RECALL AND RECOGNITION AS A FUNCTION OF LEVELS OF PROCESSING

Bipin Asthana*
and
Sunita Nagrani

ABSTRACT

The present study was an attempt to test the theoretical framework of levels-of-processing as proposed by Craik and Lockhart (1972). To accomplish this objective, 30 subjects were tested at three levels, i.e., structural, phonemic and semantic for recall and recognition both. The results indicated that when the material is encoded at deeper level, the retrieval of the material is superior to that, when the material is encoded at shallower level. Thus, the results of the present study confirm the approach of levels-of-processing as suggested by Craik and Lockhart (1972).

INTRODUCTION

The investigators in the area of memory are mostly concerned with developing models and theories. They are mostly concerned with prediction rather than description and understanding. This state of affair hamper the rate of progress in the area of memory. The short history of psychological study of memory has taught us that the features of models that have proved enduringly useful and have carried over from one generation of models to the next, have been at level of general principle rather than at the level of specific details.

Most of the models of human memory have been dominated by the concept of stores and the transfer of information among them. One

* St. John's College, Agra (India)
major criterion for distinguishing between stores has been their different retention characteristics. The essential concept is that of information being transferred from one store to another, and the store-to-store transfer models may be distinguished, at least in terms of emphasis, from explanations associate different retention characteristics with qualitative changes in memory code.

Craik and Lockhart (1972) suggested an alternative framework for memory research in terms of levels of processing. The guiding assumption of this approach is that the presentation of any stimulus initiates a series of hierarchy of processing stages which can be regarded along a continuum of depth. Sensory analysis and semantic cognitive elaboration define the end points of the continuum. Subsequent retention is a function of depth. “Thus, memory too is viewed as a continuum from the transient products of sensory analysis to the highly durable products of semantic associative operations.” (Postman, 1975).

Many theorists now agree that perception involves the rapid analysis of stimuli at a number of levels or stages (Selfridge and Neisser, 1960, Triesman, 1964; Sutherland, 1968). After a word is recognized, it may trigger associations, images or stories on the basis of subject’s past experience with the word. Such “elaboration encoding” (Tulving and Madigan, 1970) is not restricted to verbal material. Craik and Lockhart (1972) argue that similar levels-of-processing exist in the perceptual analysis of sounds, lights, smells and so on.

One of the result of this perceptual analysis is the memory trace. Such features of the trace as its coding characteristics and its persistence thus arise essentially as by products of perceptual processing (Morton, 1970). Specifically, “trace persistence is a function of depth of analysis. The deeper levels of analysis associated with more elaborate, longer lasting and stronger traces.” The memory trace is record of the encoding operation performed on the stimulus, no special movements or learning operations are necessary.

Thus, levels of processing approach think of memory tied to levels of perceptual processing. Although these levels may be grouped into stages (sensory analysis, pattern recognition, and stimulus elaboration, for example) processing levels may be more usefully envisaged as a continuum of analysis. Thus, memory, too, is viewed by this approach, as a continuum from the transient products of sensory analysis to the highly durable products semantic associative operations (Craik & Lockhart, 1972).

The levels-of-processing view point provides an account of the result of many incidental learning studies (Hyde and Jenkins, 1973; Schulman, 1974) in which semantic analysis of the material is associated with high levels of retention. The idea studies in which greater atte (Triesman, 1964) and studies have shown retention of end and the subjects expectation (1)

The level-of-processing or (1) process of reconstruction, can be described as process in of the event is reconstructed reconstruction is guided and on one hand and information fro second retrieval method, some held and recent episodic trace feature.

In postulating two mod argued ‘all encoded events are system but that some traces 1 not distinctive but similar to events of this type can be re scanning operation. Events fashion may be accessed by (2)

It seems, therefore, use recognition in the contex of 1 has been undertaken to test manipulating the levels throw of Craik and Lockhart’s appr

Problem
Is recall and recognition

Hypothesis
The amount of recall a level and lowest at structural

DESIGN
Each subject was tested level, i.e., within subject de

Material
Three list for three following way:

(a) Structural Level
A list of 20 concrete that the stimulus member
Recall and Recognition as A Function of...

levels of retention. The idea can also be applied to divided attention studies in which greater attention is associated with longer retention (Triesman, 1964) and studies of serial-position effect in free recall, that have shown retention of end-of-list items to vary with processing demands and the subjects' expectations (Craik; 1970; Jacoby and Goolkasian, 1973).

