CHAPTER VI

RESULTS AND DISCUSSION

6.1 Structure of memory abilities

In the previous chapter, statistical analysis of the data collected through administration of different kinds of memory tests has been presented. Let us now discuss the findings in the light of other investigations conducted along similar lines. Psychological literatures are replete with nomenclatures for various types of human memory to propose convenient distinctions between one type and another. Some names have been ascribed after the kind of sensation or combination of sensations with which they are associated, some after the materials to be put into memory, some after the various past experiences of the organism, while some others have been named to signify the memory-processes. Thus, there are differentiations between memories like visual versus auditory, design versus story, personal versus impersonal, short term versus long term, logical versus rote, and many more unmentionable. Obviously, complete enumeration of the types of memory will make out a good long list.
Such classifications are helpful in delimiting an area over which empirical researches can be directed to establish, refute or to re-establish some general truths about it. But when a good number of seemingly related types are involved, findings become more meaningful, parsimonious, and viably structured when they are made in relation to the common relation(s) or order(s), if any, underlying the types involved.

Naturally, the question crops up: Do different types of memory have any underlying relations or orders? In other words, is memory unitary or many? This is vitally important in connection with the study of the nature of memory in general, and its implications in the teaching-learning and reproductive activities in particular. Several studies are there to establish more than one memory. Reference has already been made to some of them in Chapter XII and they will again be referred to, as and when necessary, in course of discussing the findings of the present study.

The present study considers memories for story ($T_1$), sentence ($T_2$), design ($T_3$) and digit ($T_4$). The retained Centroid Factor Solutions of their Inter-corrrelations (cf Table VC-3) is given in Table VI-1a, and the criteria for extraction of sufficient number
of factors are given in Table VI-1b.

**TABLE VI-1a Centroid Solution for the Four Memories**

<table>
<thead>
<tr>
<th>TEST</th>
<th>COMMON FACTORS</th>
<th>COMMUNALITY ESTIMATES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>T₁</td>
<td>.598</td>
<td>.130</td>
</tr>
<tr>
<td>T₂</td>
<td>.702</td>
<td>.039</td>
</tr>
<tr>
<td>T₃</td>
<td>.378</td>
<td>-.340</td>
</tr>
<tr>
<td>T₄</td>
<td>.266</td>
<td>.283</td>
</tr>
</tbody>
</table>

**TABLE VI-1b Criteria for Sufficient Factors**

<table>
<thead>
<tr>
<th>FACTORS</th>
<th>TUCKER'S PHI</th>
<th>HUMPHREY'S RULE</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>.218</td>
<td>.4198</td>
</tr>
<tr>
<td>II</td>
<td>.507</td>
<td>.0429</td>
</tr>
<tr>
<td>III</td>
<td>.721</td>
<td>.0309</td>
</tr>
<tr>
<td>Criterion Value</td>
<td>.6</td>
<td>.1414</td>
</tr>
</tbody>
</table>

Factor I is found to be significant with respect to both the criteria, viz., Tucker's phi and Humphrey's rule, that have been employed to judge sufficiency of extraction of the possible number of significant factors, (Table VI-1b).
Factor II is significant according to Tucker's Phi, but Humphrey's rule suggests to the contrary. The sample considered, however, is not normal; so it can be expected that Factor II will be significant for larger and sufficiently normal samples. The number of significant factors is accordingly taken to be two and the first two factors are retained for discussion. Table VI-1c shows the Varimax Solution of Table VI-1a.

**TABLE VI-1c. Varimax Solution for the Four Memories**

<table>
<thead>
<tr>
<th>TEST</th>
<th>COMMON FACTORS</th>
<th>VARIANCE EXPLAINED</th>
<th>VARIMAX CRITERION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I*</td>
<td>II**</td>
<td>I</td>
</tr>
<tr>
<td>T₁</td>
<td>.523</td>
<td>-.317</td>
<td>.2735</td>
</tr>
<tr>
<td>T₂</td>
<td>.536</td>
<td>-.455</td>
<td>.2873</td>
</tr>
<tr>
<td>T₃</td>
<td>.040</td>
<td>-.507</td>
<td>.0016</td>
</tr>
<tr>
<td>T₄</td>
<td>.388</td>
<td>.022</td>
<td>.1505</td>
</tr>
</tbody>
</table>

* Rote Memory ** Logical Memory

Both the factors are present in memories for story and sentence (Table VI-1c). Factor I is present in memory for digits and is practically absent in memory for design, while Factor II is present in memory for design and is practically absent in memory for digits. This seems to account for the nonsignificance of $r_{34}$ (Table VC-7). Moreover, design ($T₃$) leads Factor II, and sentence ($T₂$) leads Factor I. These indications are of vital importance.
in determining the nature of the two factors. Obviously the question arises, what critical properties the memories for story and sentence have in common with the memory for design on the one hand, and with the memory for digits on the other?

