A Study of Verbal and Action Memory among Athletes and Non Athletes

Abstract

There are different theories about how memory works. The purpose of current study was to see whether there are significant differences in memory between people who exercise at different levels. We tested long-term memory versus working memory and action versus verbal encoding in three group: people that compete in sports, people that just exercise, and people that almost not exercise at all. People who were more physically active did not have a better action memory than people that were not physically active. The results showed no significant differences among three groups with respect to both long-term memory and working memory. These results do not support motor encoding hypothesis but are in line with episodic integration hypothesis.

Keywords: Long-term memory, working memory, enactment, athletes.

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Sammanfattning

Det finns olika teorier om hur vårat minne fungerar. Syftet med denna studie var att se om det är någon signifikant skillnad i minnet mellan människor som tränar på olika nivåer. Vi testade långtidsminnet mot arbetsminnet och action mot verbalt inkodning inom tre grupper: folk som tävlar i någon idrott, folk som motionerar och folk som nästan inte motionerar alls. Resultatet visade ingen signifikant skillnad mellan de tre grupperna, med hänsyn till både långtidsminnet och arbetsminnet. De som var mer fysiskt aktiva hade inte bättre actionminne än de som vara mindre fysiskt aktiva. Detta resultat stödjer inte motorinkodningshypotesen utan är mer i riktning med den episodiska integrationshypotesen.

Nyckelord: Långtidsminne, arbetsminne, handling (motoriskt minne), idrottare.

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A study of verbal and action memory among athletes and non-athletes

Many studies have focused on how our memory works and tried to identify the different memory systems (Tulving, 1985). The focus of this study will be more on short term-memory and long-term memory. Short-term memory was initially known as a part of memory that held small amounts of information. Later the term short-term memory was referred to as working memory, since short-term memory often was used as a name for a short storage place of memory. Working memory on the other hand, is a more complex memory that is constantly working that both store some amount of memory but also have other functions while encoding and processing information (Baddeley, 2000). Long-term memory can be divided into episodic and semantic memory systems, and these two represent things that we experience in our daily life (Eysenck, 2005). Episodic memory allows us to look back and remember events that we experience. Episodic memory also allows us to think about ourselves and others at present and in the future which are distinguished from our past memories (Wheeler, 2000).

Semantic memory is a memory system which is related to episodic memory. It allows us to know about facts, ideas or different rules and so forth. Even if these two memories seem to be very closely connected there is one aspect that separates them, and that is the awareness during process of retrieval. Episodic memory uses autonoetic consciousness, which involves self-governed recapture of ones previous experience during retrieval, whereas semantic memory do not involve retrieval of previous feelings or emotions and can only retrieve knowledge with facts (Wheeler, 2000). In episodic memory we can talk about two kinds of memory: verbal memory and action memory.
Some events can be learned either verbally or by help of action at the time of encoding. (Nilsson, 2000)

In the 1980s some researches began to focus on action memory and on how it is affected, a new paradigm which was called “the enactment effect” or “SPT-effect” (Nilsson, 2000). This new paradigm was mainly developed in experiments where subjects were instructed to perform and remember phrases such as “roll the ball”, “lift a pen” or “open the door” and so forth. This task was called subject-performed task or SPT. As control condition subjects were also instructed to repeat verbally some other phrases without performing them. This task was called verbal task or VT. After the subjects had performed or repeated these tasks they were told to recall as many of the given phrases as they could remember, both from the SPT and VT in a recall or recognition test (Nilsson, 2000). A typical result for such an experiment is that SPTs are recalled more effectively than VTs. This refers to the enactment effect or SPT effect (Nilsson, 2000).

In the last three decades, memory researchers have tried to explain why action memory and verbal memory differ from each other. Still there are questions and disagreements about the main cause for this effect (Helstrup, 2004). This has emerged in four major theories about the enactment effect. These four theories have all emerged from SPT and VT experiments and they all try to explain how our memory operates with this information.