The level-of-processing approach suggested two models of retrieval, (i) process of reconstruction, and (ii) scanning operations. Recognition can be described as process in which some approximation to initial encoding of the event is reconstructed in the perceptual/cognitive system. The reconstruction is guided and constrained by the recognition stimulus on the one hand and information from the episodic trace on the other. In the second retrieval method, some salient aspect of the probe information is held and recent episodic traces are scanned for the presence of the salient feature.

In postulating two modes of retrieval, Lockhart, Craik and Jacoby argued 'all encoded events are equally durable — traces are not lost from the system but that some traces become impossible to access because they are new or similar to other events.' Thus only very recent events of this type can be retrieved and they are accessed by means of the scanning operation. Events which are encoded in a richer, semantic fashion may be accessed by either retrieval mode.

It seems, therefore, useful to study the phenomenon of recall and recognition in the context of level of processing. The present investigation has been undertaken to test the recall and recognition performance by manipulating the levels through instructions, and hence to verify the claims of Craik and Lockhart's approach of 'levels of processing':

**Problem**

Is recall and recognition affected by the depth of encoding?

**Hypothesis**

The amount of recall and recognition will be highest at semantic level and lowest at structural level.

**DESIGN OF THE EXPERIMENT**

Each subject was tested for recall and recognition both and at each level, i.e. within subject design was used.

**Material**

Three lists for three levels of processing were prepared in the following way:

(a) **Structural Level**

A list of 20 concrete word pairs was prepared in such a manner that the stimulus member of each pair was written in upper case...
letters and-to-be remembered (TBR) members were written in 1" upper case letters. Both the members of the remaining ten pairs were 1" upper case letters.

(b) Phonemic Level

In this list, for half of the pairs both the members of the pairs were rhythmically similar e. g. CAT-BAT, while the members of a pair, among the remaining pairs were phonemically dissimilar i. e. they did not rhyme with each other, e. g. BOAT-GIRL.

(c) Semantic Level

The third list was prepared from words belonging to five categories i. e. animals, clothing, furniture, sport goods and modes of transportation. In this list both the members of ten pairs were from the same category, e. g. PANT-FROCK. The members of remaining ten pairs were from different categories, e. g. Gloves-Monkey.

Twenty different words for each list were used as distractors or lures for recognition test.

Subjects

Thirty post-graduate and undergraduate students of both sexes participated in the experiment.

Instructions

Once the subjects were settled down in the experimental room, the following instructions were given to them:

"You will be shown certain pairs of words for a very brief duration. Later on you will be tested for the memory of right hand side words. Each word or picture of the pair can help you in memorizing the right hand side word of the pair. A ready signal will be given to you before the presentation of each pair. On seeing the pair you should say "same" or "different" on the basis of size of letters, rhyme of words or category of items respectively. Immediately after the presentation of a complete list you will be required to cancel the vowels from an English newspaper. You will continue this activity till you are asked to stop."

"Immediately after the cancellation task, you will again be presented the right hand side items of the pairs presented to you previously along with certain new items, once at a time. On presentation of an item if you feel that the item is one which was presented to you previously, you should say 'old', in case you feel, it is a new item and was never presented to you before, by me, then say "new". You are also required to give me your confidence of judgement on a six point rating scale, which will be placed in front of you throughout the experiment."

"After this test phase you have to cancel the Hindi letters ए, ओ, ए औ and ए from a Hindi newspaper till you are asked to stop."

"After this second cancelation task you will be shown the item you have seen at the beginning of the list and asked to say 'old' if you remember it or 'new' if you do not."

The same instructions for the structural level, phonemic level were presented. Each subject was tested for three conditions in each condition.