Tulving (1972)\(^1\) has recently reviewed the critical properties of different memory phenomena prevalent in memory research and has identified two types of memory; the episodic memory and the semantic memory. According to him episodic memory has autobiographical information with particular modes or context of learning; on the other hand semantic knowledge is free from autobiographical reference or particular context or mode of learning. It constitutes part of the long-term memory (sometimes called the secondary memory). It comprises that part of organised and permanent human knowledge which is expressed in words and other verbal symbols. It is, thus, all of systematic human thoughts, concepts, and rules and strategies for actions and problem solving expressed in language. Obviously, from the view point of experimental contexts the memory materials considered in the study, like nearly all laboratory researches on

\(^1\) In Tulving & Donaldson (Eds) - Organisation of Memory, pp 385 - 386.
memory, are episodic even if the subjects make use, in encoding or learning, of the knowledge in the semantic thesaurus.

Workers in the area of human memory mention other two types of memory which are short-term memory (sometimes called primary memory or immediate memory), and mental imagery or imagination or visualization. "Short-term memory is usually small in capacity, short in duration (a matter of seconds, though capable of longer holding through rehearsal), and encoded, at least insofar as verbal material goes, auditorily" (Levie and Dickie, 1973). Mental imagery is encoding in memory of information in a spatial context through vision. It is distinguished from the verbal system in that the imagery system deals "with information presented simultaneously, in parallel, from different sources distributed in space, whereas the verbal system would appear specialized for dealing with information presented sequentially, in series, from sources distributed over time. In brief the imagery system (particularly visual imagery) represents information as distributed in space, whereas the verbal system deals best with information distributed in time" (Hilgard and Bower, 1977). Obviously, it can be

said about the memory types considered in the present study that $T_1$ (Story) and $T_2$ (Sentence) belong to the semantic type; $T_3$ (Design) is of visual imagery type; and $T_4$ (Digits) is of short-term memory type; $T_4$ is also of rote memory type.

Modern cognitive psychologists are in favour of information processing (IP) or computer simulation approach to theorizing human knowledge. The computer simulation theories of behaviour postulate the existence within the organism of computer-like information processing mechanisms. These mechanisms are taken to be organized and sequenced in a particular way, and each has a certain elementary function to perform. Stimuli, data, and instructions are 'input'. They have the generic name 'information'. The response is the 'output'. The IP "models attempt to portray and understand the behavior of man when he is using his rational capabilities to the utmost" (Hilgard and Bower, 1977)\(^4\). Studies in this area are rather in the formative and groping stages but they constitute the most seminal, if not the dominant, force in contemporary experimental psychology with particular reference to human memory and attention. Currently there are two major computer simulation

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4. Op cit. P 431
approaches for representing semantic knowledge: labeled graph structure (Rumelhart et al. 1972)\textsuperscript{5} and decision routine (Winograd, 1972)\textsuperscript{6}. Psychologists are more attracted by the former than the latter. This approach is of particular importance in the present piece of study too, in connection with the structure of memory materials especially sentence, story and design.

This approach represents knowledge as a network of labeled semantic relationships between universal concepts or individuals, "Networks of labeled relations among semantic concepts are not really all that different from the earlier notion of the British associationists regarding how 'complex ideas' were to be built up by associating simpler ideas together. What differs in modern accounts is, first the notion of labeling of the association with the logical (or semantic) type it exemplifies; and, second, the notion that a complex idea need have no direct correspondence to an observable stimulus or response, and yet can still be represented as a single unit in memory, a unit about which further information can be predicted" (Hilgard and Bower, 1977)\textsuperscript{7}.

\begin{itemize}
\item \textsuperscript{5} In Tulving & Donaldson (Eds) - Organization of Memory.
\item \textsuperscript{6} Winograd, T. - Understanding natural language cognitive psychology 3, 1972, pp 1 - 191.
\item \textsuperscript{7} Hilgard & Bower, p 598.
\end{itemize}
A concept is roughly analogous to an idea; it pertains to a general class or type; it has one or more distinguishing features in relation to other concepts. The number of properties, subordinates, and superordinates of a concept can be extended indefinitely. A realistic memory may consist of many thousands of such elementary concepts, each connected with many others with some labels, and as such, the amount of information it conveys is encoded in a labeled graph structure. Second order concepts are built up from more elementary ones by the rules of qualification, quantification, location and conjunction (Rumelhart et al, 1972). A sentence is a preposition or an event expressed in language. It is action based; it denotes a scenario with agents, action, and objects. It is based on a set of some elementary and second order concepts on the one hand, and on a syntax that specifies how the different elementary and/or second order concepts-words will be related to make the symbolic representation of the proposition on the other. The information structure of an event can then be assumed to be 'hinged on' some already known concepts of memory. To put it otherwise, any new propositional information or event is simply a new set of temporary logical or meaningful associations or labelled connections between