Cohen (1981, 1983) proposed that subject-performed tasks were encoded non-strategically, whereas verbal tasks could use some intentional strategies. He thought that the SPT contributed to an optimal encoding (Cohen 1981, 1983). He assumed that motor learning and enacting can provide a more optimal encoding than VT. One of the reasons
why he called this a non-strategically encoding is that he believed that performance with enacting can bring enough information for our memory to trace it for later recall (Zimmer & Cohen, 2001). According to this theory, SPT can be encoded without attention or intention and still be efficient in levels of processing. In other words, in SPT, the subjects do not use any memory strategies to remember the enacted event, it is enough just to perform the task without actually being concentrated to remember it (Cohen 1981, 1983).

Another theory proposed by Engelkamp & Zimmer (1983, 1984, 1985) assumed that our encoding can be divided into motor, visual, and verbal programs and these systems make it possible to sort out the information. These encoding programs are independent from each other. In this theory the main reason for an enactment effect is that motor encoding is more efficient for encoding information than the other two programs (Engelkamp & Zimmer 1983, 1984).

According to Bäckman and Nilsson (1984, 1985) a multimodal processing during enactment contributes to a richer encoding. This multimodal processing was developed and was later referred to as dual code hypothesis. The dual concept separates verbal components and physical components assuming that verbal components are encoded strategically and physical components are encoded non-strategically (Bäckman, Nilsson, Herlitz, Nyberg & Stigsdotter, 1991; Bäckman, Nilsson, & Kormi-Nouri, 1993).

Later Nilsson and Bäckman (1989) added to this theory that the verbal components in a way force the subject to concentrate while listen and make the encoding process intentionally, whereas in the physical component the subject automatically performs the given task and the encoding is incidentally. This in turn makes the retrieval for the verbal component explicit and the retrieval for the physical component implicit. The
combination of the implicit encoding in SPT together with verbal component in SPT makes this a better encoding (Nilsson, 2000).

The most deviant theory about the enactment effect of these four is a theory proposed by Kormi-Nouri (1995). Earlier theories suggested that the SPT encoding is automatic and effortless. However, empirical studies showed that the SPTs use some attention during encoding (Zimmer & Cohen, 2001). Kormi-Nouri (1995) assumed that encoding is entirely strategic and that both physical and verbal components are encoded strategically. One critical aspect in this theory is that the self involvement in the SPT tasks that makes the subject more aware of what he or she actually experiences. The encoding during SPTs is more efficiently encoded in the episodic memory than in the VT tasks (Kormi-Nouri, 1994, 1995, 1998, 2000). Other theories argued that the encoding uses motor components (Engelkamp & Zimmer 1983, 1984), but this theory proposed that encoding uses strategies instead of motor encoding in both verbal and motor components. The combination and integration between episodic and semantic memory is also important in this theory.

\textit{Debates between theories}

These four theories have discussed and debated about the enactment effect for the last three decades. Engelkamp (2001) clearly explains his view in a system-oriented approach. What he means by this is that one special memory system encodes and works during enactment. This system is governed by motor programs that help us to encode different items. This motor encoding is more effective and efficient than verbal and visual encoding and therefore the reason of an enactment effect.
Kormi-Nouri and Nilsson (2001) argued that both motor and verbal components use strategies during encoding. All encodings (motor, verbal, or visual) contributes to the episodic integration. However the motor encoding due to the self involvement is, more prominent over verbal and visual encoding and is therefore better recalled. Kormi-Nouri and Nilsson (2001) do not agree with the theory proposed by Cohen (1981, 1983) about a non-strategic motor encoding. However, they believe that some rehearsal and organization in the presentation of a phrase might benefit encoding both in SPTs and VTs (Kormi-Nouri & Nilsson, 2001).