Each subject was tested with five phases. First in the stimulus phase one of the two members of the pair was shown for 200 ml. sec. With the subject was required to give the other two members of the pair under the structural process conditions whether the word had been 'different' or 'same'. Under the condition of the set two words of the pair belonged to the same or different categories.

The pairs were presented at a rate of five second intervals. Ten seconds were required to complete the list.

Immediately after the presentation of the previously presented members of the pair the new members were presented. The subject was required to give his confidence of judgement which was placed in front
embers were written in 1" upper
tuning ten pairs were 1" upper

oth the members of the pairs
, while the members of a pair, rically dissimilar i. e. they did

Is belonging to five categories goods and modes of transpor-
ten pairs were from the same
bers of remaining ten pairs
es-Monkey
ere used as distractors or lures
uate students of both sexes

in the experimental room, the
words for a very brief duration.
of right hand side words. Left
help you in memorizing the
ady signal will be given to you
ring the pair you should say
of letters, rhyme of words or
ly after the presentation of a
the vowels from an english
ill you are asked to stop.

a task, you will again be
pairs presented to you previo
ime. On presentation of an
is presented to you previously,
a new item and was never
new". You are also required
on a six point rating scale,
out the experiment.”

cancel the Hindi letters
till you are asked to stop.”

“After this second cancellation task you will be presented the left
hand side item of the pairs shown to you at the beginning of the experi-
ment on seeing the item you have to tell me the corresponding right hand
side item, i. e. you have to complete the pair as it was shown to you in
the first presentation. If you do not remember the item, then say ‘do not
know’.

The same instructions were given for each level-of-processing i. e.
structural level, phonemic level and semantic level.

PROCEDURE

The experiment was conducted in a semi-dark room. The subjects
were presented the word pairs after giving them specific instructions for
each of the three conditions.

Each subject was tested individually. The experiment consisted of
five phases. First in the study phase, twenty pairs were presented one by
one for 200 ml. sec. With the help of camera shutter tachistoscope. The
subject was required to give his judgement response (same or different)
about the two members of the pairs presented to him. For word pairs,
under the structural processing condition, subjects were required to give
judgement whether the words of the presented pair were of the ‘same’ or
‘different’ size. Under the phonemic processing condition the subjects
were asked to indicate whether the words of the pair had ‘same’ or ‘dif-
frent’ rhymes. Under the semantic processing condition, the subjects had
to give judgement on the basis of categorical similarity, i. e. whether the
two words of the pair belonged to the same or different categories.

The pairs were presented with camera shutter tachistoscope. Expos-
ure time for stimulus material was 200 ml. sec. The interpair presenta-
tion time was five seconds. The responses of subjects were noted down on
a printed sheet by the experimenter.

Immediately after the presentation of all the pairs the subject was
told to perform a quite different activity i. e. to cancel the vowels from an
english newspaper to prevent rehearsal. The cancellation work continued
for a minute. After that subjects were presented the right hand side items
of the previously presented pairs (during study phase) randomly intermixed
with twenty new items. The subjects were asked to recognize the ‘old’
and the ‘new’ items. This constituted the third phase of the experiment
(Recognition test phase). Each item in the test phase remained on the
screen till the subject gave his judgement. Subjects were required to give
their confidence of judgement (‘old’ or ‘new’) on a six point rating scale,
which was placed in front of them throughout the duration of test phase.
The rating scale used is shown below:

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very</td>
<td>Certain</td>
<td>Old</td>
<td>New</td>
<td>Certain</td>
<td>new</td>
<td>Very</td>
</tr>
<tr>
<td>Certain</td>
<td>Old</td>
<td></td>
<td>New</td>
<td>Certain</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Old</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>new</td>
<td></td>
</tr>
</tbody>
</table>

The recognition judgement expressed by the subject as 'old' or 'new' for each item was recorded along with the confidence rating given by him/her.

The fourth phase again started with a cancellation task. Immediately after the recognition test was over, the subject was asked to cancel five Hindi letters from a Hindi newspaper i.e. य, र, र, र, र, and र. This task was also continued for a minute.