8. Tulving & Donaldson (Eds) - Organization of Memory.
some pre-existing concepts. Moreover, linguistic representation of an event requires fitting properly of verbal concept-symbols into the syntactic structure of a language which comprises a set of rules, more discrete than organised. Thus, there seem to be two aspects involved in a sentence: (1) the meaningful or logically associative part of the information expressed; and (2) the syntactic part inherent in the structure of the sentence. This dual nature of memory for sentence is corroborated by the presence of two facts, one associated with design and the other with digit, in the present study, even though the sentence is a meaningful one.

In such representational systems, an event, when encoded, can be treated as a unit so that predications or comments can be made about it. "Also propositions can enter into propositional conjunctions, by the use of connectives like and, then, while and causes. Thus, a sequence of events, as contained for instance in a story, would be recorded in memory as a chain of propositional events of the general form, "event 1, then (event 2 while event 3) cause event 4, then event 5 ....". Thus in a story too, there can be supposed a meaningful or logically associative aspect together with a syntactic one inherent

in the structure of the propositions as well as in the sequence of the propositions involved. This is also evidenced by the presence of the two factors as pointed out above.

Information processing approach for representing knowledge of pattern or design also proposes the principles of 'labeled graph structure' quite analogous to the representation of semantic knowledge. Labeled networks of lower-level pattern concepts build up intermediate level concepts, which, in their turn, simplify description of a complex pattern or higher order concept which is thus constructed out of relations between lower-level and/or intermediate-level concepts (Winston, 1970). When an organism is exposed to a pattern, the pattern in its entire spatial context seems to be stored in his memory rather in the form of a description of meaningful associations of various parts each representing some type of concept. In digits, however, barring some familiar combinations, no such meaningful associations can hardly be made, and as such, associations between them are made through reinforcement.

The foregoing discussions on the nature of the memory materials show that a pattern, a sentence, and a story

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10. Winston - Learning structural descriptions from examples.
have structural unity in that they each represent meaningful association or organization of concepts, imaginal in nature; whereas a sentence, a story and digits have some form of unity in them in that they each represent association of discrete concepts rather abstract in nature (in the form of syntactic structure, seriality of ideas, digits etc.) the memorization of which is characterized by rote learning. Thus we can name our first factor (Table VI-1c) as Discrete or Rote memory, and the second factor as Logical or meaningful memory. This view is corroborated by the varimax solution of the four memories and intelligence (I) (Table VI-2a), where intelligence leads the first group factor involving design, sentence, and story. This factor corresponds to the group factor of Logical memory in Table VI-1c having the highest loading in design. The second group factor (Table VI-2a) corresponds to group factor of Discrete memory.

**TABLE VI-2a Varimax Solution for the Four Memories and Intelligence (cf. Table VC-5)**

<table>
<thead>
<tr>
<th>TEST</th>
<th>COMMON FACTORS</th>
<th>VARIANCE EXPLAINED</th>
<th>VARIMAX CRITERION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I*</td>
<td>II**</td>
<td>I</td>
</tr>
<tr>
<td>T1</td>
<td>.356</td>
<td>-.520</td>
<td>.1267</td>
</tr>
<tr>
<td>T2</td>
<td>.309</td>
<td>-.620</td>
<td>.0955</td>
</tr>
<tr>
<td>T3</td>
<td>.494</td>
<td>-.070</td>
<td>.2440</td>
</tr>
<tr>
<td>T4</td>
<td>.005</td>
<td>-.355</td>
<td>.0000</td>
</tr>
<tr>
<td>I</td>
<td>.532</td>
<td>-.173</td>
<td>.2830</td>
</tr>
</tbody>
</table>

* Logical Memory  ** Rote Memory.
Factors obtained in this study fairly corroborate those obtained by Smith and McDougall (1920) who "claimed ... to substantiate Bergson's distinction between habit and meaningful memory" (Vernon, 1964).

The discrete or rote memory group factor of this study fairly affirms the rote memory group factors obtained respectively by Thurstone (1938, 1940), Thurstone and
Thurstone (1941), Woodrow (1939), Carroll (1941), Wittenburn (1943), Taylor (1947), and others. Holsinger (1938) demonstrated a group factor in immediate memory span for words, sentences, digits and pictures. The logical memory factor of this study corresponds to the 'Simultaneous' group factor (Das and Molloy, 1975) obtained among Raven's Progressive Matrices figure copying, memory for designs, cross modal coding, and performance I.Q. the highest loading being on the Raven's Progressive Matrices which is a widely used culture fair test of reasoning ability. Our rote memory factor corresponds to their 'successive' group factor found among visual short-term memory (digit in nature), serial recall, free recall, and digit span (forward), the highest loading being in serial recall. Das and Molloy (1975) found these factors for grade 4 children (our grade 6 children) in connection with studying 'simultaneous' and 'successive' processing in children (different from the context of our study). But they indicate that the above two and the 'speed' of processing are viable individual difference variables. They all lead us to decide over the issues as below:

(a) Is there any common relation among different kinds of memory?