In the present study, we want to know how athletes and sportsmen use their memory, whether they differently perform their action memory compared to non-athletes. We know that athletes and sportsmen have skilled muscles and are very well prepared for actions (Hawley, Gibala & Bermon 2007). If action memory has a special encoding program as supposed by Engelkamp & Zimmer (1985) and is automatic processing as supposed by Cohen (1981, 1983), we expect that athletes and sportsmen have a better enactment effect compared to non athletic people, since they have more practice and training for actions. On the other hand, if action memory is not different from verbal memory with respect to its strategic nature and there is no need to assume a special motor
program for action memory as supposed by Kormi-Nouri (1995, 2000), we expect to see no difference between athletic and non-athletic people in action memory.

Thus, in the present study the purpose was to see if there are any significant differences between people who exercise at different levels: with respect to people that compete in sports, people that just exercise, and people that almost have no exercise at all. We examined action memory versus verbal memory among these three groups of people, based on their earlier experience to actions and activities. We also examined action memory versus verbal memory both in long-term memory and in working memory (short-term memory). Baddeley’s working memory also distinguished between verbal components and central executive functions (Baddeley & Hitch, 1974) and it would also be interesting to see whether athletic and non-athletic people are different in this regard.

Method

Design:

One between-group variable (highly active sportsmen versus person exercising versus non-sportsmen) and one within-group variables (action versus verbal memory) were used for both long-term and short-term memory in this study. In long-term memory we used sentences and in working memory we used game concentration. In sentences, we used action encoding and verbal encoding.

Participants:

50 subjects (29 men and 21 women) aged between 19 and 32 years old participated in this study. They were divided into three groups, people that compete in sports, people that just exercise, and people that almost have no exercise at all: 16 or 17 subjects in each group. The participants were all graduated from high school. The subjects participated
voluntarily in this study and they were anonymous and coded into numbers. We asked the participants verbally through visiting their courses or in the different departments at the Örebro University. Some of our participants (athletes) were invited through phone calls or visiting their training ground. All participants followed our instruction and procedure fully correctly so we didn’t have any decline of participants.

**Materials:**

Long-term memory: 24 sentences (12 SPT, 12 VT) were used. The sentences were used in two orders. Half of the participants in each group received the first order and the other half the second order.

Vocabulary test (SRB Test in Swedish): This task was used between SPT/VT encoding and recall tests. We used this vocabulary test for two reasons: first to control vocabulary knowledge of subjects and second to make an interval between study list and test for the purpose of having a long-term memory. Maximum of eight minutes was given to do this vocabulary test. We had two different recall tests, one free recall, that means the participants had to write down everything they remember from the earlier sentences (SPT & VT). The maximum time for this FR test was four minutes. For the cued recall the participant received a paper with 24 incomplete sentences: verb or noun of each sentence was given as cue and the other part of sentence as target.

**Working memory:** We used Game concentration which included two games: 18 pictures (actions) and 18 words (concrete). For the action part we used only sport related pictures to see if the athletes in our study would differ in performance. In the word part we used familiar words (e.g., book, desk). The participants had free amount of attempt and time. The number of attempts was recorded and the time was measured by a hidden
timer. Tape-recorder was used to play up the sentences for our SPT/VT tasks, and timer (hidden) was used for all tests to measure the time for each subject.

Procedure:

All participants in our study performed all memory tests in the same room, a laboratorial room at Örebro University. The participants did the experiment one at one session. The experiment totally lasted about 30 minutes in the present study, the procedure was as following:

1 - SPT/VT tests (about 5 min). First, participants were instructed to listen to a list of phrases such as “roll the ball, lift an apple”. Before each phrase they also heard two different statements: either “action” or “sentence”. If they heard the statement “action” they performed the task. And if they heard the statement “sentence” they repeated the phrase verbally.

2 - Vocabulary test (SRB test) (maximum 8 min). Second the participants were given a vocabulary test, where they were supposed to find synonym words. Time was recorded without the participants’ knowledge.

3 - Free recall and cued recall (4+2 min). Third the participants were supposed to write down as many phrases (both action and meaning) as they could remember in a free recall test and a cued recall test.