After this activity 'S' was finally given a cued recall test. The left hand side items of the twenty pairs (which has been presented in the study phase) were presented one by one on the screen, and subjects were asked to utter the corresponding right hand side item to complete the pair, as it has been presented to them during the study phase. This constituted the fifth phase of the experiment (Cued recall test).

RESULTS

The results of the present experiment are summarized in the following tables:

**TABLE 1**

**Showing mean, S. D. and S. E. for recall and recognition performance at three levels**

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Mean</th>
<th>S. D.</th>
<th>S. E. M.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural level</td>
<td>16.50</td>
<td>1.55</td>
<td>.52</td>
</tr>
<tr>
<td>(Recall)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phonemic level</td>
<td>17.00</td>
<td>1.28</td>
<td>.43</td>
</tr>
<tr>
<td>(Recognition)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Semantic level</td>
<td>17.30</td>
<td>2.21</td>
<td>.74</td>
</tr>
<tr>
<td>(Recognition)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Structural level</td>
<td>2.7</td>
<td>1.68</td>
<td>.56</td>
</tr>
<tr>
<td>(Recall)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phonemic level</td>
<td>7.4</td>
<td>2.42</td>
<td>.81</td>
</tr>
<tr>
<td>(Recall)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Semantic level</td>
<td>5.7</td>
<td>2.33</td>
<td>.78</td>
</tr>
<tr>
<td>(Recall)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Showing significance of different levels of recog**

**Conditions**

(a) Structural V/S Semantic
(b) Structural V/S Phonemic
(c) Phonemic V/S Semantic

**Recall**

(a) Structural V/S Semantic
(b) Structural V/S Phonemic
(c) Phonemic V/S Semantic

**TAI**

**Summary of An**

<table>
<thead>
<tr>
<th>Sources of Variance</th>
<th>Sum of Squares</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Measures</td>
<td>1674.83</td>
</tr>
<tr>
<td>(Recall &amp; Recognition)</td>
<td></td>
</tr>
<tr>
<td>Between Levels</td>
<td>39.43</td>
</tr>
<tr>
<td>Interaction</td>
<td></td>
</tr>
<tr>
<td>Levels &amp; Measures</td>
<td>367.22</td>
</tr>
<tr>
<td>Within groups</td>
<td>425.50</td>
</tr>
<tr>
<td>Total</td>
<td>2507.00</td>
</tr>
</tbody>
</table>

**Showing recognition hits 'd' and 'h'**

<table>
<thead>
<tr>
<th>Levels</th>
<th>Recognition</th>
<th>Hits</th>
<th>F. A.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural level</td>
<td>.83</td>
<td>.20</td>
<td></td>
</tr>
<tr>
<td>Phonemic level</td>
<td>.85</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>Semantic level</td>
<td>87</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

**DISCUSSION AN**

The phenomenon of higher recall can be explained in terms of...
Recall and Recognition as A Function of...

TABLE 2
Showing significance of difference between mean of three levels of recognition and recall

<table>
<thead>
<tr>
<th>Conditions</th>
<th>'t'</th>
<th>'P'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recognition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Structural V/S Semantic</td>
<td>.88</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>(b) Structural V/S Phonemic</td>
<td>.75</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>(c) Phonemic V/S Semantic</td>
<td>.35</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Recall</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Structural V/S Semantic</td>
<td>2.88</td>
<td>&gt;.05</td>
</tr>
<tr>
<td>(b) Structural V/S Phonemic</td>
<td>4.80</td>
<td>&gt;.01</td>
</tr>
<tr>
<td>(c) Phonemic V/S Semantic</td>
<td>1.50</td>
<td>&lt;.05</td>
</tr>
</tbody>
</table>