The answer is in the negative; however, a common relation exists among memories of similar materials. Thus we have no Spearman's 'g' entering into all kinds of memory but we have group factors running through materials of similar nature (Table VI-1c).

(b) Is memory unitary or many?

The present study asserts two memories. It corroborates partially Ingham's (1949) conclusion that 'g' enters "into all memory activities, particularly when the material is meaningful, and a fairly broad rote memory factor can be recognized in addition" (Vernon, 1964). It concludes that 'g' enters into all meaningful memory activities which define the group factor of Logical or Meaningful memory and that there is a fairly broad Rote memory group factor in quite consonance with Bergson's Meaningful and Habit Memories (cf. Tables VI-1c, VI-2a).

(c) Is memory for a meaningful sentence integrative or associationistic?

Anderson and Bower (1972, 1973) have recently made a contrast between a Gestalt and an 'elementaristic' analysis of the memory of a meaningful sentence and

"favoured an associationistic analysis, subject to certain constraints" (Hilgard and Bower, 1977).\textsuperscript{15}
Smith and McDougall (1920) found both the meaningful and habit memories involved in a prose test.\textsuperscript{16} The present study also corroborates this finding, but the discrete or rote memory explains the major part of its communality. It accounts for .2873 out of .494 (Table VI-1), the communality of the test for sentence-memory when considered among the other three memories. It explains .3844 out of .480 of the same when considered among the memories along with intelligence (Table VI-2); and the figure is .4013 out of .4725 when all the memories along with intelligence (I) and scholastic achievement (T) are considered (Table VI-3).
On the other hand, the part of the variance which meaningful memory explains decreases from context to context; the corresponding figures are .2070 (Table VI-1c), .0955 (Table VI-2a), and .0712 (Table VI-3). Thus, when associated with more logical or meaningful materials the variance of meaningful sentence-memory is more explained by the Rote factor (58\% to 85\% of the communality, and 29\% to 40\% of the total variance) than by the logical factor. In other words, it is liable to be

\textsuperscript{15} Op. cit. p 280.
\textsuperscript{16} Vernon, 1964.
more associationistic than Gestalt or integrative in character, and thereby corroborates Anderson and Bower (1973)\(^{17}\) at least for the sample under study.

**TABLE VI-3a Varimax Solution for Memories, Intelligence and Scholastic Achievement**

<table>
<thead>
<tr>
<th>TEST</th>
<th>Common Factors</th>
<th>Variance Explained</th>
<th>Varimax Criterion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I*</td>
<td>II**</td>
<td>I</td>
</tr>
<tr>
<td>(T_1)</td>
<td>.333</td>
<td>-.524</td>
<td>.1109</td>
</tr>
<tr>
<td>(T_2)</td>
<td>.267</td>
<td>-.633</td>
<td>.0712</td>
</tr>
<tr>
<td>(T_3)</td>
<td>.445</td>
<td>-.063</td>
<td>.1979</td>
</tr>
<tr>
<td>(T_4)</td>
<td>.031</td>
<td>-.336</td>
<td>.0010</td>
</tr>
<tr>
<td>I</td>
<td>.647</td>
<td>-.148</td>
<td>.4181</td>
</tr>
<tr>
<td>T</td>
<td>.649</td>
<td>-.251</td>
<td>.4209</td>
</tr>
</tbody>
</table>

* Logical Memory  ** Rote Memory.

**TABLE VI-3b Centroid Solution for Memories, Intelligence, and Scholastic Achievement**

(em of TABLE VC-6)

<table>
<thead>
<tr>
<th>TEST</th>
<th>Common Factors</th>
<th>Communality Estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I*</td>
<td>II</td>
</tr>
<tr>
<td>(T_1)</td>
<td>.593</td>
<td>-.185</td>
</tr>
<tr>
<td>(T_2)</td>
<td>.613</td>
<td>-.311</td>
</tr>
<tr>
<td>(T_3)</td>
<td>.411</td>
<td>.203</td>
</tr>
<tr>
<td>(T_4)</td>
<td>.241</td>
<td>-.236</td>
</tr>
<tr>
<td>I</td>
<td>.589</td>
<td>.305</td>
</tr>
<tr>
<td>T</td>
<td>.657</td>
<td>.228</td>
</tr>
</tbody>
</table>

\(^{17}\) Op. cit.
<table>
<thead>
<tr>
<th>Factors</th>
<th>Tucker's Phi</th>
<th>Humphrey's Rule</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>.234</td>
<td>.402</td>
</tr>
<tr>
<td>II</td>
<td>.602</td>
<td>.095</td>
</tr>
<tr>
<td>III</td>
<td>.525</td>
<td>.086</td>
</tr>
<tr>
<td>IV</td>
<td>.591</td>
<td>.054</td>
</tr>
<tr>
<td>Criterion Value</td>
<td>.714</td>
<td>.1414</td>
</tr>
</tbody>
</table>

(d) Is memory for a story integrative or associationistic?