4 - Game concentration 1 (18 concrete words). Participants played a memory game. With 9 pairs of concrete words and a total of 18 cards faced down. Then the participants were instructed to find all pairs. Time and number of attempts were recorded without the participants’ knowledge.
5 - Game concentration 2 (18 action pictures). This was a similar game like the previous one but with 9 pairs of action pictures (sports) and a total of 18 pictures. Then the participants were instructed to find all pairs. Time and number of attempts were recorded without the participants’ knowledge.

Two lists were used to ensure that there would be a counter balance in phrases (SPT/VT). Half of the participants were given List A and the other half List B. Also in Game concentration, half of participants were assigned to each of Form 1 and Form 2. In Form 1, half of the participants were given first the words and then actions pictures. The other half received a reverse order. The same procedure was used in Form 2.

Note: It should be noted that, in this study, dependent variables are as following:

In free recall and cued recall: Number of target items correctly recalled
In game concentration tasks: Number of attempts and amount of time.

Results

I – Long-term memory

Table 1:

The results of long-term memory are presented in Table 1: The numbers show how well our participants in our study remembered each item and test in percentage.

<table>
<thead>
<tr>
<th></th>
<th>Free recall</th>
<th></th>
<th>Cued recall</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SPT</td>
<td>VT</td>
<td>SPT</td>
</tr>
<tr>
<td>Group 1</td>
<td>.35</td>
<td>.05</td>
<td>.60</td>
</tr>
<tr>
<td>Group 2</td>
<td>.38</td>
<td>.11</td>
<td>.59</td>
</tr>
<tr>
<td>Group 3</td>
<td>.38</td>
<td>.12</td>
<td>.59</td>
</tr>
</tbody>
</table>

Note: Group 1 (Highly active sportsmen), Group 2 (person exercising), and Group 3 (non-sportsmen).

A 3(Group: 1/2/3) x 2(Test: FR/CR) x 2(Item: SPT/VT) ANOVA was performed and a summary is shown in Table 2 for this data.
There was no difference between the groups in long-term memory. Group 1, mean = .28; group 2, mean = .32; group 3, mean = .33. There were differences in the tests. Cued recall was easier to remember for the participants in our study than free recall. Cued recall, mean = .39; free recall, mean = .23. There were differences in the items. The participants in our study got better result in SPT than in VT. SPT, mean = .48; VT, mean = .14.

Table 2:

<table>
<thead>
<tr>
<th></th>
<th>df</th>
<th>MSe</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groups</td>
<td>(2, 47)</td>
<td>6.5</td>
<td>.98</td>
<td>P &gt; .30</td>
</tr>
<tr>
<td>Test</td>
<td>(1, 47)</td>
<td>.80</td>
<td>233</td>
<td>P &lt; .01</td>
</tr>
<tr>
<td>Item</td>
<td>(1, 47)</td>
<td>3.02</td>
<td>284.90</td>
<td>P &lt; .01</td>
</tr>
<tr>
<td>Group x test</td>
<td>(2, 47)</td>
<td>.80</td>
<td>.04</td>
<td>P &gt; .90</td>
</tr>
<tr>
<td>Group x item</td>
<td>(2, 47)</td>
<td>3.02</td>
<td>1.52</td>
<td>P &gt; .20</td>
</tr>
<tr>
<td>Test x item</td>
<td>(1, 47)</td>
<td>1.25</td>
<td>27.98</td>
<td>P &lt; .01</td>
</tr>
<tr>
<td>Group x test x item</td>
<td>(2, 47)</td>
<td>1.25</td>
<td>1.07</td>
<td>P &gt; .30</td>
</tr>
</tbody>
</table>

The ANOVA showed no main difference between the groups. The main difference for tests was significant: The participants remembered better in cued recall (mean = .39) than in free recall (mean = .23). The main difference for items was also significant: SPTs (mean = .48) were recalled better than VTs (mean = .14). There was only one interaction effect: Test x item. The SPT effect (differences between SPTs & VTs) was more pronounced in cued recall (.42) than in free recall (.28). The remaining interactions were not significant.