TABLE 3
Summary of Analysis of Variance

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>'F' Ratios</th>
<th>'P'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Measures</td>
<td>1674.83</td>
<td>1</td>
<td>1674.83</td>
<td>212.54</td>
<td>.01</td>
</tr>
<tr>
<td>(Recall &amp; Recognition)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Levels</td>
<td>394.43</td>
<td>2</td>
<td>197.33</td>
<td>2.50</td>
<td>.05</td>
</tr>
<tr>
<td>Interaction</td>
<td>367.22</td>
<td>2</td>
<td>183.61</td>
<td>23.30</td>
<td>.01</td>
</tr>
<tr>
<td>Levels &amp; Measures</td>
<td>425.50</td>
<td>54</td>
<td>7.88</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within groups</td>
<td>2507.00</td>
<td>59</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TABLE 4
Showing recognition hits, cued recall, false alarm, d' and 'β' values

<table>
<thead>
<tr>
<th>Levels</th>
<th>Recognition Hits</th>
<th>Cued Recall</th>
<th>d'</th>
<th>'β' values range.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural level</td>
<td>.83</td>
<td>2.7</td>
<td>1.86</td>
<td>1.69 to .51</td>
</tr>
<tr>
<td>Phonemic level</td>
<td>.85</td>
<td>7.4</td>
<td>1.87</td>
<td>1.88 to .47</td>
</tr>
<tr>
<td>Semantic level</td>
<td>.87</td>
<td>5.7</td>
<td>2.41</td>
<td>2.98 to .28</td>
</tr>
</tbody>
</table>

DISCUSSION AND CONCLUSIONS
The phenomenon of higher recognition and recall at semantic level can be explained in terms of 'richness' of encoding (Lockhart, Craik and
When an item is encoded at semantic level, the larger number of features are first analyzed at input and then laid down in the episodic trace, thereby giving ‘richness’ of encoding at semantic level. Whereas the number of features analyzed at phonemic and structural levels are lesser than at semantic level, consequently the retrieval of an item encoded at semantic level become easier, hence the ‘hit’ rate is maximum at this level.

The difference between mean recall of structural and phonemic level was found significant at 0.01 level of significance.

The mean recall at phonemic and semantic level do not differ significantly (‘t’=1.50). It is due to richness of encoding.

The higher amount of recall at phonemic level then semantic level may seem to some strange one. But, when viewed in the background of memory characteristics, it seems to be quite plausible. As STM is mainly echoic. Moreover Indian subjects are more fond of rhythmic conversation, music and poetry.

The results of analysis of variance shows that main effect (measures of retention) is significant at 0.01 level of significance. The effect is in line with established results. It is well known and well documented that recognition is always better than recall.

The interaction effect was also found significant at 0.01 level of significance (F=23.30, df=2.54). This results also support the findings of poorer recall at structural level and higher recall at phonemic and semantic level. It means that memory performance is effected by levels of encoding. Henceforth, supporting the notion of levels-of-processing.

S.D.T. analysis reveals that subjects were operating at higher range of criteria and were less sensitive in responding as revealed by higher d’ value at semantic level. The performance at semantic level was better than phonemic level and structural level as is apparent from the false alarm rate (10). These results also confirm the assumptions of levels of processing approach as suggested by Craik and Lockhart (1972) and Lockhart, Craik and Jacoby (1976).

When the data were analyzed separately for ‘yes’ and ‘no’ responses the performance on all the three levels were better for ‘yes’ responses, as compared to ‘no’ responses. The higher level of retention associated with positive responses is attributed to greater congruity between the event and its coding context (Craik and Tulving, 1975, 1975; Craik, 1977). The effect of this congruous relationship is more important at semantic level, because the pre-existing relations in semantic memory. This underlies congruity, facilitate reconstructive retrieval (Craik and Tulving, 1975, pp. 91-992). This is why greater amount obtained at semantic level.

On the basis of the above discollaboration or depth of processing fa recall in similar manner.

REFERENCE

Craik, F. I. M. and Lockhart, R. S. Frame-work for memory research 684.
Lockhart, R. S.; Craik, F. I. M. and ccessing, recognition and recall.ognition London; Wiley.
Recall and Recognition as A Function of...

93

This is why greater amount of recall and recognition was obtained at semantic level.

On the basis of the above discussion it can be concluded that trace elaboration or depth of processing facilitate retrieval in recognition and recall in similar manner.

REFERENCES


Psycho-lingua


* Department of Psychology, (India)