The calculated communality estimates of $T_4$ (story) in the three test combinations are respectively .374, .397 and .3859 (Tables VI-1, VI-2, VI-3), of them .1005, .1267, and .1109 are respectively due to the Meaningful memory factor, and the remaining parts are due to the Rote memory factor. Obviously, roughly about 35% of the variance of the memory for story due to the two memory factors (which is roughly about 38% of the total variance) is due to the Logical factor, and the remaining 65% is due to the Rote factor. Thus, memory for a story is more associationistic than integrative in character, but it is less associationistic and more integrative than a sentence memory at least for the sample under consideration.
(e) Is memory for design or for digits integrative or associationistic?

In all the three combinations of tests factor analysis show practically no contribution of the rote memory factor towards the variance of the memory for design. Hence for the age-group with particular reference to the sample used in the present study we can conclude that memory for design is solely integrative and remembered in a chunk.

Arguing similarly, it can be asserted that memory for digits is associationistic and successive reinforcement is necessary for memorization.

(f) Is meaningful memory or rote memory unitary?

The contribution of meaningful memory in accounting for the variances of the memories for story, sentence, design, and intelligence is variable under variable test-combinations (Tables VI-1, VI-2, VI-3). Naturally, it casts doubt whether meaningful memory is unitary or a general name given to a cluster of meaningful memories like general meaningfulness, aesthetic meaningfulness etc., depending on the nature of meaningful memory materials, or this variability is inherent in the nature of the
sample considered. Obviously, this area seems to require further exploration.

Similar doubt also looms heavy on the nature of Rote memory as to whether there are types of roteness and, if so, how they depend on the nature of materials.

6.2 Sex difference in memory, intelligence & achievement

Next, the question is, if there is any sex-difference in memories, intelligence, and total scholastic achievement.

To decide the issue the following null hypotheses are assumed:

1. Boys and girls are not different with respect to memory for story.
2. Boys and girls are not different with respect to memory for sentence.
3. Boys and girls are not different with respect to memory for design.
4. Boys and girls are not different with respect to memory for digits.
5. Boys and girls are not different with respect to total memory.
6. Boys and girls are not different with respect to intelligence.

7. Boys and girls are not different with respect to total scholastic achievement.

The Table VB-6 on the significance of difference between means shows that the hypotheses 1, 2, 3, 6 and 7 are significant at the '01 level while the hypotheses 3 and 4 are not at all significant. Thus, in consequence, the hypotheses 1, 2, 5, 6 and 7 are rejected while the hypotheses 3 and 4 are retained. Moreover, the sign of the significant critical ratios in the mode chosen to calculate the difference between the means (Boys' - Girls') shows superiority of the girls over the boys with respect to the abilities concerned.

Thus for the age group and the samples under consideration, it seems to hold that -

Girls are superior to boys with respect to memories for story, sentence, total memory, intelligence and total scholastic achievement, but they are not different with respect to memory for design and digits.

It is pertinent to note in this context that as the samples are considerably large (100 each for boys and
critical ratio test (Garrett, 1967, p 215) has been used to test the significance of the difference between the means with the SE formula given as -

\[ T_D = \sqrt{\frac{A^2}{N_1} + \frac{B^2}{N_2}} \]

The next question taken up is to ascertain the exact relation between memory and intelligence.

The calculated communality estimates of intelligence (I) in the two test combinations (Tables VI-2, VI-3) are respectively .313 and .4399. Of them .283 and .4181 are respectively due to the Logical memory factor and the remaining parts are due to the Rote factor. Thus, when intelligence is considered exclusively among the four memories (Table VI-2), the two memory factors explain 31% of the total variance of intelligence; they, however, explain 44% of the same variance when total scholastic achievement is included in the test combination. What causes this variation from 31% to 44% requires further exploration as has already been hinted at while discussing the nature of meaningful memory, but the date at hand sufficiently establish that the two memories together play a very significant role in determining one's intelligence by explaining about 31% to 44% of its total variance.
Question naturally arises, Logical or Rote, which memory is more important in the context of intelligence? The figures noted above show that Logical memory explains almost 90% to 95% of the variation in intelligence due to both the memory factors while only 10% or less is accounted for by the Rote factor. In the context of the total variance of intelligence the Logical memory explains 28% to 42% of it while the Rote memory explains only about 3% or less.