2 – Working memory

The results of working memory (game concentration) are shown in Table 3 and Table 4.
Table 3: Number of Attempts

The mean of number of attempt for each group.

<table>
<thead>
<tr>
<th></th>
<th>Word</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>17.06</td>
<td>16.88</td>
</tr>
<tr>
<td>Group 2</td>
<td>17.29</td>
<td>17.00</td>
</tr>
<tr>
<td>Group 3</td>
<td>16.31</td>
<td>16.25</td>
</tr>
</tbody>
</table>

Note: group 1 (Highly active sportsmen), Group 2 (person exercising), and Group 3 (non-sportsmen).

Table 4: Time in seconds

The mean for times (s) used in each group.

<table>
<thead>
<tr>
<th></th>
<th>Word</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>125.47</td>
<td>119.29</td>
</tr>
<tr>
<td>Group 2</td>
<td>156.94</td>
<td>147.35</td>
</tr>
<tr>
<td>Group 3</td>
<td>125.94</td>
<td>140.25</td>
</tr>
</tbody>
</table>

Note: group 1 (Highly active sportsmen), Group 2 (person exercising), and Group 3 (non-sportsmen).

Two separate 3 (group) x 2 (Items) ANOVA were performed for the data shown in Table 3 & Table 4.

A summary for these ANOVAs is shown in Table 5 & Table 6.

Table 5: Attempt

<table>
<thead>
<tr>
<th></th>
<th>df</th>
<th>MSe</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groups</td>
<td>(2, 47)</td>
<td>16.558</td>
<td>.413</td>
<td>P &gt; .60</td>
</tr>
<tr>
<td>Attempt</td>
<td>(1, 47)</td>
<td>4.56</td>
<td>.173</td>
<td>P &gt; .60</td>
</tr>
<tr>
<td>Group x Attempt</td>
<td>(2, 47)</td>
<td>4.56</td>
<td>.02</td>
<td>P &gt; .90</td>
</tr>
</tbody>
</table>

Table 6: Time

<table>
<thead>
<tr>
<th></th>
<th>df</th>
<th>MSe</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groups</td>
<td>(2, 47)</td>
<td>3528.25</td>
<td>2.19</td>
<td>P &gt; .10</td>
</tr>
<tr>
<td>Time</td>
<td>(1, 47)</td>
<td>643.85</td>
<td>.01</td>
<td>P &gt; .90</td>
</tr>
<tr>
<td>Group x Time</td>
<td>(2, 47)</td>
<td>643.85</td>
<td>2.12</td>
<td>P &gt; .10</td>
</tr>
</tbody>
</table>

These ANOVAs showed no main effect and no interaction effects.
Discussion

In general, the results were in line with our hypothesis: in both long-term memory and working memory there was no difference in action versus verbal encoding regardless of how much people are physically active.

Long-Term Memory

The result in our study clearly showed that there is no significant difference between the three groups of people, who compete and exercise often, people that exercise sometimes, and people that almost don’t exercise at all. These findings are in line with the episodic integration view suggesting that there is no need to assume a special motor encoding and physical involvement and experience makes no difference among people in this regard (Kormi-Nouri, 1995, 2000).

The items used in this study were SPT and VT tasks. As it was expected, there was a statistical difference between these two items: SPT is easier to remember than VT. In fact, the SPT effect (difference between SPT and VT) was a large effect in our study.

According to Cohen (1981, 1983) encoding through enactment contributed to an optimal encoding and that is also the reason why SPT were remembered better. He also assumed that SPT is the best way for encoding. We don’t agree that SPT is the optimal way of encoding, but it’s clear that the participants got better result on the SPT test.

However, the SPT effect was the same for all participants in each of our three groups and the amount of physical involvement and experience made no difference.

