 6</td>
<td>n = 8</td>
<td>n = 7</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>5</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

As the results in table 1 indicate, explicit memory performance in all handedness groups was better than implicit memory moreover the performance of the examinees was better in deliberate and semantic learning than structural and phonemic ones.

Table 2. Variance analysis results of the examinees’ performance of explicit and implicit memories according to the depth of processing

<table>
<thead>
<tr>
<th>Source</th>
<th>Scale</th>
<th>Sum of squares</th>
<th>df</th>
<th>Average of squares</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explicit memory</td>
<td>Depth of processing</td>
<td>905.150</td>
<td>76</td>
<td>11.910</td>
<td>12.783</td>
<td>0.001</td>
</tr>
</tbody>
</table>

As the results show, the difference in examinees under various conditions of learning (depth of processing) is significant for the explicit memory. Examinees had better recall performance in deliberate and semantic learning (deep processing). The difference was not significant for implicit memory.
As table 3 shows, mixed and left handers performed better than right handers. However, there was no meaningful difference in the implicit memory.

4. Conclusion

The aim of this study was to show that retrieval is better achieved in deep instead of superficial processing and also, mixed and left handers have a better performance than right handers. As indicated by the results, although structural and phonemic superficial processes are not significantly different, considering deep processing (semantic and deliberate), examinees had poor performance. The reason for better performance in deep processing is that the deeper the processing, the more associations form in the mind facilitating the following recall. This conclusion is in line with the result of the study performed by Mahdavian and Kormi-Nouri (2008). It should be noted that this was being applied only to the explicit memory – i.e., deep processing was not applicable to the information retrieval from implicit memory. In other words, in contrast to the explicit memory, the implicit memory was not influenced by depths of processing. It means that during the study period, more semantic extensions of the subjects were resulted by improved performance of the examinee in explicit memory tests. However, such an advantage was not achieved in implicit memory tests (Szymanski & MacLeod, 1996). In line with this, we can refer to the study of Jacoby & Dallas (1981, cited by Medin, Ross, & Markman, 2001). They found that during the learning process, deeper encoding of the information would result in better performance and recall (explicit memory). In other words, the influence would be seen in explicit memory (not implicit). Analysis of the handedness results also indicated that although no difference could be seen in superficial processing for the handedness groups, mixed and strong left handers performed better in deep processing than right handers. These findings are in consistency with the hypothesis stating the reason mixed and left handers are better at memory retrieval is due to better information retrieval, but not better storage of the information (Christman et al., 2006; Christman et al., 2004). It means that since mixed and left handers have more hemispheric interaction, they have better memory performance. These findings show that previous reports regarding the differences of handedness under deliberate learning can be developed into incidental learning conditions in deep processing. Therefore, since there was a meaningful difference for the recall performance under deep and superficial incidental decoding conditions, intention should not be a major factor in learning for handedness groups. On the contrary, according to the deep processing viewpoint, mixed- and lef-handers’ better recall performances in explicit memory test can partly be related to the encoding conditions, too. As a result, depth of processing and handedness play undeniable roles in the memory performance and as findings of this study indicate, this can be considered as an advantage for the mixed and left handers in deep processing conditions.

Acknowledgement

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References


Table 3. Variance analysis results of difference in examinees’ performance of explicit memory according to handedness

<table>
<thead>
<tr>
<th>Source</th>
<th>Scale</th>
<th>Sum of squares</th>
<th>df</th>
<th>Average of squares</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explicit memory</td>
<td>Depth of processing</td>
<td>836.574</td>
<td>77</td>
<td>10.865</td>
<td>24.175</td>
<td>0.001</td>
</tr>
</tbody>
</table>

As table 3 shows, mixed and left handers performed better than right handers. However, there was no meaningful difference in the implicit memory.