Another relevant question may crop up: How do the four types of memories considered in the study contribute to determine intelligence?

The multiple regression of intelligence on the four memories is as below:

\[ Z_1 = .29Z_1 + .02Z_2 + .19Z_3 + .05Z_4 \]

Where \( Z_1 \) = Estimated standard score on Intelligence,
\( Z_1, Z_2, Z_3, Z_4 \) = Respective standard scores on memories 1, 2, 3 and 4, and
\(.29, .02, .19, .05 \) = Respective coefficients.

The equation implies that independent contributions of the memories for story, sentence, design, and digits
in determining intelligence are as .29 : .02 : .19 : .05, i.e. as 29:2:19:5.

Again, the multiple coefficient of correlation is -

\[ R^2_{1.1234} = .29x_{1} + .02x_{2} + .19x_{3} + .05x_{4} \]
\[ = .29 \times .336 + .02 \times .216 + .19 \times .248 + .05 \times .08 \]
\[ = .09744 + .00432 + .04712 + .00435 \]
(It is .154 (Table VI-2b) when computed through inverse matrix; the difference is due to rounding errors).

This shows that 15.3% of the variance of intelligence is attributable to the differences in the four memories under consideration, their respective contributions being 9.7%, .43%, and 4.7% and .43%.

Further, the t-values (df 195) of the corresponding coefficients are 3.82, .26, 2.74 and .74 respectively. Of them only 3.82 and 2.74 are significant (p < .01).

To sum up, we have the following findings for the sample under consideration in regard to the relation between memory and intelligence.

1. Meaningful memory and Rote memory account for together from 31% to 44% of the variation in intelligence.
2. Meaningful memory explains 28% to 42% of the intelligence variance, while Rote memory explains only about 3% or less, i.e. the former contributes some ten or more times as much as the latter, in determining intelligence.

3. The memories for sentence and digits contribute practically nothing towards intelligence; it is significantly contributed to by the memory for design or logically related visual abstract concepts, both of which are labeled graph structures.

The next pertinent issue is to determine the relative influence of different kinds of memory on scholastic achievement.

The calculated communality of total scholastic achievement (T) is .4836 (Table VI-3) of which .4209 is due to Logical memory, and .0628 is due to Rote memory. Thus, memories play a very significant role in determining one's scholastic achievement by explaining about 48% of its total variance. It is, however, conspicuous that meaningful memory accounts for 42% out of this 48% of the variance, while Rote memory accounts for only 6%. Thus, the contribution of Logical memory is seven times as large as that of Rote memory in determining one's scholastic achievement.
The next question arises: How do the four memories considered in the study contribute to determine scholastic achievement?

The multiple regression of total scholastic achievement on the four memories is calculated to be:

$$\overline{z_T} = .27z_1 + .14z_2 + .21z_3 + .09z_4$$

Where $\overline{z_T}$ is the criterion standard score on total scholastic achievement and others bear usual meanings.

The equation implies that independent contributions of memories for story, sentence, design and digits are as 27 : 14 : 21 : 09, i.e. as 27:14:21:9.

Again, the multiple coefficient of correlation can be given as:

$$R^2_{T.1234} = .27z_{T1} + .14z_{T2} + .21z_{T3} + .09z_{T4}$$

$$= .27 \times .343 + .14 \times .32 + .21 \times .292 + .09 \times .142$$

$$= .09261 + .04494 + .06132 + .01278$$

$$= .21165$$

This shows that 21\% of the variance of total scholastic achievement is attributable to the differences in the
four memories under consideration, the respective contributions being 9.26%, 4.49%, 6.13%, 1.28%.

It is pertinent to note in this context that in this analysis the effect of intelligence has not been partialled out.

Further, the t values (df, 195) of the corresponding β coefficients are 3.69, 1.89, 3.14 and 1.38 respectively. Of them only 3.69 and 3.14 are significant (p < .01); 1.89 is significant at .10 and very near the .05 level of significance and can be taken to be almost significant at the level.

To sum up, we have the following findings for the age group and sample under consideration in regard to contribution of memories to scholastic achievement without partialing out the effect of intelligence.

1. Meaningful memory and Rote memory together account for 48% of the variation in scholastic achievement.

2. Meaningful memory contributes seven times as large as Rote memory in determining scholastic achievement. Rote memory contributes only 6% to account for scholastic achievement.
3. The contributions of the memories for story and design and digits in determining scholastic achievement (without partialing out the effect of intelligence) are significant. The contribution of memory for sentence is almost significant but digit memory has no significant contribution towards achievement.

Next comes the issue as to the position of memory and intelligence as determiners of scholastic achievement.