Nilsson and Bäckman (1989) assumed that during verbal encoding we need to be more concentrated while listening but during physical components the subject perform the task automatically. Nilsson and Bäckman’s assumption does not fit with our results. If their
assumption was correct we would expect that more experienced people in sports (athletes) who have more practice in actions and have more automatic performance in their actions, should have a better SPT effect. However, this was not the case and there was no difference for SPT effect among the three groups in this study. Our results are neither in agreement with motor encoding view (Engelkamp & Zimmer 1983, 1984, 1985), nor automatic encoding view (Cohen 1981, 1983, Bäckman & Nilsson 1984, 1985). On the other hand; our results are in agreement with the episodic integration view (Kormi-Nouri 1994, 1995) assuming that SPT is a kind of verbal encoding and not a type of automatic processing.

Cohen (1981, 1983) assumed that SPT is not strategically encoded. He believed that it’s enough for us just to perform the task to remember it better. According to this theory, SPT is the best and most optimal way of encoding. He also assumed that SPT can be encoded efficient in levels of processing even if a person that performs a task does not give any attention to the action. We do not agree with Cohen’s theory that encoding during enactment is non-strategical. With observation of the participants in our study, it can be said that they were more concentrated during SPTs than when they were in VTs. All participants were also asked after the test how they thought during the SPTs and VTs. Almost everyone answered that during SPT they needed to be more focused and concentrated. What might be assumed from this study is that people do use some strategies during enactment encoding. This was because most of the participants had to think before performing a task. This is similar argument to Kormi-Nouri & Nilsson, (2001) who assumed that subjects should first plan their action in SPT-tasks and this is why SPT is superior over VT, because they have a better self involvement in this task.
We used two different recall tests, free recall and cued recall. As it was expected, there was a statistical significant difference between these two tests. This means that there is a difference between how good one can remember the information in these two tests. The participants in all three groups performed better in cued recall than in free recall. It was almost twice as easy for the participants to remember the cued recall test. According to Lockhart (2000) cues are very useful when trying to help retrieval, it can also target one to remember a specific item like in the present study.

**Working Memory (Short-Term Memory)**

The result in our study showed no difference among the groups. In the game concentration test, there was no significant difference either in word test or action test. The same results were obtained based on our two dependent variables: number of attempts and time.

We used sport pictures in the game concentration action part to see whether the sportsmen in our study would perform differently in this task. The result in our study showed no difference between sportsmen and non-sportsmen in their performance. Once again, even in working memory, there is no need to postulate a special encoding for actions and words if they are encoded similarly.

Unlike the results in long-term memory (SPT/VT), actions were not remembered better than words in working memory task. An explanation to this finding would be that the nature of working memory task does not allow a better self involvement and strategic encoding as it does in long-term memory task (SPT/VT). This would be another support for the strategic and episodic integration view (Kormi-Nouri 1994, 1995).
At the end it should be noted that a positive aspect in our study was that all our three groups had almost equal number of participants. If there would have been more women in the group with highly active sportsmen it would have been better. The other two groups had almost equal number of participants with respect to gender. In two of the groups almost all participants were students but that was not the case for our third group, the highly active athletes. Obviously, it would be better if there were equal number of students and non student in all groups. A limitation for us was that we could not find more participants in our groups. The ideal condition was to have only two groups that include at least 25 participants in each group. The two groups would then consist of people that is highly active in sports and people that do not exercise at all but it was hard to find people that do not exercise at all.

The study had been well structured and planned experiments were easy to implement with our participants. Sometimes it got hard for us to follow our schedule because some of the participants couldn’t attend on the time that they had booked. However we managed to reschedule and followed our time plan as good as possible. Another aspect that complicated our study was to find participant that would fit in our three groups. Since many of our participants did exercise at least once a week we had to adjust our groups a little bit, from people that didn’t exercise at all to people that exercised less than twice a week. In the future, one can also do another similar study with other groups of people to generalize the data.
References