The multiple regression of total scholastic achievement \( T \) on total memory \( M \) and intelligence \( I \) is calculated to be:

\[
Z_T = .30Z_M + .37Z_I
\]

Where \( Z_M \) represents standard scores on total memory and others bear usual meanings.

Again, the multiple coefficient of correlation is calculated to be:

\[
R^2_{T,MI} = .30r_{TM} + .37r_{TI}
\]

\[
= .30 \times .423 + .37 \times .471
\]

\[
= .1269 + .17427
\]

\[
= .30117
\]

The t values of the corresponding \( \beta \) coefficients are
respectively 4.76 and 5.87 both of which are significant (p < .01, df 197). This indicates that each of memory and intelligence contributes significantly towards scholastic achievement.

Hence, in determining scholastic achievement, independent contributions of total memory and intelligence are as .30 : .37, i.e. as 30 : 37; and 30.12% of the variance in scholastic achievement is attributable to the differences in memory and intelligence, the respective contribution being 12.69% and 17.43%.

Furthermore, the multiple regression of total scholastic achievement on the four memories and intelligence is calculated to be:

$$\bar{Z}_T = .13Z_1 + .06Z_2 + 14Z_3 + .07Z_4 + .36Z_I$$

Thus, in determining scholastic achievement independent contributions of the four memories are as .13 : .06 : .14 : .07 : .36, i.e. as 13:6:14:7:36. Owing to partialing out the effect of intelligence the relative contributions of the four memories, viz. 13:6:14:7 deviate from 27:14:21:9 as obtained previously.
Again, the multiple coefficient of correlation is given as below:

\[
R^2_{T.1234I} = .13r_{T1} + .06r_{T2} + .14r_{T3} + .07r_{T4} + .36r_{TI}
\]

\[
= .13 \times .343 + .06 \times .321 + .14 \times .292 + .07 \times .142 + .36 \times .471
\]

\[
= .04459 + .01926 + .04088 + .00994 + .16956
\]

\[
= .28423
\]

Hence, 28.42% of the variance of scholastic achievement is attributable to the differences in the four memories and intelligence. Their respective contributions are 4.46%, 1.93%, 4.09%, 99% (for the memories) and 16.96% (for intelligence). The total contribution of the four memories is 11.46, as against 12.69 obtained above; and that of intelligence is 16.96% as against 17.43% obtained above.

In this case obtained SMC is .2842, whereas it is .3012 as obtained above; and it is .305 as obtained through computation of inverse matrix (Table IV-3). These differences seem to be attributable to rounding errors and also to putting together the different memory scores to obtain total memory.

The corresponding \(t\) values (df 194) of the coefficients
are 1.92, .88, 2.22, 1.12 and 5.39 respectively. Of these 5.39 (p < .01) and 2.22 (p < .05) are significant; and 1.92 is almost significant (t .05 = 1.92, t .10 = 1.66).

Thus, to sum up, we find as follows in regard to relations among memory, intelligence and scholastic achievement for the age group and sample under study:

1. As determiners of scholastic achievement both intelligence and memory are significant and the former is superior to the latter.

2. Intelligence contributes about one and half times as much as memory to cause variation in scholastic achievement (17.43% Vs. 12.69%).

3. Insofar as independent contributions to the determination of scholastic achievement is concerned, intelligence contributes the most, then comes design and story each significantly; whereas sentence and digits contribute non-significantly the least. Design and story contribute almost equally; similarly do sentence and digits. The former pair contributes twice or more as much as the latter. Intelligence contributes almost four times as much as design or story memory.
4. In combination with scholastic achievement meaningful memory is more explained by design (loading .443), then by story (loading .333), the highest loading (.649) being on scholastic achievement (Table VI-3). This seems to have a very important pedagogical importance. The children of the age group under study seem to understand design more meaningfully than stories and as such presentation of meaningful factual materials, if coupled with relevant visual aids or iconic signs will be more meaningfully learned, and will render rich contribution towards achievement. Further investigations seem desirable in this regard. The second important implication is that note memory has its highest loading on sentence (-.633), then on story (-.524), then on digits (-.336), the loading on the scholastic achievement being only -.251. It shows then that although note memory cannot contribute much (only about 6%) towards scholastic achievement the learning of stories, sentences and digits which are sequential by nature, seems to require successive processing or repetition. In other words facts, sequential in nature, require drill for better acquisition; this is especially true for learning
languages. A pertinent issue crops up; does this apply to mother tongue equally well? This area calls for further exploration.

6.3 Some crucial observations

Before passing over to the next chapter, it seems useful to have a glimpse over the nature of the samples and also of the obtained statistics. It is almost universally true that the investigators in the field of social sciences often face considerable difficulties in obtaining a representative sample. This is particularly true for India, and the present investigator is not an exception. She tried to obtain a random sample for the age group under study; she made contacts with several schools in and around Calcutta, but nowhere except four she got assurance of co-operation. Of the four, in two only she received hopeful assurance of active and willing co-operation. Obviously, the investigator had to make a compromise between precision and the limited scope of sampling available by adopting cluster sampling design with the stratification criterion of sex. Properly speaking, it was a sample that can be best labelled as a sample of convenience (Chapter III).

The universe comprised grade VI school children who
usually are of the age group 11+. The sample of the present study comprises 200 children; 100 boys and 100 girls; coming mostly from the higher and/or upper class families. The fact is evident from the findings from the study of socio economic status of parents/guardians of a section of the children as below. The findings are based on Kuppuswamy's SES scale (vide appendix 6) administered on 80% of individuals in the sample (Chapter III):

<table>
<thead>
<tr>
<th>SES CLASS</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>x</td>
<td>52</td>
<td>24</td>
<td>14</td>
<td>10</td>
<td>0</td>
</tr>
</tbody>
</table>

Naturally, the sample represents a segment (and not the whole) of the continuum of socio-economic culture. It is thus not a representative sample with respect to SES. It is not considerably normal too. For each of the characteristics measured it is negatively skewed (though not very badly) most pronounced in the memories for sentence \( T_2 \), and design \( T_3 \) - (Table VC-2). It is moderately leptokurtic for digit memory \( T_4 \) and total scholastic achievement \( T \) and almost mesokurtic for intelligence \( I \). It is platykurtic slightly for
S^ and moderately for Sg and M (total memory).
The samples for boys and girls too, are not considerably normal (Tables IV A-2, VB-2). Moreover for the boys group \( r_{13} \), \( r_{14} \), \( r_{24} \), \( r_{31} \), \( r_{41} \), \( r_{T3} \) and \( r_{T4} \) (Table VA-6) are not significant. For the girls group \( r_{13} \), \( r_{34} \), \( r_{21} \), \( r_{41} \) are not significant (Table VB-6), but for the combined group of the boys and girls (viz., the whole sample) almost all the correlations except \( r_{14} \), \( r_{34} \) and \( r_{41} \) are significant (Table VC-7).

Obviously, an immediate conclusion can be drawn that each population \( r_{14} \), \( r_{34} \) and \( r_{41} \) is zero. But it is seen from Table VI-5 that in only 7% cases \( r_{41} \) deviates.

TABLE VI-5

<table>
<thead>
<tr>
<th>Correlation Symbol</th>
<th>Fisher's Z (Zr)</th>
<th>((Zr - 0)\sqrt{N-3} = Z) *</th>
<th>Area to the left of Z.</th>
</tr>
</thead>
<tbody>
<tr>
<td>( r_{14} )</td>
<td>.128</td>
<td>.129</td>
<td>.035</td>
</tr>
<tr>
<td>( r_{34} )</td>
<td>-.018</td>
<td>-.018</td>
<td>.40</td>
</tr>
<tr>
<td>( r_{41} )</td>
<td>.087</td>
<td>.09</td>
<td>.105</td>
</tr>
</tbody>
</table>

\( N = 200 \)

* Population correlation assumed is zero, by .128 or more from zero, in 21% cases \( r_{41} \) deviates by .087 or more from zero, but in 80% cases \( r_{34} \) deviates by -.018 or more in
magnitude from zero. Thus, it seems, we run the risk most if we ascribe the obtained deviation of $r_{34}$ exclusively to non-representativeness and non-normality of the sample and assume the population $r_{34}$ to be other than zero. Similarly we risk heavily if we conclude that the population values of $r_{14}$ and $r_{41}$ are each equal to zero instead of assuming that they actually represent some low relationships and that the obtained non-significant values (at .05 level) are due to peculiar nature of the sample chosen. Moreover, factor analysis (Tables VI-1, VI-2, VI-3) and other studies in the area reviewed suggest mutual independence of memories for digits and design, the former representing exclusively the Rote and the latter Meaningful. Furthermore, memory for a story and intelligence both involve both the memories, Rote and Meaningful, but not evenly; the Rote is pronounced in story and the Meaningful is in intelligence. But, while the meaningful explains about 35% of the communality of a story (p 94), the rote explains only 10% or less of that of intelligence (p 93). Moreover, digits have very non-significant contribution towards intelligence (p 100). These suggest that $r_{14}$ should be of small magnitude but significantly different from zero, while $r_{41}$ may not differ significantly
from sera. However, replication of the study seems necessary in this regard.

Hence, taking all these into consideration we seem not to be very wrong if we conclude —

1. Memories for design and digits are mutually independent;

2. Memory for digits has a definite but small relationship with memory for a story; and

3. Memory for digits has a very low relationship with intelligence and tends to be independent of it.